INTERACTIVE WHITEBOARD:
Adoption and the Impact of its Utilization on Student Learning in South Australian Secondary Schools

Amrit Pal Kaur

MSc (Hons), BEd (GNDU, Amritsar)
MEd (Science & Technology) (The University of Adelaide)

This thesis is submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy

School of Education
Faculty of Arts
The University of Adelaide

December, 2014

Supervisory Panel:

Dr Igusti Ngurah Darmawan
A/Professor Christopher Dawson

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library catalogue and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Signed: ________________________

Date : ________________________

Contents

List of Figures

Figure	Title	Page

Figure	Title	Page

List of Tables

Table	Title	Page

Table	Title	Page

Table	Title	Page

Abstract

This research study explored the adoption and utilization of Interactive Whiteboard (IWB) technology by teachers and students of secondary schools in South Australia, Australia and investigated the impact of its use on the student learning (learning approaches and quality of learning outcomes). This research was conducted using a mixed method design which was comprised of both the quantitative (predominant) and qualitative (supportive) approaches for collecting and analysing data. Three different survey questionnaires were used for the quantitative phase during which data were collected at school (12), teacher (30) and student (269) levels. Interviews were used to collect qualitative data from 16 teachers.

The school questionnaire had some general questions to collect some information regarding the kind of Information and Communication facilities present at the schools; the teacher questionnaire included four scales which were Attitudes towards ICT (AICT), Attitudes towards IWB (AIWB), Approaches towards Teaching (ATI) and Classroom Interactions using IWB (CIIWB); and the student questionnaire was comprised of five scales which were Attitudes towards ICT (AICT), Attitudes towards IWB (AIWB), Classroom Interactions using IWB (CIIWB), Learning Approaches using IWB (LA) and Learning Outcomes using IWB (LO).

The Cronbach's alpha values and Confirmatory Factor Analysis (CFA) techniques were used to establish the reliability and validity of all these scales. Single Level Path Analysis (SEM) technique was used to examine the relationships among the variables present at teacher and student levels separately. To examine the relationships among the nested variables at three levels (school-teacher-student) and the cross-level interaction effects on the outcome variable, Hierarchical Linear Modeling (HLM) was used. The interview data were hand analysed using open-coding technique.

The findings from the teacher level path analysis revealed that the classroom interaction level of teachers using IWB was positively influenced by their attitudes

towards IWB, the IWB related support they received from schools, their student-focused teaching approach and their age. The results from student level path analysis showed that the students' perceived classroom interactions using IWB were positively associated with their perceived deep learning approach (direct association) and their perceived quality of learning outcomes (indirect association through deep learning approach). Students' attitudes towards IWB also had significant positive influence on their perceived deep learning approach, their perceived classroom interactions using IWB and their perceived quality of learning outcomes.

The three-level (HLM) model of deep learning approach using IWB indicated that perceived classroom interactions using IWB (student-level factor), IWB support (teacher-level factor) and ICT integration level in classrooms (school-level factor) had direct positive influence on their perceived deep learning approach. The three-level model of learning outcomes using IWB revealed that students' perceived learning outcomes when using IWB were directly influenced by their perceived classroom interactions, their attitudes towards IWB, their perceived deep and surface learning approaches, their gender (all student-level factors) and the age of the teacher (teacher-level factor).

Overall, it was evident that the students who had experienced an interactive and enhanced interactive classroom environment using IWB, and those who had more positive attitudes towards IWB tended to adopt a deeper learning approach and the quality of their learning outcomes improved. This association between these important factors provides clear evidence that the IWB technology, when used in an interactive or enhanced interactive way by the teachers and the students, can make the students more inclined towards adopting deeper approach to learning along with improving the quality of their learning outcomes.

The major contribution of this study is in the form of providing the much needed evidence of the impact of the use of IWB on the learning of the secondary school students along with the understanding of the inter-relationships among various other important factors at school, teacher and student levels. In future, more exclusive studies can be done to explore the issues of learning approaches and learning outcomes using IWB in separate studies using longitudinal or other suitable research methods.

Keywords: Information and Communication Technology (ICT), Interactive Whiteboard (IWB), IWB adoption, IWB use, ICT attitudes, IWB attitudes, classroom interactions using IWB, learning approaches using IWB, learning outcomes using IWB, student learning, teaching approaches, mixed-method research, secondary school teachers, secondary school students, secondary schools, South Australia, Australia.

Acknowledgements

First and foremost, I am grateful to The Almighty God, for always being with me, showering blessings upon me throughout my life and for guiding me and providing me with the courage and strength to complete this study.

It is said in our culture that there is no difference between God and Guru (the Teacher), and I have experienced this to be absolutely true during my research journey, so I would like to express my deepest gratitude and special appreciation to my principal supervisor, Dr. I Gusti Ngurah Darmawan and co-supervisor A/Prof Christopher Dawson for their outstanding guidance, amazing supervision, priceless advice and providing me with an excellent atmosphere during my study. Dr. Darmawan, thank you very much for inspiring and helping me to apply for this scholarship and I can never thank you enough for your endless support, valuable insights and continuous encouragement which kept me going. Dr. Dawson, how can I thank you enough for your valuable suggestions, encouragement and guidance to expand my research horizons by recommending the conferences, both at national and international level, for me to present my work. Your expertise and invaluable advice during the thesis writing phase has helped me to improve my academic writing. I would also like to thank both of my supervisors for their unconditional support, care and patience during the time I was facing difficulties at the personal front of my life. You have helped me to grow as a researcher, an academic and as a person. If it weren't for both of you, I would never have accomplished this.

I would also like to thank the Australian government for providing me the scholarship (Australian Postgraduate Awards) through the University of Adelaide to pursue this degree. Special thanks to the Vice-Chancellor of the University of Adelaide, the Dean of Faculty of Professions and Faculty of Arts, the Head of School of Education, and Postgraduate Coordinator for making available all the facilities and resources needed throughout my candidature. My thanks are also addressed to the Principals, Vice-Principals and ICT coordinators of the participating schools who gave permissions and made arrangements for me to be able to collect data from their schools and I am extremely thankful to all the participants of the study.

My sincere thanks to Dr. Linda Westphalen, Dr. Francis Ben and other academic staff members in the School of Education who were always there to help and support whenever I needed it during my research study. I am also thankful to the non-academic staff in the School of Education for their helpful services. Many thanks to my friends Ayesha, Dr. Burhannudin, Wilham, Dr. Poulomee and Dr. Joy for all your research related suggestions and fun-filled discussions that made my time at school extremely enjoyable.

And finally, a special thanks to my parents (Mummy ji and Daddy ji) for everything, today I am here just because of you and no words can express my love for you and that how blessed I feel to have you as my parents; thanks to my mother-in-law and father-in-law who had supported me during the writing phase of my thesis. And at the end I would like to thank my husband, Raminder Singh and my loving daughter, Kudrat Kaur for being the most important part of my life and for making it worth living.

Chapter 1
Introduction

Various countries around the world are investing huge amounts of money to equip their classrooms with the latest kinds of Information and Communication (ICT) tools. Interactive Whiteboard (IWB) is one such tool which was introduced in the educational sector more than a decade ago and has been widely adopted in many countries since then. Most prominent among these countries are United Kingdom (UK), United States of America (USA) and Canada, with Australia moving enthusiastically in this direction with many national and state level efforts investing in this educational technology. But the decision to make this investment in Australia was mainly based on the research findings from other countries especially the United Kingdom. There is a serious lack of any rigorous research studies investigating various IWB related issues in the Australian context. And most important among these is its impact on student learning. The present study was aimed at addressing this problem by investigating the adoption process of IWB technology by teachers and students and more importantly its impact on the student learning at the secondary school level in South Australia. The findings of this study have added the much required information to the education sector regarding the adoption of this technology at the secondary level, and the evidence of the impact of the use of IWB on learning. These findings can be used by the policy makers, school administrators and teachers to gain greater understanding about various factors which lead to the successful adoption and effective utilization of this technology together with its effect on the learning.

As this is the introductory chapter for the study on the topic: "Interactive Whiteboard: adoption and the impact of its utilization on student learning in South Australian secondary schools", it provides the detailed description of the background or context of this study which is followed by stating the research problem. The aims of this study, the key research questions along with the importance and limitations of this research are also given in this chapter.

1.1 Background/Context of the Study

In order to establish the background or the context for the present study, it was necessary to review the past research done in the field of ICT educational research with the main focus on IWB educational research. It also helped in gaining the understanding of the current state of research in these fields of research, along with leading to the identification of the current issues and gaps in ICT educational research as a whole and IWB educational research in particular. The following sections present the detailed description on the background of the study.

1.1.1 Information and Communication Technology (ICT)

ICT is an acronym for Information and Communication Technology. Technically speaking, ICT is the combination of informatics technology (the field dealing with the information processing systems) together with other, related technologies, specifically communication technology (UNESCO, 1994). In other words, this term is collectively used for the "technologies used for accessing, gathering, manipulation and presentation or communication of information" (MCEETYA, 2000). While there is no universally accepted definition of ICT, in simple words it is a broad subject concerned with digital technological tools and resources used to communicate, create, store, manage and process information (Tinio, 2003). "These technologies include computers, the Internet, broadcasting technologies (radio and television), and telephony" (Tinio, 2003, p. 4).

1.1.2 ICT in Education

In today's world, a wide cross-section of society has accepted ICT as an entrenched characteristic of its culture (Steketee, 2005). Today's generation live in an ICT rich world with digital technologies continuing to influence many aspects of every individual's life (Elliott, 2004) through technologies in the home, business, commerce, media and education. So, in this digital-age world, it is important to equip the students with the appropriate technological skills and knowledge which can ultimately help them to live a successful life as creative and confident users of ICT (Cook, 2010; MCEETYA, 2008; Steketee, 2005). To meet this challenge, the educational scenario all over the world has gone through tremendous changes due to an increase in the introduction of various kinds of technological tools into the school classrooms (Albirini, 2006; Holmes, 2009; Munro, 2010; Paas & Creech, 2008). Various countries, especially the developed ones, are spending huge amounts of money to supply their classrooms with the latest ICT tools, with the vision of preparing their future generations for a knowledge-based economy (Albirini, 2006; Holmes, 2009). The other term which is commonly used in literature for these ICT tools is 'educational technologies' and these terms have been used interchangeably in the present research.

1.1.3 Scenario of ICT in Australian education system

In Australia, various policies and strategies in regard to the successful integration of ICT in education have been developed and implemented by The Department of Education, Employment and Workplace Relations (DEEWR), Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), The Department of Education and Training, Queensland (DETE), Department of Education and Children's Services, South Australia (DECS) and Department for Education and Child Development, South Australia (DECD) at both national and state level. The Australian Labor party, after winning the 2007 federal election, announced the $2 billion 'Digital Educational Revolution' (DEEWR, 2007). Its main purpose was to give grants to the eligible schools to help to provide new and upgraded ICT for students in Year 9-12 (DEEWR, 2007, 2009). The aim of the first round of this policy was to bring all secondary schools across Australia to a computer to student ratio of 1:2, with the final goal to reach up to 1:1 ratio for all secondary school (year 9-12) students by 2011 (DEEWR, 2009). The second main aim was to provide a broadband internet connection with a speed of up to 100 megabits per second to Australian schools (DEEWR, 2007, 2009). Further, in 2008 all the Ministers of Education in Australia approved the educational policy named 'Melbourne Declaration on Educational Goals for Young Australians' which also highlighted the necessity of teaching and learning with technologies for preparing our students for 21st century living by stating in the Preamble that "In the 21st century Australia's capacity to provide a high quality of life for all will depend on the ability to compete in the global economy on knowledge and innovation" (MCEETYA, 2008, p. 4). More specifically, goal 2 of this declaration stated that "All young Australians become successful learners, confident and creative individuals, and active and informed citizens" (MCEETYA, 2008, p. 8). This was further linked to goal 2.1 indicating that successful learners should "have the essential skills in literacy and numeracy and are creative and productive users of technology, especially ICT, as a foundation for success in all learning areas" (MCEETYA, 2008, p. 8).

Similarly, the emphasis on the need for developing the technological skills of students to live successfully in knowledge economy and society (DETE, 2001) have also been reflected in 'DECS Strategic Plan for Learning and Business Technologies 2006-2010' which emphasised the need of the students to use technology by making the students "participate in programs that focus on the development of 21st century skills, resources and projects to assess their ICT literacy" (DECS, 2006, p. 6). Similarly 'ICT Strategic Statement 2012-2014' also intended to "provide a strong foundation for children and young people that prepares them to become confident, creative and informed members of a digitally enhanced society"(DECD, 2012, p. 4).

1.1.4 ICT educational research: a broad picture

It was vital to have a sound understanding of the current state of ICT educational research, which is a complex and very broad area (McDougall & Jones, 2010), because the research on any educational technology (IWB in this case) needed to be developed with an awareness about the latest findings and the current issues. Secondly, researching ICT in education is also a very challenging field because of the sheer number of technological tools being introduced into the educational sector (Cox, 2010) at a very fast rate. Without the understanding of this complex nature of implementation and utilization of various educational technologies, it was difficult to develop a meaningful study (McDougall & Jones, 2010).

During the review of the past research studies, it was found that the first most important issue, which has also resulted in criticism of ICT educational research, was related to its focus of investigation. In the majority of studies done so far in this area, the researchers have focused primarily on the technology in use and not on the educational importance of that technology i.e., the impact of it on learning and teaching (Ham, 2010; McDougall & Jones, 2010; Romeo & Russell, 2010). Another shortcoming which was found to be one of the main concerns of educational researchers was that most of the ICT research done in education has lacked a theoretical underpinning which relates ICT use to teaching and learning (McDougall & Jones, 2010; Romeo & Russell, 2010). Due to this, the field of ICT research in education has become separated from the main body of educational research, which has ultimately been giving rise to many debates in this area. It was then been realized that the development of ICT research should be based on appropriate learning theories e.g., social learning theories (McDougall & Jones, 2010; Romeo & Russell, 2010). Thirdly, it was also found that the lack of historical perspective (lessons learnt from the pitfalls in the past) was another matter which needed the urgent attention of those who are intending to do quality research in this field (McDougall & Jones, 2010; Romeo & Russell, 2010). Overall, it was being pointed out that, due to above stated shortcomings, the large majority of studies done in ICT educational field have not contributed much towards the improvement of educational theories or the advancement of educational practice. So, it has been recommended that any researcher planning to do research on any educational technology should address the issues of teaching and learning in the first place, with technology being given secondary importance (McDougall & Jones, 2010).

1.1.5 Introduction of IWB in Australian education system

Among some of the recent educational technologies which have found their way into the classrooms, interactive whiteboards (IWBs) have come forward as a very widely accepted educational technology (Holmes, 2009; Mohon, 2008). Countries around the world are taking considerable interest in investing huge amount of money into the process of implementation of IWB into their schools. Thus, in the UK, all schools had the opportunity of installing IWBs into their classrooms following the support provided by government in the form of grants/funds in millions of pounds to the schools (Bennett & Lockyer, 2008; Hockly, 2013; Kelley, Underwood, Potter, Hunter, & Beveridge, 2007; Miller, Averis, Door, & Glover, 2005; Mohon, 2008). It is clear that the enthusiasm for the adoption of IWB is very high around the world, and Australia is no exception, with different education authorities investing in this new technology (Bennett & Lockyer, 2008).

The fast paced adoption of this new IWB technology is due to its unique feature of bringing together many ICTs in a very convenient manner (Betcher & Lee, 2009; Murcia, 2010). In the last decade, Australian schools have made a considerable financial investment in the purchase and installation of interactive whiteboards for classroom use (Jones & Vincent, 2006). At national level, under the policy of 'Digital Education Revolution', the federal government has provided the opportunity for schools to apply for up to a $1 million grant for purchasing various ICT tools, and IWBs are given a special consideration in that (DEEWR, 2007). At state level also, governments of various states are providing funds to schools, especially to equip them with IWBs. For instance, the NSW state government has announced an allocation of $66 million for this purpose, and the ACT government has also encouraged their schools to install IWBs (Bennett & Lockyer, 2008; Holmes, 2009; Hunter, 2006).

1.1.6 What is Interactive Whiteboard?

The Interactive Whiteboards, which are also known as 'digital' or 'electronic' whiteboard (Kennewell & Higgins, 2007), were initially developed for official presentations at meetings in typical office scenarios, but have been more recently introduced into educational settings (Higgins, Beauchamp, & Miller, 2007; Smith, Higgins, Wale, & Miller, 2005) with the vision of transforming the educational process.

The Interactive Whiteboard is a large touch-sensitive board or display panel. It is connected to a data projector and a computer and the computer image is projected onto it (Bennett & Lockyer, 2008; Kennewell & Higgins, 2007; White, 2007). "The image can be controlled by touching the board either by hand or with a special stylus, as well as by using the computer mouse or keyboard. The user can write, type or draw on the surface, then save, alter or print the image" (White, 2007, p. 6). So the user can control the computer from the projected image on the board (Mohon, 2008). In this way, it provides the facility to the "teachers and students to view, manipulate, create and distribute electronic teaching and learning resources using familiar computer applications" (Bennett & Lockyer, 2008). In other words we can say that it combines "the functionality of audio-visual presentation and computer-based interactivity" (Bennett & Lockyer, 2008, p. 289). Basically the IWB is the combination of following four components (White, 2007):

- The IWB
- A data projector
- A computer
- Software

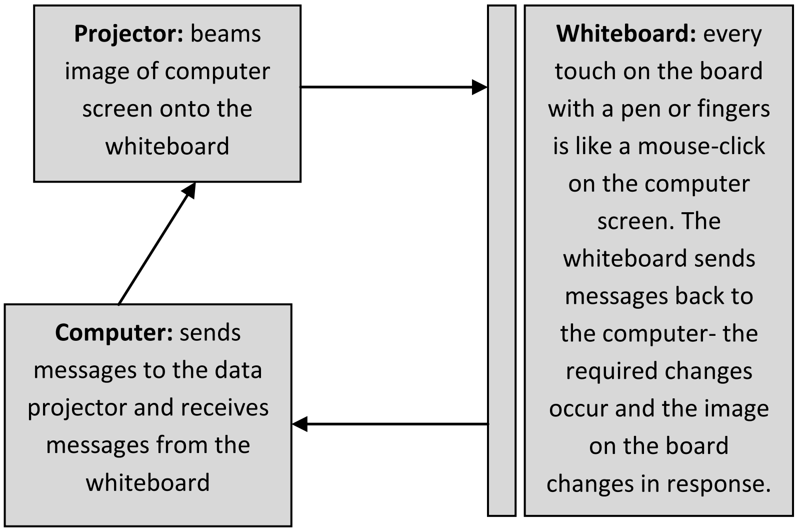


Figure 1.1: Different Components of a typical IWB (Becta, 2004)

Figure 1.1 shows, in a very simple manner, the way in which the components of IWB are connected to each other and their specific function. The software accompanying IWBs provide the facility for the users in a classroom environment to interact with digital content in a very convenient manner and to undertake activities which were previously not possible while using a large display (Kennewell & Higgins, 2007; SMART, 2006). Some of the examples of most commonly performed activities using IWBs are

> …*manipulating text and images; making notes in digital ink; saving notes for later review by using e-mail, the Web or print; viewing websites as a group; demonstrating or using software at the front of a room without being tied to a computer; creating digital lesson activities with templates, images and multimedia; writing notes over educational video clips; using presentation tools that are included with the white boarding software to enhance learning materials; showcasing student presentations.*
>
> (SMART, 2006, p. 5)

1.1.7 IWB educational research

The bulk of the IWB research literature has been generated from the UK studies which were conducted after the installation of this ICT tool into all the UK schools more than a decade ago (Bennett & Lockyer, 2008; Hockly, 2013; Kelley et al., 2007; Miller et al., 2005). Being a relatively new educational technology in other countries like USA, Canada and Australia, the available literature on IWB research from these countries is limited (Schuck & Kearney, 2007; Sweeney, 2010). Further, there is lack of IWB research literature in refereed academic journals (Becta, 2003, 2004; Mohon, 2008; Smith et al., 2005; White, Barnes, & Lawson, 2012). The IWB research literature reviewed in the present research can be divided into four categories based on the focus of the research:

- The majority of studies done in this area concentrate on various aspects of teaching with IWBs (Bennett & Lockyer, 2008; Bourbour & Bjorklund, 2014; Glover & Miller, 2003; Hodge & Anderson, 2007; Holmes, 2009; Jewitt, Moss, & Cardini, 2007; Kelley et al., 2007; Kent, 2006; Kitson, Fletcher, & Kearney, 2007; Lai, 2010; Littleton, 2010; Mercer, Hennessy, & Warwick, 2010; Miller & Glover, 2010; Mohon, 2008; Murcia, 2008; Schmid, 2010; Sweeney, 2010; Vincent, 2007).
- There are few studies done with the focus to study IWB from the learners' viewpoint (Beeland, 2002; Goodwin, 2008; Haldane, 2007; Hall & Higgins, 2005; Jones & Vincent, 2006; Kennewell & Beauchamp, 2007; Knight, Pennant, & Piggott, 2005; Swan, Schenker, & Kratcoski, 2008; Wall, Higgins, & Smith, 2005; White et al., 2012; Yanez & Coyle, 2011).
- In some studies, the researchers focused on the combination of teaching and learning issues (Armstrong et al., 2005; Bayne, 2007; Hennessy & London, 2013; Hockly, 2013; Lopez, 2010; Murcia, 2010; Schuck & Kearney, 2007; Shi, Yang, Yang, & Liu, 2012; Slay, Sieborger, & Hodgkinson-Williams, 2008; Somyürek, Atasoy, & Özdemir, 2009; Twiner, Coffin, Littleton, & Whitelock, 2010; White, 2007), and
- In others the focus is on use of IWBs in particular subject areas (Bourbour & Bjorklund, 2014; Glover, Miller, Averis, & Door, 2007; Hennessy, Deaney,

Ruthven, & Winterbottom, 2007; Hockly, 2013; Holmes, 2009; Kent, 2006; Lopez, 2010; Miller et al., 2005; Miller & Glover, 2006, 2010; Murcia, 2010; Parslow, 2008; Schmid, 2010; Shi et al., 2012; Swan et al., 2008; Vita, Verschaffel, & Elen, 2014; Xu & Moloney, 2011; Yanez & Coyle, 2011).

Several critical issues related to the use of IWB as a pedagogical tool in schools had surfaced from this literature review, and these are discussed underneath using two separate headings:

- IWBs and teachers/teaching
- IWBs and learners/learning

1.1.7.1 IWBs and teachers/teaching

The research literature in the area of IWB use in teaching showed a positive picture as a whole. Especially, it highlighted the fact that the touch sensitive screen option of IWB delivers a number of possible benefits for teachers, including greater flexibility, versatility, resourcefulness and the ability to deliver multimodal presentations effectively, teaching in a group setting or whole-class setting (Betcher & Lee, 2009, p. 3; Hennessy & London, 2013; Higgins et al., 2007; Kennewell & Beauchamp, 2007; Kennewell & Higgins, 2007; Littleton, 2010; Mohon, 2008; Slay et al., 2008; Smith et al., 2005; Somyürek et al., 2009; Twiner et al., 2010). The IWB has the potential to cater for a variety of learning styles, improves classroom interactivity and student participation, and also some classroom management issues (Bourbour & Bjorklund, 2014; Higgins et al., 2007; Holmes, 2009; Littleton, 2010; Shi et al., 2012; Smith et al., 2005; Somyürek et al., 2009; Twiner et al., 2010). Various studies have highlighted that the use of IWBs helps teachers to develop resources and to plan and structure their lesson more easily (Bennett & Lockyer, 2008; Holmes, 2009; Jones, 2002; Smith et al., 2005). When effectively used it can help to capture and hold student attention, encourage them to get involved in problem solving, support collaborative learning by motivating them to participate during the lesson (Bourbour & Bjorklund, 2014; Hockly, 2013; Holmes, 2009; Jones & Vincent, 2006). The convenience for the teacher to use pre-prepared lessons and the facility for them to review materials at a later date are other advantages identified in some studies (Holmes, 2009).

Further, some of the unique advantages of an IWB (Smith et al., 2005) were also underlined in some research articles which separates it from other whole-class ICT demonstration facilities (WCIDFs) (Jones & Vincent, 2006; Kelley et al., 2007). These unique features of an IWB lie in the interactivity facility provided by it. A number of articles indicated that the IWB allows two types of interaction; one is dialogic interaction among students, and between students and teachers (pedagogical interactivity) and the other is physical interaction with the IWB (physical interactivity) (Jones & Vincent, 2006; Littleton, 2010; Mercer et al., 2010; Smith et al., 2005). Another difference between teaching using IWB and a desktop/laptop is that the teacher can maintain an eye contact with the whole class while standing in front of the class and s/he does not have to sit or stand on one corner of the class hiding behind the computer screen (Kelley et al., 2007). This helps in maintaining the pace of the lesson and seamless flow of information, along with capability for the teacher to emphasize and highlight important points using just a touch of the finger or a pen (Kelley et al., 2007). It is due to these unique features that a large number of teachers are showing more acceptances for introducing IWBs into their teaching in comparison to any other ICT tool (Kelley et al., 2007).

Along with many potential teaching benefits, some problems related to IWB integration in education have also been identified in various studies (Smith et al., 2005). The first and most critical problem faced by teachers is the lack of adequate training for using this technology effectively in their classrooms (Glover & Miller, n.d.; Hockly, 2013; Holmes, 2009; Smith et al., 2005) because it has been realized that teachers' technological knowledge and skills are the keys in using IWB for facilitating better interactions in the classrooms (Bourbour & Bjorklund, 2014). Researchers are now raising this issue by pointing out that some teachers, especially in the initial stages of the IWB adoption, use the IWB just to complement their traditional teaching where it is used simply for writing or projecting material (Hall & Higgins, 2005; Hennessy & London, 2013; Holmes, 2009; Warwick & Kershner as cited in Murcia, 2010). Secondly, lack of time to prepare lessons with the IWB is also considered as a major problem for teachers who are in their initial stages of familiarisation IWB use (Higgins et al., 2007), because teachers usually need more time for lesson preparation with the IWB as compared to regular lessons (Glover & Miller, n.d.). A common theme which emerges out of the IWB literature focus on teaching aspects is that teacher proficiency with the technology, including incorporating various pedagogical skills and strategies, is a key factor which leads to the effective use, and ultimately to positive outcomes (Hockly, 2013; Lai, 2010; Schmid, 2010). But a concern is shown by most of the authors that teachers have not yet acquired the required level of skills to use the IWB effectively (Glover et al., 2007; Holmes, 2009).

1.1.7.2 IWBs and learners/learning

IWB research studies done with a central focus on student learning outcomes are very rare. Instead, in the available studies, the role of IWB in facilitating situations for learning has been the main focus of the researchers (Beeland, 2002; Jones, 2002; Kennewell & Beauchamp, 2007; Knight et al., 2005; Shi et al., 2012; Xu & Moloney, 2011; Yanez & Coyle, 2011) rather than direct outcomes of learning. Only a few articles have been found which mentioned the impact of IWB use on student achievement or learning outcomes (Lopez, 2010; SMART, 2006; Swan et al., 2008; White, 2007; Xu & Moloney, 2011). All these studies were small scale case studies which used qualitative approaches to research, except for the study done by Xu and Moloney (2011) which used both quantitative and qualitative methods of data collection. Further most of these studies were focused on the learning outcomes of a particular subject, for example, the study by Lopez (2010) was focused on English language learners (ELL); Xu and Moloney (2011) were focused on Chinese language; the study conducted by White (2007) focused on the numeracy and literacy outcomes; and Swan et al. (2008) also focused on English, Arts and Mathematics. So, although all these studies indicated a positive impact of IWB use on student learning outcomes in a particular subject-area, the researcher could not find any large scale study which had investigated the impact of IWB on other subject areas as well. The research studies, mainly from the United Kingdom, the

United States and Australia (limited), indicated that the proper use of IWB, along with the accompanying software, creates a positive and enjoyable learning environment which helps the students to get more engaged, motivated, focused and interested in the classroom (Beeland, 2002; Hall & Higgins, 2005; Higgins et al., 2007; Hodge & Anderson, 2007; Kennewell & Beauchamp, 2007; Knight et al., 2005; Schuck & Kearney, 2007; Shi et al., 2012; SMART, 2006; Smith et al., 2005; Wall et al., 2005; White et al., 2012; Xu & Moloney, 2011; Yanez & Coyle, 2011). The ability to present information in several ways (multimodal) allows a teacher to prepare for a variety of learning styles (Lee & Boyle, 2003; Murcia, 2010) and this is considered as the main factor which can contribute towards the above stated advantages for students in a whole class or small group learning situations (Beeland, 2002; Bennett & Lockyer, 2008; SMART, 2006; Smith et al., 2005; Yanez & Coyle, 2011). "It allows all pupils to engage with the same central focal point in the classroom-something that is not easy to achieve with other types of technology" (Becta, 2004, p. 3). This also can lead to the development of a collaborative and interactive learning environment which encourages the students to actively participate in lessons using dialogic interaction and become more confident learners (Bennett & Lockyer, 2008; Bourbour & Bjorklund, 2014; Hennessy et al., 2007; Jones, 2002; Littleton, 2010; Mercer et al., 2010; Murcia & Sheffield, 2010; White, 2007; Xu & Moloney, 2011).

The contribution of IWB in promoting interactivity in the classroom is seen as the key factor which has positive effect in enhancing the overall learning environment within the class (Becta, 2004; Littleton, 2010; Miller et al., 2005). The type of interaction which is increased by the virtue of IWB use is between teacher, students, subject matter and the technology itself (Becta, 2004). In a few studies, the students mentioned that the facility for revisiting or reviewing the previous learning helps them to have clear knowledge about the level of their learning, and hence increases their confidence (Becta, 2004; Knight et al., 2005; SMART, 2006). A few studies also pointed out the enthusiasm of students to use the board themselves as a factor contributing towards them being more involved in their own learning (Slay et al., 2008; White, 2007). This kind of IWB use also helps learners with a kinesthetic/tactile preference (Murcia, 2010; Smith et al., 2005). In investigations on student's opinion about the usefulness of the IWB for learning, it has been seen that students are positive about its impact on their learning (Mathews-Aydinli & Elaziz, 2010; SMART, 2006; White, 2007). A few researchers have also highlighted the important role it can play in the learning of children with some kind of visual or other physical disability (Kennewell & Morgan, 2003), and there is lack of research in this area where more exploratory research is needed.

But one should keep in mind that it is evident in some research studies that if not properly used IWB can prove to be a problem for students. Some researchers have criticized IWB integrated lessons as being too highly paced, as with any other presentation technology, which in turn does not give much opportunity for students to think or participate in the lesson (Hennessy et al., 2007; Holmes, 2009; Wall et al., 2005). And if a lesson, in which students are given the opportunity to work on the board, is not effectively planned, then it can result in some management problems because the students waiting for their turns become bored (Hennessy et al., 2007). Over-crowding of information on the IWB is another problem which sometimes confuses students instead of improving their understanding (Higgins et al., 2007; Holmes, 2009). The overall picture which emerged during the review of IWB research focusing on learning is that, if properly used, IWB can have positive impact on student learning.

Various problems related to ICT and IWB educational research have been identified by the researcher while reading the ICT and IWB research literature. These issues or gaps in the research literature are discussed in details in the next section.

1.2 Statement of Research Problem

The critical issues which emerged during this review of ICT and IWB research literature are discussed in this section, which collectively were used as the problem statement for this research.

1.2.1 Issues in ICT Educational Research

The review of literature for this study had started by identifying the literature on the broader field, i.e., ICT educational research. During this review, some problems or gaps in this field of research were identified which needed to be addressed urgently. First and the most essential one was the issue of the lack of rigorous research evidence for the effectiveness of ICT in improving student learning. In other words, the research findings from this field were found to be fragmented and so the research had failed to provide solid evidence that the use of ICT in education leads to the improvement in the overall process of learning, the attitudes of students towards learning and the quality of their learning outcomes. Secondly, most of the ICT research in the educational sector has been done at a small-scale (e.g., action research) level using inappropriate methodologies resulting in non-conclusive findings. Even where some conclusions regarding the value of ICT use in teaching and learning arose, they are not properly conveyed to the practitioners in the education sector. Thirdly, the ICT educational research mostly tends to focus on the technological aspect of it rather than focusing on the impact of technology on human behaviour (use, perceptions, learning etc.) and does not take into consideration the theoretical underpinnings when designing and conducting research studies. This leads to the problem of ICT research becoming detached from sound educational research and, ultimately, educational practice.

1.2.2 Issues in IWB Educational Research

When the literature focused on the IWB use in education was examined, a number of critical issues surfaced which needed to be addressed by further research. Before discussing these issues, it is important to clarify is that the bulk of literature explored in the present study came from the UK based research studies.

1.2.2.1 Lack of IWB studies in Australian context

As it is already mentioned that the available research literature is mostly comprised of UK based research studies and this research literature consisted mainly of articles available on the internet which included reports published by government agencies, school-based research projects or discussion papers and only a few IWB research articles from refereed journals. This pointed towards the first issue identified in IWB educational research which was the serious lack of IWB studies done in Australia and especially in the South Australian context. As mentioned above, in Australia schools are enthusiastically installing IWB in the classrooms. The trend, which started from primary school level and is now leading towards secondary level classrooms, is largely based on the research findings from other countries like UK and USA. Considering the high cost of installing this technology in the classrooms, it is essential that the process of equipping the Australian schools should be guided by the findings of the research done in the Australian context of education.

1.2.2.2 Lack of large-scale quantitative research studies

It has also been noticed that even in the countries like UK and USA, most of the studies conducted in this field are the qualitative in nature and done at the small-scale such as case-studies or action research which included only small number of participants and focus on one or two subject-areas at the most. There has been lack of studies which included large number of participants using quantitative approaches to investigate various critical issues related to IWB use. So the available evidence for the effectiveness of IWB in teaching and learning was found to be scattered because it has been collected from various small-scale studies focusing on different aspects of IWB use. This shortage of large scale quantitative studies led to the problem of an inability to generalize the research findings to generate solid-based conclusions. In addition to this, the studies in this area are found to be mainly focused on the use of IWB at primary school level and only very few studies had investigated the use of IWB at secondary school level. This led to a big gap in the literature of IWB educational research.

1.2.2.3 Lack of studies to investigate the impact of IWB use on student learning

Thirdly, although the various small-scale IWB studies collectively depicted a positive picture regarding the use of IWB for teaching (mostly as positive teaching experiences) and learning (mostly as positive learning experiences), very few studies have tried to investigate the impact of its use on the specific learning outcomes or achievement of the students. As also mentioned for the ICT educational research as a whole, this is one of the most critical issues which prominently emerged during the IWB related literature review. Even those studies, where the focus was on student learning, the emphasis was given to studying the impact of IWB use on the learning environments as a whole or to investigating its impact on some students' attributes e.g., student motivation and engagement in the classrooms etc. The IWB related studies provided little evidence of the impact of its use on the learning approaches and specific learning outcomes, although there were a couple of studies where the impact of IWB on students' learning achievements in a particular subject area was investigated. So it was realized that this void in the available IWB research literature could only be filled if IWB research studies would focus on these crucial aspects of student learning and provide the much needed evidence of the actual impact of IWB use on student learning. Further, it was also evident in the literature that understanding this relationship between IWB use and student learning is a key factor in the effective adoption of IWB in education.

The present study was designed as an attempt to address the issues in order to provide a much needed contribution to the IWB educational literature. The specific aims of the present study are described in the next section.

1.3 Aims of the Research

The purpose of this study was to investigate the impact of the use of IWB on the student learning approaches and outcomes at secondary school level in South Australia. As mentioned in the above section, this kind of research study was urgently needed in the Australian educational context. In other words, the main aim of this study was to explore various factors related to the adoption and utilization of IWB and to investigate their interaction with one another and their impact on student learning. This was also done with the purpose of collecting evidence regarding the impact of IWB use on student learning (learning approaches and learning outcomes), if any.

Apart from this overall objective, the specific aims of this research were:

1. To analyse the adoption of IWB by teachers and students in the South Australian secondary schools along with the factors affecting it.
2. To explore the classroom interactions using IWB as an educational tool.
3. To investigate the effect of the IWB adoption level and IWB classroom interactions on the learning of the secondary school students.

So it can be said that the current study was primarily focused on the student learning as a result of to IWB use, and the IWB technology itself was given the secondary importance.

1.4 Key Research Questions

To achieve the above stated aims, the study addressed the following research questions which are grouped into general and specific categories. Generally, the study addressed the following questions:

1. How do the environmental, personal and attitudinal features of the teachers, and their general approaches towards teaching, influence the adoption of IWB and the classroom interactions when IWB is used?
2. How do the environmental, personal and attitudinal features of the students influence their reception of IWB, and their classroom interactions using it?
3. How do various school, teacher and student level factors interact with one another and what are their impact on the students' learning approach and outcomes?

These general questions led to the following specific questions under 3 broad headings:

1. School level

    1a What kind of ICT related facilities are available for the teachers and the students in the schools?

    1b What is the level of IWB integration into the classrooms in the schools?

1c How does the availability of ICT related facilities to the teachers influence their attitudes towards ICT and IWB, their teaching approaches and their classroom interactions using IWB?

1d How does the availability of ICT related facilities to the students influence their attitudes towards ICT and IWB, their classroom interactions using IWB, their learning approaches and their learning outcomes?

2. Teacher level

2a. What are the factors which influence the decision to adopt IWB by the teachers?

2b. How do the personal/demographic factors of the teachers influence their attitudes towards ICT and IWB, their teaching approaches and their classroom interactions using IWB?

2c. What is the relationship between teachers' attitudes towards ICT and their attitudes towards IWB?

2d. How do the attitudes towards ICT and IWB influence the teaching approaches of the teachers and their classroom interactions using IWB?

2e. What is the influence of the teachers' general approach towards teaching on their classroom interactions using IWB?

2f. What are the perceptions of the teachers on the impact of use of IWB on the learning approaches and learning outcomes of the students?

3. Student level

3a. How do the personal/demographic factors of the students influence their attitudes towards ICT and IWB, their classroom interactions when using IWB, their learning approaches and learning outcomes using IWB?

3b. What is the influence of the students' attitudes towards ICT on their attitudes towards IWB?

3c. What is the influence of the students' attitudes towards ICT and IWB on their classroom interactions when using IWB, their learning approaches and learning outcomes using IWB?

3d. How do the students' classroom interactions using IWB influence their learning approaches and their learning outcomes?

1.5 Importance of the Research

This study was expected to make some significant contributions to the present research literature and the educational practice which are given underneath:

- As there has been scarcity of the studies providing the research evidence related to impact of IWB use on student learning, the findings of this study were expected to provide this kind of evidence because it would be the first of its kind to investigate two important concepts of learning i.e., student learning approaches and quality of learning outcomes, in relation to IWB use which would be a major contribution to the IWB research literature.
- The second contribution of this research towards IWB research literature would be in the form of addressing the problem of a shortage of IWB studies with the primary focus on the student issues, as the primary focus in the present study was on students.
- The third important contribution of this study lay in the fact that there is a serious lack of IWB research studies done in Australia and more specifically in South Australia. There were hardly any studies found which were done on critical issues related to IWB use in South Australian schools. So the current research was expected to fill this gap and to provide guidance to the schools to help them to make informed decisions regarding incorporating IWB technology into their classrooms.
- This study was also important because it was done on a large scale by using predominately quantitative methods of data collection along with qualitative methods of interpretation which is not usually done in this field of research. The IWB research literature is comprised mainly of small scale qualitative

studies focusing on one or two subject-areas and come up with scattered findings regarding different critical issues related to IWB use in education. But the present research made an effort to deal with this problem up to some extent. Apart from this, this study also included all the main subject-areas at secondary school level in South Australia unlike majority of other IWB studies which focus only on the IWB use in one or two subject areas at the primary level of schooling.

- This study also tried to investigate the relationship between various prevailing factors at school, teacher and student level and their influence on each other in terms of IWB adoption and utilization and ultimately the student learning. This would be a crucial contribution because it would provide the understanding and knowledge of these issues in the Australian context. These findings would also be helpful in providing suggestions to the teachers regarding effective pedagogical methods using IWB. These types of suggestions could also be used to improve teacher education or professional development courses by providing the idea of kind of support, facilities and training required to prepare teachers to use IWB successfully.

Combining all the various aspects of this study together, it was the first time that all these issues i.e., adoption, utilization and impact of IWB on secondary school students learning approaches and quality of learning outcomes were addressed in one study.

1.6 Limitations of the Research

Like all the other research studies, the present study also had some limitations which are discussed in this section. The first limitation of this study was related to the data collection procedure used in this study i.e., a cross-sectional procedure of data collection was used. This was done due to the limited time availability for completing this research which did not allow the researcher to undertake a longitudinal study. The second considerable limitation was related to the sampling procedure which was used in this research. Ideally, the researcher should have used random sampling, which is the most rigorous form of probability sampling, but in this research the non-probability convenience sampling was used in the main quantitative phase because of the limited number of South Australian secondary schools with IWB installed in their classrooms.

1.7 Description of the Chapters of the Thesis

This thesis is consisted of twelve chapters. Chapter One is the introduction which provides detailed description about the background or context of this study, the problem statement, aims of the study, and the key research questions along with the importance and limitations of this research.

Chapter Two provides the detailed account of the literature reviewed in this research for the development of the theoretical framework for this study. It includes the discussion about various factors which were identified in the previous literature and used to develop the theoretical framework for the present study. These factors are discussed under three headings i.e., Adoption of ICT in Education, Classroom Environment and Student Learning. The explanation of the theoretical framework is given in the last section of this chapter.

Chapter Three presents the description of the methods and methodology used for collecting data for this study. It includes the information about the sample used in this study and the instruments used for collecting the data. Further, it includes description about the pilot study conducted before commencing the actual data collection followed by the detailed account on the process of collecting the data for the current study. The ethical issues which were taken into consideration during the data collection process are also discussed in this chapter.

Chapter Four provides the details about the data preparation and the descriptive analysis of the quantitative data done in this study. It begins with the discussion about the steps taken in the preparation of quantitative data for the analysis followed by the details about the process of dealing with missing data which further led to next step of descriptive analysis including mean, variance, standard deviation and test for the normality of the data.

In Chapter Five, the findings related the preliminary or descriptive analysis are given which were generated using SPSS software in order to understand the characteristics of the participants of this research, which included the demographic information on teacher and student participants of this study, and the general information about the participating schools.

Chapter Six presents the findings from the statistical analysis conducted for the validation of the teacher questionnaire used in this study. SPSS software was used for reliability analysis and initial factor analysis and AMOS software was used conducting the final confirmatory factor analysis. A detailed account about these statistical techniques and the steps used to conduct these analyses is given in this chapter along with the findings of the reliability and the factor analysis for each scale of teacher questionnaire.

In Chapter Seven, the findings from the statistical analysis conducted for the validation of the student questionnaire are given. The statistical techniques and statistical software used for this purpose are the same as used for validating the teacher questionnaire. The findings for the reliability analysis and the factor analysis are given separately for each scale of the student questionnaire. Each section contains the summary table of separate scales giving the details of its sub-scales and the items in them followed by the results of the reliability and the factor analysis.

Chapter Eight and Nine provides the findings from the single level path analysis for the teacher and the student levels respectively. In Chapter Eight, a detailed account about the process of path analysis including specification of the model and trimming the model is given followed by the description of the variables used and the findings of the teacher level path analysis. As the description of single level path analysis technique is already given in Chapter Eight, it is not repeated in Chapter Nine, which contains the findings of the student level path analysis along with the detailed description of the variables used at student level path model.

Chapter Ten deals with the presentation of the results of the HLM analysis (three-level modeling) done in this study which includes findings related to the direct effects from various levels and also the interaction effects between the variables at three different levels i.e. student level, teacher level and school level. The findings related to two different three-level models are given i.e. Three-Level Learning Outcomes using IWB Model (students' perceived learning outcomes using IWB is an outcome variable) and Three-Level Deep Learning Approach using IWB Model (students' perceived deep learning approach using IWB is an outcome variable). Before discussing the findings, a description about the HLM procedure is given which also includes details about the model building and trimming process used in HLM analysis.

Chapter Eleven provides the detailed findings from the qualitative phase of this study. In includes the findings from the qualitative data collected during the interviews of the participating teachers. This chapter presents the description about the process of qualitative data analysis including data preparation, data coding and theme generating processes. It also gives details about the sample used for the qualitative phase followed by the findings from the qualitative data analysis.

The last chapter of this thesis i.e., Chapter Twelve presents the discussion of the findings from this study including both the quantitative and qualitative findings. These findings are discussed in relation to the research questions and in comparison to the previous research findings. This is followed by the discussion of practical and theoretical implications of these findings and ultimately the final conclusion is given in the last section of this chapter.

1.8 Summary

This chapter provides the introduction to a research study conducted to investigate the topic of the impact of the IWB use on student learning in South Australian secondary schools. It starts with the detailed description about the context of the study, which includes the background of the study, along with presenting the identified gaps in the literature. This is followed by the sections presenting the problem statement, aims of the study, key research questions, potential contribution and the limitations of the study.

Chapter 2
Literature Review for Theoretical Framework

2.1 Introduction

This chapter reviews the literature that had been identified by the researcher for the present study. The research literature, which was explored with the purpose of becoming familiar with the past research on ICT and IWB use in education, and to identify current issues in ICT educational research as a whole and IWB educational research in particular, has already been presented in Chapter One while explaining the context or background of the study. The third aim for reviewing the literature during this study was the identification of the important factors needed to develop the theoretical framework for investigating the issues related to the current study. This review of past studies, which led to development of theoretical framework (Figure 2.7) for the current study, is given in this chapter in the following sections. It is important to note that the two terms i.e., 'ICT tools' and 'educational technologies' are used interchangeably in this chapter.

2.2 Theoretical Framework

A theoretical or conceptual framework is a collection of interrelated concepts, somewhat like a theory but not necessarily so well worked-out (Borgatti, 1999): it can be thought of as a map with conceptual directions. It is a description of the major variables initially believed to be operating within the territory of the problem structured by the researcher's overarching view of how the variables work together to form a model that potentially leads to new understandings (Fall, 1997). In simple words, the framework is a general structure that outlines the main factors or variables to be studied, and provides the information about the set of concepts and processes involved in the research process (Dix, 2007; Miles & Huberman, 1994). It is a practical instrument that guides the direction of the whole research process and helps the researcher to decide and explain the route he/she is taking (Borgatti, 1999; Dix, 2007).

It has already been mentioned in the Chapter One that researching ICT in education is a very broad and complex area, and it is ever evolving mainly because of the continuous introduction of new technologies into education, which makes this area a very challenging one to study. It is because of this complexity that the new theories and models for researching ICT adoption/acceptance are also continually developing and there is no single model or theory which is applicable for researching every kind of ICT tool. Similarly, during the development of the theoretical framework for this research, it was discovered that no single theory or model in itself was able to cover all the aspects or issues which were intended to be addressed in this research. Secondly, because this study was the first of this kind in this area of IWB educational research, it was necessary to develop a new theoretical/conceptual framework by putting together the related concepts, theories and other models.

Further, thorough review of ICT and IWB literature was also necessary to gain a deeper understanding of the issues which were to be studied and to identify the factors or variables related to these issues. Similarly it was also necessary to explore how these various factors and variables could possibly be related to each other. It was this detailed understanding, which led to the development of the theoretical framework for the present study, which is given in the Figure 2.7. The following sections contain the detailed description of the literature reviewed with the purpose of identifying the ICT/ IWB related variables and factors, and their inter-relationship in the educational setting.

2.2.1 The Development of the Theoretical Framework

This section provides the information about the step by step development of the theoretical framework for the present study by giving details of the literature reviewed for this purpose. For the ease of understanding, this whole section is divided into three sub-sections which are: Adoption of ICT in Education; Classroom Environment; and Student Learning.

2.2.1.1 Adoption of ICT in Education: in-sights from the literature

It was mentioned in the introduction section that educational systems all over the world are introducing a huge range of ICT tools/educational technologies at very fast pace with the intention of transforming the teaching and learning process (Albirini, 2006; Holmes, 2009; Jones, 2002; Munro, 2010; Paas & Creech, 2008). But it is also evident in the examination of research studies, that the actual adoption pace of these technologies at the classroom level is very slow (Cox et al., 2003; Steketee, 2005), and in most of the situations the expected transformation of educational process has not been fully achieved (Cuban, 2001; Elliot, 2004; Somekh, 2008; Teo, 2009). It was then realized that these educational technologies were injected into the educational structures without developing and implementing proper measures for updating the whole system of education. So a number of researchers started to look into this issue with the aim of identifying the factors responsible for the disappointing results from the various efforts by the countries which had led the path of introducing technology into their educational scenario (Albirini, 2006; Mumtaz, 2000). The main educational technology which became the focus of these studies was computers. Later, in the early nineties, it started to become clear that simply installing technological tools into the classrooms was not necessarily going to transform the teaching and learning process (Albirini, 2006; Honey, Culp, & Spielvogel, 2005; Paas & Creech, 2008; Somekh, 2008). Also as the result of these studies, it was realized that the integration of computers or other ICT tools into educational system was not an isolated process, and there were various inter-related factors which play critical roles in successful adoption and effective use of these technologies in the school classrooms (Albirini, 2006; Paas & Creech, 2008). Based on these studies, several theories and models related to the adoption of computers/ICT have been developed.

The present study was focused on some important issues related to the adoption of one of the latest educational technologies i.e., IWB, but it was important for the researcher to first become familiarised with ICT adoption theories and models in order to develop sound theoretical grounds for the present research. And it has already mentioned above that ICT educational research has been criticized for not being grounded in established theories/models related to human behaviour or social practices, which has resulted in its disconnection from the main body of educational research (McDougall & Jones, 2010). It was also emphasized that "for knowledge to be practical – that is, powerful in changing the social practices of human beings - it needs to be grounded in a coherent body of theory" (Somekh, 2010). Keeping these critical points in mind, various theories and models were examined for developing a sound understanding of the process of adoption of innovations/technologies (Somekh, 2010). Along with this, several research studies focusing on the uptake of ICT tools were also reviewed, which helped to further identify the crucial factors in this process. The few available studies focusing particularly on IWB uptake were also examined. The various theories, models and studies which were consulted to identify various factors for the present research are outlined in the following sections.

2.2.1.1.1 Theories and Models

It is important to begin this section by giving a brief description of the theories and models reviewed for the present study, and which appeared to be relevant to it.

1. **Tripartite Model of Attitudes:** Attitude of a person is defined as a predisposition to approach or avoid an idea, event, and person or object (Johnston, 2002).

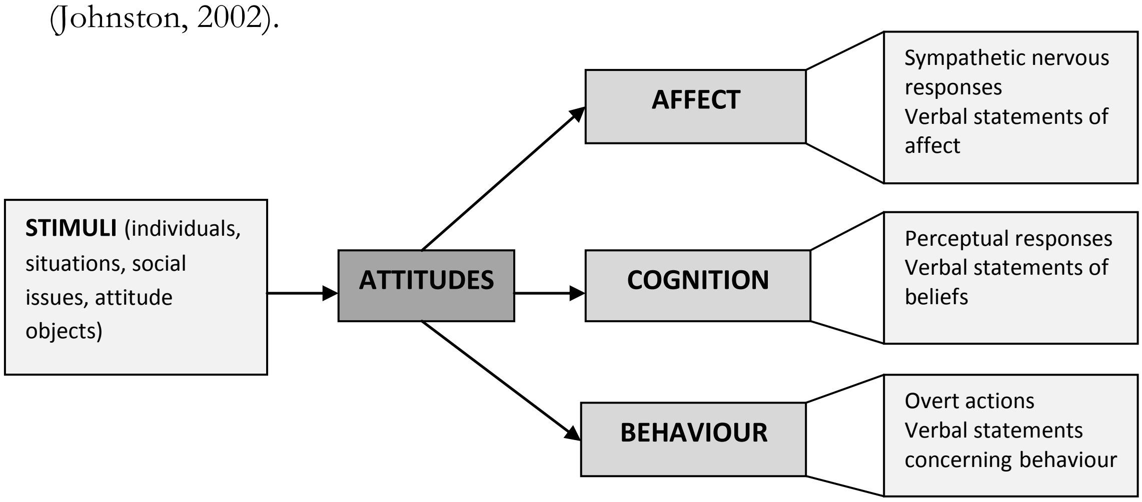


Figure 2.1: Tripartite Model of Attitudes given by Rosenberg and Hovland in 1960 (Hunt, 2007)

The studies in the field of attitudes resulted in the development of a model called 'Tripartite Model of Attitudes' (Figure 2.1) which was offered by Rosenberg and Hovland in 1960 (Ajzen, 2005) and it proposes that an attitude consists of three components: affective, behavioural and cognitive (Burns, 2000; Jones & Clarke, 1994; Selwyn, 1997). The affective component of attitudes defines the feelings towards a social object, the behavioural component refers to specific actions toward a social object and the cognitive component is related to the beliefs about a social object (Burns, 2000).

2. **Theory of Diffusion of Innovation:** Diffusion of Innovation theory was given by Everett Rogers in 1983. The purpose was to explain the steps with which an innovation is adopted or rejected by the members of a social system (Sendecka, 2006) with the attitude of people towards the innovation playing the central role in it (Albirini, 2006). Rogers stated that:

    It conceptualizes the sequence of events where individual passes through initial point of basic knowledge of innovation, through forming a favourable or unfavorable attitude toward it, through a decision to either adopt or reject it, and through utilization of innovation to finally seeking reinforcement of the adoption decision made.

    (Sendecka, 2006, p. 36)

3. **Technology Acceptance Model (TAM):** The Technology Acceptance Model (Figure 2.2) has been the most widely used model to study the acceptance and utilization of technology (Ma & Liu as cited in Sendecka, 2006) and was developed by Davis, Bagozzi, and Warshaw in 1989 (Sendecka, 2006).

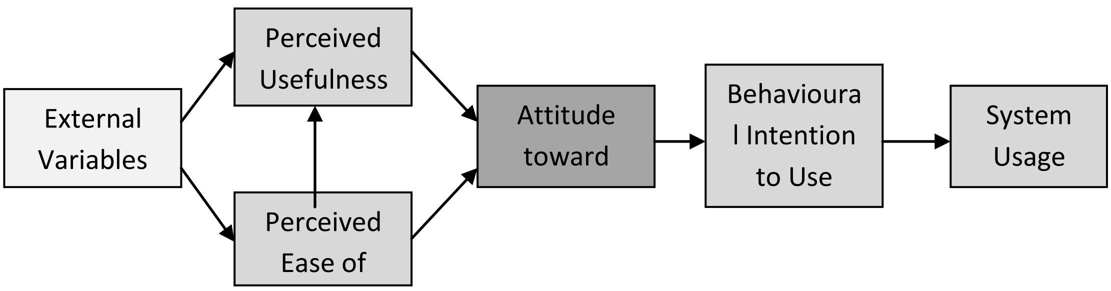


Figure 2.2: Technology Acceptance Model (Ma & Liu as cited in Sendecka, 2006)

According to TAM, the development of attitudes of a person towards a technology depends upon "its perceived usefulness and perceived ease of use on the part of that person" (Davis as cited in Sendecka, 2006, p. 31). The perceived usefulness of technology includes the degree of belief of a person that using that particular technology will improve his/her present work (Davis as cited in Sendecka, 2006). Similarly, "perceived ease of use of a technology explains the degree of belief of a person that he/she will not need to put extra effort to use that particular technology" (Davis as cited in Sendecka, 2006, p. 31).TAM has some similarities with the Diffusion of Innovation theory because it emphasizes the importance of beliefs, attitudes and intentions of a person in the adoption process (Noiwan, Piyawat, & Norcio, 2004). In simple words, beliefs related to the usefulness and ease of use of a technology results in the development of the attitude towards that technology which ultimately results in the intention to use, followed by the actual use of the technology (Sendecka, 2006).

4. **Theory of Planned Behaviour (TPB):** Theory of Planned Behaviour (Figure 2.3) was developed by Ajzen in 1991 and is the revised and extended version of the 'Theory of Reasoned Action' (TRA) which was proposed by Fishbein and Ajzen in 1975.

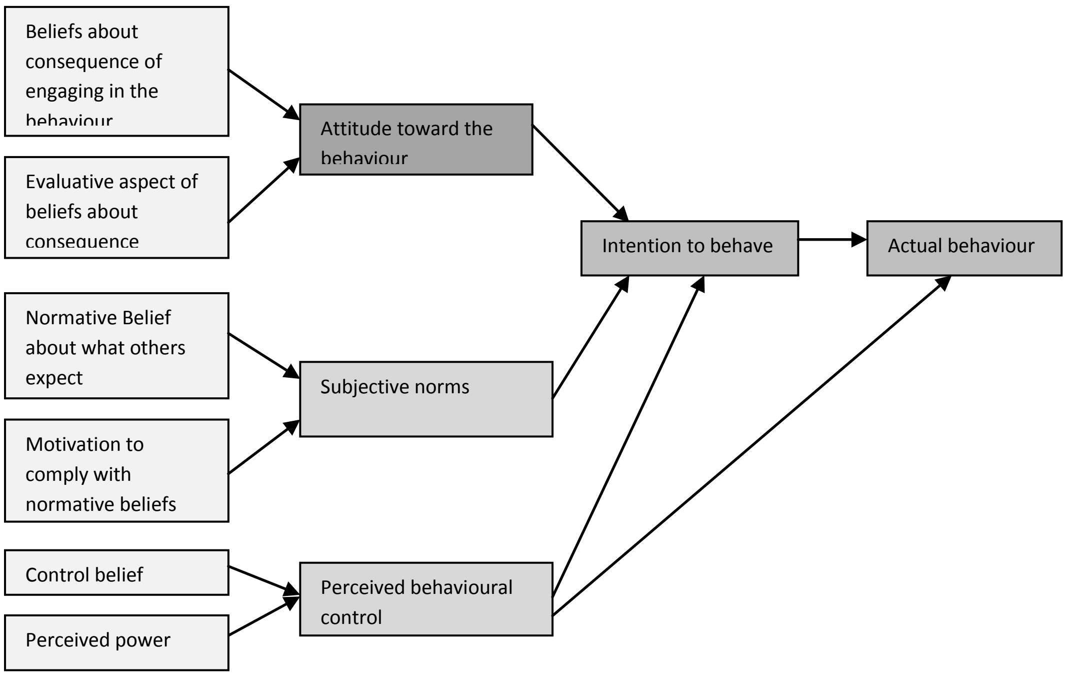


Figure 2.3: Theory of Planned Behaviour proposed by Ajzen in 1991 (Sendecka, 2006)

TPB states that "attitudes, subjective norms, and perceived behavioural control are all positively related to the intentions about the behaviour. Intention about the behaviour will thus predict the actual behaviour of a consumer" (Sendecka, 2006, p. 30). It is suggested that the likelihood of a particular kind of behaviour depends upon many factors and one such factor is attitude towards that behaviour (Ajzen & Fishbein, 1980). This theory has been successfully applied to various situations and technologies (Ajzen, 2005; Sendecka, 2006).

2.2.1.1.2 Teachers: the key to success

In this section, the findings of the research studies investigating the important factors responsible for the adoption of educational technologies are discussed. Absence of research into several important issues, especially the role and importance of the end-users (teachers and students) of the ICT tools, has been responsible for the disappointing results in the beginning of the process of introducing technology into schools (Albirini, 2006; Mumtaz, 2000). In the following paragraph, the research findings related to teachers are discussed in detail.

The research conducted in last three decades in the area of introduction of technology into education is collectively projecting similar findings; that the teachers are the most important agents for successful/effective adoption of ICTs because they are the decision makers of either to incorporate it or not in their teaching (Albirini, 2006; Lee et al., 2007; Somekh, 2008; Teo, 2009). And among the most important issues related to teachers, it is found that the attitudes of the teachers play the most important role in this process of adoption/rejection of technologies and their continuous use in their teaching (Albion, 1999; Albirini, 2006; Cox et al., 2003; Higgins & Moseley, 2001; Knezek & Christensen, 2002; Mumtaz, 2000; Scrimshaw, 2004; Sime & Priestley, 2005; Somekh, 2008; Steketee, 2005; Teo, 2009; Xu & Moloney, 2011). As stated in the above section, attitude is the favourable or unfavourable tendency of individuals towards an entity based on the evaluation of this entity by the individuals. It is important to mention here that the findings related to the importance of attitude of the teacher in the decision process are in line with the 'Theory of Diffusion of Innovations' and 'Technology Acceptance Model'. This crucial relationship between the attitudes and the acceptance/adoption of technology has also been brought into light in the research reports which claim that the unfavourable attitude of teachers towards the technologies is one of the central reasons responsible for the slow adoption of the ICT tools/educational technologies (Albirini, 2006; Mumtaz, 2000; Steketee, 2005; Teo, 2009; Yushau, 2006). So, it has been suggested that it is vital to understand the attitudes of the teachers towards ICT, and only then would it be possible to encourage them to integrate ICT in their teaching (Albirini, 2006).

Further, it is necessary to understand the relationship between the attitude and the behaviour (e.g. acceptance of technology). Initially it was assumed that attitudes would be strong and direct predictors of behaviour (Eiser, 1987). But later research has shown that attitudes are important, but they are not the only factors that influence behaviour as pointed out by Myers (1993) in the 'Theory of Planned Behaviour'. Based on this, further research focusing on the recognition of those additional factors which contribute towards the decision of a teacher to accept or reject an ICT tool has been undertaken (Mumtaz, 2000; Teo, 2009). There has been much reported research in this area, and a variety of factors have been proposed in different studies (Albirini, 2006; Mumtaz, 2000). The point to be noted here is that the factors identified in different studies vary because of the different contexts of the studies. For the purpose of the present study, a number of research articles were examined, including literature reviews, and a number of factors, which are discussed in the next paragraph, were collected. To enable better understanding, these factors are divided into two categories; the personal factors (teacher) and the environmental factors (school) (Teo, 2009).

The personal factors or characteristics of the teacher emphasised in most of the research reports are gender, age, qualification, teaching experience, time management, computer or ICT training/confidence/competence/experience/self-efficacy/motivation of the teacher (ACS, 2005; Albirini, 2006; Armstrong et al., 2005; Higgins, Beauchamp, & Miller, 2007; Holmes, 2009; Knezek & Christensen, 2002; Mumtaz, 2000; Scrimshaw, 2004; Somekh, 2008; Steketee, 2005; Teo, 2009; Webb & Downes, 2003). Of these characteristics such as gender, age, qualification, teaching experience of the teachers are also known as extraneous or confounding variables and can be controlled within the research design (Albirini, 2006). A second category of factors is environmental factors which include all the facilitating conditions such as administrative/organisational support in the form of technical/ICT support, financial support, availability of ICT resources, access to the resources and facility for professional development (Albirini, 2006; Knezek & Christensen, 2002; Mumtaz, 2000; Scrimshaw, 2004; Somekh, 2008; Steketee, 2005; Teo, 2009).

One other factor identified by the researchers in the field of ICT education research is that of the teaching approaches of the teachers. It has been found that the pedagogical or teaching approaches of the teacher play significant role in his/her decision for adoption or rejection and the use of any educational technology in his/her teaching (Jenkins, 1999; Trucano, 2005). So, alternative teaching approaches have been analysed within the literature review for the present study with the intention of properly understanding this concept. It has been understood that an individual's teaching approach is comprised of the kinds of teaching intentions and the strategies adopted by that individual teacher (Trigwell & Prosser, 2004). Based on this, five main categories of teaching approach have been identified in the literature: teacher-focused strategy with the intention of transmitting information to students; teacher-focused strategy with the intention that students acquire the concepts of the discipline; a teacher/student interaction strategy with the intention that students acquire the concepts of the discipline; a student-focused strategy aimed at students developing their conceptions; a student-focused strategy aimed at students changing their conceptions (Trigwell & Prosser, 2004). Research has shown that the approaches of teachers not only influence their adoption of the ICT tools, but are also important in determining the effective use of a particular ICT tool by teachers (Jenkins, 1999; Trucano, 2005). Research makes evident that the teachers who use student-centred approaches of teaching tend to use ICT much more effectively in their teaching than those who are more inclined towards the teacher-centred approaches (Trucano, 2005).

After reading thoroughly about the process of adoption of ICT by teachers in the classrooms, it became clear that the decision of adopt or reject of an educational technology depends on complex interactions between many factors. These include attitudinal factors, personal factors, and environmental factors along with the approach towards teaching.

2.2.1.1.3 Students: the ultimate end-users

When the need of research into the issue of the slow integration of ICT into education rose, most of the studies concentrated on the adoption/acceptance of technology by teachers. There is no doubt that a teacher is the main decision maker when it comes to the use of a particular kind of educational technology in the classroom (Albirini, 2006; Lee et al., 2007; Somekh, 2008; Teo, 2009), but it is also important to keep in mind that teachers are not the only end-users of technological tools in education (Albirini, 2006; Mumtaz, 2000). The ultimate end-users of technology in education are students (Albirini, 2006) because the whole process of education is focused on the students and their learning. This means the actual successful integration of ICT into school classrooms can only be possible if students are also adopting or accepting it in their learning process (Selwyn, 1997). So, it is equally important to study the adoption/acceptance of the educational technology by the students as well (Noiwan et al., 2004; Zimitat, 2004).

However, it was revealed during the review of literature that there are not large number of studies have examined the attitudes, perceptions and behaviour of students towards the use of ICT in their learning; and studies focusing on secondary school students are very rare (Sun, Chao, & Shih, 2005). In a few studies done in nineties, it became clear that just giving access to computers, or other kind of ICT tools, does not necessarily result in the acceptance of that educational technology by students (Jones & Clarke, 1994; Selwyn, 1997). The reason behind this was highlighted by Ainley and Searle (2005) that for successful integration of any technology in education, it is very important for the students to start to appreciate the importance of that technology to their learning and also to adopt it to facilitate that learning. Some more studies done in the area of ICT adoption by students showed that the attitudes and perceptions of the students towards technology play a significant role in their decision to accept/reject the ICT tools (Zimitat, 2004). Other than this, their competence, confidence (Schrum & Hong, 2002) and experience with technology (Kent & Facer, 2004), availability of technology (Cavanagh, Reynolds, & Romanoski, 2004; Hopson, Simms, & Knezek, 2001), learning style, gender, age, interests and motivation (Knezek & Christensen, 2002) are factors which may affect the rate of adoption or acceptance of a technology by students.

One critical point which has been raised by some researchers is that the classroom use of a technological tool by students depends greatly on their teachers' level of use of that tool (Christensen, 2002). So, one can say that the teachers' level of adoption of an ICT tool might contribute importantly toward the students' adoption/acceptance of that ICT tool. But there is need of further research in this area.

Overall, it was found that the important student related factors are similar to the teacher related factors as far as the adoption of ICT is concerned. Thus the same theories and models were applicable in the case of students i.e., the 'Tripartite Model of Attitudes' the 'Theory of Diffusion of Innovation', the 'Technology Acceptance Model', and the 'Theory of Planned Behaviour' (Ajzen & Fishbein, 1980; Albirini, 2006; Burns, 2000; Jones & Clarke, 1994; Noiwan et al., 2004; Selwyn, 1997). The student related factors were also divided into three categories: the attitudinal factors which include affective, behavioural and cognitive components related to computers/technology; the personal factors which include age, gender, year level, learning style, computer or ICT competency/confidence/experience; and last, but not the least, were the environmental factors which include the availability of ICT, teacher support and access to ICT (Armstrong et al., 2005; Higgins et al., 2007; Hopson et al., 2001; Jones & Clarke, 1994; Newhouse, 2002; Noiwan et al., 2004; Selwyn, 1997; Zimitat, 2004).

2.2.1.2 Classroom Environment: setting for educational activity

Following this understanding of the major issues prevailing in ICT educational research as a whole, and IWB research in particular, along with understanding the salient features of IWB, the factors impacting the adoption of technology by teachers and students were also examined. The next step was to gain an understanding of the issues related to the utilization of IWB in the educational setting i.e., school classroom. For this purpose, the theory of learning which underlies the educational system in Australian schools, a model of classroom educational setting depicting the components of an ICT integrated classroom, and most importantly the research studies (although very rare) documenting the type of learning environment created due to the use of IWB, were reviewed.

2.2.1.2.1 Theories of Learning- Constructivism

The educational system of any country is built on some of the pedagogical philosophies (DETE, 2001) which define the position of various components in it (Newhouse, 2002) and in order to study any aspect of that system, the researcher should have knowledge of that philosophy. The philosophy which is the foundation of the present day educational system in Australia, also called the 'western educational system', is constructivism (Newhouse, 2002). Constructivism is the name given to the group of theories of learning (DETE, 2001), so there are many different kinds of constructivism (Liu & Mathews, 2005). However, the central element of constructivism, no matter of which kind, is that learners acquire or build knowledge on their prior knowledge in response to their experiences of 'active' participation in their environment including their social environment (DETE, 2001; Liu & Mathews, 2005; Newhouse, 2002). The kind of constructivism which includes the notion of learning in the South Australian Curriculum Standards and Accountability (SACSA) Framework is social constructivism (DETE, 2001). This concept of constructivism was provided by Vygotsky in 1978 (Liu & Mathews, 2005; Newhouse, 2002), and is also known as a socio-cultural theory of learning (Armstrong et al., 2005). In socio-cultural theory, the main emphasis is given to the learners' environment which is believed to be playing central role in the process of knowledge construction by the learners who are interacting with their immediate environment (Liu & Mathews, 2005). It means that the learning cannot be separated from its context (social interactions) in which it is taking place (Cook, 2010). "Learning is thus considered to be a largely situation-specific and context-bound activity" (Liu & Mathews, 2005, p. 388).

Another key idea given by socio-cultural theory is that human learning activities are mediated by tools (Armstrong et al., 2005). In the classroom scenario, these tools could include pen, paper, writing board, computer, diagrams, language etc. (Armstrong et al., 2005) and they are used to create the environment which can facilitate the learning. Educators around the world believe that the introduction of educational technology as a tool into the classrooms environment also needs to be strongly based on the constructivist view of learning, only then can it contribute towards supporting the learners (Newhouse, 2002). It is necessary to mention that the learning environments offer some affordances and constraints which the learner uses to generate new learning (Armstrong et al., 2005; Liu & Mathews, 2005). A third component of socio-cultural theory is that emphasis is given to the role of the teacher to scaffold the activities in order to set the learning task for the students (Newhouse, 2002).

2.2.1.2.2 Learning Environment - Educational Activity Setting Framework

It is explained in the above section that, according to the socio-cultural theory of learning, it is not possible to separate learning from the environmental context in which it is taking place. Secondly, the actions performed by learners during the construction of learning process are mediated by various kinds of tools. Educational technologies are the latest kinds of tools which are being introduced and used in the learning environments in the schools with the expectation of improving learning. A number of studies which have attempted to isolate the impact of ICT tools on learning, without considering the other prevailing factors, have concluded that there can never be a direct link between the ICT use and the learning outcome, because ICT is just an element within the learning environment (Newhouse, 2002) and it is impossible to entirely remove the effects of other elements of the learning environment (Newhouse, 2002). Another way of understanding this point is that technology can impact the learning of the students indirectly by influencing the learning environment and making it more learning supportive (Honey et al., 2005). Therefore if a researcher wants to study the impact of an ICT tool on learning, s/he should start by investigating how that particular ICT tool is enhancing the environment of learning, which could further be linked to actual student learning. But, before investigating learning environment, it is important to understand the various components or elements of a typical learning environment and how they interact with one another.

In the present study the term 'learning environment' is the classroom in a school as the school classroom is the place where actual educational activity takes place. A typical classroom in a school is a physical and cultural setting which involves a teacher interacting with a number of students with the focus on education (Kennewell, 2010; Newhouse, 2002). "Increasingly, research on learning in schools is focusing on the classroom as a setting for activity and the role of the teacher in orchestrating the features of the setting (particularly ICT) so as to optimize the potential for student learning" (Kennewell & Beauchamp, 2007, p. 227). In 2008, Kennewell et al. developed a framework to study the relationships between teachers, students and tools in a classroom learning environment, especially to study the role of new educational technologies in enhancing the learning environment and ultimately learning outcomes. The 'educational activity setting' is the term used for the classroom learning environment in this framework (Kennewell, 2010). The description of the theoretical, physical and characteristic features and the important concepts used in this framework is given in the following paragraphs (Kennewell, 2010).

Theoretically, in this framework, the learning environment portrays the socio-cultural (explained in the above section) aspects of learning. The people included in such an environment are the teacher (may also include any support staff) and the learners, and the characteristic features of all these people influence the activities taking place in this environment. These features include their previous knowledge, attitudes, experience and behaviours, and these participants interact under the constant influence of the subject culture, school culture and the social culture as a whole. Other physical components of this activity setting are the resources and tools available which help to "stimulate structure and support activity in the classroom" (Kennewell, 2010, p. 113). These tools or resources can be classified as physical tools like pen, paper, writing board; semiotic tools like language, diagrams and educational resources like books, posters, worksheets etc. ICTs can be categorized as versatile tools because it is difficult to put ICT in particular category based on its broad functionality. All the components and their characteristics, along with the aim of the activity, play decisive roles in the kind of ICT use in this activity setting. There are two important concepts attached to the components of any educational setting i.e., the affordances and constraints provided by them. The affordances provided by the features or components of an activity setting are the opportunities for actions supported by them (Kennewell, Tanner, Jones, & Beauchamp, 2008). The constraints on the other hand are the limitations applied to the activity in the form of the boundary of the action. The research into the impact of the use of an ICT tool on learning can only be possible after gaining knowledge about the affordances and constraints offered by that particular ICT tool, and also about the way in which the teachers and students use these affordances and constraints during the interaction in a learning environment.

Now in order to understand how the teacher and students interact in the learning environments using various learning kinds of tools, it is essential to consider the role of orchestration and reflection during the learning process (Kennewell, 2010, p. 117). Both these terms are related to the role of a teacher in supporting the learning task of the students. As was mentioned above, this framework is based on the socio-cultural theory of learning and one of the main considerations of this theory is that the teachers' role in scaffolding the learning process is very important in supporting students to learn effectively. Orchestration (scaffolding) is the controlled use of the affordances of the features of the learning setting by the teacher after providing a learning task to the students which challenge them to think (Kennewell, 2010, p. 115). The teacher uses orchestration of the affordances in order to provide the controlled support to the students based on their progress in the given task towards the desired learning outcome. The continuous process of reflection by the teacher on students' learning goes side by side with the process of orchestration because it helps the teacher to manipulate the affordances of the features according to students' progress. Another kind of reflection comes after the completion of the learning task which is meant for the analysis of the outcome of the task i.e., reflection on the learning outcome.

This framework of educational activity setting is general in approach and is suitable for understanding pedagogical practices taking place in the educational activity setting (classrooms). Especially, it is very useful in analysing the impact of ICT use because all the important aspects of a learning activity setting can be covered using this framework i.e., the researcher can study the "teachers' ability to teach interactively, students' ability to learn intentionally" (Kennewell, 2010, p. 118) and capability of ICT to support both of them (Higgins et al., 2007).

2.2.1.2.3 Educational activity setting with IWB as a tool

It has been clear by now that any educational technology can only impact learning indirectly by creating a supportive learning environment while working as a component of the overall educational learning environment. Secondly, in order to study the impact of an ICT tool on student learning, the researcher needs to study the interaction between a number of elements in the educational activity setting which includes the affordances and constraints of the tool itself, the pedagogical approaches of the teacher in regard to that technology and the students' perspective of the use of that tool in their learning (Higgins et al., 2007). As far as the IWB use is concerned there is serious lack of research studies bringing all these issues together. But in a very limited number of studies (qualitative), issues such as the features of IWBs and teachers' teaching approaches in the use of IWB have been explored. The findings from these research studies were reviewed in order to identify the factors related to IWB use in the classroom and these are discussed below:

A. IWB and classroom interactivity

Various advantages of IWBs for teachers and students have been listed by many authors in their articles and have been discussed in 'IWB educational research' section of this literature review. In this section, the focus is on the interactivity feature of the IWB, because this feature combines all its advantages (Kennewell &

Morgan, 2003). The understanding of which kind of classroom interactivities are supported by IWB use could help to understand the role of IWB in enhancing the whole learning environment (Haldane, 2007). Secondly classroom interactivity is considered the most important factor leading to the learning of students in an constructivist environment (Higgins et al., 2007).

The term interactivity is used here for "an interactive process that engages the learner and facilitates the cognitive development appropriate to the individual" (Cuthell as cited in Mohon, 2008, p. 306). From the perspective of interaction supported by IWB use in the classroom, two dimensions have been identified: pedagogical interaction i.e. interaction between teacher and learner or learners and learners that improves the learning, and the technical interaction i.e. the interaction between the teachers or students and the IWB itself that provide the possibility to work with wide range of digital materials (Higgins et al., 2007; Kennewell et al., 2008). In the dimension of pedagogical interactivity, the effective use of IWB offers the opportunity for teacher-student and student-student interaction by promoting deeper questioning and discussions in the classroom (Mohon, 2008). In the dimension of technical interactivity, the teachers get the advantage of presenting information using various modes of representation during whole class teaching, and students also get chance to express their knowledge and understanding using multi-modal representations (Hennessy, Deaney, Ruthven, & Winterbottom, 2007). Some of the unique features of IWB which can lead to enhanced interactivity in the classrooms if properly used are:

> *drag-and-drop (objects on the board can be moved around); hide-and-reveal (objects placed over others can be removed); highlighting (transparent color can be placed over writing or other objects); animation (objects can be rotated, enlarged, and set to move along a specified path); indefinite storage and quick retrieval of material; and feedback (when a particular object is touched, a visual or aural response is generated)*
>
> (Kennewell & Higgins, 2007, p. 207)

It is clear that if effectively used, the IWB has the affordances to promote interaction between teachers, students, subject matter and the technology itself which is not possible with other kinds of technology (Armstrong et al., 2005; Becta, 2004).

B. Stages of IWB use by teachers

The affordance of interactivity provided by IWB can only be used fully if the teachers have a clear perception of it, because IWB cannot be interactive of its own (Armstrong et al., 2005; Haldane, 2007). "The digital board simply provides an opportunity to occur; it is a medium, a mere carrier of information and messages, not the creator of the messages or the one to decide how the messages will be conveyed" (Haldane, 2007, p. 259). So, as with any other ICT tool, teachers play a central role in the effective use of IWB. A few qualitative studies have been done in the UK to explore the ways in which IWBs are used by teachers in their classrooms and, based on the different approaches adopted by the teachers, different stages of IWB use have been identified (Glover, Miller, Averis, & Door, 2007; Miller, Averis, Door, & Glover, 2005). This, so-called three-tier-classification of IWB use by teachers is briefly discussed below:

1. **Supported didactic stage:** It is basically a teacher-centred approach and is the initial stage of IWB use by teacher in a classroom. IWB use is limited to providing visual support to the lesson and mostly used just to complement a traditional way of teaching. The affordances offered by IWB like interactivity, including student participation, questioning, and discussion are not used.
2. **Interactive stage:** At this stage, the teacher become more familiar with the IWB but is not fully confident to use it to its full potential. The verbal, visual and kinaesthetic features of IWB are used to some extent to motivate the students to think and to participate during the lesson. Also at this stage the teacher frequently switches between IWB and non-IWBs e.g., simple whiteboard etc. The teachers at this stage are usually willing to further explore the affordances of IWBs and to learn to integrate it more fully in their teaching.

3. **Enhanced interactive stage:** This is the stage at which the IWB becomes the integral part of a teachers' teaching and its interactivity facility is used up to full extent by the teacher. Teachers are totally aware of the affordances offered by IWBs and are confident users of this technology. The teachers prepare and plan their lessons with the aim of giving considerable opportunity to the students to actively participate in their own learning by using IWB stimuli (verbal, visual and kinaesthetic) either as individuals, in pairs or groups or as a whole class. A wide variety of resources are used by the teacher which includes his/her own teaching resources or the one taken from the Internet.

After exploring the available research on the theoretical basis of learning and the variables interacting with each other in a classroom learning environment especially with a focus on the IWB integrated learning environment, it was clear that the learning of the students is related to the way with which variables in a learning environment i.e., school classroom interact with each other. In terms of use of an ICT tool (e.g., IWB) in the classroom, its contribution to learning largely depends on the way in which this particular tool is used, which ultimately depends on teachers' and students' attitudes and perceptions about its use along with their previous experiences of similar kind of other ICTs.

2.2.1.3 Student Learning: the educational end-product

Towards the end of building the theoretical framework for the present study, the focus was on developing the understanding about the concept of learning because learning is the ultimate end-product of the educational system. Apart from this, the literature in the area of ICT educational research as a whole, and IWB educational research in particular, has highlighted the lack of evidence of the impact of IWB use on the learning outcomes of the students (Chandra & Lloyd, 2008; Jamieson-Proctor & Finger, 2008; Kennewell & Beauchamp, 2007; Reynolds, Treharne, & Tripp, 2003; Schuck & Kearney, 2007; UNESCO, 2009). In order to design research to undertake investigations, the knowledge and understanding of the various concepts of learning were vital, along with clear idea of the type of learning outcomes focused on the research.

To address this, a model of the learning process, a theory of learning approaches of students, both given by John Biggs (Biggs, Kember, & Leung, 2001) and the taxonomy of learning objectives given by Benjamin Bloom (Krathwohl, 2002) were reviewed. All of these i.e., the model, the theory and the taxonomy are discussed in the following sections along with a brief description of the ideas which have been used in the present study.

2.2.1.3.1 Students Approaches to Learning (SAL) theory

The idea of an approach to learning was introduced by Marton and Säljö in 1976 when they investigated the relationship between student perceptions of a reading task and their learning of it (Biggs et al., 2001; Rao, Gu, Zhang, & Hu, 2007; Serife, 2008). Later on, the idea of different approaches to learning was extensively elaborated by Biggs which led to the emergence of 'student approaches to learning (SAL) theory' in 1987 (Biggs et al., 2001; Rao et al., 2007). According to this theory, there are basically two kinds of approaches which a student can adopt while learning. These are the 'surface approach' and the 'deep approach' (Biggs et al., 2001; Phan & Deo, 2007; Marton & Saljo as cited in Serife, 2008).

Theoretically, the categorization of the learning approach is based on the idea that "students approach their studies for various reasons and these reasons influence the way they go about their learning" (Phan & Deo, 2007, p. 721). In the SAL theory the reasons for approaching a learning task are denoted by the word 'motives' and the ways with which students approach their learning are named as 'strategies' of learning. Further, it is stated that students choose a particular kind of learning strategy based on their motive to learn (Phan & Deo, 2007). If the motive is extrinsic e.g., to avoid failure etc., then the student will most probably think of just fulfilling the minimum requirements and choose a strategy such as rote learning or memorizing etc. (Biggs et al., 2001; Phan & Deo, 2007; Rao et al., 2007; Serife, 2008). This is considered as a surface learning approach. On the other hand if the motive is intrinsic e.g., gaining deep understanding of a concept etc., then the student will adopt strategies like wide reading and discussions etc. (Biggs et al., 2001; Phan & Deo, 2007; Rao et al., 2007; Serife, 2008). This motive and strategy combines to form deep learning approach. Based on this it was suggested that the students should be encouraged to adopt the deep approach to learning because it leads to life-long learning as compared to surface approach which is just the reproduction of the information with little understanding (Biggs et al., 2001; Phan & Deo, 2007; Serife, 2008).

Overall, one can say that the learning approach of the students was identified as a factor which plays very important role in the learning outcomes of the students. Later on, the relationship between learning approaches and learning outcomes of the students in a typical classroom environment was studied extensively by Biggs, and he developed a model explaining the whole process of learning. This model is discussed in the next section.

2.2.1.3.2 3-P model of learning process

The 3-P model of learning (Figure 2.4) was developed by John Biggs in 1989, and this divides the process of learning into three phases i.e., presage, process, and product. "The overarching assumption is that learning outcomes are a result of the interactions of teaching and learning contexts with student approaches to learning" (Dix, 2007). In other words, one can say that the activities taking place in the learning situation or environment i.e., interaction between students, teachers and the learning context results in a student's particular approach towards learning (Entwistle & Ramsden as cited in Dix, 2007; Phan & Deo, 2007). Among many variables playing a role in deciding which approach will be chosen by the student, the role of teaching environment or learning context is considered as the most critical (Serife, 2008). This relationship is shown in the process phase of 3-P model which illustrates that students' belief or perceptions of the good teaching/learning environment encourage them to adopt a deep learning approach whereas perceptions of bad teaching/learning environment lead them to adopt a surface learning approach (Dix, 2007; Serife, 2008).

Next, the relationship between the process phase and the product phase of this model depicts that students' approach towards learning plays a critical role in deciding the quality of learning outcomes (Dix, 2007). Generally speaking, the deep approach to learning is linked with high quality of student learning outcomes; whereas the surface approach leads low quality of learning outcomes (Biggs et al., 2001; Dix, 2007; Rao et al., 2007; Gijbels et al. as cited in Serife, 2008). Academically speaking, low quality learning outcomes can be exemplified as mere reproduction of the facts or ideas without any kind of evaluation or analysis done by student in contrast to the high quality learning outcomes such as analysing, experimenting, or creating new information, concepts or ideas (Rao et al., 2007).

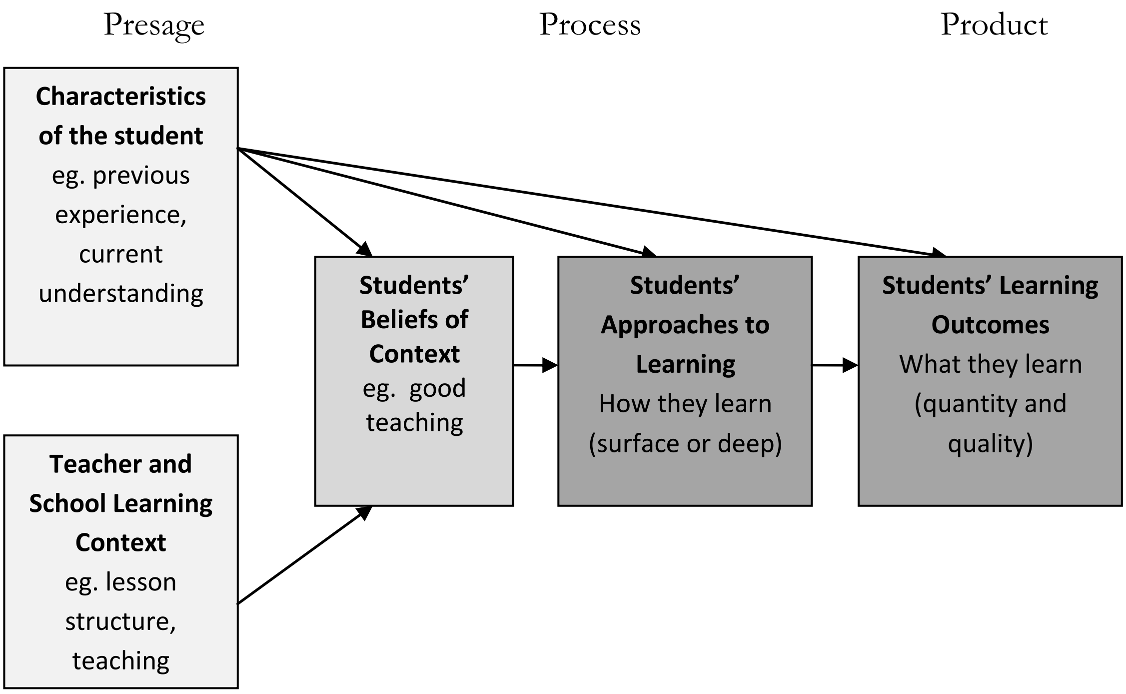


Figure 2.4: Biggs' 3-P model of learning process (Dix, 2007)

The 3-P model of learning process was considered to be suitable to use for designing a research study focusing on the impact of IWB integrated learning environment on learning of the students because it clearly illustrates the relationship between student and teacher characteristics, teaching/learning environment and student learning in the form of students' approaches to learning and learning outcomes. The description of students' different approach to learning has already been given in the previous section. The next section will deal with the concept of learning outcomes of the students which has been utilized in designing the present study.

2.2.1.3.3 Taxonomy of Learning Objectives- the cognitive domain

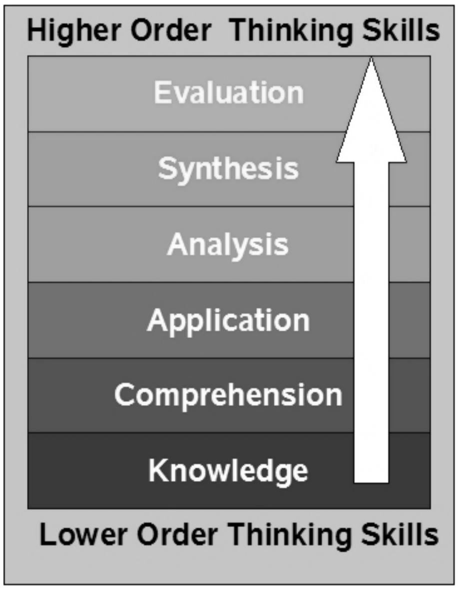


Figure 2.5: Bloom's Taxonomy (Churches, 2009)

The Taxonomy of Learning Objectives (Figure 2.5) was developed by Bloom et al. in 1956 and is a classification of educational aims i.e., student learning outcomes which are expected as a result of instruction (Halawi, McCarthy, & Pires, 2009; Krathwohl, 2002). The importance of mentioning the learning objectives in the curriculum was highlighted by Tyler in 1949 when he stated that these objectives could be used as the guidelines to evaluate the learning of the students (Halawi et al., 2009). The Taxonomy of Educational Objectives, also known as Bloom's original taxonomy, was developed for similar purposes i.e., to guide the researchers, curriculum developers, teachers/instructors in evaluating the learning system and the course material, as well as the student learning after completing a course (Halawi et al., 2009; Krathwohl, 2002). In this taxonomy the learning was categorized into three domains which are the cognitive domain, affective domain and psychomotor domain (Krathwohl, 2002). "The cognitive learning domain focuses on mental skills that help the learner to know, comprehend, apply what he/she learned to a new situation, analyse, synthesise/construct and evaluate the value of ideas and materials"(Odhabi, 2007, p. 1127). The affective domain deals with the emotions, feelings and attitudes towards the learning and the psychomotor domain focuses on physical movement, coordination or motor-skill area (Halawi et al., 2009; Odhabi, 2007).

The focus of Bloom's original taxonomy was the cognitive domain of learning (Halawi et al., 2009; Krathwohl, 2002). This domain was divided into six categories of learning outcomes arranged in order starting from the simple (concrete) and moving towards the complex ones (abstract) (Halawi et al., 2009; Krathwohl, 2002; Odhabi, 2007). Initially, this cognitive taxonomy did not receive much attention of the researchers and educators but later on it was largely accepted, being translated into 22 languages (Krathwohl, 2002) and used extensively to evaluate the learning of the students in different learning environments (Halawi et al., 2009). The main reason of the widespread use of cognitive taxonomy is its suitability to apply to secondary and higher level of education (Chyung as cited in Halawi et al., 2009).

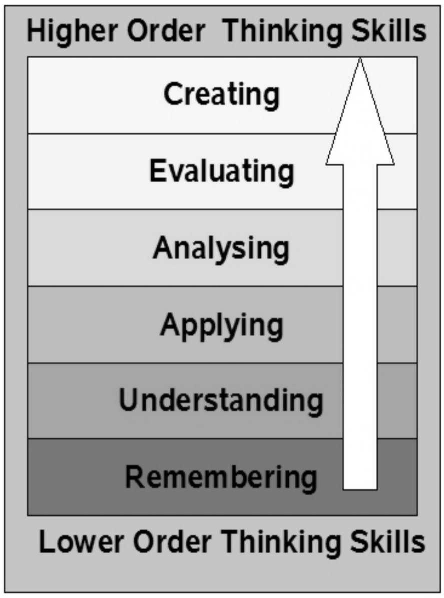


Figure 2.6: Bloom's Revised Taxonomy (Churches, 2009; Krathwohl, 2002)

Later, in 2001, Lorin Anderson and David Krathwohl revised the original Bloom's Taxonomy which is popularly known as Bloom's Revised Taxonomy (Figure 2.6). In the revised form, the original one-dimensional cognitive taxonomy is converted into two-dimensional form with two categories named as 'knowledge' and 'cognitive processes'. The 'knowledge' dimension is almost similar to the 'knowledge' category of the original taxonomy and the 'cognitive processes' dimension "resembles the six categories of the original Taxonomy with the Knowledge category named Remember, the Comprehension category named Understand, Synthesis renamed Create and made the top category, and the remaining categories changed to their verb forms: Apply, Analyze, and Evaluate" (Krathwohl, 2002, p. 218).

Bloom's Revised Taxonomy is developed to categorize the different levels of cognition based on their quality and therefore is a powerful tool in the hands of educators, teachers or instructors to use while designing and developing the quality learning experiences for the students (Churches, 2009; Krathwohl, 2002). The bottom three categories of this taxonomy are grouped as 'Lower Order Thinking Skills' (LOTS) and the upper three are called 'Higher Order Thinking Skills'

(HOTS) (Figure 7). The first two levels named 'remembering' and 'understanding' are usually considered as base for all the upper categories of objectives (Churches, 2009; Krathwohl, 2002). The categories which come in HOTS are linked to the development of deeper cognitive ability in the learner and are most important from the educational point of view (Churches, 2009).

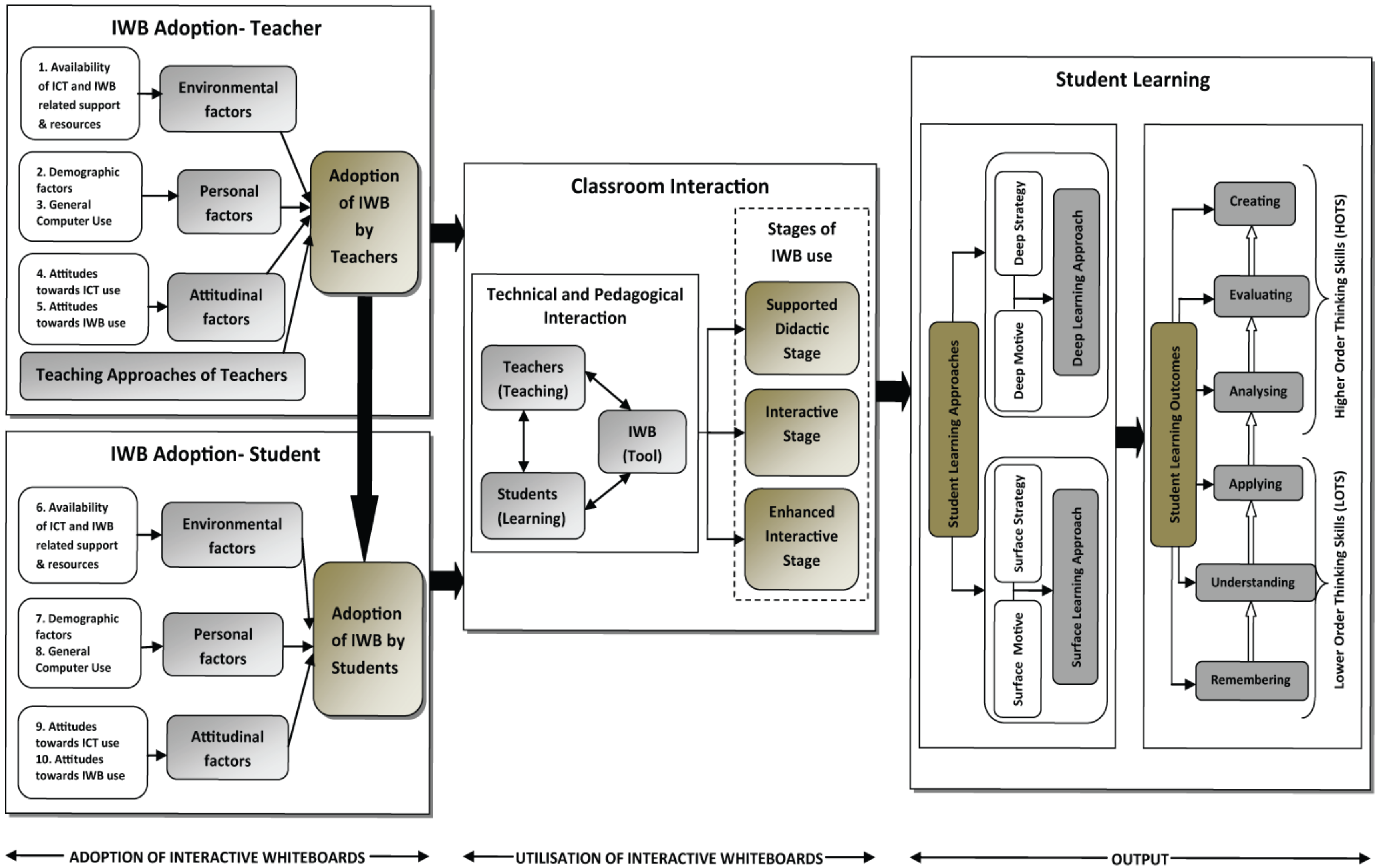
One critical point which emerges from this taxonomy is that different types of learning environments and experiences could foster different types of cognitive abilities which are categorized in this taxonomy at different levels (Churches, 2009). Secondly, it is a well-known fact that the higher order thinking skills (HOTS), which are mentioned as the most important ones, can only be developed in the students when the teacher plans or designs the higher order thinking activities or environments so that the students can be engaged in these activities (Tarlinton, 2003). Based on the above mentioned two important points, it was decided to use the Bloom's revised taxonomy to evaluate the student learning/cognitive outcomes in IWB integrated learning environments to determine its impact on the learning, if any (Bailey, 2001; Halawi et al., 2009). It is also important to mention here that the researchers have frequently used Bloom's taxonomy to examine students' learning outcomes in a traditional classroom environment, but there is lack of studies done in ICT integrated learning environments (Halawi et al., 2009).
So, the theoretical framework to guide the present study was developed by putting together the information from all the above sections, and is presented in Figure 2.7.

2.2.2 The Explanation of the Theoretical Framework

This section deals with explanation of the theoretical framework given in Figure 2.7. Broadly speaking, the basis of this framework were taken from the Learning Process Model given by Biggs which is also called the '3-P model of learning process' (1989) and is explained in the above sections. Although the theoretical framework for this research consisted of three phases just like 3-P model, the variables in these phases differ from that of 3-P Learning Process Model. Thus the names of these phases were different i.e., the IWB Adoption Phase, the IWB Utilization Phase, and the Learning Output Phase. In the first phase, the focus was on analysing the IWB adoption of teachers and students in South Australian secondary schools. As shown in Figure 2.7, the adoption was studied at the teacher level and the student level. Based on the knowledge from the ICT adoption theories and models, various potentially relevant factors affecting the adoption of the ICT/IWB by teachers and students have been mentioned. The factors affecting the teachers' adoption have been categorized into four categories: environmental factors, personal factors, attitudinal factors and teaching approaches of the teachers. At student level, also, there were the same categories of factors affecting use of ICT/IWB by students, except the teaching approach which was specifically related to teachers. Another important point to mention here is that the environmental factors basically include the ICT/IWB support and resources provided by the schools, so the knowledge and understanding of these factors added another level in the investigation at the adoption phase i.e. the School level.

The next phase mentioned in this framework was of IWB utilization in the classroom. Here the 'classroom activity setting framework' given by Kennewell et al. (2008) was used. This framework was used with the intention of investigating the technical and pedagogical interactions between the teacher, the students and the IWB in classroom learning environment. It was necessary to study the classroom interactions using IWB because, during the literature review, it was found that research studies conducted to find a direct link between ICT use and student learning, without considering the other factors impacting the learning of the students, have concluded that there could not be a direct link between the use of ICT and learning outcomes of the students. So the decision was made to investigate the impact of IWB on student learning in an indirect way by introducing the concept of classroom interactions using ICT based on Kennewells' framework, and then studying the impact of these interactions on learning. Based on the different stages of use of IWB by the teacher, the interaction in the classroom was categorized as Supported Didactic, Interactive and Enhanced Interactive as suggested by Miller et al. (2005).

Figure 2.7: Theoretical Framework: Impact of the use of Interactive Whiteboard (IWB) on the secondary school students' learning in South Australia



The last phase of this framework was the output phase where the ultimate outcome of education i.e., student learning was included. Based on the detailed study of the concept of student learning, the 'Student Approaches to Learning Theory' given by Biggs in 1987 and a 'Bloom's revised taxonomy of learning objectives' revised by Anderson & Krathwohl in 2001 were selected to study the impact of different types of use of IWB on student learning. The student learning approach was studied as a deep or surface approach, and the student learning outcomes as 'lower order thinking skills' and 'higher order thinking skills'.

So briefly speaking, the above stated theoretical framework proposed that personal, attitudinal and environmental factors influence the adoption of IWB by both teachers and students. Further the level of adoption of the IWB influences the way it is used in the classroom which in turn influences the learning approaches and ultimately the quality of the learning outcomes of the students. So, this framework was used to study the relationship between the teacher and student level adoption of IWB; its level of utilization in the classroom; and the learning approaches and quality of learning outcomes of the students at secondary school level in South Australia with the ultimate purpose of providing evidence for the impact of IWB use on student learning.

2.3 Summary

This chapter provides the details about the research literature reviewed for the development of the theoretical framework used in the present study. The description about the various factors which were identified in the previous literature and used to develop the theoretical framework is given in the different sections. All these factors are discussed under three headings i.e., Adoption of ICT in Education, Classroom Environment and Student Learning. The last section of this chapter consists of the illustration of theoretical framework used in this study along with the explanation of its components.

Chapter 3
Data Collection: Methods and Methodology

3.1 Introduction

This research study aimed to examine the impact of the use of Interactive Whiteboards (IWBs) on the learning of the students at the secondary school level in South Australia. This involved investigating a number of factors which were identified through an extensive review of the literature related to this field of study, and were used to develop a theoretical framework for this study (Figure 2.7, Chapter Two). As already mentioned in Chapter Two, this theoretical framework consists of three phases which involved factors from three levels of investigation i.e. School level, Teacher level and Student level. So, the main purpose of this study was to investigate the inter-relationships among these factors at these three levels and to examine how they impact the learning approach and outcomes of the students. To fulfil the purpose of this study it was necessary to design this research carefully by selecting and using appropriate research methods for selecting the participants and data collection instruments (including pilot testing) and for collecting and analysing the data.

This chapter outlines the methodology and methods used in this research for data collection, including the sample for the study, the instruments used for the data collection, the pilot study, the procedure of data collection and the ethical considerations.

3.2 Research Design

3.2.1 Data Collection Methods

This research was conducted using a mixed method design which included the use of both quantitative and qualitative methods for collecting and analysing data (Creswell, 2005, p. 509). The decision to integrate both the quantitative and qualitative methods was based on the researcher's understanding that mixed method design can provide a more comprehensive picture and better understanding of the research problem (Creswell, 2005, p. 510). The quantitative method is useful in collecting numeric data from a large number of participants and the findings from quantitative study can be generalised (Creswell, 2005, p. 45). On the other hand, the qualitative data are mainly collected in the form of words from a small number of participants and is analysed to obtain deeper understanding about the phenomenon (Creswell, 2005, p. 45; Key, 1997). The mixed method design combines the advantages of both quantitative and qualitative approaches (Creswell, 2008, p. 559) and hence can yield superior understanding (Johnson & Onwuegbuzie, 2004) of the research questions (Thurmond, 2001). In other words, it can be said that the mixed method design of research is best suited when the researcher is interested in studying a research phenomenon in a multidimensional way by collecting extensive data to provide answers to the research questions (Burhanuddin, 2013, p. 102). Further, it is necessary to note that, although both the quantitative and the qualitative data were collected in this study, the study was predominantly quantitative with qualitative data being used to provide the extra support in the form of in-depth information regarding some crucial research issues.

3.2.2 Sample

The participants in this study were secondary school teachers and students in South Australia. A two-stage purposive sampling technique or judgmental sampling (Battaglia, 2008) was used by the researcher to select the participants for this research. The two-stage purposive sampling is one of the categories of the non-probability sampling technique (Sweeney, 2010), and is used when the researcher selects individuals who possess certain characteristics (which the researcher wants to investigate), are easily available and willing voluntarily to participate in the research study (Creswell, 2005, p. 204). In this two-stage sampling, the first-stage units were the schools with installed IWB in secondary classrooms. The second-stage units were the teachers within those schools who use IWB in their teaching and were willing to participate in this study along with their students.

3.2.3 Preparation of Instruments for Data Collection

The detailed description about the data collection instruments used in this research is given in the following sections.

3.2.3.1 Survey Questionnaires

For the quantitative phase of this research two main self-report survey questionnaires were used; one for the teachers and one for the students. Survey research is an approach which is very popularly used in educational research and is suitable for investigating the attitudes, opinions, behaviours or characteristics of a population (Creswell, 2005, p. 52). During the review of related literature, including ICT and IWB educational research and various theories and models, the researcher gained an understanding that the relationship between the use of IWB in the classroom and its impact on the learning (approaches and outcomes) of the students could only be studied by taking into consideration other prevailing factors such as the attitudes of students and teachers towards ICT in general, the attitudes of students and teachers towards IWB, the availability of IWB related support and resources, the teaching approaches of the teachers, and the classroom interactions between students, teachers and IWB. These factors could play either direct or indirect roles in the impact of IWB on student learning and were crucial to be addressed in this research.

Further, the theoretical framework (Figure 2.7, Chapter Two) was developed for this research where all the above stated crucial factors were categorised into three different phases i.e., the adoption of IWB; utilization of IWB; and student learning. This framework was further used as a guideline for developing the survey questionnaires used to collect the quantitative data during this study (Figure 3.2). Each questionnaire was divided into different sections, which were further divided into sub-sections. Each sub-section was a scale which was either developed by the researcher or was the modified form of a well-established instrument or scales used to measure a particular factor or latent variable where a latent variable is a factor which cannot be measured directly (Byrne, 1989; Diamantopoulos & Siguaw, 2000).

Each scale consisted of a number of items or questions i.e., observed variables (also called reflector or manifest variables) (Byrne, 1989) which together were used to measure the latent variable (Byrne, 1989; Diamantopoulos & Siguaw, 2000). This relationship between the latent variable (factor) and the observed variable is illustrated in Figure 3.1 which is also called a measurement model.

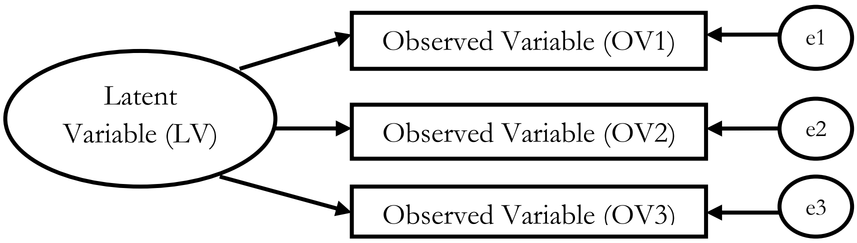


Figure 3.1: Measurement Model (Skrodal, 2010, p. 161)

It is an example of the measurement model in which one latent variable (LV) is shown to be reflected by three observed variables (OV1, OV2 and OV3). It also shows the error terms i.e., e1, e2 and e3 associated with each respective observed variable, each representing the error in measuring an underlying factor. The detailed account about the different measurement models used in this study is given in Chapters 6 and 7. Further it should be noted that the modification of most of the already established scales was necessary to suit the context of the present research study, and the details of these questionnaires are given in the following paragraphs.

3.2.3.1.1 Teacher Questionnaire

The teacher questionnaire (Appendix C) for this research was developed for the purpose of collecting information from teachers regarding their:

- demographic information
- general computer and IWB use,
- attitudes towards the use of ICT and IWB as educational tools,
- general approach towards teaching,
- classroom interactions using IWB, and
- perceptions of the impact of IWB use on student learning approaches and outcomes.

There were 138 items in the initial teacher questionnaire (before the changes made on the basis of pilot testing). This questionnaire was divided into five main sections each focusing on a particular factors which, together, collected useful data to inform the present study. The main sections of this questionnaire were personal factors; attitudinal factors; general approach towards teaching; learning environment; and student learning. Each of these sections is discussed below.

1. **Section 1- Personal Factors:** Under the section of personal factors, there were two sub-sections:
   - **Demographic factors:** The questions asked about teachers' demographic background including age, gender, years of teaching experience, teaching qualifications, subject area and year-levels where they used IWB.
   - **General information about computer use:** This sub-section contained the items designed to gather information regarding the type of use of computers by different teachers. Questions asking about the type of access to computers and the internet at and away from the school; experience, competence and confidence level of teachers in the use of computers; type of computer related training; and frequency of use of computers in their classrooms were included.

   This section was developed by the researcher and consisted of yes-no, multiple choice and rating-scale questions. The main purpose of this section was to obtain background information about the participating teachers.
2. **Section 2- Attitudinal factors:** In order to investigate the adoption of IWB by teachers and its use in the classrooms, it was important to first understand the attitudes of teachers towards technology because "teacher's attitudes play a critical role in the effectiveness of technology" (McFarlane, Hoffman, & Green, 1997, p. 3). So, the second section in this questionnaire dealt with the attitudinal factors and also consisted of two sub-sections or two scales:
   - **Attitudes towards the use of ICT as an educational tool (AICT):** The first sub-section which dealt with the ICT related attitudes of teachers was the modified form of the 'Technology Attitude Survey'

(TAS) which was developed by McFarlane et al. (1997). This survey "was developed to assess teachers' attitudes toward the general use of technology as an educational tool in the classroom" (McFarlane et al., 1997, p. 3). Hence, it was found to be suitable for investigating the attitudes of the teachers' towards ICT in this study. It is important to mention here that the items in this survey were re-worded to suit the context of the present study and 17 items out of 20 were used for the present study. Three items were excluded as they did not fulfil the requirements of the study. The reliability analysis was done by the developers of this survey which showed that it was a highly reliable instrument with 0.95 as value of Cronbach's alpha (McFarlane et al., 1997). Further the validity of this instrument "was supported by moderate correlations with the computer competency scale of the Teacher Effectiveness Scales (TES)" (McFarlane et al., 1997, p. 3). As it is already mentioned above, the AICT scale contained 17 items.

- **Attitudes towards the use of IWB as an educational tool (AIWB):** The second sub-section under this section contained a scale to assess teachers' attitudes towards the use of IWB as an educational tool in the classroom. For this purpose the researcher used a modified version of the scale, 'Teacher Attitude Questionnaire', developed by Mathews-Aydinli and Elaziz (2010). This instrument was very suitable to be used in this study because it was also developed with the purpose of studying the attitudes of the teachers toward the use of IWB (Mathews-Aydinli & Elaziz, 2010). Although, the items in this instrument were re-worded to match the Australian context of the present study. Secondly, the original was designed for the IWB use in a foreign language i.e. one subject area only but in the present study, the teachers from many different subject-areas participated, so there was a need of the more generalised items. It is also a highly reliable scale with the Cronbach's alpha of 0.78 when piloted (Mathews-Aydinli & Elaziz, 2010). The AIWB scale consisted of 24 items.

It is important to mention that in both these sub-sections the five-point Likert-scale had been used: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (A). Despite of some limitations of Likert-scale (LaMarca, 2011), it was decided to use it use it in these sub-sections because it is said to be most useful attitude scale to be used in a group-testing situation which is easy to administer (Dix, 2005), easy for the respondents to answer and the responses are easy to quantify (White et al., 2012). Another important point to mention here is that some of the items in both these scales/sub-sections were slightly reworded, and also some additional items were added in to suit the context of present study.

3. **Section 3- General Approach towards Teaching (ATI):** The third section of the teacher questionnaire, which again consisted of Likert-scale items, was designed to explore the teaching approaches of the teachers. The 'Approaches to Teaching Inventory' (ATI) by Trigwell and Prosser (2004) was used in this section without making any changes to it. This inventory has been used successfully in many studies to investigate the relationship between teacher's approaches towards teaching and students' learning approaches (Trigwell & Prosser, 2004). This was the main reason for selecting this instrument to be included in the teacher questionnaire because the researcher was also interested in studying a similar kind of relationship in this research. The author reported that the reliabilities for two sub-scales i.e., Information Transmission/Teacher-focused (ITTF) and Conceptual Change/Student-Focused (CCSF) in this inventory were 0.73 and 0.75 respectively (Trigwell & Prosser, 2004). This instrument also uses a five-point Likert-scale but the categories were different from the AICT and AIWB scales, instead using: Rarely True (RT), Sometimes True (ST), True about half the times (HT), Frequently True (FT), Always True (AT).
4. **Section 4- Learning Environment:** Section four was designed by the researcher to explore the pedagogical and technical interactions in classrooms using IWB. The scales in this section were developed by the researcher and were not adopted from any pre-existing instruments. This section was divided into two sub-sections:

- **General Information about IWB use:** This was designed by the researcher to explore the way with which the teachers used IWB in their teaching. This sub-section contained yes-no, multiple-choice and rating-scale items.
- **Classroom interactions using IWB (CIIWB):** This scale contained a series of statements designed to explore the ways that the teachers went about teaching in a specific context using IWB. It was developed entirely by the researcher based on the knowledge gained during the literature review regarding different stages of IWB use by teachers in the classroom (Glover et al., 2007). The detailed account of these stages i.e. Supported Didactic, Interactive or enhanced interactive is given in the Chapter 2 (Sub-section B of Section 2.2.1.2.3). It contained 11 Likert-scale items and the categories used were: Rarely True (RT), Sometimes True (ST), True about half the times (HT), Frequently True (FT), Always True (AT).

5. **Section 5- Student Learning:** The last section of the teacher questionnaire was compiled to study teachers' perspectives about the possible impact of IWB use on student learning. The concept of student learning was addressed in two ways in this research i.e., students' approaches towards learning and the quality of the learning outcomes. So, based on these criteria, this section of the questionnaire was also divided into two scales or sub-sections i.e., Learning Approach and Learning Outcomes. Again Likert-scale items were used in both the scales.
   - **Learning Approach (LA):** The learning approaches related items were a slightly reworded version of 'Revised Two Factor Study Process Questionnaire' (R-SPQ-2F) by Biggs et al. (2001). This is a very successful instrument which was developed for assessing the deep and surface learning approaches of the students and so was perfectly suitable for the purpose of this study. It was tested by the authors with a sample of 495 students and the Cronbach alpha values were 0.73 for Deep approach and 0.64 for Surface approach (Biggs

et al., 2001). The questions/items were re-worded in the present study in order to incorporate the role of IWB into the context, and to understand how teachers perceive the approaches of their students towards learning when IWB is used.

- **Learning Outcomes (LO):** The items for exploring teachers' perceptions about the quality of learning outcomes of students as a result of IWB use were designed by the researcher based on the 'Bloom's Revised Taxonomy of Learning Outcomes' (Krathwohl, 2002). The reasons for using Bloom's Revised Taxonomy in the present study have already been explained in the Chapter 2 (Section 2.2.1.3.3). Four items representing each level of the Bloom's Taxonomy were developed.

There were total 18 five-point Likert-scale items in the Learning Approach (LA) scale and 24 items in Learning Outcomes (LO) scale and the categories used for both these scales were same as used in the CIIWB scale i.e. Rarely True (RT), Sometimes True (ST), True about half the times (HT), Frequently True (FT), Always True (AT). The researcher had included a student learning section in the piloted teacher questionnaire for the triangulation purposes i.e., collecting and converging data regarding the same issue from different resources in order to develop better understanding (Creswell, 2005), but this section was removed from the final teacher questionnaire. The reason for not including this section in the final questionnaire for teachers is explained in the section 3.4.2. (Finalising the instruments) of this chapter.

Apart from the various scales to collect the research data from the teacher participants of this study, this questionnaire also had a permission section at the end which was included to ask the teachers about their willingness to participate in a follow-up interview. Further, the teachers were also asked to provide their contact details (telephone or email) if they were willing to participate in the interview, so that the researcher could contact them to make arrangements for the interviews.

3.2.3.1.2 Student Questionnaire

The student questionnaire (Appendix D) for this research was developed with the purpose of collecting information from students regarding their:

- general computer and IWB use,
- attitudes towards use of ICT and IWB as educational tools,
- classroom interactions using IWB, and
- perceptions of the impact of IWB use on their learning approaches and outcomes.

Along with this, demographic information was also collected from the students. There were 105 items in the student questionnaire, which was divided into four main sections each focusing on different factors. The main sections were personal factors; attitudinal factors; learning environment; and student learning. Each of these sections is discussed in detail in the following paragraphs.

1. **Section 1- Personal Factors:** The first section, which was developed by the researcher to gather demographic and general computer use information from the students, was divided into two sub-sections which were:
    - **Demographic factors:** Questions asking about the gender, year level, and subject-area which the students were studying using an IWB were included under the heading of demographic factors.
    - **General Information about your computer use:** This sub-section contained the items designed to gather information regarding the students' access to computers and internet facilities at and away from school, and the frequency of their use, along with asking about their experience, competence and confidence levels in using the computers.

    This Personal factors section contained yes-no, multiple choice and rating-scale types of questions/items.
2. **Section 2- Attitudinal Factors:** Similar to the teachers' questionnaire, the attitudinal section in the students' questionnaire also contained the items to explore the attitudes of the participants towards ICT as a whole and IWB

specifically. This section was also divided into two sub-sections dealing with ICT and IWB separately.

- **Attitudes towards the use of ICT as an educational tool (AICT):** The items used in the ICT attitude scale was taken from part one of the 'Computer Attitude Questionnaire' (CAQ v5.22) and modified and reworded according to the context of present study. The CAQ v5.22 is a version of Computer Attitude Questionnaire developed by Knezek and Christensen (1995) and is a very well established instrument. It was developed particularly for secondary school students, so was very suitable to be used in this study. There are seven parts in the original instrument but only part one was relevant to this study, so only this part was used in the student questionnaire. The scale uses 15 Likert-scale items: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (A). The Cronbach's alpha values mentioned by the authors revealed very high reliability of this instrument. Part one of CAQ v5.22 instrument contained three factors i.e., Computer Importance (Cronbach's alpha - 0.82); Computer Enjoyment (Cronbach's alpha- 0.82); and Computer Anxiety (Cronbach's alpha- 0.84) (Knezek & Christensen, 1995).
- **Attitudes towards the use of IWB as an educational tool (AIWB):** The items used in the section were taken from the 'Interactive Whiteboard Student Survey' developed by Mathews-Aydinli and Elaziz in 2010 and amended by the researcher. This survey was selected because it was developed with the purpose of exploring the attitudes of students "toward the use of interactive whiteboards (IWBs) in a foreign language" (Mathews-Aydinli & Elaziz, 2010, p. 235) and used for the similar purpose in this study. Although, because the present study included students from different subject-areas, so the items of the instrument were re-worded. Secondly, the original survey was used in Turkey, so modifications

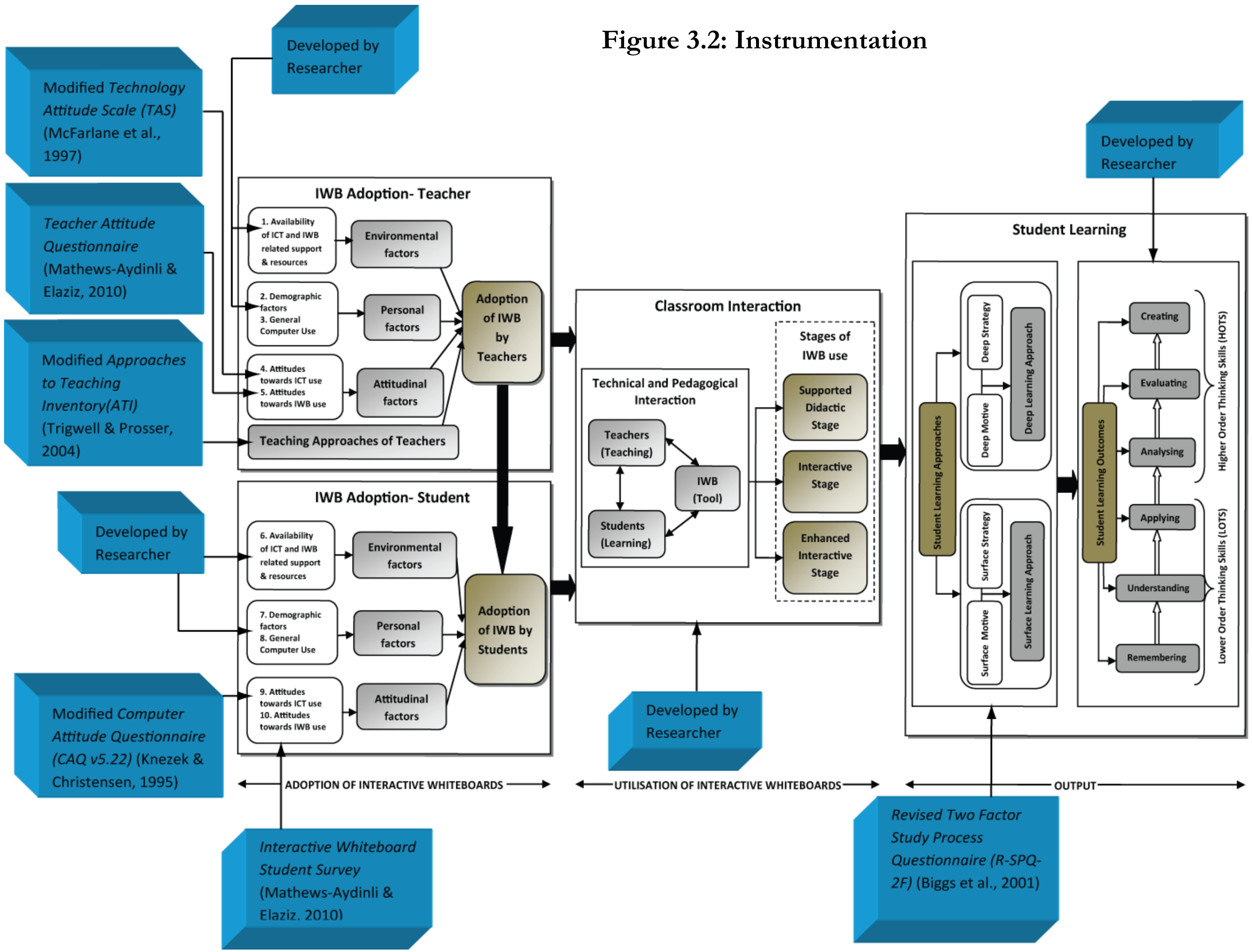
were made in the survey to suit the Australian Secondary School context. This survey was consisted of 17 Likert-scale items with the same categories as the AICT scale. When piloted by the developers, this questionnaire showed high reliability with a Cronbach's alpha value of 0.79 (Mathews-Aydinli & Elaziz, 2010).

3. **Section 3- Learning Environment:** The learning environment section was developed entirely by the researcher based on the extensive review of literature and had similar questions to teacher questionnaire, but from the students' point of view. This section also had two scales or sub-sections:
   - **General Information about IWB use:** This was designed by the researcher and consisted of the items asking about the availability of IWB to students and frequency of its use by the teachers teaching the student participants, together with questions asking about the competence and confidence level of students in using IWB. The main purpose of this sub-section was to gain background knowledge about the students' IWB use. This scale contained yes-no, multiple-choice and rating-scale items.
   - **Classroom interactions using IWB (CIIWB):** The second sub-section contained a series of statements designed to explore the types of interactions of the students in classrooms using IWB. This scale was also developed by the researcher based on the understanding, gained during the literature review, regarding the possible types of IWB use i.e. Supported Didactic, Interactive or enhanced interactive (Sub-section B of Section 2.2.1.2.3) (Glover et al., 2007). It contained similar items to the teacher questionnaire's classroom interactions scale but the wording of items was changed to obtain the responses from students' point of views. It also contained 11 Likert-scale questions with categories: Rarely True (RT), Sometimes True (ST), True about half the times (HT), Frequently True (FT), Always True (AT).

4. **Section 4- Student Learning:** The last section dealt with the student learning which contained statements allowing investigation of the perceptions of the students about the impact of IWB use on their approaches towards learning and their learning outcomes. As it contained two different aspects of student learning, it was developed in two sub-sections:

    - **Learning Approaches (LA):** For the purpose of investigating the point of views of the students towards the impact of IWB use on their approaches to learning, the Biggs 'Revised Two Factor Study Process Questionnaire' (R-SPQ-2F) (2001) was used without making any changes to it. It is important to mention that the students were asked to give response to the statements in this scale by keeping in mind their learning approaches when IWB is used. As already mentioned in the teacher questionnaire section, this is a widely used and successful instrument which is used to explore the deep (Cronbach's alpha- 0.73) and surface (Cronbach's alpha -0.64) learning approaches of the students (Biggs et al., 2001). It was the most suitable scale to use in this study.
    - **Learning Outcomes (LO):** For exploring the quality of students' learning outcomes, items which were developed by the researcher based on Bloom's Revised Taxonomy of Learning Objectives (2001) were used (Anderson et al., 2001). It is already mentioned in the Chapter 2 that the development of the cognitive abilities (quality of learning outcomes) categorised in the Bloom's Revised Taxonomy depends upon the learning environment and experiences of the students (Churches, 2009; Tarlinton, 2003), so Bloom's Revised Taxonomy was best suitable to be used to design a scale to investigate the impact of learning environments using IWB on the quality of learning outcomes of the participating students. Four items were designed for each level of Bloom's taxonomy with total of 24 Likert-scale items in this scale. The main purpose behind developing this

Figure 3.2: Instrumentation



scale was to gather information regarding the students' views about the impact of IWB use on their learning outcomes.

Both of the above instruments also used a five-point Likert-type scale with the categories: Rarely True (RT), Sometimes True (ST), True about half the times (HT), Frequently True (FT), Always True (AT).

The student questionnaire also contained a permission section requesting their willingness to participate in a follow-up interview. Further, students were requested to give their contact details to help the researcher to reach them if they were ready to participate.

3.2.3.1.3 School Questionnaire

Apart from the teacher and the student questionnaire, the researcher also developed a small school questionnaire (Appendix E) to be completed by any suitable staff member e.g. the ICT coordinator or any other relevant person from the administrative staff of the school. This questionnaire contained 17 items and was designed to gather general information regarding the kind of ICT related support and resources provided by the school to its teachers and students. The information gathered through this questionnaire provided a profile of the participating school.

3.2.3.2 Interviews

The qualitative phase of this research included the teacher participants only because the number of student participants who showed the willingness to participate in the follow-up interviews was very small (only three out of 269). A face-to-face interview method was used to interview the teacher participants. The interview method is one the most popular and well-accepted method of qualitative data collection (Creswell, 2005, p. 214; CSHD, 2007). The interviews were designed to be semi-structured and conducted on a one-to-one basis to gain in-depth understanding (Bennett & Lockyer, 2008; Glesne, 2006) of the attitudes, perceptions and experiences of teachers (Demircioglu, 2008) related to IWB adoption, utilization and its impact on learning. The interviews were 15-20 minutes in duration and recorded using a digital voice recorder. It is already mentioned in the 'Data Collection Methods' section that the qualitative data were collected as an extension to the quantitative data collected in this study with an aim of forming a more comprehensive picture of the research phenomenon.

The interview method is said to be very suitable when the researcher wants to gain in-depth understanding of attitudes, beliefs, perceptions and motives of the respondents (Barriball & While, 1994; Richardson, Dohrenwend, & Klein, 1965; Smith, 1975) and it also helps to obtain information quickly and directly from the participants (Zikmund, 1997). Secondly, it provides the advantage of comparing the responses of the participants by making sure that all the participants respond to all the questions (Bailey, 1987) and also helps to bring out other issues or ideas which could not be addressed by any other kind of data collection technique (Sekaran, 1992). Further, in a face-to face interview, the researcher has the chance to establish a sense of rapport with the participants and can use probes for obtaining more information from them, and also to clarify any confusing answers (Barriball & While, 1994). A semi-structured design of the interview allowed the researcher to have some control over the over-all direction of the conversation with the participants along with giving the much required freedom for them to express their views in their own way.

3.2.3.2.1 Preparation of the Interview Questions

The interview questions (Appendix M) were prepared by keeping in mind the focuses of the study which were

- to gain in-depth understanding of teacher's views about the use of IWB in their teaching,
- to identify the factors influencing their use of IWB in the classroom, and
- to explore their perceptions about its impact on student learning.

The questions were sequenced so that they could help the researcher to keep track of the direction of the conversation with the participants and also could be used as prompts wherever needed. The main themes which were addressed in the interviews, and formed the focuses of the questions were: the reasons behind the IWB use by teachers; their perceptions regarding use of IWB for teaching and learning; their different methods of using IWB; students' interaction with IWB in their classrooms; the kind of IWB related support and training they receive from the school; their views regarding IWB impact on student learning approaches and outcomes; and their views regarding the barriers, constraints and negative impacts of IWB use, if any.

3.3 Ethical Considerations

A researcher must always be engaged in totally ethical practices during all the steps of the research process (Kvale, 1996), so the knowledge of the ethical standards is essential for the researcher. The main issues to be considered are respecting the rights of the participants, honouring the research sites and reporting the research fully and honestly (Creswell, 2005, p. 12). The rights of the participants include the knowledge of the purpose and aims of the study, the use of the results, and the likely social consequences the study will have on their lives. They also have the right to refuse to participate in the study and may withdraw at any time (Cohen, Manion, & Morrison, 2000). Further the protection of the anonymity and confidentiality of the informants is a responsibility of the researcher (Cohen et al., 2000). Permission has to be taken before entering the research site and the researcher has to take care that he/she should not disturb the research site or keep disturbance to minimum (Creswell, 2005).

As a first step of obtaining ethical approval for this study, the research proposal was submitted by the researcher to the University of Adelaide Human Research Ethics Committee (HREC). The research received the approval from the HREC on 15th of September, 2010(ethics approval number H-152-2010). After this the ethics approval application was also submitted to education providers in South Australia; the Department of Education and Children's Services (DECS) and Catholic Education South Australia (CESA). The Association of Independent Schools of South Australia (AISSA) was also contacted to ask about the Ethics approval procedure for independent schools. CESA approved the study on 17th of November, 2010 with a condition that the researcher needed to obtain a Police Check certificate from the South Australia Police Department before commencing the data collection from the Catholic schools. The reason behind this condition was that the study included students who were under the age of 18 years. The approval from DECS was obtained on 30th of November, 2010). In the case of Independent schools, AISSA instructed the researcher to contact the participating schools directly to ask for their permission to collect the data.

Consent to participation was achieved by attaching a consent form to the questionnaire with the researcher asking the participants to fill in this form before completing the questionnaire (Appendix J). The consent form had the information regarding the title of the research project and reference to the information sheet. Other than this, the information regarding the confidentiality and the choice of the participants to withdraw consent at any time was also provided on the consent form (HREC, 2010). All the participants were also provided with the information sheet which contained all the information regarding the research, including the nature and purpose of the research, the role of the participants, possible benefits and risks of the study and privacy issues (HREC, 2010). This information was given to help the participants to decide whether they wanted to be the part of the research or not. Four separate information sheets were prepared for schools, teachers, students and parents (students under 18 required parent consent) respectively (Appendix F, G, H and I). Along with the consent forms for the teacher and the student participants, a parent consent form (for the students under 18 years of age) (Appendix K) and an independent complaints procedure form (Appendix L) were also distributed.

The major ethical issue in this research was the confidentiality of the participants. Assurance was given to all the participants that their privacy would be respected and that the individuals would not be identified in the final report arising from the study. They were also assured that they could withdraw themselves, or any information which they had provided, at any time during the research process.

3.4 Pilot testing of the instruments

A pilot study was conducted by the researcher to establish the validity and reliability of the teacher (Appendix: A) and student questionnaires (Appendix: B) before proceeding to the actual data collection phase. A pilot study plays an important role in determining the adequacy of the research questionnaires for the study before the actual study (Forgasz & Kaur, 1997; Hopkins, 2000; Teijlingen & Hundley, 2001). It helps the researcher identify any kind of inappropriateness, confusion, complexity and ambiguous language in the survey instruments (Forgasz & Kaur, 1997; Hopkins, 2000). In this way, the pilot study is very useful for refining the questionnaires which then ultimately improves the main study (Forgasz & Kaur, 1997).

The schools chosen for the pilot study were all independent schools. The main reason for this was that the researcher had no ethical approval from DECS (for public schools) and CESA (for catholic schools) at the time of the pilot study. So, contacting the independent schools was the only option because, in the case of independent schools, each school decides on an individual basis regarding participating in any research and granting the permission for conducting data collection. As the first step towards collecting the pilot data, the researcher approached two schools in the Adelaide Metropolitan area. Both of these schools showed great interest and willingness to participate in the pilot study. Further, arrangements were made by the schools for the researcher to meet with the ICT coordinators of these schools to talk about the significance of this research study in detail and also to explain about the type of participation needed from the schools. After that, the researcher met with the participating teachers and their students to explain briefly about the research topic. The researcher provided the survey questionnaires (both teacher and student) along with the consent forms, information sheets and complaint forms to the participating teachers during these meetings. As all the participating students were younger than 18 years of age, to comply with ethical requirements it was necessary for the students to have their parents sign the consent form before them completing the questionnaires. Hence, after consultation with the participating teachers, it was decided to give 3-4 days to the students to fill in the questionnaire at their homes and bring the filled questionnaire back along with the signed parent consent forms. Their teachers collected these from them and they were handed over to the researcher at a previously decided day and time. Four teachers and 47 students from these two schools participated in the pilot study.

3.4.1 Pilot data analysis

Data analysis for the Pilot study was undertaken in February, 2011. The Statistical Package for the Social Sciences (SPSS) software program was used to enter, organise and prepare the pilot data for analysis. The main purpose of analysing the pilot data was to examine the validity and reliability (consistency) of the student and teacher questionnaires. The validity of teacher questionnaire was established by using the concept of content validity (Forgasz & Kaur, 1997) and in case of student questionnaire, the construct validity (Creswell, 2005) was also established along with the content validity. The construct validity of teacher questionnaire was not possible to establish because of very small sample size (four) of teachers in the pilot study. The content validity of teacher and student questionnaires was established by asking for the feedback and suggestions from two education research experts from the university (before conducting pilot study). In the case of the teacher questionnaire, four teachers (participants in the pilot study) from two different schools were also asked for their feedback and opinion about improving it. The construct validity of student questionnaire was established by using a suitable type of factor analysis (exploratory factor analysis) using Varimax rotation with SPSS software. Based on the values shown in 'Rotated Component Matrix' in the Output file, all the items from all the scales were behaving well.

As far as the reliability or internal consistency of a scale was concerned, Cronbach's alpha (α), which is based on the Classical Test Theory (CTT) statistics, is one of the most commonly used indices (Skrodal, 2010). The reliability analysis is based on the idea that, because all the questions/items in a scale are meant to measure same factor, so they must be correlated to each other (Skrodal, 2010). The reliability analysis for different scales constituting the student questionnaire was undertaken using SPSS software which showed that three scales (AIWB, LA, LO) out of five were showing high reliability but two scales (AICT and CIIWB) were not showing high values of Cronbach alpha (See Table 3.1). In spite of showing low Cronbach's

Alpha values, it was decided to keep these scales in the final student questionnaire because they were aimed particularly at measuring the constructs which had crucial importance in the conceptual framework of this research. Secondly, it was expected that these scales might show better reliability results with a bigger sample size after the final (actual) data collection and analysis.

Table 3.1: Cronbach's Alpha values for different scales of Student Questionnaire

S.No.	Name of the Scale	Label of the Scale	Cronbach's Alpha
1	Attitudes towards ICT	AICT	0.32
2	Attitudes towards IWB	AIWB	0.89
3	Classroom Interactions using IWB	CIIWB	0.18
4	Learning Approaches	LA	0.99
5	Learning Outcomes	LO	0.99

3.4.2 Finalising the Instruments

The final teacher questionnaire (Appendix C) was different from the one used in the pilot study (Appendix A). The teacher questionnaire for the pilot study included a feedback section at the end to identify the views of participating teachers about the length, language and usefulness of the questionnaire. All the teachers who participated in the pilot study suggested that they found the teacher questionnaire to be a little lengthy and also that the teachers might not be in the position to comment about the learning approaches and outcomes of the students, so this section should not be included in the questionnaire. Based on these suggestions, the last section of the teacher questionnaire i.e., Student learning (Learning approaches + Learning Outcomes) was removed. So, the final teacher questionnaire contained 96 items. The final student questionnaire (Appendix D) was identical (105 items) as the one used in the pilot study except for some minor changes.

3.5 Final Data Collection procedure

3.5.1 Selection of schools, teachers and student participants

To select the participants, the researcher first selected those secondary schools in South Australia which were having IWB installed in their classrooms. There are three main education providers in South Australia; Department of Education and Children's Services (DECS), Catholic Education South Australia (CESA) and Association of Independent Schools of South Australia (AISSA). The total number of secondary schools in South Australia is 247 among which 158 are the DECS schools, 33 are Catholic schools and 56 secondary schools are Independent schools (Australian Schools Directory, 2011). All the three types of schools were contacted by the researcher mostly via telephone to enquire about the availability of IWB facility in their secondary classrooms. The schools which had IWB installed in their secondary classrooms were then again contacted via email to ask about their willingness to participate in the present study. The email contained details regarding the research topic and the kind of participation needed from the schools. The researcher also attached the Research Information Sheet, Consent Forms, Complaint Form and a scanned copy of ethical approval from the concerned education provider along with the email.

The researcher had a positive response from 16 schools, which showed interest in being part of this study. Following this, the researcher contacted either the Principals or the ICT coordinators of these schools and arranged a face-to-face meeting to explain the research topic and the kind of participation needed from the school. In most of the participating schools, the ICT coordinators took the responsibility of distributing the questionnaires among the teachers who used IWB and were willing to participate in this research study. In some instances the researcher obtained the contact details of the teachers who used IWB and contacted them directly via email or telephone to ask about their willingness to participate. Eventually 30 secondary school teachers from different subject areas participated from 12 different schools. Two types of schools participated; public schools (seven schools) and independent schools (five schools). None of the catholic secondary schools participated in this study mostly because of their busy schedules and other research commitments. The student participants came from those classes which the participating teachers were teaching using IWB. Out of 30 participating teachers, students of 18 teachers participated in this study. The number of returned filled student questionnaires was 280, but after the preliminary examination of these questionnaires, it was found that 11 questionnaires were either not filled completely or not filled at all, hence these questionnaires were excluded, and so the number of student participants whose data was used in this study was 269 (See Table 3.2).

Table 3.2: Table showing description of the number of participants

S.No	School description (type)	No. of schools	No. of teachers	No. of students	No. of teachers in interviews
1	Government (Public) Schools	7	23	140	10
2	Independent Schools	5	7	129	6
	Total	12	30	269	16

The participants for the qualitative phase (Interviews) of this research were the secondary school teachers who participated in the quantitative study and were self-selected because they were asked in the survey questionnaire about their willingness to participate in the face-to-face interviews. Out of 30 teachers who participated in this study, 16 agreed to participate in the interviews.

3.5.2 Administration of the survey questionnaires

In this research, the quantitative phase, which was the predominant phase of data collection, started from the second school term in the year 2011. As already described above (Section 3.2), in this phase the surveys were used to collect data by using quantitative questionnaires (Creswell, 2005). Three types of questionnaires were used for gathering data from participants at three levels i.e., school level, teacher level and student level. The details of these questionnaires are given in the section 3.2 of this chapter.

All the questionnaires were delivered personally by the researcher to the relevant person in each school, which was either the ICT coordinator of the school or the participating teacher him/herself. The questionnaires delivered were ready for distribution with the information sheets, consent forms and complaint forms inserted into each questionnaire separately. This was done to ensure hassle free distribution of the questionnaires among the students and participating teachers. In most of the schools, the researcher met the teachers personally to explain about the research topic and the data collection process. In some schools, the researcher also interacted face-to-face with the students before distributing the questionnaires with the purpose of explaining the research study and to address any questions from them regarding filling in the questionnaire.

The questionnaires were delivered separately to each school at separate times during the whole year of 2011 starting from second term of school. The main reason for this was that each school was responding to the request for data collection at its own convenience based on its schedule and the availability of the teachers to participate. Apart from this, some schools took a very long time just to decide on their willingness to participate in this study. So the whole process of first convincing each school to participate, then convincing the teachers and their students to participate, followed by arranging meetings with the persons in-charge to make schedules for distributing the questionnaires and then deciding about the possible time-frame needed by the students to fill and return the questionnaire, along with fixing a day to collect the filled questionnaires was a long process. And because this process of data collection started at different time for different schools, instead of starting at same time in all the schools, it took almost one year to collect the quantitative data for the study.

It is important to mention that all the participants were given the time-frame ranging from few days up to a few weeks to fill the questionnaire, except for one school where the participants, including the teacher, filled the questionnaire on the spot. This was done on the advice of the participating teachers because it was the last day of the school term and the students were going on holidays. Further as it was not in the hands of the researcher to decide a fixed time-limit for every school to return the filled questionnaires, and this decision was left to the participating teachers or the ICT coordinators of the schools. The researcher, after consulting with the participating teacher or ICT coordinator, decided on an anticipated day for collection of the returned filled questionnaires and personally collected all the filled questionnaires.

3.5.3 Conducting the Interviews

The delays in the collection of quantitative data, which was mainly due to slow response of schools and the prolonged time taken by the participants to return the filled questionnaires, forced the researcher to start the qualitative phase of data collection before the quantitative phase was completely over. The qualitative phase, which provided the elaborated information regarding the research issues, started in the month of August 2011 and was undertaken using semi-structured, one-to-one interviews to gain in-depth understanding of the complex relationship between different crucial factors (Bennett & Lockyer, 2008; Glesne, 2006) related to IWB adoption, utilization and its impact on learning.

Further, it is important to mention here that the participants of the qualitative phase were only invited for interviews after they had completed the quantitative questionnaire, as in the quantitative questionnaire, each teacher participant was asked for their willingness to participate in the follow-up interview. So the researcher could only identify the willing participants after receiving the filled quantitative questionnaire from them. So for each volunteer the quantitative phase of data collection was followed by a qualitative phase where they participated in the face-to-face interviews. The researcher took the indication of the teachers to participate in the interviews as a sign of their interest in the research topic, which gave assurance of getting valuable and in-depth information related to the research issues (Newton, 2010).

Each willing participant was contacted personally by the researcher using either phone or email, whichever was indicated as the preferred way of contact by the teachers, to make the schedule for the interview. The participants were given a free choice to select any suitable day and time based on their own schedule. This was done by keeping in mind the convenience of the teachers because they usually have extremely busy schedules. The interviews were of 15-20 minutes in duration and were recorded using a digital voice recorder. The researcher sent the list of interview questions to the teachers beforehand, so that they could get the idea about the focus of the interview. Before starting the interview, the researcher again explained the reason for the interview to each participant and asked for their permission to record the interview session using a voice recorder. After finishing the interview, the researcher thanked the participants for their time and valuable information they provided to inform this study. 16 interviews were conducted before December, 2011.

3.6 Summary

This chapter describes the research methods and methodology used in this study and thus provides details about the research design, instrumentation, and techniques of data collection. Mixed method research design, which included both quantitative and qualitative data collection, was used in this study with the intention of gaining a comprehensive understanding of the research phenomenon (impact of IWB use on student learning). The major part of data collected for this study was quantitative in nature and were collected using three survey questionnaires i.e., School Questionnaire (17 items), Teacher Questionnaire (96 items) and Student Questionnaire (105 items). These questionnaires were developed to address factors such as: demographic factors; environmental factors; attitudinal factors related to ICT and IWB; classroom interactions using IWB; teaching approaches (for teacher participants only); and learning approaches and outcomes (for student participants only). The qualitative data, which was collected from only teacher participants using a face-to-face interview method, provided additional in-depth understanding of the teachers' perceptions of IWB use in their teaching and its impact on student learning.

Chapter 4
Data Preparation and Descriptive Analysis

4.1 Introduction

This chapter provides details of the data preparation, and the descriptive analysis of the quantitative data, done in this study. It begins with the discussion of the steps taken in the preparation of quantitative data for the analysis followed by the details of the process of dealing with missing data which further led to next step of descriptive analysis including mean, variance, standard deviation and test for the normality of the data.

4.2 Data Preparation

The initial step before starting the quantitative data analysis was to prepare the data for analysis. As already mention in Chapter 3, the quantitative data for this research was collected using three different questionnaires i.e., teacher, student and school questionnaire. So these three separate sets of data were prepared using a statistical software package called SPSS (Statistical Package for the Social Sciences). In the SPSS data sets/files, the variables were represented by the columns and the total number of participants was depicted by the rows. Further, there were some negative statements within the research instruments which needed reverse scoring. So, these items were re-coded and then given the same name as that of the original item, but with an addition of a suffix "R". After entering and organizing the SPSS data files for school, teachers and students, frequency analysis using SPSS was done to check the accuracy of data entry (Kline, 1998, p. 72). The next process was to examine the data using descriptive statistics. But before moving ahead with the descriptive analysis, it was necessary to screen the data to check for any missing values, in other words, the missing data followed by the test for normality of the distribution of data. The following sections provide the details of these procedures in the context of this study.

4.2.1 Summary of the items used in research questionnaires

4.2.1.1 Summary of items used in Teacher Questionnaire

The summary of all the items in different scales of the teacher questionnaire are given in the Table 4.1, 4.2, 4.3 and 4.4. Each table contains the list of the items for each scale. A brief description about re-coded items used in each scale is also given with each table.

Table 4.1: Scale 1: Attitudes towards ICT (AICT)

Item Code	Nature of statement	Item Code to indicate reverse scoring	Item text
AICT1	Positive	None	Knowing how to use various ICT tools is a necessary skill for me
AICT2	Negative	AICT2R	I get confused when using ICT
AICT3	Positive	None	I like using ICT tools in my teaching
AICT4	Positive	None	I feel confident in my ability to learn about ICT
AICT5	Negative	AICT5R	Working with ICT makes me nervous
AICT6	Positive	None	I now use my knowledge of ICT in many ways as a teacher
AICT7	Positive	None	I wish I could use technology more frequently
AICT8	Negative	AICT8R	ICT makes me feel stupid
AICT9	Positive	None	A job using ICT would be very interesting
AICT10	Negative	AICT10R	I don't expect to use ICT much at work
AICT11	Negative	AICT11R	I am not the type to do well with ICT
AICT12	Negative	AICT12R	I feel uncomfortable using most ICT tools
AICT13	Negative	AICT13R	Working with ICT is boring
AICT14	Positive	None	It is important to know how to use ICT in order to get a teaching position
AICT15	Positive	None	I know that if I work hard to learn about ICT, I will do well
AICT16	Negative	AICT16R	ICT makes me feel uneasy
AICT17	Positive	None	I am able to do as well working with ICT as my fellow teachers

The scale 1 in the teacher questionnaire i.e., Attitudes towards ICT (AICT) scale had eight negatively stated items which were AICT2, AICT5, AICT8, AICT10, AICT11, AICT12, AICT13 and AICT16 which were re-coded and named as

AICT2R, AICT5R, AICT8R, AICT10R, AICT11R, AICT12R, AICT13R and AICT16R respectively.

Table 4.2: Scale 2: Attitudes towards IWB (AIWB)

Item Code	Nature of Statement	Item code to indicate reverse scoring	Item text
AIWB1	Positive	None	Using IWB-based resources reduces the time I spend on writing during the lessons
AIWB2	Negative	AIWB2R	When using an IWB in my lessons, I spend more time in the preparation of the lesson
AIWB3	Positive	None	I think using an IWB makes it easier to include different subject-specific learning resources when preparing the lesson plan
AIWB4	Positive	None	I think using an IWB makes it easier to display the available learning resources to the whole class
AIWB5	Positive	None	It is beneficial to be able to save and print the materials generated during the lessons
AIWB6	Positive	None	I give more effective explanations in my lessons when using an IWB
AIWB7	Positive	None	IWB helps me to easily summarize the lesson
AIWB8	Positive	None	Using an IWB, I can more easily control/manage the whole class
AIWB9	Positive	None	I can immediately reach the extra learning resources during my lesson when using an IWB
AIWB10	Positive	None	I think IWB can be a good supplement to support teaching
AIWB11	Positive	None	Using an IWB makes me a more efficient teacher
AIWB12	Positive	None	Using an IWB makes it easier for me to move back and forth in the lesson very conveniently
AIWB13	Positive	None	I like using IWB technology in my lessons
AIWB14	Negative	AIWB14R	I feel uncomfortable in front of my students when using an IWB
AIWB15	Negative	AIWB15R	I do not think my students are ready for this IWB technology
AIWB16	Negative	AIWB16R	What I do in class with my usual methods is sufficient for teaching my subject
AIWB17	Positive	None	Reviewing the whole lesson towards the end is very easy if the lesson is taught using an IWB
AIWB18	Negative	AIWB18R	I am not the type to do well with IWB-based applications
AIWB19	Positive	None	I think IWBs make learning this subject more enjoyable
AIWB20	Negative	AIWB20R	I believe that training is required to teach with IWB technology
AIWB21	Negative	AIWB21R	If I do not get sufficient training, I do not feel comfortable with using IWBs in classrooms
AIWB22	Positive	None	I can keep my student's attention in lessons longer with the help of IWB technology
AIWB23	Positive	None	I think IWB increases the interaction and participation of the students in the classes
AIWB24	Positive	None	I think my students are more motivated when I use an IWB in lessons

It can be seen in Table 4.2 that the Attitudes towards IWB (AIWB) scale had seven negative items which were AIWB2, AIWB14, AIWB15, AIWB16, AIWB18, AIWB20 and AIWB21. These items were re-coded and the re-coded items were named as AIWB2R, AIWB14R, AIWB15R, AIWB16R, AIWB18R, AIWB20R and AIWB21R respectively.

Table 4.3: Scale 3: Approaches towards Teaching (ATI)

Item Code	Nature of Statement	Item Code to indicate reverse scoring	Item text
ATI1	Positive	None	I design my teaching in this subject with the assumption that most of the students have very little useful knowledge of the topics to be covered
ATI2	Positive	None	I feel it is important that this subject should be completely described in terms of specific objectives relating to what students have to know for formal assessment items
ATI3	Positive	None	In my interactions with students in this subject I try to develop a conversation with them about the topics we are studying
ATI4	Positive	None	I feel it is important to present a lot of facts to students so that they know what they have to learn for this subject
ATI5	Positive	None	I feel that the assessment in this subject should be an opportunity for students to reveal their changed conceptual understanding of the subject
ATI6	Positive	None	I set aside some teaching time so that the students can discuss, among themselves, the difficulties that they encounter studying this subject
ATI7	Positive	None	In this subject I concentrate on covering the information that might be available from a good textbook
ATI8	Positive	None	I encourage students to restructure their existing knowledge in terms of developing new ways of thinking about the subject
ATI9	Positive	None	In teaching sessions for this subject, I use difficult or undefined examples to provoke debate
ATI10	Positive	None	I structure this subject to help students to pass the formal assessment items
ATI11	Positive	None	I think an important reason for running teaching sessions in this subject is to give students a good set of notes
ATI12	Positive	None	In this subject, I only provide the students with the information they will need to pass the formal assessments
ATI13	Positive	None	I feel that I should know the answers to any questions that students may put to me during this subject
ATI14	Positive	None	I make available opportunities for students in this subject to discuss their changing understanding of the subject
ATI15	Positive	None	I feel that it is better for students in this subject to generate their own notes rather than always copy mine
ATI16	Positive	None	I feel a lot of teaching time in this subject should be used to question students' ideas

The scale 3 of the teacher questionnaire was Attitudes towards Teaching Inventory (ATI) and as the Table 4.3 shows it did not contain any negative item, so none of the items in this scale needed re-coding.

Table 4.4: Scale 4: Classroom Interactions using IWB (CIIWB)

Item Code	Nature of Statement	Item Code to indicate reverse scoring	Item text
CIIWB1	Positive	None	In my teaching I use IWB to provide visual support to the lesson
CIIWB2	Positive	None	When I deliver lessons using IWB, students get maximum chance to participate in the learning process
CIIWB3	Positive	None	I prepare my lessons by using a number of IWB-based teaching/learning resources
CIIWB4	Negative	CIIWB4R	In my teaching using IWB I do not allow the students to work on the IWB
CIIWB5	Positive	None	I use all the features of IWB i.e., visual, verbal and kinesthetic for the representation of a topic in multi-modal form
CIIWB6	Positive	None	I use both simple whiteboard and IWB in my classroom simultaneously
CIIWB7	Positive	None	I use IWB in my teaching in the way which encourage the students to participate in classroom discussions
CIIWB8	Negative	CIIWB8R	I do not think there is any difference in my teaching with and without IWB
CIIWB9a	Positive	None	In my classroom the use of IWB creates more interaction between students in the class
CIIWB9a	Positive	None	In my classroom the use of IWB creates more interaction between students and me
CIIWB10	Positive	None	My use of IWB in my classroom helps my students initiate questioning related to the lesson
CIIWB11	Positive	None	I use IWB in a way in my classroom so that the students get more involved in their learning

The Table 4.4 above shows the items of the scale 4 of the teacher questionnaire which was Classroom Interactions using IWB (CIIWB). This scale had two negative items which were CIIWB4 and CIIWB8. These items were re-coded and the re-coded items were named as CIIWB4R and CIIWB8R respectively.

4.2.1.2 Summary of items used in Student Questionnaire

The summary of the items in different scales of the student questionnaire are given in Tables 4.5, 4.6, 4.7, 4.8 and 4.9. Each of these tables shows the items from different scales of this questionnaire. The brief description of recoded items in each scale is given after each table.

Table 4.5: Scale 1: Attitudes towards ICT (AICT)

Item Code	Nature of Statement	Item Code to indicate reverse coding	Item text
AICT 1	Positive	None	I enjoy doing things using ICT
AICT2	Negative	AICT2R	I am tired of using ICT
AICT3	Positive	None	I will be able to get a good job if I learn how to use ICT
AICT4	Negative	AICT4R	I get a sinking feeling when I think of trying to use an ICT tool
AICT5	Positive	None	I would work harder if I could use ICT more often
AICT6	Positive	None	I enjoy lessons in which I use ICT
AICT7	Positive	None	I know that ICT give me opportunities to learn many new things
AICT8	Negative	AICT8R	Working with ICT makes me nervous
AICT9	Positive	None	I believe that it is very important for me to learn how to use ICT
AICT10	Positive	None	I feel comfortable working with ICT
AICT11	Negative	AICT11R	I think it takes a long time to finish when I use ICT
AICT12	Negative	AICT12R	Using ICT tools is very frustrating
AICT13	Positive	None	ICT do not scare me
AICT14	Negative	AICT14R	I will do as little work with ICT as possible
AICT15	Negative	AICT15R	ICTs is difficult to use

The items of the first scale of the student questionnaire i.e., Attitudes towards ICT (AICT) are given in the Table 4.5. It can be seen that seven items in this scale were re-coded which included AICT2, AICT4, AICT8, AICT11, AICT12, AICT14 and AICT15 and the re-coded items were named as AICT2R, AICT4R, AICT8R, AICT11R, AICT12R, AICT14R and AICT15R respectively.

Table 4.6: Scale 2: Attitudes towards IWB (AIWB)

Item Code	Nature of Statement	Item Code to indicate reverse coding	Item text
AIWB1	Positive	None	IWB makes learning more interesting and exciting
AIWB2	Positive	None	IWB makes the teachers' drawings and diagrams easier to see
AIWB3	Negative	AIWB3R	It seems difficult for me to use the IWBs
AIWB4	Positive	None	I find opportunity to learn from different sources with the use of IWBs
AIWB5	Positive	None	I like going to the front of the class to use the IWB
AIWB6	Positive	None	I prefer lessons that are taught with an IWB
AIWB7	Positive	None	Using IWB saves time
AIWB8	Negative	AIWB8R	Sometimes deficiencies of the IWB screen and sunlight in the classroom make it difficult to see the things on the IWB
AIWB9	Positive	None	I concentrate better when my teacher uses an IWB in lessons
AIWB10	Positive	None	I like to participate in lessons more when my teacher uses an IWB
AIWB11	Negative	AIWB11R	I find it hard to keep up with the lesson in which my teacher uses IWB
AIWB12	Positive	None	I find the lesson to be more organised when my teacher uses IWB
AIWB13	Negative	AIWB13R	It makes me uncomfortable when my work is shown to the whole class on the IWB
AIWB14	Positive	None	I find it easier to keep attention during the lesson when IWB is used
AIWB15	Positive	None	Use of IWB makes it easier for me to be motivated during lessons
AIWB16	Positive	None	The lessons become more enjoyable when taught using IWB

The scale 2 of the student questionnaire was Attitudes towards IWB (AIWB) and the items for this scale are given in the Table 4.6. Four items in this scale i.e., AIWB3, AIWB8, AIWB11 and AIWB13 were re-coded and the re-coded items named as AIWB3R, AIWB8R, AIWB11R and AIWB13R respectively.

Table 4.7 on next page enlisted the items of third scale of the student questionnaire which was Classroom Interactions using IWB (CIIWB). Two items of this scale i.e., CIIWB4 and CIIWB8 were re-coded and named as CIIWB4R and CIIWB8R respectively.

Table 4.7: Scale 3: Classroom Interactions using IWB (CIIWB)

Item Code	Nature of Statement	Item Code to indicate reverse coding	Item text
CIIWB1	Positive	None	My teacher uses IWB to show us the visual material related to the lesson
CIIWB2	Positive	None	When my teacher teaches using IWB, all the students get maximum chance to participate in the learning process
CIIWB3	Positive	None	My teacher uses a number of IWB-based teaching/learning resources in lessons
CIIWB4	Negative	CIIWB4R	My teacher does not allow students to work on the IWB
CIIWB5	Positive	None	My teacher represents the information related to a topic on the IWB in multi-modal form i.e., using visual, verbal and kinesthetic forms together for a topic
CIIWB6	Positive	None	My teacher uses both simple whiteboard and IWB in the classroom simultaneously
CIIWB7	Positive	None	My teacher teaches using IWB, I participate in Classroom discussions more than usual
CIIWB8	Negative	CIIWB8R	There is not much difference between my teachers' use of a traditional board and an IWB in terms of teaching techniques and methods
CIIWB9A	Positive	None	When my teacher uses IWB, overall there is more interaction between students in the class
CIIWB9B	Positive	None	When my teacher uses IWB, overall there is more interaction between students and teacher
CIIWB10	Positive	None	I usually initiate questioning related to the lesson when my teacher teaches using IWB
CIIWB11	Positive	None	When my teacher teaches using IWB, I often get the opportunity to go in front of the class to work on IWB

The items used in the fourth scale of the student questionnaire i.e., Learning Approaches using IWB (LA) scale are given in the Table 4.8 on the next page. It clearly indicates that in this scale seven items were negatively stated and needed re-coding. These items were LA3, LA4, LA7, LA12, LA15, LA16 and LA19. The recoded items were named as LA3R, LA4R, LA7R, LA12R, LA15R, LA16R and LA19R respectively.

Table 4.8: Scale 4: Learning Approaches using IWB (LA)

Item Code	Nature of Statement	Item Code to indicate reverse coding	Item text
LA1	Positive	None	I find that at times learning gives me a feeling of deep satisfaction
LA2	Positive	None	I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied
LA3	Negative	LA3R	My aim is to pass the course while doing as little work as possible
LA4	Negative	LA4R	I only study seriously what's given out in class or in the course outlines
LA5	Positive	None	I feel that virtually any topic can be highly interesting once I get into it
LA6	Positive	None	I find most new topics interesting and often spend extra time trying to obtain more information about them
LA7	Negative	LA7R	I do not find my course very interesting so I keep my work to the minimum
LA8	Positive	None	I learn some things by rote, going over and over them until I know them by heart even if I do not understand them
LA9	Positive	None	I find that learning can at times be as exciting as a good novel or movie
LA10	Positive	None	I test myself on important topics until I understand them completely
LA11	Positive	None	I find I can get by in most assessments by memorizing key sections rather than trying to understand them
LA12	Negative	LA12R	I generally restrict my learning to what is specifically set as I think it is unnecessary to do anything extra
LA13	Positive	None	I work hard at my studies because I find the material interesting
LA14	Positive	None	I spend a lot of my free time finding out more about interesting topics which have been discussed in class
LA15	Negative	LA15R	I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics
LA16	Negative	LA16R	I believe the teachers should not expect students to spend significant amounts of time learning topics everyone knows won't be examined
LA17	Positive	None	I come to most classes with questions in mind that I want answering
LA18	Positive	None	I make a point of looking at most of the suggested readings that go with the lessons
LA19	Negative	LA19R	I see no point in learning material which is not likely to be in the examination
LA20	Positive	None	I find the best way to pass examinations is to try to remember answers to likely questions

Table 4.9: Scale 5: Learning Outcomes (LO)

Item Code	Nature of Statement	Item Code to indicate reverse coding	Item text
LO1	Positive	None	I find it easier to recall a topic which is taught by my teacher using IWB
LO2	Negative	LO2R	I do not understand the lessons when my teacher uses an IWB
LO3	Positive	None	When I learn about a new topic using IWB, I can think of its use in my day to day life very easily
LO4	Positive	None	When new topics are introduced by my teacher using IWB, it helps me to make connections with my previous learning
LO5	Positive	None	Learning a topic using IWB helps me to make critical judgments
LO6	Negative	LO6R	Learning on IWB does not help me to improve my creative power
LO7	Positive	None	I think I can remember a topic more easily when taught using IWB rather than simple board
LO8	Positive	None	When two separate concepts or ideas are represented using IWB, I usually find myself comparing them to see the similarities or differences between them
LO9	Negative	LO9R	When a lesson is taught using IWB, I find it very hard to use my previous knowledge in it
LO10	Positive	None	I can easily explore relationships between different concepts of a topic which I learn with IWB
LO11	Positive	None	It is easier to understand the significance of a topic taught on IWB
LO12	Positive	None	I find that working on IWB in front of the class helps me to express my creativity
LO13	Negative	LO13R	I find it hard to remember the information which is represented on IWB
LO14	Positive	None	Using audio and visual materials with IWB helps me understand lessons better
LO15	Positive	None	Learning about a concept using IWB helps me to think of ways of implementing that concept to various situations
LO16	Positive	None	Making comparisons between two different ideas learnt on IWB is always easier for me
LO17	Negative	LO17R	It is hard to make judgments about the overall significance of a given idea when it is represented using IWB
LO18	Positive	None	I have noticed that learning on IWB helps me generate new knowledge out of my understanding
LO19	Positive	None	The learning material represented using verbal, visual and kinesthetic features of IWB is easy to remember
LO20	Positive	None	I find it easier to summarize at the end of a lesson which is taught with the use of IWB
LO21	Positive	None	Learning using IWB helps me to think that how can I apply the knowledge of one subject to another subject area
LO22	Negative	LO22R	I always find it hard to organize the different concepts represented on IWB in my own way
LO23	Positive	None	I could deeply evaluate any idea or concept when represented on IWB
LO24	Positive	None	When various facts and ideas are represented in a lesson using IWB it helps me to synthesize new concepts out of it

The items for the last scale of the student questionnaire, the Learning Outcomes (LO) scale, are given in the Table 4.9. Six items in this scale were re-coded which were LO2, LO6, LO9, LO13 and LO22. The re-coded items were named as LO2R, LO6R, LO9R, LO13R and LO22R respectively.

4.2.2 Missing Data

When using the survey questionnaires to collect data, the occurrence of missing data is not uncommon. The term missing data refers to the absence of "valid values on one or more variables" (Hair, Black, Babin, & Anderson, 2013, p. 40). One of the main reasons for missing data in the returned filled questionnaires is that the participants have purposefully chosen not to answer certain questions (Darmawan, 2003, p. 69). That could be due to some personal reasons, but sometimes it happened unintentionally where the participant may have missed the question by mistake (Dix, 2001). Not being able to fill in the questionnaire in the given time span (Dix, 2001) and loss of interest in it are some of the other reasons which can lead to incomplete responses to the questionnaires. The presence of missing data reduces the sample size and there are chances that analysis of data containing non-random missing data could result in biased outcomes (Hair et al., 2013, p. 40). So it is crucial for the researcher to check for the presence and the extent of missing data before beginning any kind of statistical analysis (Hair et al., 2013, p. 68). According to Hair et al. (2013, p. 45), "Tabulating the percentage of variables with missing data for each case and the number of cases with missing data for each variable is used to determine the extent of missing data and also allows checking for any exceptionally high levels of missing data that occur for individual cases or observations".

The step of checking for the presence and the percentage of the missing data further leads to the next crucial step which is handling the data which has missing values in it. Depending upon the extent of missing data, the researcher needs to decide on a remedy to deal with it in order to obtain reliable results (Hair et al., 2013, p. 68). Complete case approach (list-wise deletion), all-available approach (pair-wise deletion) and imputation methods (filling in the missing values with estimated scores) are the three types of statistical techniques used "to accommodate missing data in the analysis" (Little and Rubin as cited in Darmawan, 2003, p. 69; Hair et al., 2013, pp. 49-51).

The mean substitution method involves replacing the missing values for a variable with the "mean value of that variable calculated from all valid responses"(Hair et al., 2013, p. 51). It is the most commonly and extensively used method but it has some disadvantages. As Hair et al. (2013, p. 52) note it can change the actual distribution of values and the variance estimates along with depressing the observed correlation because all the missing data will have single constant value. On the other hand, one of the main advantages of using the mean substitution method is that it is very easy to apply and results in complete dataset with all the values available for analysis. It is also considered as best suitable method to use when dealing with low levels of missing data (Hair et al., 2013, p. 53). In the present study, the percentage of the missing data for each variable on teacher and student questionnaires was less than 5% (Appendix V and W respectively), so the imputation method using mean substitution was used to remedy the missing values in the data (Hair et al., 2013, p. 54).

4.3 Descriptive analysis

After examining the presence and extent of missing values in the research data, the next step was the descriptive analysis of the data, which is done to examine the basic characteristics of the data. The main aim for doing descriptive analysis was to summarize and describe the data in a simple way, to present the demographic information about the participants of this study and to test the normality of distribution of data. In this study, the descriptive analysis was done using SPSS software. In the following sections, a detailed account is given about descriptive techniques used in this study and its findings.

4.3.1 Mean, Variance and Standard deviation

As an initial step the mean, variance and standard deviation values were calculated for each variable on both the teacher and the student questionnaires. Appendix R and Appendix S shows the tables containing these descriptive analysis results for teacher and Student data respectively. Mean is the measure of central tendency which is used to find the most typical value in a data set (Kline, 1998, pp. 43-44). Variance and standard deviation are the measures of variation which are used to get an idea of the spread of a set of data values around its mean (Kline, 1998, p. 52).

In Appendix R, it can be seen that the range of the mean value for the variables in the teacher questionnaire is between 1.73 and 4.87. The values of standard deviation ranges between 0.346 - 1.358 and the variance values are between 0.120 - 1.845. Further, the Appendix S shows that the mean values for the variables in the student questionnaire ranges between 1.93 and 4.26. The standard deviation values show the range between 0.874 to 1.389 and the variance ranges between 0.764 and 1.930.

4.3.2 Test for Normality of Data

The test for normality of data was done to evaluate the data to examine its compliance with the statistical assumptions underlying the multivariate techniques (Hair et al., 2013, p. 68). Test for normality, which is a primary assumption in multivariate analysis, was used in this study at this step (Hair et al., 2013, p. 69). Normality can be defined as the "degree to which the distribution of the sample data corresponds to a normal distribution" (Hair et al., 2013, p. 34).

Skewness and kurtosis are two measures which are used to describe the shape of any distribution. Skewness is the measure of the symmetry of a distribution and kurtosis measures the peakedness or flatness of the distribution in comparison to the normal distribution (Hair et al., 2013, pp. 33-34). In normally distributed data, the values of skewness and kurtosis are close to zero (Darmawan, 2003, p. 88). In this research these two measures were used to examine the distribution of data for each variable. According to Kline (1998, p. 82), for the distribution to be considered as normal, the accepted absolute value for skewness should be <3 and for the kurtosis, the absolute value should be <8. This was used as a guideline for this research. The results of descriptive analysis of the teacher and student data (Appendices T and U) clearly depicts that the skewness values for all the variables are below 3 and for kurtosis also, the values are way below 8. This shows that the data in this study are normally distributed.

4.4 Summary

This chapter provides the details of the process of the data preparation used to prepare the quantitative data of this study for the analyses. It begins with the summary of the items present in the quantitative questionnaires followed by the details about the process of dealing with missing data which further led to next step of descriptive analysis including mean, variance, standard deviation and test for the normality of the data. It further presents the findings of the descriptive analysis of the quantitative data done in this study.

Chapter 5
Demographic Information on Participants

5.1 Introduction

In this chapter, the demographic information on teacher and student participants, and the general information about the participating schools, is given. This is also the part of preliminary or descriptive analysis which was used to understand the characteristics of the participants of this research. SPSS software was used to generate these results and a detailed account is given in the following sections.

5.2 Schools

This study involved 12 South Australian secondary schools. All the schools were asked to provide general information about the school especially regarding the ICT availability at the school. Table 5.1 summarizes the information collected from the participating schools using the School Questionnaire. Out of 12 schools, 10 filled the questionnaire and 2 schools did not provide any information. So in Table 5.1, the information is summarized from the 10 schools. As it is shown in the table, the level of ICT integration in these schools ranges from average to very high with only one school reporting average levels and most of them considered above average (4), high (3) and very high (2). Further, none of the participating schools had IWB installed in all the classrooms. One school had only one classroom with IWB and the maximum number of classrooms reported by another school with installed IWB was 40. When asked about the teachers and students having access to the internet, again all the schools provide full internet access to the teachers and students with the exception of one school which mentioned that more than half of the teachers have internet access at the school, but not all of them. Seven schools stated that all the teachers have full access to the software and hardware all the time and three mentioned they have full access on frequent occasions. In addition the students

Table 5.1: General Information about participating Schools

School ID	1	2	3	4	5	6	7	8	9	10
No. of Teachers	80	122	80	118	120	50	27	17 (High School)	110	97
No. of Students	780	800	1100	1385	1300	500	300	127 (High School)	980	1200
Level of ICT Integration in classrooms	4 (Above Average)	5 (High)	4 (Above Average)	6 (Very High)	4 (Above Average)	5 (High)	3 (Average)	4 (Above Average)	5 (High)	6 (Very High)
IWB installed in all classrooms	No	No	No	No	No	No	No	No	No	No
No. of classrooms with IWB installed	16	Missing	21	18	40	27	1	4	11	7
Year levels having access to IWB	3 (Half)	Missing	2 (Less than Half)	4 (More than Half)	3 (Half)	5 (All of them)	1 (Only One)	4 (More than Half)	2 (Less than Half)	5 (All of them)
On-site technical support to teachers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
On-site technical support to students	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broadband Internet connection at School	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of teachers with access to internet	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	3 (More than Half)	4 (All of them)	4 (All of them)
No. of students with access to internet	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)	4 (All of them)
Schools encourages teachers to use ICT more	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School encourages ICT related training of teachers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School runs IWB training sessions	4 (Monthly)	2 (Half Yearly)	4 (Mont--hly)	3 (Quart-erly)	2 (Half Yearly)	0 (Not at all)	2 (Half Yearly)	2 (Half Yearly)	1 (Yearly)	2 (Half Yearly)
Teachers have full access to software & hardware	5 (All the times)	4 (Freque-ntly)	5 (All the times)	5 (All the times)	5 (All the times)	5 (All the times)	4 (Frequ-ently)	4 (Freque-ntly)	5 (All the times)	5 (All the times)
Students have full access to software & hardware	5 (All the times)	4 (Freque-ntly)	4 (Frequ-ently)	5 (All the times)	4 (Frequen-tly)	5 (All the times)	0 (Not at all)	5 (All the times)	1 (Rarely)	5 (All the times)

from five schools had full access to software and hardware all the time; three mentioned frequent access, one mentioned about rare access and one school clearly mentioned that the students do not have the full access to the software and hardware. All the schools mentioned that they provide on-site technical support to teachers and students and all the schools have broadband internet connection.

Further all the schools reported that they encourage the teachers to use more and more ICT in their teaching and to also go for ICT related training with five schools running half-yearly ICT training sessions; two running monthly sessions; one quarterly and one on a yearly basis. One school did not mention any kind of ICT training sessions run by it.

5.3 Teacher participants

5.3.1 Type of Schools

Out of total 30 teachers, who participated in the study, 23 were from Department of Education and Children Services (DECS) schools and seven were from Independent schools from Adelaide and surrounding areas in South Australia.

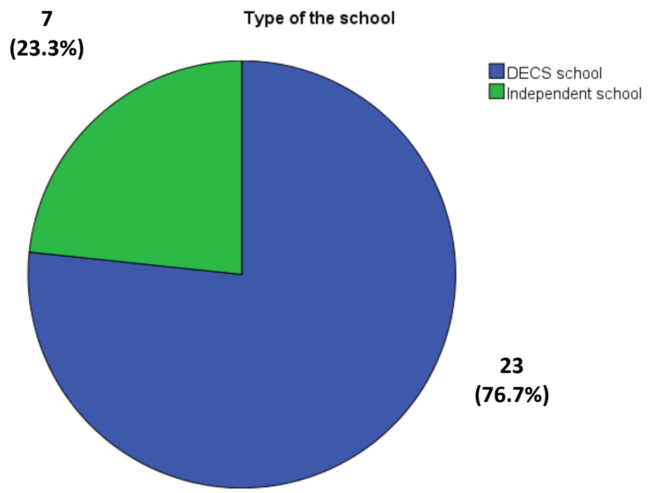


Figure 5.1: Distribution of type of schools of teacher participants

Table 5.2: Cross-tabulation of Teachers by Type of the School and School ID

		School ID												
		1	2	3	4	5	6	7	8	9	10	11	12	Total
Type of the school	**DECS school**	0	0	9	4	0	1	0	2	0	4	1	2	23
	Independent school	2	2	0	0	1	0	1	0	1	0	0	0	7
	Total	2	2	9	4	1	1	1	2	1	4	1	2	30

Table 5.2 shows the cross tabulation of teachers by type of the schools and each school's ID. School ID was the number allotted to each school in order to identify it without revealing the name of the school. This table gives a clear overall picture of the distribution of the teacher participants on the basis of the type of the school where they teach.

5.3.2 Gender distribution of Teacher Participants

Out of 30 participating teachers, 18 were female and 12 were male teachers.

Table 5.3: Gender of the Teacher Participants

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	12	40.0	40.0	40.0
Female	18	60.0	60.0	100.0
Total	30	100.0	100.0	

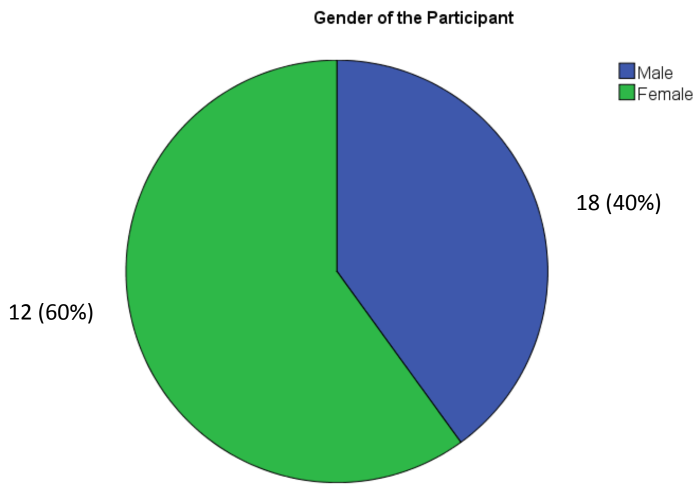


Figure 5.2: Gender of the Teacher Participants

5.3.3 Age of the Teacher Participants

The distribution of the teacher participants based on their age is presented in Table 5.4 and also in Figure 5.3 underneath. It is clear from the table and the bar-chart that maximum numbers of participants i.e., 11 (36.7%) belong to age range of 46 and above followed by the age group 41-45 with seven (23.3%) participants; four (13.3%) participants from 31-35 and 20-25 age groups each; three (10.0%) from the age range of 26-30 and only one (3.3%) participant was from 36-40 age range.

Table 5.4: Cross-tabulation of Age by Gender of the Teacher participants

		Gender of the Participant		
		Male	**Female**	**Total**
Age of the Participant	20-25	0	4	4
	26-30	2	1	3
	31-35	2	2	4
	36-40	1	0	1
	41-45	2	5	7
	46-Above	5	6	11
Total		12	18	30

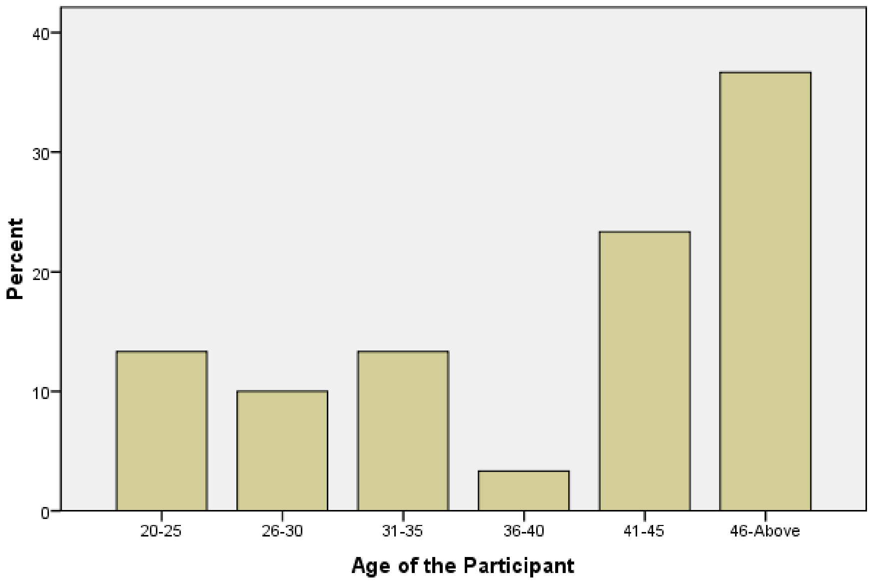


Figure 5.3: Age of the Teacher participants

5.3.4 Teaching experience of the Teacher Participants

In terms of the teaching experience, eight (26.7%) teachers had 6-10 years; seven (23.3%) had 21-above years; six (20%) had 16-20 years; four (13.3%) had 1-5 years; three (10%) had 11-15 years and two (6.7%) had less than one year of teaching experience.

Table 5.5: Teaching Experience of the Teacher Participants

Teaching Experience	Frequency	Percent	Valid Percent	Cumulative Percent
less than 1 year	2	6.7	6.7	6.7
1-5 years	4	13.3	13.3	20.0
6-10 years	8	26.7	26.7	46.7
11-15 years	3	10.0	10.0	56.7
16-20 years	6	20.0	20.0	76.7
21-above	7	23.3	23.3	100.0
Total	30	100.0	100.0	

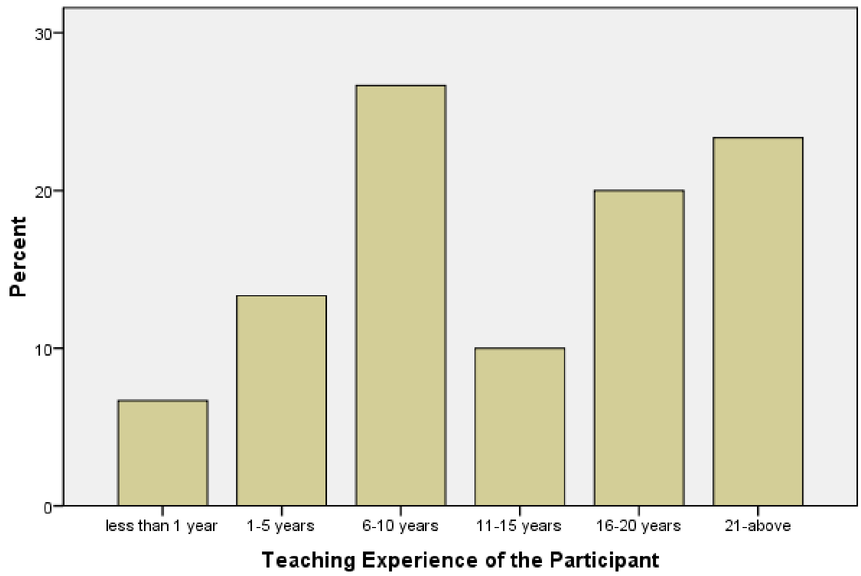


Figure 5.4: Teaching Experience of the Participants

5.3.5 Teaching Qualifications of the Participants

Figure 5.5 shows that 14 teachers (46.7%) had a Graduate Diploma in Education as their teaching qualification, eight teachers (26.7%) a Bachelor of Teaching degree, and eight some other type of qualification which is summarized in Table 5.6.

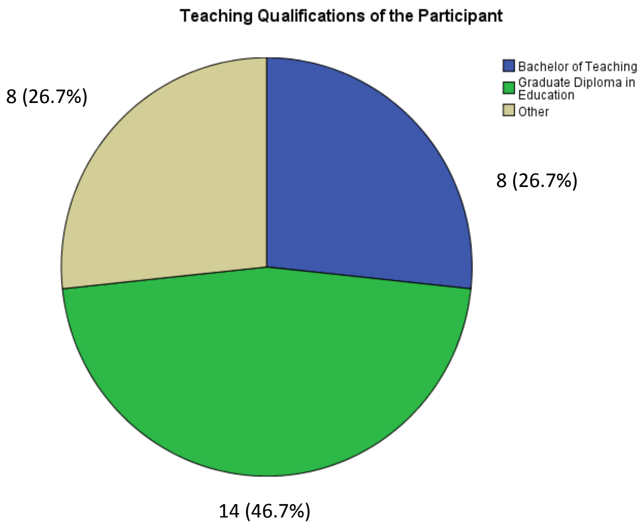


Figure 5.5: Teaching Qualifications of Participants

Table 5.6: Other teaching qualifications specified by the teacher participants

Other Qualifications	Frequency	Percent	Valid Percent	Cumulative Percent
B.A. Dip Ed GCME M.Ed	1	3.3	3.3	76.7
B.Ed	1	3.3	3.3	80.0
Bachelor of Education	1	3.3	3.3	83.3
Bachelor of education, Bachelor of Arts	1	3.3	3.3	86.7
Bachelor of Education, Certificate IV Training and Assessment	1	3.3	3.3	90.0
M.Ed B.Sc	1	3.3	3.3	93.3
PhD	1	3.3	3.3	96.7
Post Graduate of Secondary Education	1	3.3	3.3	100.0
Total	30	100.0	100.0	

5.3.6 Subject-areas taught by the participants using IWB

Because the teachers who participated in this study were from different subject areas, they were asked to specify which main subject-area they teach using IWB.

Although the teachers were asked to specify only one main subject-area, some of them selected more than one subject-area from the options provided. The results are summarized in the Table 5.7. As it can be seen, 13 teachers, which is the highest number of teachers for one subject-area, reported that they teach Science using the IWB. The second highest number of teachers was seven who teach Mathematics, four teach English, three Languages and three an Arts subject. Design & Technology and Society & Environment were two other subject-areas which were reported by one teacher each.

Table 5.7: Subject-areas taught by teachers using IWB

S.No.	Subject-area	Number of Participants
1	English	4
2	Science	13
3	Mathematics	7
4	Society and Environment	1
5	Languages	3
6	Arts	3
7	Design and Technology	1

Teacher participants were asked to specify any other subject-area they teach using IWB which were not mentioned in the options given. Six teachers stated six other subject-areas which are given in the Table 5.8.

Table 5.8: Other subject areas specified by the teacher participants

S.No.	Subject-area	Number of Participants
1	Christian Studies	1
2	Curriculum Support	1
3	Literacy	1
4	Media	1
5	Media Studies	1
6	Modern Greek	1

5.3.7 Year level to which the participants teach using IWB

The bar chart in Figure 5.6 reveals the frequency of the teachers according to the year level they teach using IWB. Seven (23.3%) teachers teach years 10 and 12 each, five (16.7%) years 9 and 11 each and three (10.0%) teachers teach years 7 and 8 each.

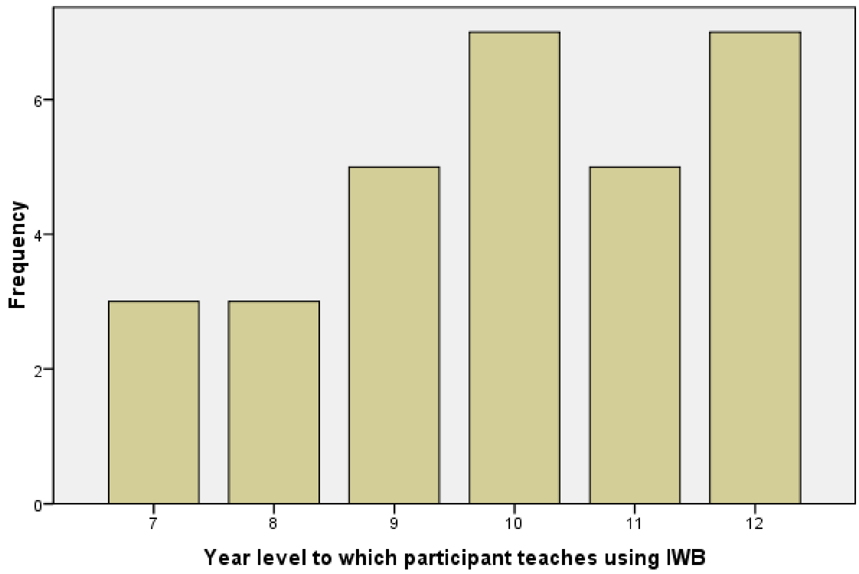


Figure 5.6: Year levels to which teachers teach using IWB

5.3.8 Access to Computer and Internet by teacher participants

All the teachers indicated that they own a computer and have full access to computer and internet facilities at and away from the school.

5.3.9 Computer Literacy of teacher participants

The teachers were asked to indicate their computer literacy level on the scale of 0-10. There were three aspects of computer literacy chosen for this purpose i.e. computer experience, computer competency and computer confidence. The teachers were asked to indicate their level of all these aspects on three separate scales. The findings from the responses of the teachers are depicted in Figures 5.7, 5.8 and 5.9 underneath. It can be clearly seen in these bar diagrams that most of the participating teachers consider themselves to be on level 5 or above in all these three aspects of computer literacy.

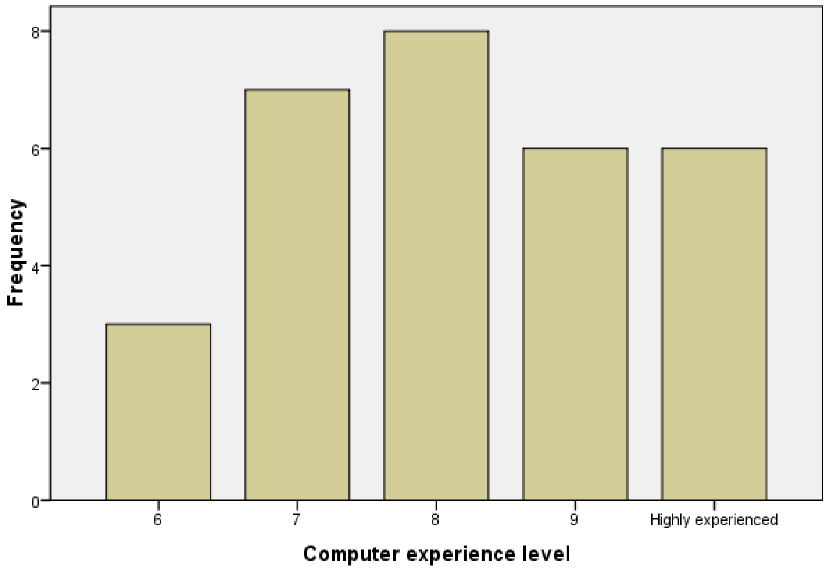


Figure 5.7: Computer experience level of teacher participants

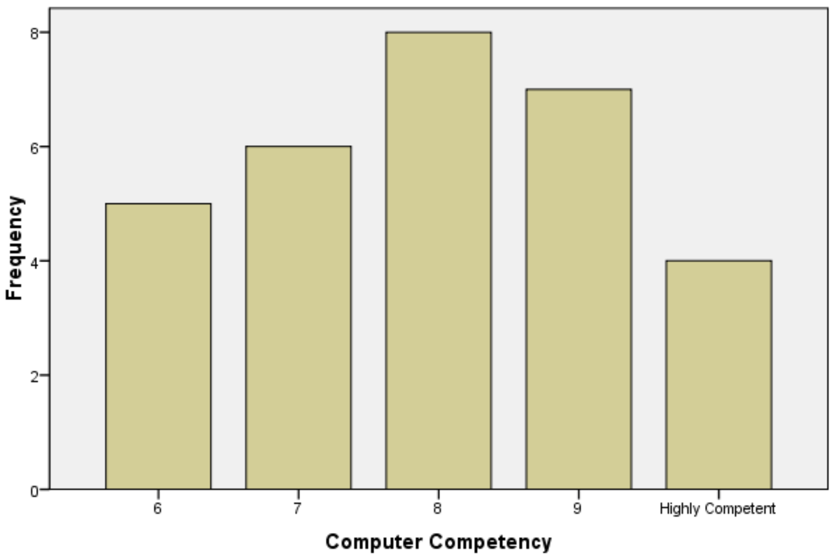


Figure 5.8: Computer Competency of teacher participants

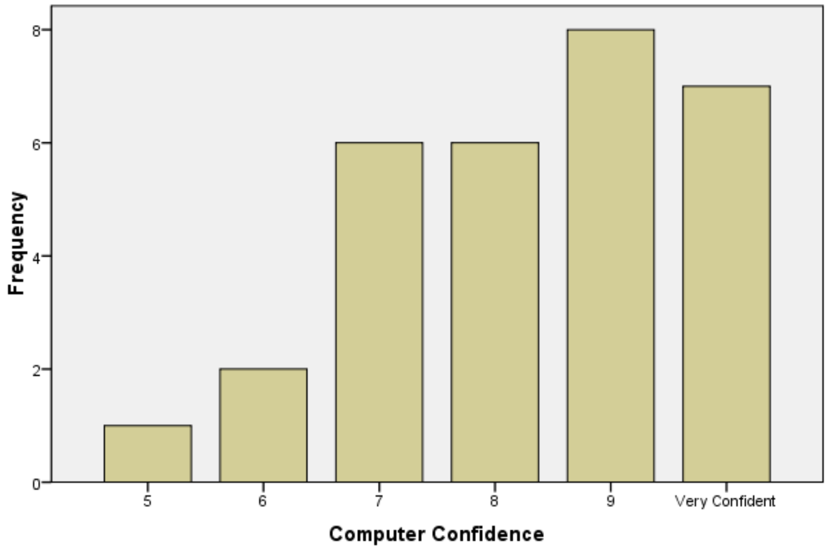


Figure 5.9: Computer Confidence of teacher participants

5.3.10 Frequency of classroom computer use by teacher participants

With regard to the frequency of computer use (Table 5.9), 22 (73.3%) teachers reported that they use computers in the classroom on the daily basis, six (20.0%) indicated about twice a week. One (3.3%) teacher stated once in a week use and another (3.3%) reported only occasional use of the computers in their classroom.

Table 5.9: Frequency of Classroom Computer use by teacher participants

Frequency of Classroom Computer use	Number of Participants	Percent	Valid Percent	Cumulative Percent
Occasionally	1	3.3	3.3	3.3
Once in a week	1	3.3	3.3	6.7
Almost twice a week	6	20.0	20.0	26.7
Daily	22	73.3	73.3	100.0
Total	30	100.0	100.0	

5.3.11 Computer Training of teacher participants

As far as the computer related training is concerned, six teachers had never had any computer related training. All the other teachers indicated having some kind of computer training which is summarized in Table 5.10.

Table 5.10: Type of computer training of teacher participants

Type of Computer Training	Number of Participants
No training	6
Basic Computer Training	6
Computer Applications	15
Computer Integration	13

5.3.12 Access to IWB by teacher participants

When asked about the ease of access to the IWB, 25 teachers out of 30 indicated that they had an easy access, but 5 indicated that they did not.

5.3.13 Frequency of IWB use by teacher participants

As it can be seen in Figure 5.10, 50% (15) of the teachers use the IWB on daily basis; 33.3% (10) use them twice a week and 16.7% (5) reported about occasional use only.

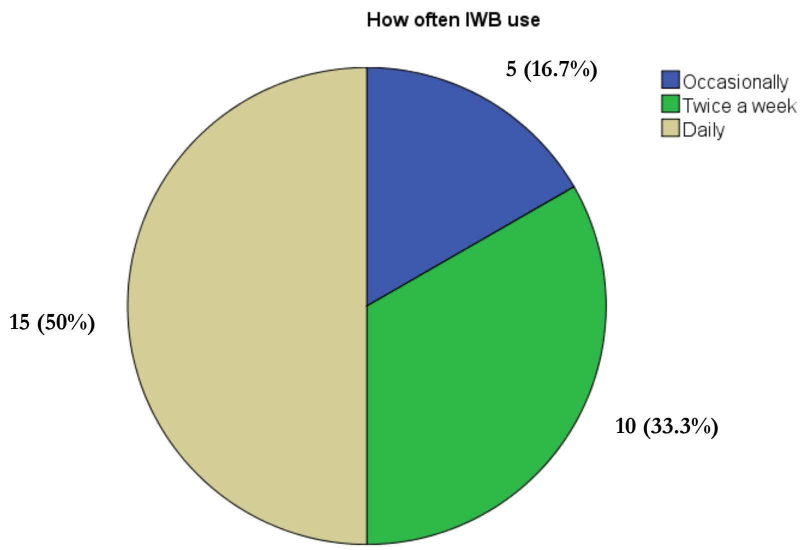


Figure 5.10: Frequency of IWB use by teacher participants

5.3.14 Type of IWB related training of teacher participants

Five teachers mentioned that they never had any kind of specific IWB related training. Table 5.11 shows that 17 teachers had basic IWB training while eight among the 30 mentioned that they had training about IWB applications/tools and further eight teachers had training for IWB integration into curriculum.

Table 5.11: Type of IWB Training of teacher participants

Type of IWB Training	Number of Participants
Basic IWB Training	17
IWB applications/tools	8
IWB integration into curriculum	8

Further, it is important to mention that 16 teachers indicated they had been self-trained as in IWB use. 20 teachers attended IWB training sessions provided by companies which installed IWB in their schools, four got IWB related training by attending IWB professional development workshops. One teacher mentioned learning from colleagues, one attached school IWB workshops, and one mentioned attendance at a CEGSA conference as the source of learning about IWB.

5.3.15 IWB related support from School for teacher participants

The findings revealed that 27 out 30 teachers indicated that their school authorities encourage them to use IWB in their teaching. The teachers were also asked about the type of IWB related support they get from their schools. The findings are depicted in Table 5.12.

Table 5.12: IWB related support for teacher participants

Type of Support	Yes	No	Sometimes	Total
IWB Technical Support at School	10	7	13	30
IWB training workshops at School	9	6	15	30
Help from Colleagues	14	6	10	30

5.3.16 Competence of teacher participants at working with IWB

The majority of teacher participants (nine) indicated their IWB competence level at 5 on a 0-10 scale. Five were at level 7 and 8, four indicated highest competence level of 10, three were at level 6 and level 9 each and one teacher indicated competence level below 5 i.e. 4 on the scale of 1-10 (See Figure 5.11). So most of the teachers indicated competence level of 5 and above except one at level 4.

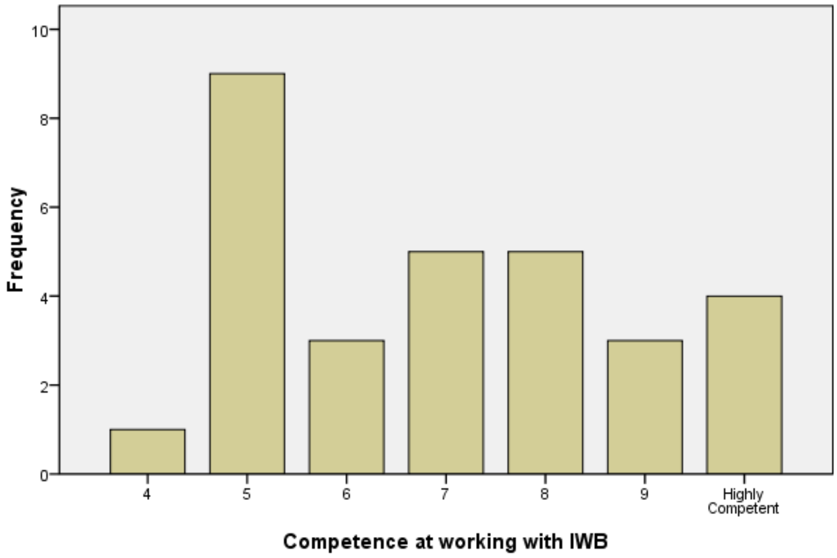


Figure 5.11: IWB competence level of teacher participants

5.3.17 IWB Confidence level of teacher participants

Similarly, the teachers also indicated their level of confidence with working with IWB (Figure 5.12). All the teachers reported level 5 or above in the IWB related confidence. Level 5, 6 and 7 were indicated by six teachers each, three teachers were at level 8; four at level 9 and five teachers indicated that they are very confident in using IWB and choose level 10 on 0-10 scale.

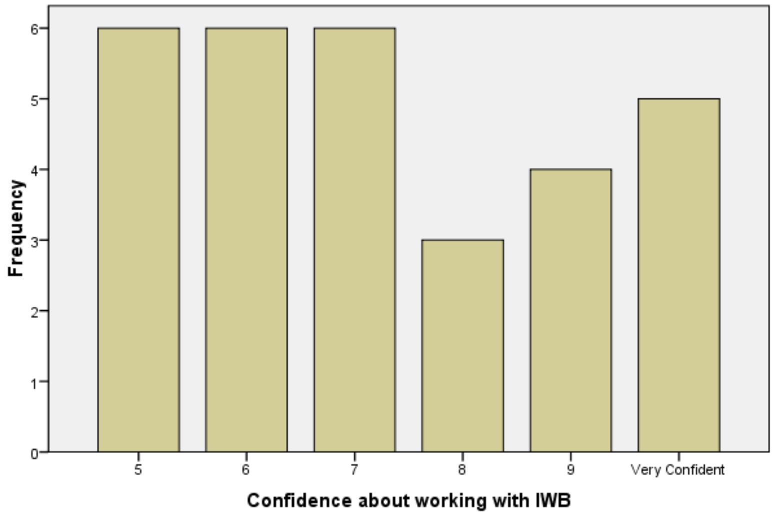


Figure 5.12: IWB Confidence level of teacher participants

5.3.18 IWB Experience level of teacher participants

With regard to the experience level in using IWB, the majority of teachers (seven) were at level 5. The next highest was at levels 6 and 7 each i.e., five each followed by level 10 with four teachers. Level 4 and 9 were indicated by three teachers each; two teachers indicated level 8 and one indicated level 3 as the experience level in using IWB (See Figure 5.13).

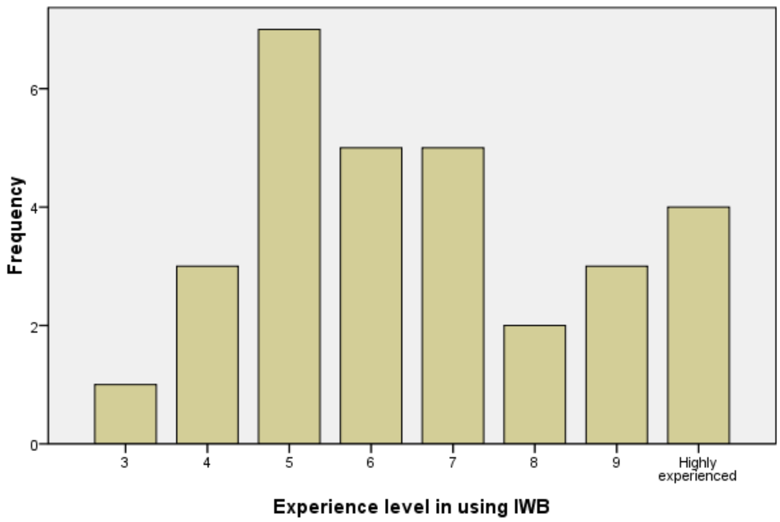


Figure 5.13: IWB Experience level of teacher participants

5.4 Student participants

5.4.1 Number of Students from each School

Out of the total of 12 schools, students of nine schools participated in the study. The frequency table on the next page (Table 5.13) shows the number of the students from each school. School ID is the number allotted to each school in order to identify it without revealing the name of the school. This table gives an overall picture of the distribution of the number of student participants among the nine participating schools.

Table 5.13: Distribution of number of student participants from each school

School ID	Frequency	Percent	Valid Percent	Cumulative Percent
1	35	13.0	13.0	13.0
2	31	11.5	11.5	25.5
3	74	27.5	27.5	52.0
4	31	11.5	11.5	63.6
5	13	5.8	5.8	68.4
6	20	7.4	7.4	75.8
7	16	5.9	5.9	81.8
8	17	6.3	6.3	88.1
9	32	11.9	11.9	100.0
Total	269	100.0	100.0	

5.4.2 Types of the Schools

Figure 5.14 shows that out of total 269 students, who participated in the study, 142 (52.8%) were from Department of Education and Children Services (DECS) schools and 127(47.2%) (Figure 5.13) were from Independent schools in Adelaide and surrounding areas in South Australia.

5.4.3 Gender of the student participants

Table 5.14 is a cross-tabulation of student participants by types of schools and their gender: there were total of 159 (59.1%) male students among whom 85 students were from DECS schools and 74 were from independent schools. On the other hand the total number of female students participating in this study was 110 (40.9%) with 57 from DECS schools and 53 from independent schools.

5.4.4 Year level of the student participants

The maximum number of student participants i.e. 78 (29.0%) were from year 11 followed by year 9 with 59 (21.9%) participants. Year 10 had 48 (17.8%) of the participants and 43 (16%) were from year 8. 24 (8.9%) students were from year 7 and 17 (6.3%) were year 12 students (See Figure 5.15).

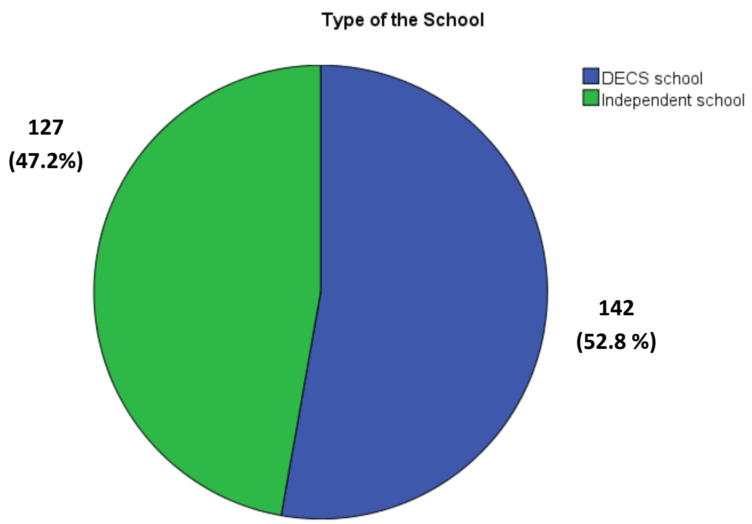


Figure 5.14: Distribution of the number of student participants based on the types of schools

Table 5.14: Cross-tabulation of Student participants by Type of School and Gender

		Gender of the Participant		
		Male	Female	Total
Type of the School	DECS school	85	57	142
	Independent school	74	53	127
Total		159	110	269

5.4.5 Subject-areas learnt using IWB by student participants

The student participants were asked to specify which main subject-area they learn using IWB. Although the students were asked to specify only one main subject, some of them selected more than one subject-area from the options provided. The results are summarized in the Table 5.15.

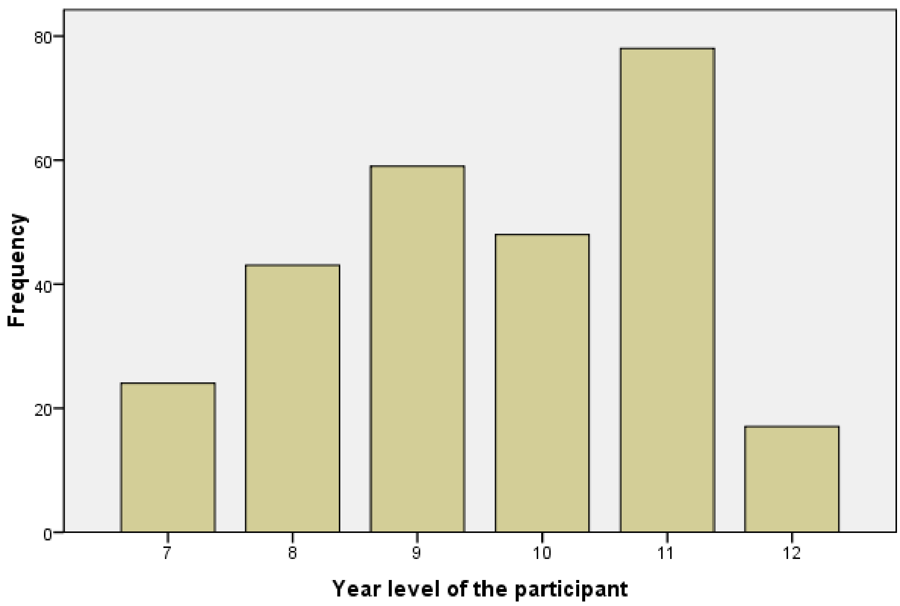


Figure 5.15: Distribution of the student participants based on their year level

The highest number of students reported that they learn Science using the IWB, the second highest number was 95 who learn English, 89 students chose the options of Mathematics and Languages each, 43 reported Design and Technology, 42 specified Society and Environment and 33 reported Health and Physical Education.

Further in Table 5.16, a list of those subject-areas is given which were reported by the students other than the options given. 30 students mentioned Media studies; 10 reported use of IWB in Support; Nine mentioned their Personal Learning Plan; Six Extension Science; five Humanities; three Christian Studies and Home-group. Two used IWB in their Research Project and one student mentioned Commerce, Information Technology, Food Technology, and Program X.

Table 5.15: Subject areas learnt by student participants using IWB

S.No.	Subject-area	Number of Participants
1	English	95
2	Science	144
3	Mathematics	89
4	Society and Environment	42
5	Languages	89
6	Arts	39
7	Design and Technology	43
8	Health and Physical Education	33

Table 5.16: Other Subject-areas specified by student participants

S.No.	Other Subject Areas	Number of Participants
1	Media	30
2	Support	10
3	Personal Learning Plan	9
4	Extension Science/Science Extension	6
5	Humanities	5
6	Christian Studies	3
7	Homegroup	3
8	Research Project	2
9	Commerce	1
10	Information Technology	1
11	Food Technology	1
12	Program X	1
13	Other	1

5.4.6 Access to Computer and Internet by student participants

All the student participants had access to computers at school and 99.3% (267) of them also indicated access to computers away from school. 99.6% (268) students mentioned having access to the internet at school and 97.8% (263) had internet access away from school (See Table 5.17).

Table 5.17: Student participant's access to Computer and Internet at and away from School

	Yes (Frequency)	**Percent**	**No** (Frequency)	**Percent**
Access to Computers at School	269	100.0	0	0.0
Access to Computers away from School	267	99.3	2	0.7
Access to Internet at School	268	99.6	1	0.4
Access to Internet away from School	263	97.8	6	2.2

5.4.7 Frequency of Computer Use at School by student participants

As far as the frequency of computer use at school is concerned, Figure 5.16 shows that 77.7% (209) students used computers daily; 12.3 % (33) almost twice a week; 1.9% (5) once a week and 7.8% (21) students use computers only occasionally.

5.4.8 Frequency of Computer Use by student participants away from School

As can be seen in Figure 5.17, 85.1% (229) students use computers daily when away from school. 5.9% (16) use them almost twice a week, and the same numbers of participants use them occasionally. Just 1.1% (3) students indicated that they never used computers away from school and 0.7% (2) reported about once in a week use.

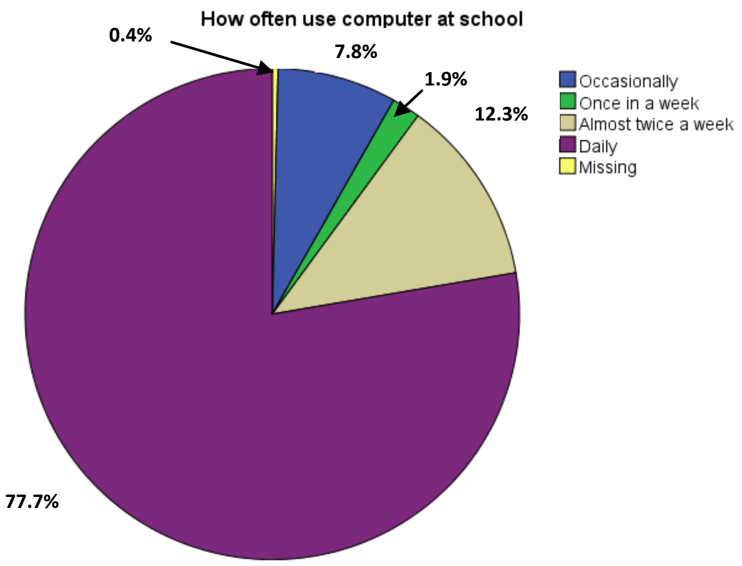


Figure 5.16: Frequency of Computer Use by student participants at school

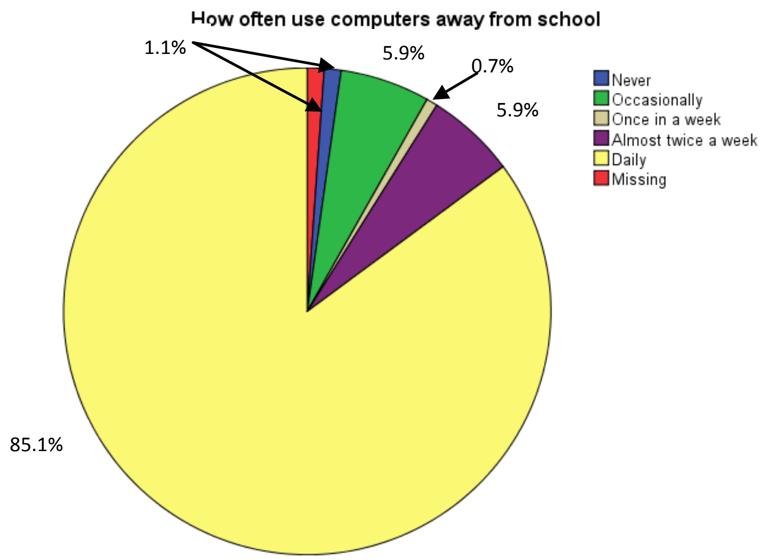


Figure 5.17: Frequency of Computer Use by student participants away from school

5.4.9 Computer Literacy Level of student participants

Just like the teachers, the students were also asked to indicate their computer literacy level on the scale of 0-10. Here also, three aspects of computer literacy were chosen i.e. computer experience, computer competency and computer confidence. As it can be seen in Figures 5.18, 5.19 and 5.20, the greatest number of students chose level 8 in computer experience (79) and competency (76). In the case of computer confidence, the greatest number (75) selected level 10 i.e. highest level of confidence. Apart from this most of the students choose higher levels (6 and above) in all the aspects of computer literacy which means that the students considered themselves highly computer literate.

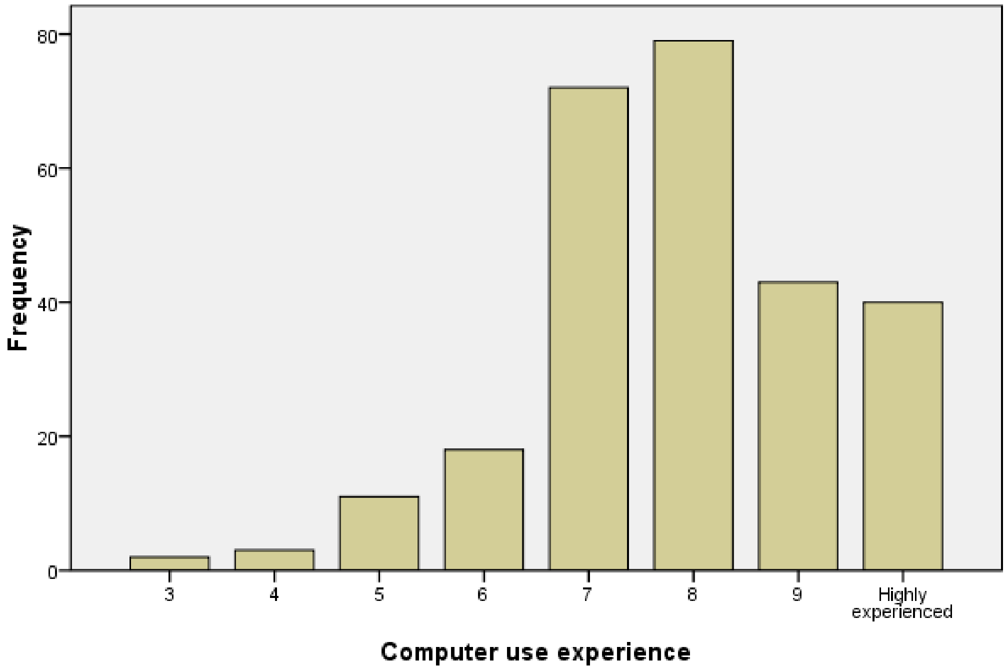


Figure 5.18: Computer use experience of student participants

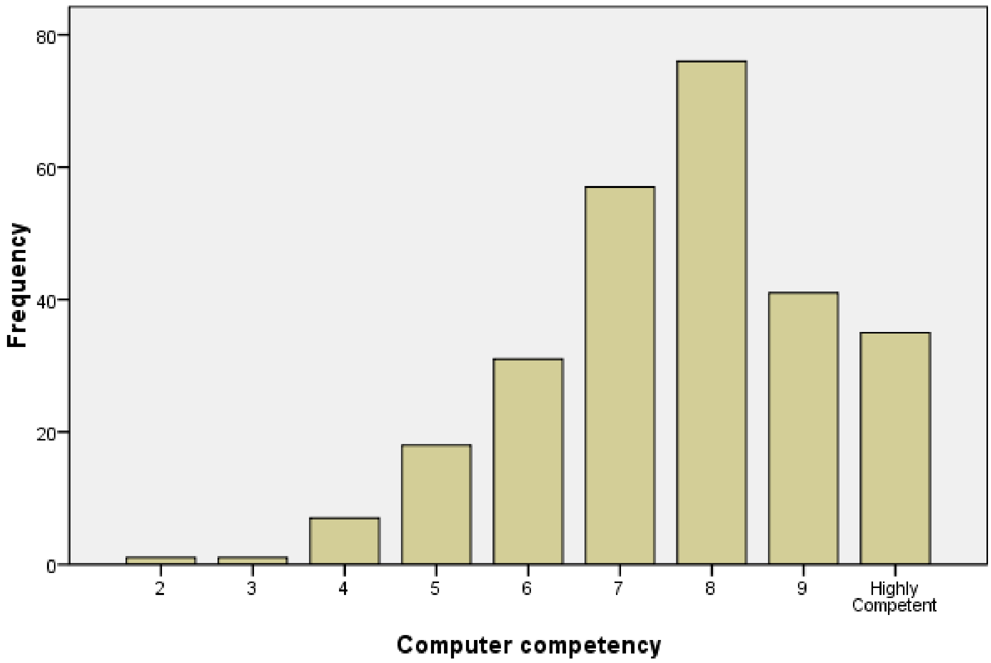


Figure 5.19: Computer competency level of student participants

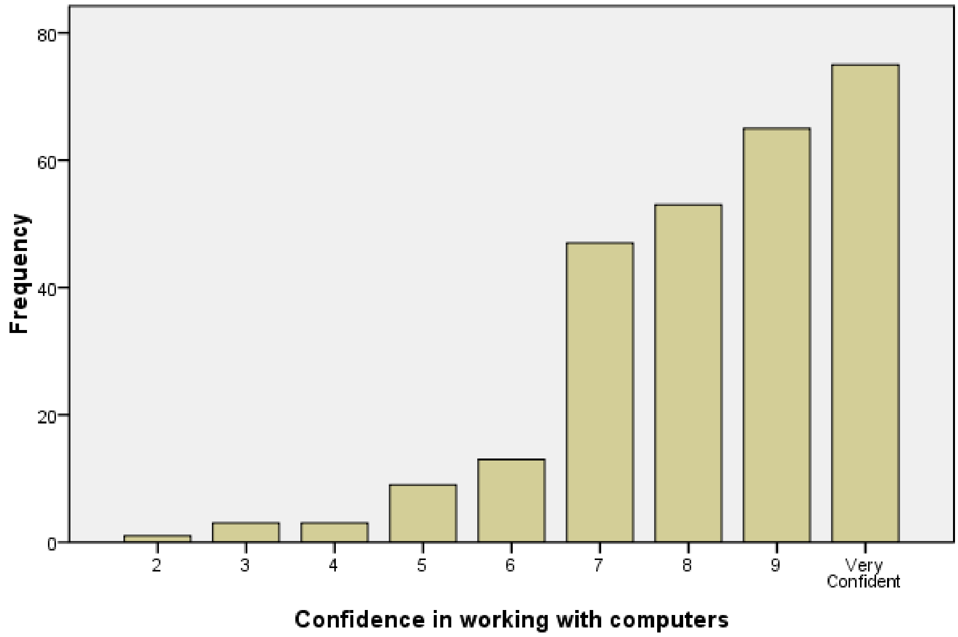


Figure 5.20: Computer confidence level of student participants

5.4.10 IWB installed in Classrooms of student participants

When asked about the availability of IWB in their classrooms, 229 (85.1%) students indicated that they have IWB installed in their classrooms, while 39 (15.5%) students had no IWB installed in their classrooms (Figure 5.21).

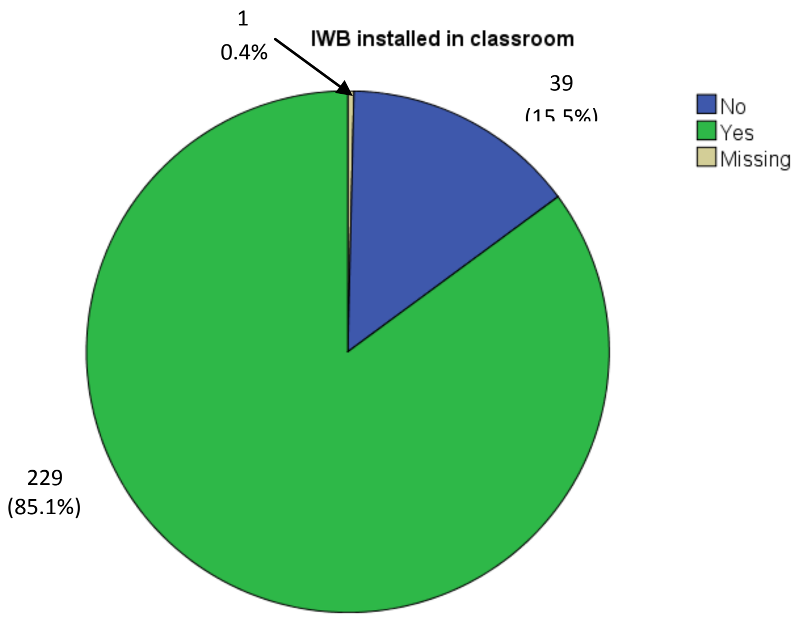


Figure 5.21: IWB installed in classrooms of student participants

5.4.11 Frequency of IWB use by teachers of student participants

In the terms of frequency of IWB use by the teacher (Figure 5.22), 104 (38.7%) reported daily use; 64 (23.8%) reported almost twice a week use; 60 (22.3%) mentioned about only occasional use; 24 (8.9%) indicated once in a week and 5 (1.9%) indicated fortnightly use of IWB by their teacher.

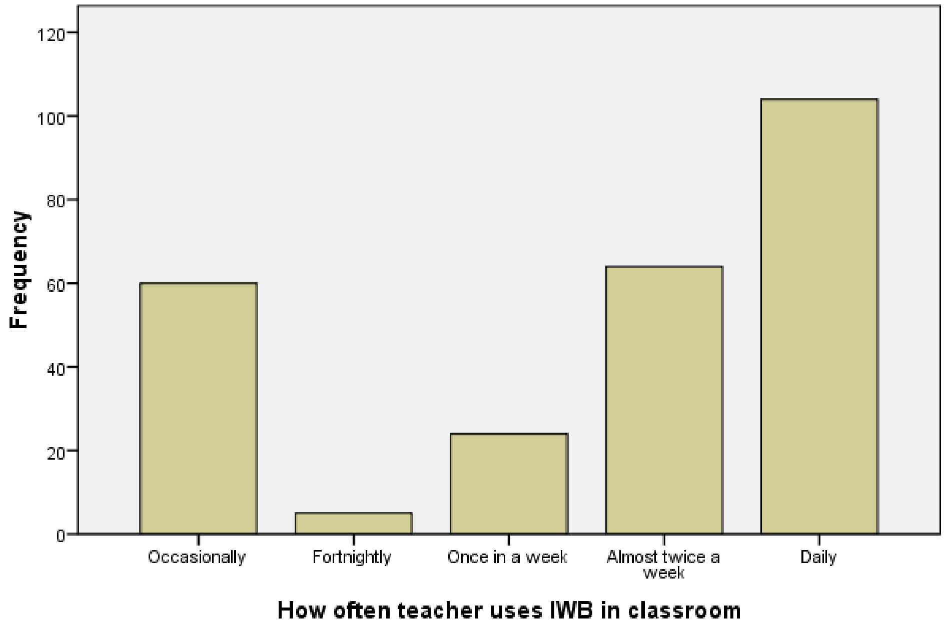


Figure 5.22: Frequency of IWB use by teacher

5.4.12 Competence and confidence levels of student participants in using IWB

The IWB related competence and confidence levels of the student participants are shown in Figure 5.23 and 5.24 respectively which were measured using rating scales. Tables 5.18 and 5.19 also summarized the findings regarding these two aspects of IWB literacy of the students. As the bar-charts are depicting, maximum numbers of students selected the level between range of 4 to 8 for competence (0= Novice; 10= Highly Confident) and 5 to 9 for confidence (0= No Confidence; 10= Very Confident) in working with IWB.

Table 5.18: Competence level of student participants at working with IWB

IWB Competence Level	Frequency	Percent	Valid Percent	Cumulative Percent
Novice	6	2.2	2.3	2.3
1	7	2.6	2.7	5.9
2	13	5.8	5.9	9.9
3	7	2.6	2.7	12.5
4	31	11.5	11.8	25.3
5	50	18.6	19.0	43.3
6	26	9.7	9.9	53.2
7	51	19.0	19.4	72.6
8	40	15.9	15.2	87.8
9	20	7.4	7.6	95.4
Highly Competent	12	5.5	5.6	100.0
Total	263	97.8	100.0	
Missing	6	2.2		
Total	269	100.0		

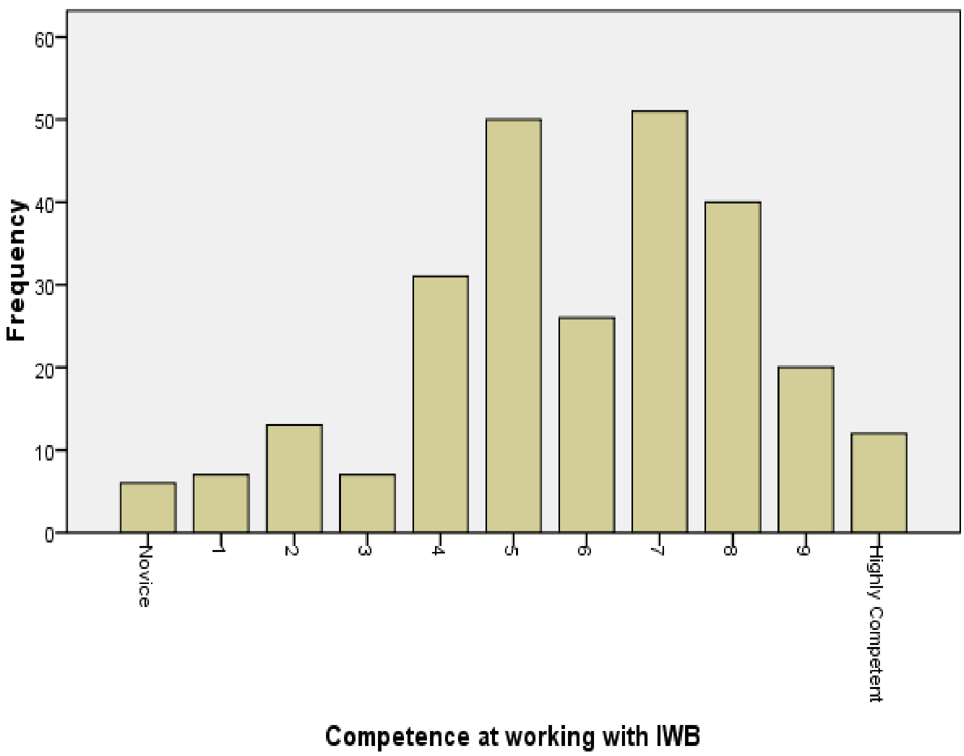


Figure 5.23: IWB Competence level of student participants

Table 5.19: Confidence level of student participants at working with IWB

IWB Confidence Level	Frequency	Percent	Valid Percent	Cumulative Percent
No Confidence	4	1.5	1.5	1.5
1	4	1.5	1.5	3.0
2	9	3.3	3.4	6.5
3	17	6.3	6.5	12.9
4	17	6.3	6.5	19.4
5	41	15.2	15.6	35.0
6	32	11.9	12.2	47.1
7	41	15.2	15.6	62.7
8	48	17.8	18.3	81.0
9	32	11.9	12.2	93.2
Very Confident	18	6.7	6.8	100.0
Total	263	97.8	100.0	
Missing	6	2.2		
Total	269	100.0		

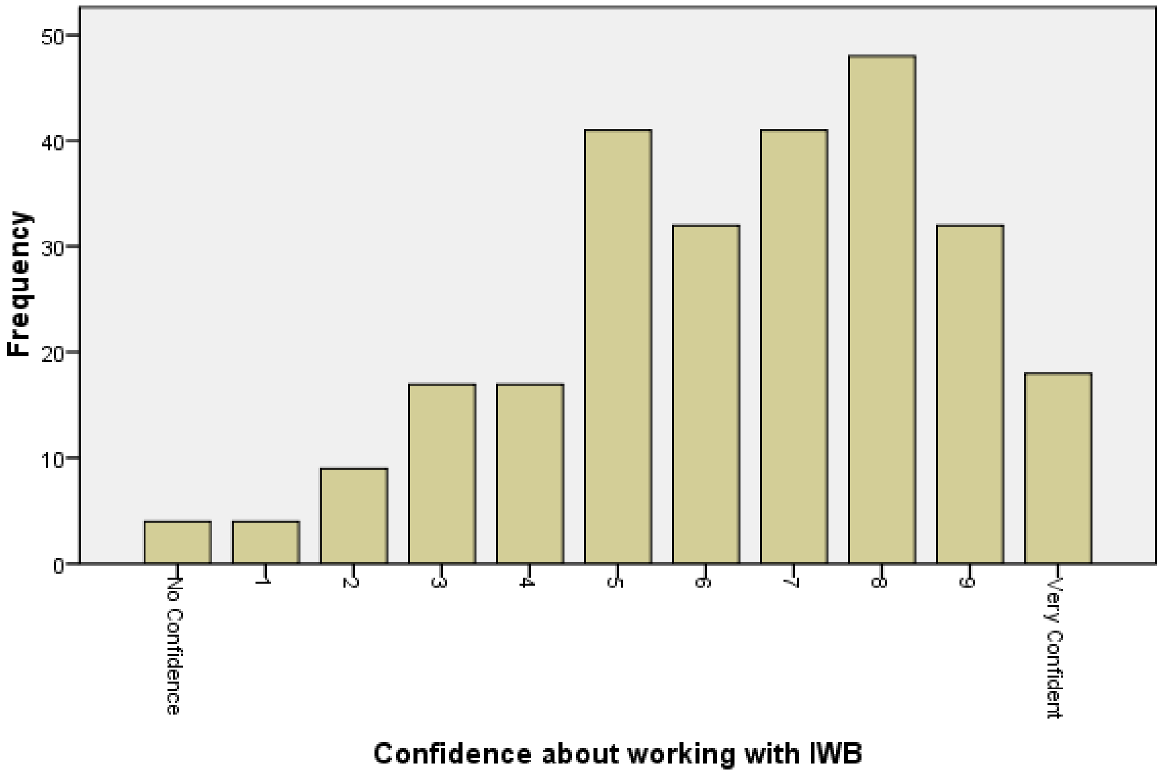


Figure 5.24: IWB Confidence level of student participants

5.5 Summary

In this Chapter, the findings related the preliminary or descriptive analyses are given which were generated using SPSS software in order to understand the characteristics of the participants of this research. This chapter begins with findings related to the participating schools which included the general information about these schools. This is followed by the findings related to the demographic information on teacher and student participants in this study. These findings are depicted in the form of tables and pie-charts, and bar diagrams are also used to summarize the findings.

Chapter 6
Validation of the Teacher Questionnaire Scales

6.1 Introduction

Before conducting the quantitative data analysis it was necessary to establish the reliability and the validity of the instruments used to collect the data for this research because that was a pre-requisite of generating valid research findings. The initial sections of this chapter explain the statistical techniques used in this research for the purpose of validation of scales in the Teacher Questionnaire. Further the findings from these analyses are given for each scale separately.

6.2 Statistical techniques used in instrument validation

The details about the statistical techniques used for the instrument validation in this study are given in the following sections.

6.2.1 Reliability

One aim of a good research is to obtain scores that are reliable. A scale or an instrument is considered reliable if the individual scores obtained from it are stable and consistent (Creswell, 2005, p. 162). In other words, "the reliability of measurement indicates the stability and consistency with which the scores obtained from an instrument are measuring the concept" (Sekaran as cited in Darmawan, 2003, p. 90). Stability of the scores means that the scores should almost be the same when the scale or the instrument is being administered again and again at different times(Creswell, 2005, p. 162). Further the scores are considered consistent when a participant answers a particular question in one way and keeps on answering the other similar questions in the same way (Creswell, 2005, p. 162).

There are many different ways of examining the reliability of an instrument or a scale but two most commonly used procedures are test-retest reliability and internal consistency reliability (Pallant as cited in Darmawan, 2003, p. 90). The test-retest reliability is determined by administering a test (instrument) to the same participants at two different times and calculating the correlation between scores from these two separate occasions (Creswell, 2005, p. 162). "High test-retest correlations indicate more reliable measurement" (Darmawan, 2003, p. 90). However, the test-retest reliability was not feasible for this study, so the second procedure for examining the reliability was used i.e., internal consistency reliability. The underlying assumption used in this kind of reliability estimate is that because "all the items in a scale typically aim to measure the same thing, they should be correlated with each other to maintain internal consistency" (Bland & Altman, 1997, p. 572). This consistency depicts the extent to which the items in a scale are all measuring the same factor (Darmawan, 2003, p. 90). For example, the items of an Attitude towards ICT (AICT) scale should all measure the attitudes of the participants towards ICT. Creswell (2005, p. 164) also explained that "scores from an instrument are reliable and accurate if an individual's scores are internally consistent across the items on the instrument". He further gave an example, "If someone completes the items at the beginning of the instrument one way (e.g., positive about negative effects of tobacco), then they should answer the questions later in the instrument in a similar way (e.g., positive about health effects of tobacco)".

In this study, Cronbach's alpha (α) is used to test the internal consistency of the items. This technique provides a coefficient which is achieved by determining the average correlation of the items of an instrument (Curtis, 2005; Santos, 1999). The value of Cronbach alpha lies between 0 (no reliability) to 1(perfect reliability) (Kline, 1998, p. 194). So this implies that higher the value of Cronbach's alpha better is the reliability. But there is no particular rule about what value of reliability coefficient should be considered as the indicator of good reliability (Kline, 1998, p. 194). A general rule of thumb is that reliability coefficients of 0.70 and above are considered as adequate (Hair et al., 2013; Kline, 1998, p. 194).

6.2.2 Validity

Apart from making sure that the instrument used in the research gives the reliable scores, it is also necessary to examine whether these scores are valid too (Creswell, 2005, p. 164). In a general sense, the concept of validity in research can be explained by thinking of it as a characteristic of research method. In this sense, a research method is considered valid if it is examining what it is supposed to examine (Brown, 2000). In the context of this study, validity is related to the scores obtained using an instrument which "indicates how accurately the recorded values reflect the factors being measured" (Sekaran as cited in Darmawan, 2003, p. 89). Another important aspect of validity was mentioned by Pallant (2001) which tells about the "extent to which the scores obtained from a scale measure what the scale is supposed to measure not something else" (Darmawan, 2003, p. 89).

Validity is examined in three different ways and based on this three types of validity are considered i.e., content, criterion-related, and construct validity (Creswell, 2005, p. 164).

6.2.2.1 Content Validity

Content Validity deals with the scope of the questions on the instrument and their scores. It tells about the adequacy of the questions and the degree to which these questions and their scores are representative of all the possible questions that could be asked about the phenomenon which is being studied (Creswell, 2005, p. 164). One of the basic types of content validity, which is also used in this research, is face validity. As already mentioned under Pilot data analysis section in Chapter 3, the face validity for the instruments used in this study was achieved by asking the suggestions from two experts at the university level and four teachers at the school level along with conducting the pilot testing (pilot study) of the instruments. Along with that, the extensive literature review which was undertaken to come up with the structure of the instruments (questionnaires) used in this research was another way which helped the researcher to achieve the content validity. But according to Creswell (2005, p. 165), "this form of validity is less useful in assessing personality or aptitude scores when the universe of questions is less certain".

6.2.2.2 Criterion-related validity

This is the second type of validity which is used to find out "whether the scores from an instrument are a good predictor of some outcome (or criterion) they are expected to predict" (Creswell, 2005, p. 165). But criterion-related validity is only useful if the researcher can identify a suitable criterion or outcome (Creswell, 2005, p. 165; Darmawan, 2003, p. 89). Therefore, this type of validity is not used in this study.

6.2.2.3 Construct validity

This is the kind of validity measure used in this study. Before defining the construct validity, it is first important to understand the meaning of construct. According to Brown (2000), "A construct, or psychological construct as it is also called, is an attribute, proficiency, ability, or skill that happens in the human brain and is defined by established theories". He also gave "overall English language proficiency" as an example of a construct. In the field of educational research measurement, a unified form of the concept of construct validity is used which brings together all the different types of validity i.e., content, criterion-related, and construct (Brown, 2000). It reveals the meaningfulness, significance, usefulness and the purpose of the scores from an instrument (Creswell, 2005, pp. 164-166). It is clear from the above description of the construct validity that this type of validity is multi-faceted, so "there is no single best way to study it" (Brown, 2000). Hence, it is usually determined by using both statistical and practical procedures. In this study construct validity was established using the technique of factor analysis.

6.2.2.3.1 Factor analysis

Factor analysis is an oldest and best-known statistical technique which is used to analyze the interrelationships (correlation) between sets of observed and latent variables (Byrne, 2010, p. 5; Hair et al., 2013, p. 92). It is important to note that a factor model provides information about the way, and the extent, with which the observed variables (manifest variables) are linked to their underlying unobserved variables (latent variables) especially the "strength of the regression paths from the factors to the observed variables (the factor loadings) are of primary interest" (Byrne, 2010, p. 6). The advancement in the computing technology, and the availability of a wide variety of statistical software, has made factor analysis one of the most commonly used and "efficient tool to ascertain the underlying construct of the studied characteristics" (Lu, 2006). There are two different approaches of undertaking factor analysis i.e., confirmatory factor analysis and exploratory factor analysis.

1. **Exploratory factor analysis (EFA):** This data reduction technique is used by the researchers when there is no previous knowledge of the possible structure of the data and the researcher needs to explore the relationships among the variables and the factors. As Hair et al. (2013, p. 92) explained, in exploratory factor analysis, the researcher follow the approach of "take what the data give you". Further, no restriction is applied on the variables to load them on particular factors (Lu, 2006).

2. **Confirmatory factor analysis (CFA):** This is a kind of factor analysis used to confirm a hypothetical factor model. In this case, the researcher already has the prior knowledge of possible correlations among the variables and the factors based on well-established theories and previous research (Byrne, 2010, p. 6). So, the researcher uses the technique of confirmatory factor analysis "to test the probability that a particular or hypothesized factor structure is supported or confirmed by the data" (Cramer, 2003, p. 28) or in other words, "to assess the degree to which the data meet the expected structure" (Hair et al., 2013, p. 92). In this research, confirmatory factor analysis was used to establish the construct validity of the scales of both teacher and student questionnaires because these scales were either adopted from already established instruments or developed based on the well-established theories and an extensive research literature review by the researcher.

6.3 Use of SPSS software for the validation of the scales

IBM SPSS (Statistical Packages for Social Sciences) Statistics 20 was used in this study to undertake reliability analysis i.e. calculating Cronbach's alpha scores and for conducting initial validation of the factor structures in which the 'number of factors to be extracted' was fixed to one and 'no rotation' was chosen (because the number of factors specified was one).

6.4 Use of AMOS software for the validation of the scales

AMOS (Analysis of Moment Structures) software was used in this study to perform Confirmatory Factor Analysis. This software uses Structural Equation Modeling approach for analysing the data (Arbuckle, 2009, p. 1). Amos is a very easy program to use for visual SEM which gives the option of specifying, viewing and modifying a model by using drawing tools which are simple and quick. Checking the model fit, and making any needed modifications in the model, is also a straight forward process (Arbuckle, 2009, p. 1).

6.5 Structural Equation Modeling (SEM)

Structural equation modeling (SEM) is a "statistical methodology that takes a confirmatory (i.e., hypothesis-testing) approach to the analysis of the structural theory bearing on some phenomenon" (Byrne, 2010, p. 3). As the name suggests, SEM procedure consists of two main aspects: structural (regression) equations to represent casual processes and pictorial modeling of these structural relations (Byrne, 2010, p. 3). SEM uses two statistical concepts: factor analysis (measurement model) and multiple regression analysis (structural model) (Hair et al., 2013, pp. 546-547). In other words, the measurement model represents the relationship between the observed and the unobserved variables. On the other hand, the structural model represents the relationship among the unobserved variables (Byrne, 2010, pp. 12-13). Further, SEM tests the hypothesized model by analysing all the variables simultaneously to find out how consistent they are with the data (Byrne, 2010, p. 3). The goodness-of-fit is used as a measure to accept or reject the model (Byrne, 2010, p. 3).

6.6 Confirmatory Factor Analysis for the current study using AMOS

It was already explained in the Chapter 3 that in the current study the constructs were developed based on previous studies and theories. For the teacher questionnaire, the Attitudes towards ICT had two constructs: Usefulness and Ease of Use; the Attitudes towards IWB incorporated four constructs: Attitudes (Teaching), Attitudes (General), Attitudes (Motivational) and Attitudes (Training); Further Approaches towards teaching had two constructs: Conceptual Change Student Focused and Information Transmission Teacher Focused; and Classroom Interactions using IWB was developed in three constructs: Supported Didactic Stage, Interactive Stage and Enhanced Interactive Stage. For the student questionnaire, the Attitudes towards ICT was developed around three constructs: Enjoyment, Importance and Anxiety; Attitudes towards IWB incorporated four constructs: Attitudes (Motivational Issues), Attitudes (Affective Factors), Attitudes (Management) and Attitudes (Learning Support); Classroom Interactions using IWB had three constructs: Supported Didactic Stage, Interactive Stage and Enhanced Interactive Stage; Learning Approaches had four constructs: Deep Motive, Deep Strategy and Surface Motive, Surface Strategy; and Learning Outcomes was developed in six constructs: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating.

As it was already mentioned above, AMOS was used to undertake confirmatory factor analysis in this study. As a first step, hypothesized measurement models were prepared. Measurement models are used to indicate the association (how and how much) between the indicators and the latent variables/factors (See Figure 3.1 in Chapter 3) (Byrne, 2010, p. 6). Generally, four geometric symbols are used to make these models: circles (or ellipses) to represent unobserved latent variables; rectangles (or squares) to represent observed variables/indicators; a single-headed arrow represents the impact of one variable on another; and a double-headed arrow represents covariance or correlation between pairs of variables (Byrne, 2010, p. 9). Apart from this the error term is drawn as a latent error (Darmawan, 2003, p. 83) which represents the measurement error (Byrne, 2010, p. 10). In order to enable CFA to test the model, AMOS software automatically assign "1" (regression weight) value to the factor-loading regression paths (Burhanuddin, 2013, p. 141; Byrne, 2010, p. 45).

After providing AMOS with the model to be analysed the next step was to specify the data file from which the data was used by the program to do all the computations. In the present study SPSS data files for both teacher and student data were used because AMOS can read data in SPSS file format (Darmawan, 2003, p. 83). Further, by using the *Calculate Estimates* function of AMOS, the regression coefficients were calculated to examine the influences of factors on the indicators (Burhanuddin, 2013, p. 141). The default method used by AMOS to compute parameters was maximum likelihood (Darmawan, 2003, p. 82).

In this study, all the constructs were structured in five different models: (a) single factor model, (b) correlated factor model, (c) uncorrelated factor model, (d) hierarchical factor model, and (e) nested factor model (Curtis, 2005; Darmawan, 2003; Hair et al., 2013). This strategy of testing structural equation models is called the alternative models case strategy where several alternative/competing models are proposed and compared based on the model fit and the best model is selected (Byrne, 2010, p. 8).

To select the best model for this study, the factor loadings of each observed variable/indicator onto its latent factor were looked at. The factor loading represents the correlation between the indicator and the factor (Hair et al., 2013, p. 90). Also the "squared loading is the amount of the variable's total variance accounted for by the factor" (Burhanuddin, 2013, p. 143). For the purpose of this study, factor loadings in the range ±0.30 to ± 0.40 were considered to meet the minimal level for interpretation of structure; loadings ± 0.50 or >0.50 were considered practically significant; loadings exceeding 0.70 were considered indicative of well-defined structure (Hair et al., 2013, p. 115).

Further, a number of fit indices were used to compare all the five models for all the scales used in the teacher and student questionnaires. These fit indices are χ^2/DF (chi-square divided by the number of degrees of freedom); GFI (goodness-of-fit-index), TLI (Tucker-Lewis Index), CFI (comparative fit index), and RMSEA (root mean square error of approximation). It is general trend to follow some cut off values for RMSEA i.e. if a model shows RMSEA value close to zero or less than 0.05, this indicates a good fit (Darmawan, 2003, p. 96); if its value is 0.08 or less then this indicates a reasonable error in approximation but if the value of RMSEA is more than 0.1, this means that the model cannot be considered as good (Browne & Cudeck, 1993). But new research has been raising questions about the above stated cut off values to determine the model fit and has shown that following these cut off values can lead to over-rejection of models when the sample-size is small (Chen, Curran, Bollen, Kirby, & Paxton, 2008; Hu & Bentler, 1999). Hence, it is recommended that multiple indices should be used along with human judgement when deciding the model fit (Chen et al., 2008). As the sample size for teacher participants is small in this study, so the cut off value were not followed strictly. Another indicator used for goodness of fit was a ratio of chi-square (χ^2/DF) which, if is less than 5 in a large sample model would indicate a good fit (Darmawan, 2003, p. 96) between the hypothesized model and the sample data. The other indices i.e., GFI, TLI and CFI indicate a good fit for the model when their minimum values are equal or close to 0.90 (Byrne, 2010, pp. 77-79).

Apart from the above stated procedures, the theoretical underpinnings used for the construct development were also considered while identifying the best fitting model. Also, the preference was given to retain as many items as possible for each construct. So, in this way, the final measurement models for both the teachers and the student data were selected.

6.7 Findings

The findings from the reliability and validity analysis for each scale of the teacher questionnaire are given in the following sections. Each section contains the summary table of separate scales giving the details of the items on that particular scale followed by the findings of the reliability and the confirmatory factor analysis (CFA). As already mentioned above, the internal consistency or reliability analysis was done using SPSS software and the factor analysis (CFA) was done twice, first with the use of SPSS and then again with AMOS (Analysis of moment structure).

It is important to mention here that out of the five models which were tested for each construct using AMOS, only the final model (best fitting model) is shown in the following sections. All other models are given in the Appendix X (Standardised Results of Confirmatory Factor Analysis (CFA) for Teachers).

6.7.1 Scale 1: Attitudes towards ICT (AICT)

The AICT scale was the modified form of a 'Technology Attitude Scale' (TAS) which was developed by McFarlane et al. (1997). It had two sub-scales: Usefulness and Ease of use. Table 6.1 gives the description of the items in these two sub-scales. It is important to mention here that the recoded items were used in the reliability and factor analysis for this scale.

6.7.1.1 Reliability of the Scale

The Cronbach's alpha coefficient for full scale came out to be 0.913 which shows a highly reliable scale. For the sub-scales, the reliability coefficient for Usefulness was 0.634 and for Ease of Use, the Cronbach's alpha was 0.920.

6.7.1.2 Factor Analysis using SPSS

The SPSS output of the factor analysis depicted that three items i.e., AICT7, AICT14 and AICT 15 were showing very low factor loadings (0.340, 0.295 and -0.022 respectively) as compared to the other items all of which had obtained moderate to very high loadings on their factors. Based on these findings it was decided to drop these three items from the scale.

Table 6.1: Summary of AICT scale on Teacher Questionnaire

Scale	Sub-scale	Item-code	Item Description
Attitudes towards ICT (AICT)	Usefulness	AICT1	Knowing how to use various ICT tools is a necessary skill for me
		AICT3	I like using ICT tools in my teaching
		AICT6	I now use my knowledge of ICT in many ways as a teacher
		AICT7	I wish I could use technology more frequently
		AICT10R	I don't expect to use ICT much at work
		AICT13R	Working with ICT is boring
		AICT14	It is important to know how to use ICT in order to get a teaching position
	Ease of Use	AICT2R	I get confused when using ICT
		AICT4	I feel confident in my ability to learn about ICT
		AICT5R	Working with ICT makes me nervous
		AICT8R	ICT makes me feel stupid
		AICT9	A job using ICT would be very interesting
		AICT11R	I am not the type to do well with ICT
		AICT12R	I feel uncomfortable using most ICT tools
		AICT15	I know that if I work hard to learn about ICT, I will do well
		AICT16R	ICT makes me feel uneasy
		AICT17	I am able to do as well working with ICT as my fellow teachers

6.7.1.3 Final Reliability of the Scale

The reliability analysis was again done, after dropping the items which were not working well in during the factor analysis, with SPSS. The reliability coefficient for the full scale was 0.944 which again showed a highly reliable scale. The findings for the reliability coefficients of separate sub-scales are given in the Table 6.2. As it is clear from the findings, the values of reliability coefficients for both the sub-scales had increased after removing the three items from the scale i.e. for Usefulness, Cronbach's alpha increased from 0.634 to 0.701 and for Ease of Use, it increased from 0.920 to 0.946.

Table 6.2: Cronbach's alpha coefficient for each sub-scale of AICT scale

Scale	Sub-scale	Cronbach's Alpha
Attitudes towards ICT (AICT)	Usefulness	0.701
	Ease of Use	0.946

6.7.1.4 Factor Analysis using SPSS

The factor analysis was also conducted again for separated sub-scales after dropping the items which showed low factor loadings. The findings are summarized in the Table 6.3.

Table 6.3: Factor loadings for AICT scale

Scale	Sub-scale	Item-code	Factor Loadings
Attitudes towards ICT (AICT)	Usefulness	AICT1	0.528
		AICT3	0.884
		AICT6	0.809
		AICT10R	0.601
		AICT13R	0.550
	Ease of Use	AICT2R	0.894
		AICT4	0.874
		AICT5R	0.941
		AICT8R	0.835
		AICT9	0.682
		AICT11R	0.914
		AICT12R	0.799
		AICT16R	0.911
		AICT17	0.815

It can be seen in the Table 6.3 that nine items showed very high factor loadings i.e., between 0.809 - 0.941 and five items obtained moderate to high range of factor loadings i.e., 0.528 - 0.799. This shows that these items were good reflectors of their respective factors.

6.7.1.5 Confirmatory Factor Analysis using AMOS

Five measurement models i.e., 1 Factor Model, 2 Orthogonal Factor Model, 2 Correlated Factor Model, Hierarchical Model and Nested Model were developed and their fit indexes were compared to identify the best fitting model.

Table 6.4: Fit Index: Model Fit Summary for AICT scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	2.015	.775	.815	.187
2	2 Orthogonal Factor	2.890	.582	.646	.255
3	2 Correlated Factor	2.291	.714	.761	.211
4	Hierarchical	2.749	.613	.672	.246
5	Nested	2.161	.743	.814	.200

As it can be seen by comparing the χ^2/DF, TLI, CFI and RMSEA values as shown in the Table 6.4, the 1 Factor Model was the better fitting as compared to the other four models, so 1factor model was chosen as the final model for AICT scale.

In Table 6.5 the factor loadings for the 1 factor model are given. It can be seen that ten items obtained high to very high factor loadings between the ranges of 0.768-0.955. Three items showed moderate loadings i.e., between 0.419- 0.655. There was one item which showed low factor loading (0.378) but it was also above the minimum accepted factor loading value i.e., 0.30. Hence, all the items were good indicators of the common factor AICT.

Table 6.5: Factor loadings for 1 factor model for AICT scale

Scale	Items/Indicators	Factor Loadings
Attitudes towards ICT (AICT)	AICT1	0.419
	AICT3	0.891
	AICT6	0.773
	AICT10R	0.448
	AICT13R	0.378
	AICT2R	0.885
	AICT4	0.876
	AICT5R	0.955
	AICT8R	0.799
	AICT9	0.655
	AICT11R	0.875
	AICT12R	0.768
	AICT16R	0.853
	AICT17	0.790

Figure 6.1 on the next page shows the structure of the measurement model chosen as the final model for AICT scale on teacher questionnaire i.e. the 1 Factor model.

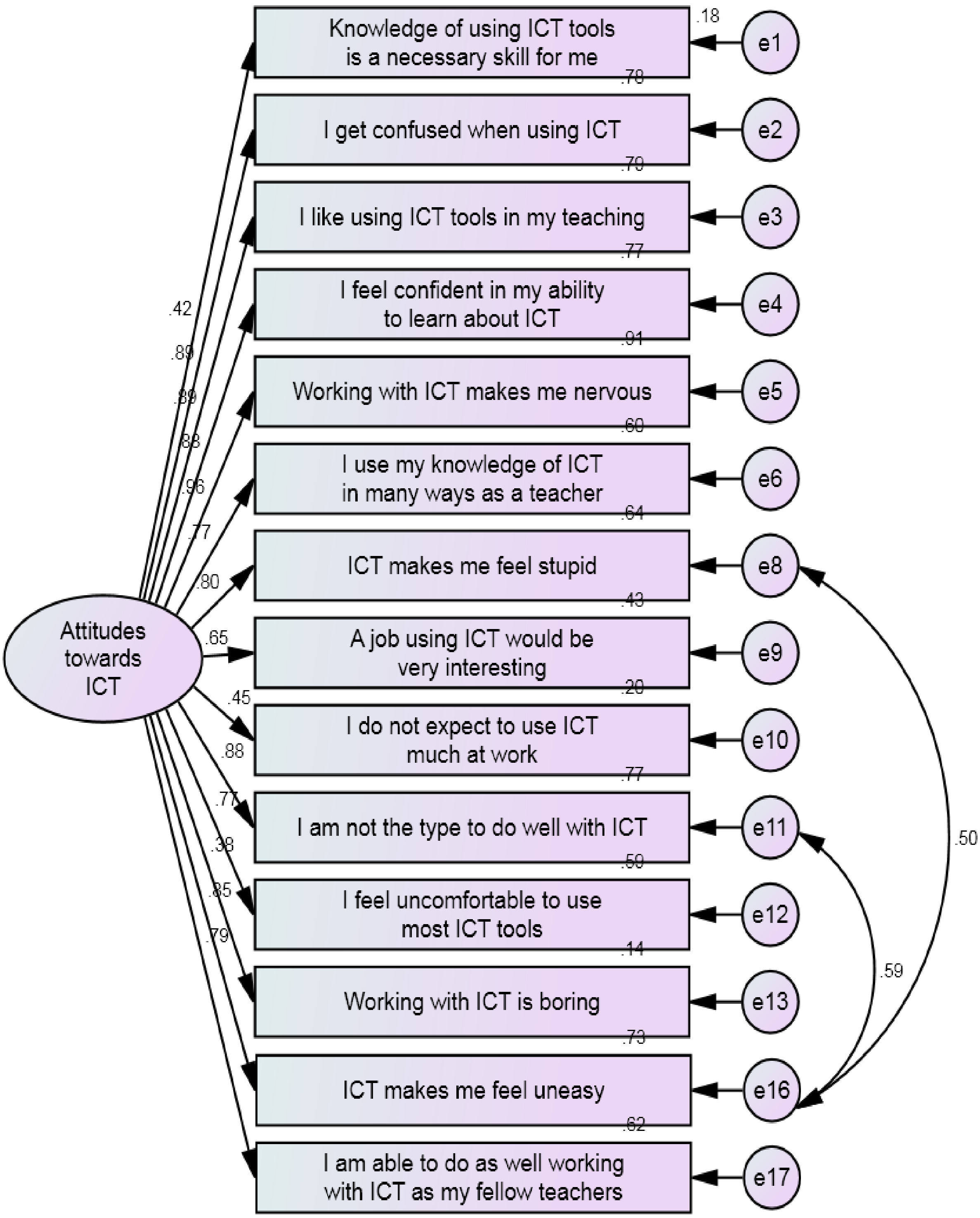


Figure 6.1: 1 Factor model for AICT scale of Teacher Questionnaire

6.7.2 Scale 2: Attitudes towards IWB (AIWB)

The AIWB scale in the teacher questionnaire was the modified version of a scale named 'Teacher Attitude Questionnaire' developed by Mathews-Aydinli and Elaziz (2010) which was used to explore teacher's attitudes towards the use of IWB as an educational tool in the classroom. It had four sub-scales, the details of which are given in the Table 6.6. Some of the items in this scale were negatively worded, so the recoded form of these items was used during the reliability and factor analysis.

6.7.2.1 Reliability of the Scale

The reliability coefficient for full scale was 0.882 which suggested highly reliable scale, and the reliability analysis of sub-scales showed the Cronbach's alpha for Attitudes (Teaching) was 0.875; for Attitudes (General) 0.495; for Attitudes (Motivational) 0.915; and for Attitudes (Training) 0.750. Hence, all the sub-scales showed high reliability except one i.e., Attitudes (General).

6.7.2.2 Factor Analysis using SPSS

The factor analysis of sub-scales using SPSS revealed that items AIWB2R and AIWB16R had very low factor loadings i.e., -.052 and -.263 respectively. So both these items were dropped from the scale before moving to further analysis.

6.7.2.3 Final Reliability of the Scale

The reliability coefficient for full scale after removing items AIWB2R and AIWB16R was 0.926. The Cronbach's alpha for the first sub-scale i.e., Attitudes (Teaching) was 0.911; for Attitudes (General), the value was 0.765; for Attitudes (Motivational) 0.915 and for Attitudes (Training) 0.750. This shows that after removing item AIWB2R from sub-scale Attitudes (Teaching), its reliability coefficient was increased. The Cronbach's alpha value for Attitudes (General) sub-scale was again low; removing item 16R the value of Cronbach's alpha for this subscale was also increased.

Table 6.6: Summary of the AIWB scale of Teacher Questionnaire

Scale	Sub-scale	Item-code	Item Description
Attitudes towards IWB (AIWB)	Attitudes in terms of teaching (Teaching)	AIWB1	Using IWB-based resources reduces the time I spend on writing during the lessons
		AIWB2R	When using an IWB in my lessons, I spend more time in the preparation of the lesson
		AIWB3	I think using an IWB makes it easier to include different subject-specific learning resources when preparing the lesson plan
		AIWB4	I think using an IWB makes it easier to display the available learning resources to the whole class
		AIWB5	It is beneficial to be able to save and print the materials generated during the lessons
		AIWB6	I give more effective explanations in my lessons when using an IWB
		AIWB7	IWB helps me to easily summarize the lesson
		AIWB8	Using an IWB, I can more easily control/manage the whole class
		AIWB9	I can immediately reach the extra learning resources during my lesson when using an IWB
		AIWB10	I think IWB can be a good supplement to support teaching
		AIWB11	Using an IWB makes me a more efficient teacher
		AIWB12	Using an IWB makes it easier for me to move back and forth in the lesson very conveniently
		AIWB17	Reviewing the whole lesson towards the end is very easy if the lesson is taught using an IWB
	General attitudes towards the use of IWB (General)	AIWB13	I like using IWB technology in my lessons
		AIWB14R	I feel uncomfortable in front of my students when using an IWB
		AIWB15R	I do not think my students are ready for this IWB technology
		AIWB16R	What I do in class with my usual methods is sufficient for teaching my subject
		AIWB18R	I am not the type to do well with IWB-based applications
	Attitudes in terms of motivational issues (Motivational)	AIWB19	I think IWBs make learning this subject more enjoyable
		AIWB22	I can keep my student’s attention in lessons longer with the help of IWB technology
		AIWB23	I think IWB increases the interaction and participation of the students in the classes
		AIWB24	I think my students are more motivated when I use an IWB in lessons
	Attitudes related to training (Training)	AIWB20R	I believe that training is required to teach with IWB technology
		AIWB21R	If I do not get sufficient training, I do not feel comfortable with using IWBs in classrooms

6.7.2.4 Final Factor Analysis using SPSS

The factor loadings in SPSS factor analysis, after dropping two items (AIWB2R and AIWB16R), showed that most of the factors obtained very high loadings i.e., 12 items obtained loadings between 0.813-0.960; four items had loadings between 0.706-0.784 which is also considered as a high loading; four items obtained moderate range of factor loading i.e., 0.549-0.665 and only one item had loadings of 0.450 which was also above the minimum acceptable value of 0.30.

Table 6.7: Factor loadings of AIWB scale

Scale	Sub-scale	Items	Factor Loadings
Attitudes towards IWB (AIWB)	Attitudes (Teaching)	AIWB	0.450
		AIWB3	0.627
		AIWB4	0.771
		AIWB5	0.549
		AIWB6	0.911
		AIWB7	0.872
		AIWB8	0.618
		AIWB9	0.706
		AIWB10	0.665
		AIWB11	0.878
		AIWB12	0.789
		AIWB17	0.836
	Attitudes (General)	AIWB13	0.828
		AIWB14R	0.820
		AIWB15R	0.577
		AIWB18R	0.877
	Attitudes (Motivational)	AIWB19	0.784
		AIWB22	0.928
		AIWB23	0.909
		AIWB24	0.960
	Attitudes (Training)	AIWB20R	0.901
		AIWB21R	0.901

6.7.2.5 Confirmatory Factor Analysis using AMOS

Confirmatory factor analysis completed using AMOS as well to further establish the construct validity of the scale. Table 6.8 summarizes the model fit indexes for five measurement models which were developed and compared for the purpose of identifying the best fitting model for the AIWB scale in the teacher questionnaire.

Table 6.8: Fit Index: Model Fit Summary for AIWB scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	2.431	.441	.494	.222
2	4 Orthogonal Factor	2.459	.429	.479	.224
3	4 Correlated Factor	1.926	.638	.685	.179
4	Hierarchical	2.051	.589	.635	.190
5	Nested	2.244	.513	.602	.207

Table 6.8 clearly shows that if all the four indexes are compared (χ^2/DF, RMSEA, TLI and CFI), then the 4 Correlated factor model and the Hierarchical model are better fitting as compared to other three models, because they obtained better values on all these fit indexes. Eventually, the Hierarchical model was chosen as the final model for this scale based on the principles of parsimony in the measurement modeling (Burhanuddin, 2013, p. 184). According to this, the Hierarchical model is easier to handle in the later statistical analysis like single level path analysis as compared to the 4 Correlated factor model.

Table 6.9 gives the factor loadings obtained during the Confirmatory Factor Analysis using AMOS. The three first order factors obtained high loadings (0.87, 0.81 and 0.70) on the common second order factor, but one factor showed a low loading i.e., 0.36 which was still above the minimum acceptable value (0.30). Further, all the items/indicators loaded well on their respective factors (first order factors). Nine items showed very high loadings i.e., between 0.841-0.965; three items obtained high loadings between the range of 0.724-0.777. Eight indicators obtained moderate range of loadings which fall between the range of 0.504-0.695 and only one item showed factor loading which could be considered low i.e. 0.447. The Hierarchical model chosen as the final model for AIWB scale is shown in Figure 6.2.

Table 6.9: Factor Loadings for Hierarchical model of AIWB scale

Scale (Second Order Factor)	Sub-scale (First Order Factors)	Factor Loadings	Items/Indicators	Factor Loadings
Attitudes towards IWB (AIWB)	Attitudes (Teaching)	0.87	AIWB1	.575
			AIWB3	.570
			AIWB4	.685
			AIWB5	.504
			AIWB6	.921
			AIWB7	.903
			AIWB8	.658
			AIWB9	.632
			AIWB10	.546
			AIWB11	.850
			AIWB12	.777
			AIWB17	.864
	Attitudes (General)	0.81	AIWB13	.841
			AIWB14R	.724
			AIWB15R	.447
			AIWB18R	.756
	Attitudes (Motivational)	0.70	AIWB19	.695
			AIWB22	.915
			AIWB23	.909
			AIWB24	.940
	Attitudes (Training)	0.36	AIWB20R	.648
			AIWB21R	.965

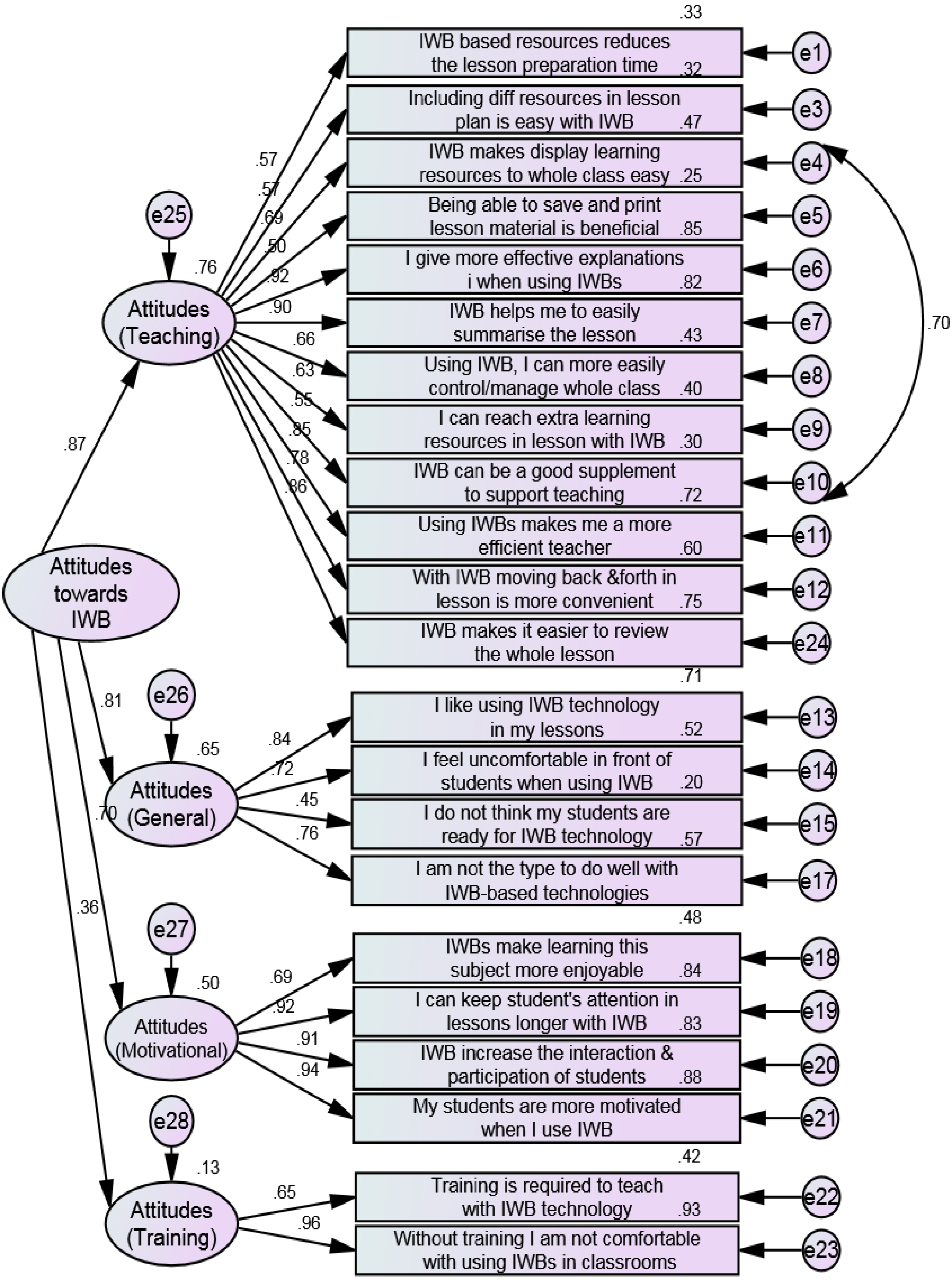


Figure 6.2: Hierarchical model for AIWB scale of Teacher Questionnaire

6.7.3 Scale 3: General Approach towards Teaching (ATI)

The 'Approaches to Teaching Inventory' (ATI), developed by Trigwell and Prosser (2004), was used as third scale in the teacher questionnaire, without making any changes to it. Table 6.10 below provides the details of the sub-scales and the items present in the scale. This scale had two sub-scales which were Conceptual Change Student Focused (CCSF) and Information Transmission Teacher Focused (IITF), each containing eight items. No recoding was needed in this scale.

6.7.3.1 Reliability of the Scale

The reliability analysis of full scale was undertaken and the value of Cronbach's alpha obtained was 0.721 which indicated high reliability of the scale. The reliability analysis of each sub-scale gave the values of Cronbach's alpha for each sub-scale i.e., 0.763 for CCSF and 0.658 for IITF. Hence, both these sub-scales showed good reliability.

6.7.3.2 Factor Analysis using SPSS

The factor analysis of both the sub-scales showed that three items which ATI2 (0.126), ATI12 (0.166) and ATI14 (0.271), obtained low factor loadings. So, it was decided to drop these items from the scale before moving on the further analysis.

6.7.3.3 Final Reliability of the Scale

The follow up reliability analysis gave the Cronbach's alpha value of 0.729 for the full scale; 0.775 for CCSF sub-scale; and 0.711 for IITF sub-scale. So both the full scale and the sub-scales showed high reliability.

Table 6.10: Summary of items in ATI scale used in Teacher Questionnaire

Scale	Sub-scale	Item-code	Item Description
Approach towards Teaching (ATI)	Conceptual Change Student Focused (CCSF)	ATI3	In my interactions with students in this subject I try to develop a conversation with them about the topics we are studying
		ATI5	I feel that the assessment in this subject should be an opportunity for students to reveal their changed conceptual understanding of the subject
		ATI6	I set aside some teaching time so that the students can discuss, among themselves, the difficulties that they encounter studying this subject
		ATI8	I encourage students to restructure their existing knowledge in terms of developing new ways of thinking about the subject
		ATI9	In teaching sessions for this subject, I use difficult or undefined examples to provoke debate
		ATI14	I make available opportunities for students in this subject to discuss their changing understanding of the subject
		ATI15	I feel that it is better for students in this subject to generate their own notes rather than always copy mine
		ATI16	I feel a lot of teaching time in this subject should be used to question students' ideas
	Information Transmission Teacher Focused (ITTF)	ATI1	I design my teaching in this subject with the assumption that most of the students have very little useful knowledge of the topics to be covered
		ATI2	I feel it is important that this subject should be completely described in terms of specific objectives relating to what students have to know for formal assessment items
		ATI4	I feel it is important to present a lot of facts to students so that they know what they have to learn for this subject
		ATI7	In this subject I concentrate on covering the information that might be available from a good textbook
		ATI10	I structure this subject to help students to pass the formal assessment items
		ATI11	I think an important reason for running teaching sessions in this subject is to give students a good set of notes
		ATI12	In this subject, I only provide the students with the information they will need to pass the formal assessments
		ATI13	I feel that I should know the answers to any questions that students may put to me during this subject

6.7.3.4 Factor Analysis using SPSS

The factor loadings for the sub-scales after dropping the items are given in the Table 6.11. It clearly shows that all the items show good loadings on their factors. There was only one item i.e., ATI10 which showed low factor loadings, 0.305, but because it was above the minimum acceptable level for factor loadings, this item was also accepted.

Table 6.11: Factor Loadings for ATI scale

Scale	Sub-scale	Items	Factor Loadings
Approach towards Teaching (ATI)	Conceptual Change Student Focused (CCSF)	ATI3	0.736
		ATI5	0.658
		ATI6	0.596
		ATI8	0.748
		ATI9	0.559
		ATI15	0.666
		ATI16	0.686
	Information Transmission Teacher Focused (ITTF)	ATI1	0.714
		ATI4	0.519
		ATI7	0.864
		ATI10	0.305
		ATI11	0.555
		ATI13	0.785

6.7.3.5 Confirmatory Factor Analysis using AMOS

In confirmatory factor analysis using AMOS, it was seen that ATI10 had very low factor loading (0.19). Hence, it was decided to remove this item from the scale. The fit indexes for the five measurement models are given in Table 6.12. The 2 Orthogonal model and the Nested model showed better fit as compared to the other three models. The χ^2/DF values for the 2 Orthogonal model and Nested model were 1.360 and 1.296 and RMSEA values were 0.111 and 0.101 respectively.

Table 6.12: Fit Index: Model Fit Summary for ATI scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	1.952	-.025	.291	.181
2	2 Orthogonal Factor	1.360	.612	.732	.111
3	2 Correlated Factor	1.378	.593	.723	.114
4	Hierarchical	1.378	.593	.723	.114
5	Nested	1.296	.682	.824	.101

The TLI and CFI values for these two models were higher than the other three factor models (1 Factor, 2 Correlated and Hierarchical). Further among 2 Orthogonal and the nested models, the 2 Orthogonal factor model was chosen as the final model for the ATI scale because it was simpler and easier to handle in complicated analysis, when compared with the Nested model.

Table 6.13: Factor loadings for 2 Orthogonal factor model for ATI scale

Scale	Sub-scale	Items	Factor Loadings
Attitudes towards ICT (ATI)	Conceptual Change Student Focused	ATI5	.575
		ATI8	.681
		ATI15	.588
		ATI16	.626
		ATI3	.656
		ATI6	.539
		ATI9	.449
	Information Transmission Teacher Focused	ATI4	.373
		ATI11	.436
		ATI13	.630
		ATI1	.664
		ATI7	.915

The Table 6.13 above shows the factor loadings for the items in 2 Orthogonal factor model. It is clear from the table that ATI7 obtained very high loading i.e., 0.915; eight items showed moderate loadings i.e., between 0.539- 0.681and three items showed low loadings between 0.373- 0.449. Figure 6.3 shows the final 2 Orthogonal model for the ATI scale on the teacher questionnaire.

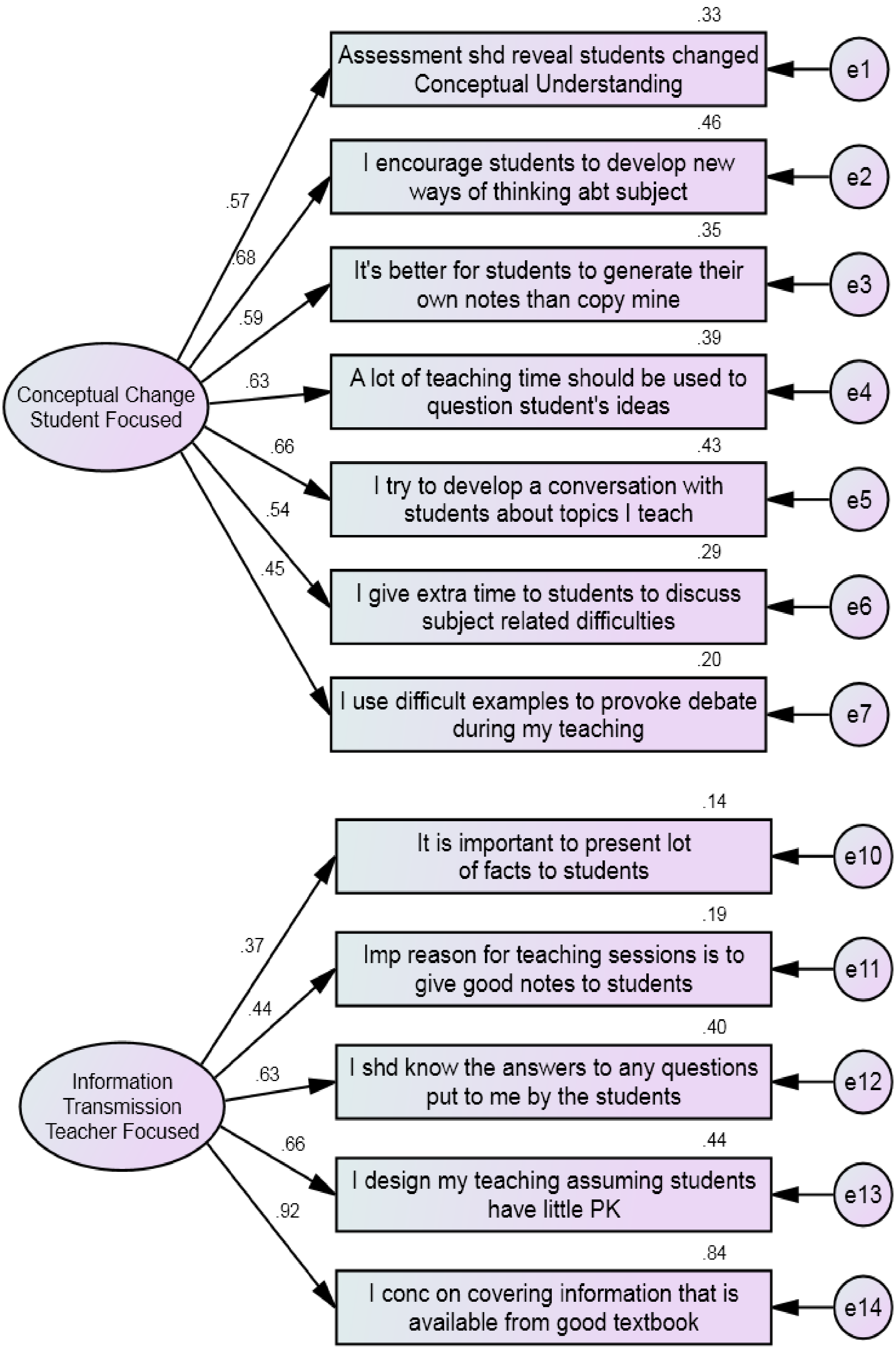


Figure 6.3: 2 Orthogonal Factor Model for ATI scale of Teacher Questionnaire

6.7.4 Scale 4: Classroom Interactions using IWB (CIIWB)

This scale was developed by the researcher based on the knowledge gained during the literature review, of different ways of teaching in the classroom using IWB. It had three sub-scales which were Supported Didactic (SD), Interactive (I) and Enhanced Interactive (EI). The details of the sub-scales and the items in them are given in the Table 6.14. No recoding of items was needed for this scale.

Table 6.14: Summary of items used in CIIWB scale in Teacher Questionnaire

Scale	Sub-scale	Item-code	Item Description
Classroom Interactions using IWB (CIIWB)	Supported Didactic (SD)	CIIWB1	In my teaching I use IWB to provide visual support to the lesson
		CIIWB4	In my teaching using IWB I do not allow the students to work on the IWB
		CIIWB6	I use both simple whiteboard and IWB in my classroom simultaneously
		CIIWB8	I do not think there is any difference in my teaching with and without IWB
	Interactive (I)	CIIWB7	I use IWB in my teaching in the way which encourage the students to participate in classroom discussions
		CIIWB9(a)	In my classroom the use of IWB creates more interaction between students in the class
		CIIWB9(b)	In my classroom the use of IWB creates more interaction between students and me
		CIIWB10	My use of IWB in my classroom helps my students initiate questioning related to the lesson
	Enhanced Interactive (EI)	CIIWB2	When I deliver lessons using IWB, students get maximum chance to participate in the learning process
		CIIWB3	I prepare my lessons by using a number of IWB-based teaching/learning resources
		CIIWB5	I use all the features of IWB i.e., visual, verbal and kinesthetic for the representation of a topic in multi-modal form
		CIIWB11	I use IWB in a way in my classroom so that the students get more involved in their learning

6.7.4.1 Reliability of the Scale

Cronbach's alpha for the full scale was 0.751 which showed high reliability. For the sub-scales, the reliability coefficient for first sub-scale (Supported Didactic) was low i.e., 0.361; for second sub-scale (Interactive), the Cronbach's alpha value was high i.e., 0.840; and for third sub-scale (Enhanced Interactive), the reliability coefficient was also high i.e., 0.818.

6.7.4.2 Factor Analysis using SPSS

The factor analysis of sub-scales revealed that in the Supported Didactic sub-scale, one item i.e., CIIWB8 showed a very low loading (-0.095) on its factor, so this item was removed.

6.7.4.3 Final Reliability of the Scale

After removing CIIWB8, the reliability analysis of Supported Didactic sub-scale was again 0.491. Table 6.15 shows the Cronbach's alpha values for all the three sub-scales of CIIWB.

Table 6.15: Cronbach's alpha coefficient for each sub-scale of CIIWB scale

Scale	Sub-scale	Cronbach's alpha
Classroom Interactions using IWB (CIIWB)	Supported Didactic Stage	0.491
	Interactive Stage	0.840
	Enhanced Interactive Stage	0.818

6.7.4.4 Factor analysis using SPSS

Factor loadings were obtained for each item (Table 6.16). It can be seen that all the items showed very high factor loading between the range of 0.715- 0.899 except one item i.e., CIIWB1 which obtained moderate loading on its factor i.e., 0.540.

Table 6.16: Factor loadings for CIIWB scale

Scale	Sub-scale	Items	Factor Loadings
Classroom Interactions using IWB (CIIWB)	Supported Didactic Stage	CIIWB1	0.540
		CIIWB4	0.773
		CIIWB6	0.774
	Interactive Stage	CIIWB7	0.859
		CIIWB9(a)	0.899
		CIIWB9(b)	0.715
		CIIWB10	0.820
	Enhanced Interactive Stage	CIIWB2	0.852
		CIIWB3	0.892
		CIIWB5	0.742
		CIIWB11	0.770

6.7.4.5 Confirmatory Factor Analysis using AMOS

During the confirmatory factor analysis using AMOS, the two items i.e., CIIWB4 (0.19) and CIIWB6 (0.12) showed very low loadings on their factor, so these items were dropped from the scale. The fit indexes of five hypothesized measurement models were compared which indicated that among these five models, Hierarchical model is best fitting. The Hierarchical model was selected as the final model. Table 6.18 gives the factor loadings for first order factors and the indicators in the Hierarchical model. Seven items/indicators showed high to very high loadings on their respective factors i.e., between the range of 0.707-0.902 and two items obtained moderate loadings i.e., 0.468 and 0.664. Overall all the items loaded well, so it can be concluded that the items were good indicators of their factors. Further the factor loadings of two first order factors i.e., Supported Didactic (SD) and Enhanced Interactive (EI) were very high on the common second order factor (CIIWB) and the third factor i.e., Interactive (I) obtained moderate loading.

Table 6.17: Fit Index: Model Fit Summary for CIIWB scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	2.713	.576	.682	.243
2	3 Orthogonal Factor	3.062	.489	.603	.267
3	3 Correlated Factor	2.245	.692	.786	.207
4	Hierarchical	2.128	.721	.806	.197
5	Nested	2.472	.635	.787	.225

Table 6.18: Factor loadings for Hierarchical model for CIIWB scale

Scale (Second Order Factors)	Sub-scale (First Order Factors)	Factor Loadings	Items (Indicators)	Factor Loadings
Classroom Interactions using IWB (CIIWB)	Supported Didactic Stage (SD)	0.90	CIIWB1	.772
	Interactive Stage (I)	0.66	CIIWB7	.870
			CIIWB9A	.752
			CIIWB9B	.468
			CIIWB10	.835
	Enhanced Interactive Stage(EI)	0.90	CIIWB2	.828
			CIIWB3	.844
			CIIWB5	.664
			CIIWB11	.707

The structure of the final Hierarchical model chosen for CIIWB scale is shown in Figure 6.4 on the next page.

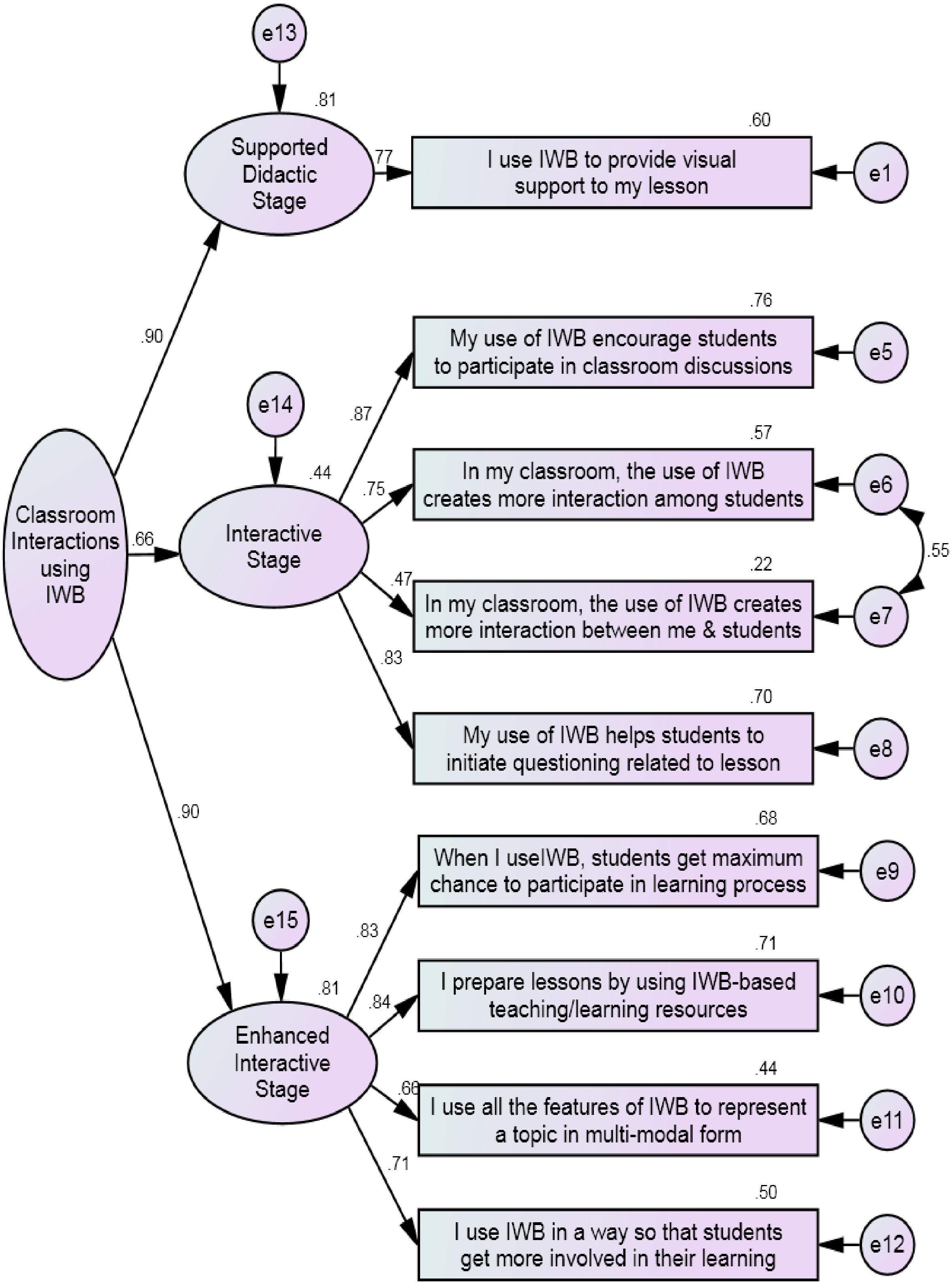


Figure 6.4: Hierarchical Model for CIIWB scale of Teacher Questionnaire

6.8 Summary

This chapter presents the findings from the statistical analysis undertaken for the validation of the teacher questionnaire used in this study. SPSS software was used for reliability analysis and initial factor analysis and AMOS software was used for the final confirmatory factor analysis. A detailed account about these statistical techniques, and the steps used to conduct these analyses using above stated software, is given in this chapter along with the findings of the reliability measures and the factor analysis for each scale of the teacher questionnaire.

Chapter 7
Validation of the Student Questionnaire Scales

7.1 Introduction

In this chapter, the findings from the statistical analysis undertaken for the validation of the student questionnaire are given. The statistical techniques used for this purpose are the same as used for the teacher questionnaire validation and are explained in the chapter 6. As already mentioned in the chapter 6, SPSS software was used for the reliability analysis and initial factor analysis and AMOS software for conducting the final Confirmatory Factor Analysis. A detailed account of these statistical techniques, and the steps used to conduct these analyses, is given in Chapter 6, so these details are not repeated in this chapter. In the following sections, the findings are given for each scale of the student questionnaire. Each section contains a summary table of separate scales, the details of its sub-scales and the items in them followed by the results of the reliability and the factor analysis. For the results of CFA using AMOS only the final measurement model (best fitting model) is given in the following sections. All other models are given in the Appendix Y (Standardised Results of Confirmatory Factor Analysis (CFA) for Students).

7.2 Scale 1: Attitudes towards ICT (AICT)

The ICT attitude scale (AICT) in the student questionnaire was the modified/reworded version of the 'Computer Attitude Questionnaire' (CAQ v5.22) which was developed by Knezek and Christensen in 1995. This scale was divided into three sub-scales which were Enjoyment, Importance and Anxiety. The description of the items in these sub-scales is given in Table 7.1. It should be noted that re-coded items were used for the reliability and factor analysis for this scale.

Table 7.1: Summary of AICT scale on Student Questionnaire

Scale	Sub-scale	Item-code	Item Description
Attitudes towards ICT (AICT)	Enjoyment	AICT1	I enjoy doing things using ICT
		AICT2R	I am tired of using ICT
		AICT6	I enjoy lessons in which I use ICT
		AICT10	I feel comfortable working with ICT
		AICT15R	ICTs is difficult to use
	Importance	AICT3	I will be able to get a good job if I learn how to use ICT
		AICT5	I would work harder if I could use ICT more often
		AICT7	I know that ICT give me opportunities to learn many new things
		AICT9	I believe that it is very important for me to learn how to use ICT
	Anxiety	AICT4	I get a sinking feeling when I think of trying to use an ICT tool
		AICT8	Working with ICT makes me nervous
		AICT11	I think it takes a long time to finish when I use ICT
		AICT12	Using ICT tools is very frustrating
		AICT13R	ICT do not scare me
		AICT14	I will do as little work with ICT as possible

7.2.1 Reliability of the Scale

As an initial step of the validating process, the reliability analysis was performed for the full AICT scale by using SPSS software. As discussed in Chapter 6, in this research, Cronbach's alpha is used as the measure of internal consistency of the scales. The Cronbach's alpha for full AICT scale was 0.891 showing a highly reliable scale. It should be noted that this scale showed very low reliability (0.32) during the pilot study, but these reliability findings with bigger sample size showed that this was a highly reliable scale. Further, the reliability analysis for each sub-scale was completed and the findings are summarized in Table 7.2.

Table 7.2: Cronbach's Alpha Coefficients for each sub-scale of AICT scale

Scale	Sub-scale	Cronbach's Alpha
Attitudes towards ICT (AICT)	Enjoyment	0.811
	Importance	0.698
	Anxiety	0.824

7.2.2 Factor Analysis using SPSS

As it is already mentioned in Chapter 6, factor analysis was conducted in this study to establish the construct validity of the scales. For factor analysis using SPSS, the factor loadings in the 'Component Matrix' table of the SPSS output of factor analysis gives the factor loadings of each item or the observed variable on that particular factor. The factor loadings for each item in the three sub-scales are given in the Table 7.3. It shows that all the items/observed variable were loading well on to its latent variable with most of the items showing factor loading above 0.70.

Table 7.3: Factor Loadings for AICT scale

Scale	Sub-scale	Item-code	Factor Loadings
Attitudes towards ICT (AICT)	Enjoyment	AICT1	0.817
		AICT2R	0.714
		AICT6	0.783
		AICT10	0.767
		AICT15R	0.719
	Importance	AICT3	0.775
		AICT5	0.572
		AICT7	0.739
		AICT9	0.837
	Anxiety	AICT4	0.766
		AICT8	0.835
		AICT11	0.747
		AICT12	0.806
		AICT13R	0.512
		AICT14	0.711

7.2.3 Confirmatory Factor Analysis using AMOS

The construct validity was further established by conducting confirmatory factor analysis of the scales using AMOS. Five types of measurement models (See Chapter 6) were developed for each scale and the comparison was made between them based on the goodness of fit and the factor loadings to identify the best fitting model i.e., the hypothesized factor structure of the measurement model best supported by the data. The details of the fit indexes and the factor loadings were already given in Chapter 6 so are not repeated here. Table 7.4 summarizes the fit indexes for the five alternative models for Attitudes towards ICT (AICT) scale.

The results shown in the above table shows that the 3 correlated factor model, hierarchical model and the nested model had shown a better fit as compared to the 1 factor model and 3 orthogonal model because the χ^2/DF values for these three models was less than 5 (<5). Further the value of RMSEA these models are not greater than 0.1 which also confirmed better fitting models. The values of TLI and CFI were in the range of 0.786-0.891 which also indicated good fitting models. Although all these three models were showing a good fit, it was important to select one final structure of the measurement model.

For the AICT scale, the hierarchical model was selected as a final model based on the principle of parsimony in the measurement modeling, because hierarchical model is easy to manage during further analyses (Burhanuddin, 2013, p. 184) like single level path analysis. Figure 7.1 shows the Hierarchical model for the AICT scale which shows that the three latent variables (first order factors) loaded onto a single second order factor (AICT) in the model.

Further in Table 7.5, the factor loadings of the hierarchical model of this scale are given. It can be seen that two first order factors i.e., Enjoyment and Anxiety had high loadings onto single second order factor i.e., AICT and the third first order factor i.e., Importance also obtained practically significant loading onto AICT. Further one item/indicator (AICT8) had very high loading i.e., 0.800; five items had loadings between 0.703 - 0.790; seven items had loading between 0.623-0.695, one item had 0.437 loading and one had 0.398. All these items fall within the acceptable range of factor loadings (Hair et al., 2013, p. 115), so these items are considered as good indicators of the three latent factors.

Table 7.4: Fit Index: Model Fit Comparison for AICT scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	4.997	.704	.778	.122
2	3 Orthogonal Factor	6.919	.561	.671	.149
3	3 Correlated Factor	3.390	.823	.872	.094
4	Hierarchical	3.885	.786	.843	.104
5	Nested	3.293	.830	.891	.093

Table 7.5: Factor Loadings for Hierarchical model of AICT scale

Scale (Second order factor)	Sub-scale (First order factors)	Loadings	Items (Indicators)	Loadings
Attitudes towards ICT (AICT)	Enjoyment	0.89	AICT1	.762
			AICT2R	.646
			AICT6	.703
			AICT10	.722
			AICT15R	.665
	Importance	0.58	AICT3	.632
			AICT5	.398
			AICT7	.672
			AICT9	.790
	Anxiety	-0.95	AICT4	.695
			AICT8	.800
			AICT11	.638
			AICT12	.774
			AICT13R	.437
			AICT14	.623

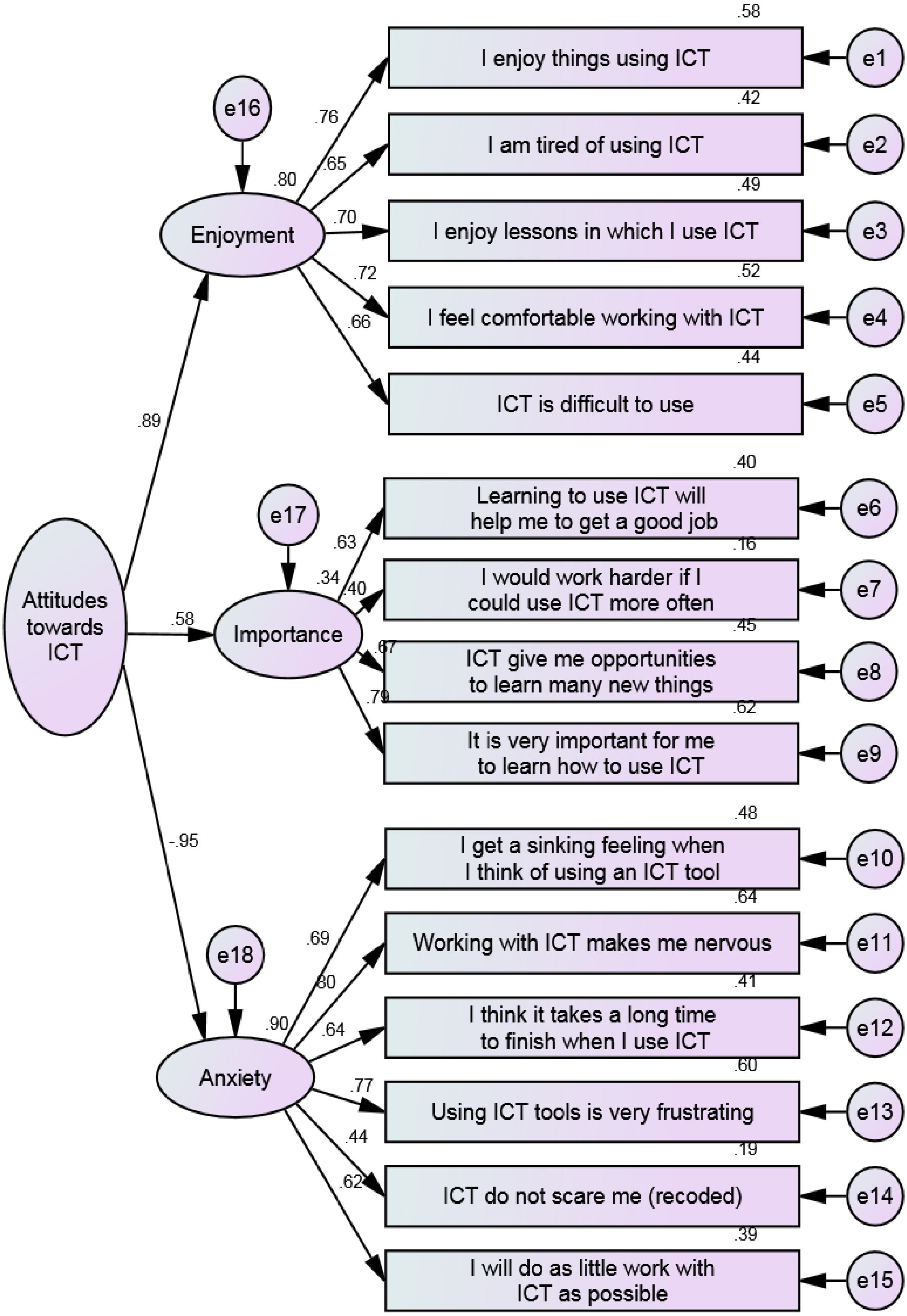


Figure 7.1: Hierarchical model for AICT scale of Student Questionnaire

7.3 Scale 2: Attitudes towards IWB (AIWB)

The AIWB scale was the modified version of 'Interactive Whiteboard Student Survey' developed by Mathews-Aydinli and Elaziz in 2010. There were four sub-scales in this scale and the summary is given in the Table 7.6: Attitudes related to the motivational issues; Attitudes related to affective factors; Attitudes related to time management; Attitudes related to support in learning. In this scale also, the re-coded form of the negatively worded items was used for the reliability and factor analysis.

Table 7.6: Summary of AIWB scale of Student Questionnaire

Scale	Sub-scale	Item-code	Item Description
Attitudes towards IWB (AIWB)	Attitudes Motivational Issues	AIWB1	IWB makes learning more interesting and exciting
		AIWB9	I concentrate better when my teacher uses an IWB in lessons
		AIWB10	I like to participate in lessons more when my teacher uses an IWB
		AIWB14	I find it easier to keep attention during the lesson when IWB is used
		AIWB15	Use of IWB makes it easier for me to be motivated during lessons
		AIWB16	The lessons become more enjoyable when taught using IWB
	Attitudes Affective Factors	AIWB3R	It seems difficult for me to use the IWBs
		AIWB5	I like going to the front of the class to use the IWB
		AIWB6	I prefer lessons that are taught with an IWB
		AIWB 13R	It makes me uncomfortable when my work is shown to the whole class on the IWB
	Attitudes Management / Organisation	AIWB7	Using IWB saves time
		AIWB 11R	I find it hard to keep up with the lesson in which my teacher uses IWB
		AIWB12	I find the lesson to be more organised when my teacher uses IWB
	Attitudes Support in Learning	AIWB2	IWB makes the teachers' drawings and diagrams easier to see
		AIWB4	I find opportunity to learn from different sources with the use of IWBs
		AIWB8R	Sometimes deficiencies of the IWB screen and sunlight in the classroom make it difficult to see the things on the IWB

7.3.1 Reliability of the Scale

The reliability coefficient for full scale was 0.870 which shows very high reliability of the scale. For the sub-scales, the Cronbach's alpha was 0.899 for Attitudes Motivational Issues; 0.446 for Attitudes Affective Factors; 0.437 for Attitudes Management Issues; 0.338 for Attitudes Support in Learning. So except from the Attitudes Motivational Issues sub-scale, all other three sub-scales had shown low reliability coefficient.

7.3.2 Factor Analysis

The factor analysis of the sub-scales revealed that AIWB11R (0.073) and AIWB8R (0.026) were showing low factor loadings on their latent variables, so these items were dropped from the scales before moving on to Confirmatory factor analysis using AMOS.

7.3.3 Final Reliability Analysis using SPSS

After dropping the items which were not loading well during the factor analysis, the reliability analysis was redone and the findings are given in the Table 7.7 which shows the Cronbach's alpha for each sub-scale of AIWB scale.

Table 7.7: Cronbach's alpha coefficient for each sub-scale of AIWB scale

Scale	Sub-scale	Cronbach's Alpha
Attitudes towards IWB (AIWB)	Attitudes Motivational Issues	0.899
	Attitudes Affective Factors	0.608
	Attitudes Management Issues	0.701
	Attitudes Support in Learning	0.607

7.3.4 Factor Analysis using SPSS

After reliability analysis, the factor analysis was also redone after dropping the items which were not behaving well in the initial analysis. The findings are summarized in Table 7.8. All the items showed high factor loadings on their respective factors.

Table 7.8: Factor Loadings of AIWB scale

Scale	Sub-scale	Item-Code	Factor Loadings
Attitudes towards IWB (AIWB)	Attitudes Motivational Issues	AIWB1	0.771
		AIWB9	0.875
		AIWB10	0.843
		AIWB14	0.739
		AIWB15	0.846
		AIWB16	0.835
	Attitudes Affective Factors	AIWB5	0.849
		AIWB6	0.849
	Attitudes Management Issues	AIWB7	0.879
		AIWB12	0.879
	Attitudes Support in Learning	AIWB2	0.848
		AIWB4	0.848

7.3.5 Confirmatory Factor Analysis using AMOS

The output of confirmatory factor analysis revealed that two items i.e., AIWB3R (0.20) and AIWB13R (0.11) were showing low factor loadings, so these items were also removed from the scale. The fit indexes for the comparison between five hypothesized measurement models for AIWB scale are given in Table 7.9. The values of χ^2/DF (<5), RMSEA (<0.1) and TLI and CFI (close to 0.90) indicated that the best fitting models were 1 factor model and Hierarchical model. Apart from these two models, 4 correlated factors model also had χ^2/DF value less 5 and RMSEA value below 0.1. The values for TLI and CFI for this model were also close to 0.9 but it was not better than the 1 factor and hierarchical models. On the other hand, nested model had χ^2/DF value more than 5; RMSEA value more than 0.1; TLI and CFI in the range of 0.798-0.878, so it was not a good fit with the sample data. The 4 orthogonal model was the worst fitting model with very high value of χ^2/DF (30.956) which is way more than the recommended value of <5, the RMSEA value was also much greater than 0.1 and TLI and CFI were much lower than 0.90. So among these five models, the hierarchical model was clearly the best fitting model with minimum values of χ^2/DF (2.941), and RMSEA (0.085) and maximum values of TLI (0.917) and CFI (0.946).

Table 7.9: Fit Index: Model Fit Comparison for AIWB scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	2.989	.915	.941	.086
2	4 Orthogonal Factor	30.956	-.280	.048	.334
3	4 Correlated Factor	3.029	.913	.947	.087
4	Hierarchical	2.941	.917	.946	.085
5	Nested	5.720	.798	.878	.133

Figure 7.2 shows the hierarchical model for AIWB scale with four first order factors loading onto a single second order factor (AIWB). Table 7.10 summarizes the factor loadings for the hierarchical model of AIWB scale. It shows that the all the four first order factors had very high factor loadings onto Attitudes towards IWB (AIWB) (second order factor). Among the items, four items showed high factor loading i.e., between the range of 0.800-0.880; five of them showed factor loading between 0.733-0.792 which is again consider as high loading; two items had loading of 0.652 and 0.654 and only one item had factor loading of 0.500 which is also considered as practically significant. So, these findings indicated that the items are good reflectors of their latent (first order factors) variables.

Table 7.10: Factor loadings for hierarchical model of AIWB scale

Scale (Second order factor)	Sub-scale (First order factors)	Loadings	Items (Indicators)	Loadings
Attitudes towards IWB (AIWB)	Attitudes Motivational Issues	0.97	AIWB1	.764
			AIWB9	.843
			AIWB10	.825
			AIWB14	.654
			AIWB15	.800
			AIWB16	.792
	Attitudes Affective Factors	0.90	AIWB5	.500
			AIWB6	.880
	Attitudes Management/ Organization	0.95	AIWB7	.733
			AIWB12	.742
	Attitudes Support in Learning	0.93	AIWB2	.752
			AIWB4	.652

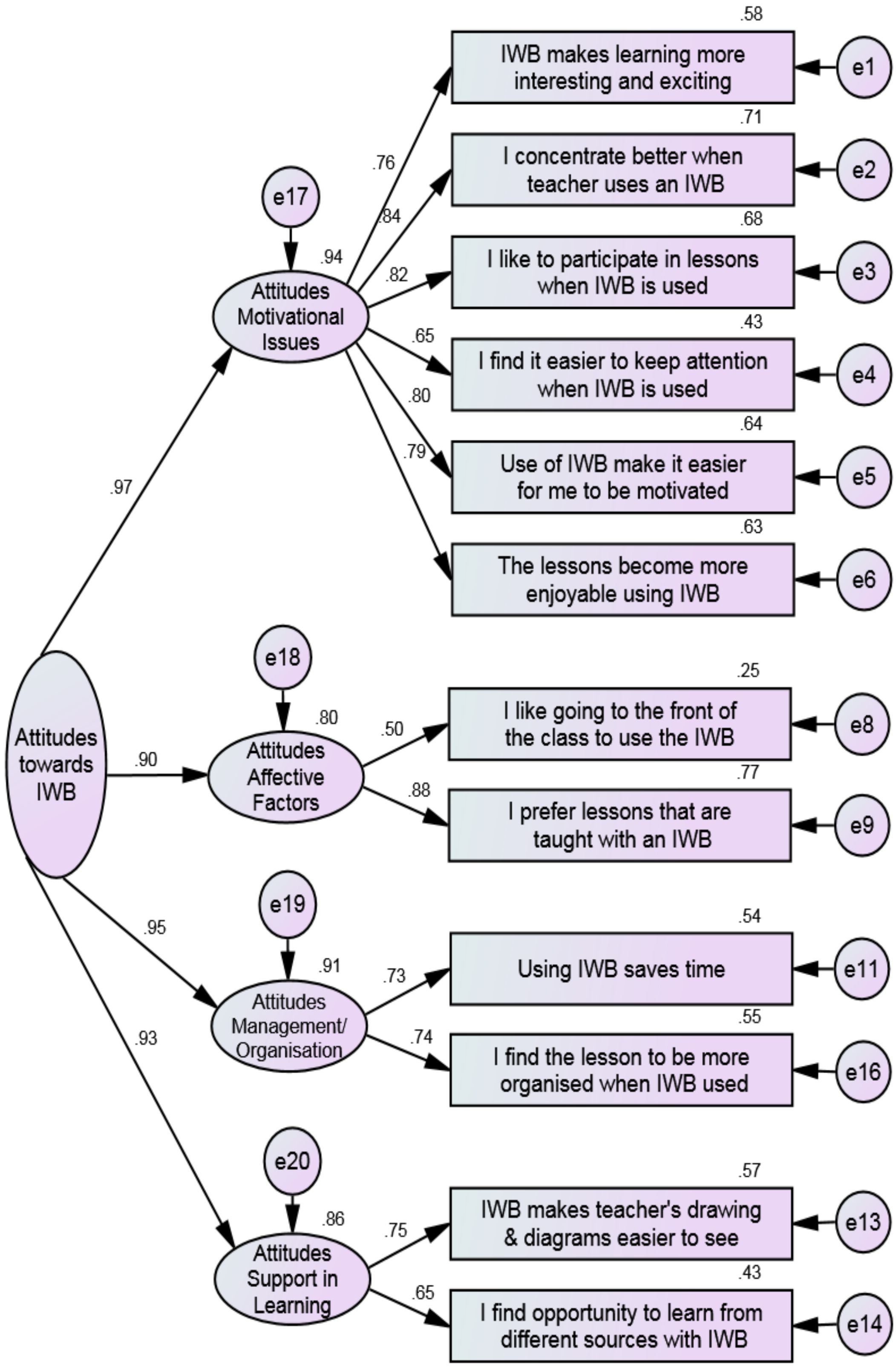


Figure 7.2: Hierarchical model for AIWB scale of Student Questionnaire

7.4 Scale 3: Classroom Interactions using IWB (CIIWB)

The CIIWB scale was developed by the researcher based on the understanding gained following the literature review regarding the possible types of IWB use (Miller et al., 2005). The scale was derived to explore the types of interactions the students experience in classrooms using IWB and consisted of scale had three sub-scales: Supported Didactic, Interactive or enhanced interactive. Table 7.11 gives summary about the items in these sub-scales. No recoding was needed in this scale.

Table 7.11: Summary of CIIWB scale of Student Questionnaire

Scale	Sub-scale	Item-code	Item Description
Classroom Interactions using IWB (CIIWB)	Supported Didactic	CIIWB 1	My teacher uses IWB to show us the visual material related to the lesson
		CIIWB 4	My teacher does not allow students to work on the IWB
		CIIWB6	My teacher uses both simple whiteboard and IWB in the classroom simultaneously
		CIIWB8	There is not much difference between my teachers' use of a traditional board and an IWB in terms of teaching techniques and methods
	Interactive	CIIWB7	My teacher teaches using IWB, I participate in Classroom discussions more than usual
		CIIWB9a	When my teacher uses IWB, overall there is more interaction between students in the class
		CIIWB9b	When my teacher uses IWB, overall there is more interaction between students and teacher
		CIIWB10	I usually initiate questioning related to the lesson when my teacher teaches using IWB
	Enhanced Interactive	CIIWB2	When my teacher teaches using IWB, all the students get maximum chance to participate in the learning process
		CIIWB3	My teacher uses a number of IWB-based teaching/learning resources in lessons
		CIIWB5	My teacher represents the information related to a topic on the IWB in multi-modal form i.e., using visual, verbal and kinesthetic forms together for a topic
		CIIWB11	When my teacher teaches using IWB, I often get the opportunity to go in front of the class to work on IWB

7.4.1 Reliability of the Scale

The reliability coefficient of the full scale was 0.750. Just like AICT scale, CIIWB scale also obtained very low value for Cronbach's alpha (0.18) during the pilot study, but these reliability findings with bigger sample size showed that this was a highly reliable scale. For the sub-scales, the reliability coefficient for Supported Didactic was 0.203 which is very low value. The Cronbach's alpha coefficient for the Interactive sub-scale was 0.798 and for Enhanced Interactive was 0.679.

7.4.2 Factor Analysis

The findings of factor analysis completed at the sub-scale level (Table 7.12) showed that, except for Item 1 i.e., CIIWB1 (factor loading: - 0.228) from the Supported Didactic sub-scale, all the other variables/items loaded well on their respective factors.

Table 7.12: Factor loadings for CIIWB scale

Scale	Sub-scale	Item Codes	Factor Loadings
Classroom Interactions using IWB (CIIWB)	Supported Didactic	CIIWB1	-0.228
		CIIWB4	0.644
		CIIWB6	0.516
		CIIWB8	0.731
	Interactive	CIIWB7	0.778
		CIIWB9a	0.814
		CIIWB9b	0.841
		CIIWB10	0.727
	Enhanced Interactive	CIIWB2	0.773
		CIIWB3	0.809
		CIIWB5	0.661
		CIIWB11	0.614

7.4.3 Confirmatory Factor Analysis using AMOS

In the Confirmatory factor analysis with AMOS, three items i.e., CIIWB4 (-0.15), CIIWB6 (0.18) and CIIWB8 (-0.05) obtained very low factor loadings on their common first order factor, so these items were dropped from the scale, then five separate measurement models were developed for comparison purposes. Table 7.13

summarizes the fit indexes for five different measurement models for CIIWB scale which reveals that 3 correlated model, hierarchical model and nested models showed better fit as compared to 1 factor and 3 orthogonal models. The values of χ^2/DF for these three models were below 5 and RMSEA was near to 0.1. The 1 factor model and 3 orthogonal model had very high values for both χ^2/DF and RMSEA, so they were not considered as a good fitting models. Among 3 correlated, hierarchical and the nested models, the hierarchical model was selected as a final model for further analysis again because it was easy to handle in the complex model analysis.

Table 7.13: Fit Index: Model Fit Comparison for CIIWB scale

S.No	Model	CMIN/DF	TLI	CFI	RMSEA
1	1 Factor	5.711	.721	.832	.133
2	3 Orthogonal Factor	11.445	.380	.614	.197
3	3 Correlated Factor	3.975	.823	.902	.105
4	Hierarchical	4.377	.800	.884	.112
5	Nested	4.367	.800	.911	.112

Further the factor loadings summary given in the Table 7.14 depicts all the three first order factors showed high factor loading onto the common CIIWB construct (second order factor) i.e., 0.92, 0.79 and 0.93.

Table 7.14: Factor loadings for hierarchical model of CIIWB scale

Scale (Second Order Factors)	Sub-scale (First Order Factors)	Loadings	Items (Indicators)	Loadings
Classroom Interactions using IWB (CIIWB)	Supported Didactic Stage	0.92	CIIWB1	.690
	Interactive Stage	0.79	CIIWB7	.649
			CIIWB9A	.748
			CIIWB9B	.828
			CIIWB10	.569
	Enhanced Interactive Stage	0.93	CIIWB2	.732
			CIIWB3	.719
			CIIWB5	.543
			CIIWB11	.474

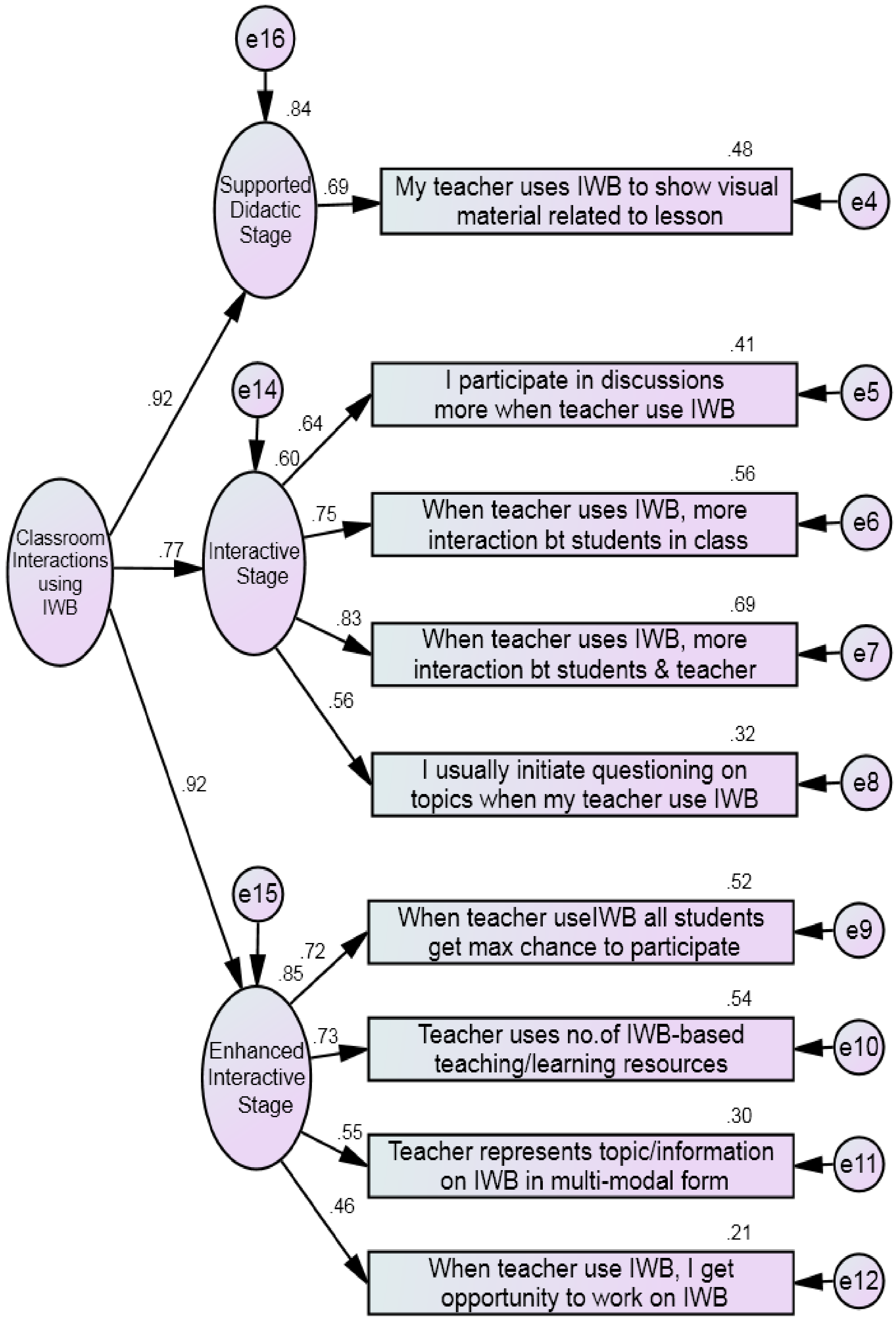


Figure 7.3: Hierarchical model for CIIWB scale of Student Questionnaire

The indicators also showed significant loadings on each distinct first order factor. Four items had loadings in the range of 0.719 - 0.828; four loadings between the ranges of 0.543-0.690 which is also considered as practically significant and one indicator had a loading of 0.474 which is also above the minimum value of 0.30. The final hierarchical model for CIIWB scale is shown in the Figure 7.3.

7.5 Scale 4: Learning Approaches using IWB (LA)

Biggs 'Revised Two Factor Study Process Questionnaire' (R-SPQ-2F) (2001) was used as the 'Learning Approaches using IWB' (LA) scale in this study for investigating the points of view of the students towards the impact of IWB use on their approaches to learning. This scale has sub-scaling at two levels i.e., the full LA scale is divided into two sub-scales, Deep Approach and Surface Approach. And both these sub-scales are further divided into two sub-scales i.e., Deep Approach has Deep Motive and Deep Strategy and Surface Approach has Surface Motive and Surface Strategy as sub-scales. The summary of the sub-scales and their items is given in the Table 7.15 on the next page. No recoding was needed in this scale.

7.5.1 Reliability of the Scale

As an initial step, the reliability analysis was done for the full scale and for the first level sub-scaling. The Cronbach's alpha coefficient was 0.757 for full scale and for each first level sub-scale, the reliability coefficient was 0.827 (Deep Approach) and 0.782 (Surface Approach).

7.5.2 Factor Analysis using SPSS

The SPSS output of factor analysis including both sub-scales clearly indicated that the Item 16 (LA16) on the Surface Approach sub-scale had very low factor loading (0.138). All the other items loaded very well on their respective latent factors. So, Item LA16 was dropped from the scale based on the findings of the factor analysis.

Table 7.15: Summary of LA scale of Student Questionnaire

Scale	Sub-scale		Item-code	Item Description
Learning Approaches using IWB (LA)	Deep Approach (DA)	Deep Motive (DM)	LA1	I find that at times learning gives me a feeling of deep satisfaction
			LA5	I feel that virtually any topic can be highly interesting once I get into it
			LA9	I find that learning can at times be as exciting as a good novel or movie
			LA13	I work hard at my studies because I find the material interesting
			LA17	I come to most classes with questions in mind that I want answering
		Deep Strategy (DS)	LA2	I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied
			LA6	I find most new topics interesting and often spend extra time trying to obtain more information about them
			LA10	I test myself on important topics until I understand them completely
			LA14	I spend a lot of my free time finding out more about interesting topics which have been discussed in class
			LA18	I make a point of looking at most of the suggested readings that go with the lessons
	Surface Approach (SA)	Surface Motive (SM)	LA3	My aim is to pass the course while doing as little work as possible
			LA7	I do not find my course very interesting so I keep my work to the minimum
			LA11	I find I can get by in most assessments by memorizing key sections rather than trying to understand them
			LA15	I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics
			LA19	I see no point in learning material which is not likely to be in the examination
		Surface Strategy (SS)	LA4	I only study seriously what's given out in class or in the course outlines
			LA8	I learn some things by rote, going over and over them until I know them by heart even if I do not understand them
			LA12	I generally restrict my learning to what is specifically set as I think it is unnecessary to do anything extra
			LA16	I believe the teachers should not expect students to spend significant amounts of time learning topics everyone knows won't be examined
			LA20	I find the best way to pass examinations is to try to remember answers to likely questions

7.5.3 Final Reliability Analysis using SPSS

After dropping LA16, the reliability coefficient of full LA scale was 0.774. The Cronbach's alpha coefficients for first level and second level sub-scales are given in Table 7.16. It can be seen that the reliability coefficient for Surface Approach had increased after removing item LA16 from it.

Table 7.16: Cronbach's alpha coefficient for each sub-scale of LA scale

Scale	Sub-scale	Cronbach's alpha	Sub-scale	Cronbach's alpha
Learning Approaches using IWB (LA)	Deep Approach (DA)	0.827	Deep Motive (DM)	0.679
			Deep Strategy (DS)	0.705
	Surface Approach (SA)	0.806	Surface Motive (SM)	0.720
			Surface Strategy (SS)	0.474

7.5.4 Factor Analysis using SPSS

The findings of the factor analysis done after removing the item 16 (LA16) are given in Table 7.17. Most of the items obtained high factor loadings i.e., between the range of 0.66-0.78. Only four items fell within the range of 0.448-0.565 as far as the factor loadings was concerned, but their factor loadings were still above the minimum value i.e., 0.30, so can be considered as moderate loadings. Further, the final factor analysis was done using AMOS and the findings of this analysis are discussed in the next section.

Table 7.17: Factor loadings for Learning Approaches using IWB (LA) scale

Scale	Sub-scale		Item Codes	Factor Loadings
Learning Approaches using IWB (LA)	Deep Approach (DA)	Deep Motive (DM)	LA1	0.665
			LA5	0.661
			LA9	0.689
			LA13	0.731
			LA17	0.560
		Deep Strategy (DS)	LA2	0.565
			LA6	0.699
			LA10	0.662
			LA14	0.705
			LA18	0.746
	Surface Approach (SA)	Surface Motive (SM)	LA3	0.786
			LA7	0.744
			LA11	0.448
			LA15	0.777
			LA19	0.660
		Surface Strategy (SS)	LA4	0.668
			LA8	0.547
			LA12	0.725
			LA20	0.696

7.5.5 Confirmatory Factor Analysis using AMOS

It is already mentioned above that the sub-scaling for this scale was done at two levels, i.e., the full scale had two sub-scales: Deep Approach and Surface Approach which further were divided into four sub-scales (two each): Deep Motive, Deep Strategy, Surface Motive and Surface Strategy. So in order to identify the best fitting measurement model, the hypothesized models were developed including sub-scales up to second level. The summary of the findings of the fit indexes of these measurement models is given in Table 7.18. As the table shows, 2 orthogonal factor model, 4 and 4a correlated factor model and hierarchical 3 factor model had come up to be as better fitting models than the other five models. And among these four better fitting models, Hierarchical 3 model was selected as the final model for the LA scale. This model had χ^2/DF value of 3.599 which was below 5; the RMSEA value was below 0.1 i.e., 0.98 and TLI and CFI values were 0.645 and 0.716 respectively.

Table 7.18: Fit Index: Model Fit Summary for LA scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	6.137	.298	.439	.138
2	2 Orthogonal Factor	3.162	.705	.764	.090
3	4 Orthogonal Factor	5.708	.357	.486	.133
4	4 Correlated Factor	3.049	.720	.785	.087
5	4a Correlated Factor	3.176	.703	.765	.090
6	Hierarchical	4.693	.496	.602	.117
7	Hierarchical 2	4.029	.586	.669	.106
8	Hierarchical 3	**3.599**	**.645**	**.716**	**.098**
8	Nested	4.053	.583	.704	.107

Figure 7.4 illustrates the hierarchical model selected as the final model for LA scale. It clearly shows that the first level sub-scales i.e., Deep Approach and Surface Approach, function as separate scales in which Deep Approach and Surface Approach were the second order factors and Deep Motive and Deep Strategy were the first order factors. For Deep Approach and Surface Motive and Surface Strategy were the first order factors for Surface Approach. The factor loadings for both these scales are given in the Tables 7.19 and 7.20 and were named as 'Deep Learning Approach using IWB' (DLA) and 'Surface Learning Approach using IWB' (SLA). Both these tables clearly show that first order factors for both the scales i.e., Deep Motive & Deep Strategy and Surface Motive & Surface Strategy obtained very high factor loadings (0.86-0.94) on their respective constructs (second order factors). Most of the indicators/items in these separate scales also showed moderate to high factor loadings. There was only one item in the DLA scale and three items in the SLA scale which showed factor loadings between the range of 0.303-0.492 but these loadings were still above the minimum acceptable value of 0.30.

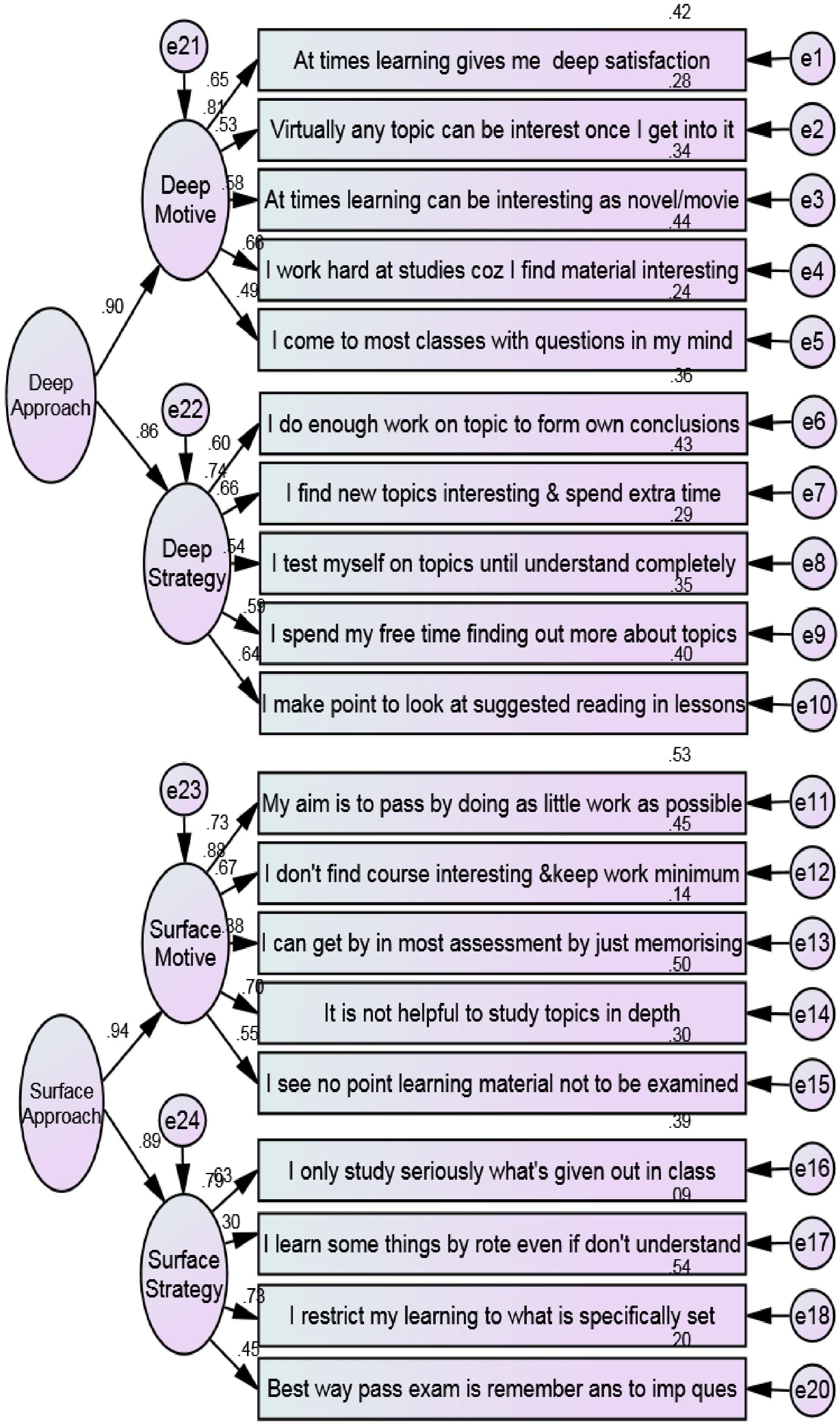


Figure 7.4: Hierarchical models for DLA and SLA scales of Student Questionnaire

Table 7.19: Factor loadings for Deep Learning Approach using IWB (DLA) scale

Scale (Second order factors)	Sub-scale (First order factors)	Loadings	Items (Indicators)	Factor Loadings
Deep Learning Approach using IWB (DLA)	Deep Motive	0.90	LA1	.647
			LA5	.528
			LA9	.582
			LA13	.660
			LA17	.492
	Deep Strategy	0.86	LA2	.596
			LA6	.655
			LA10	.537
			LA14	.593
			LA18	.636

Table 7.20: Factor loadings for Surface Learning Approach using IWB (SLA) scale

Scale (Second order factors)	Sub-scale (First order factors)	Loadings	Items (Indicators)	Factor Loadings
Surface Learning Approach using IWB (SLA)	Surface Motive	0.94	LA3	.731
			LA7	.667
			LA11	.380
			LA15	.704
			LA19	.550
	Surface Strategy	0.89	LA4	.625
			LA8	.303
			LA12	.735
			LA20	.451

7.6 Scale 5: Learning Outcomes using IWB (LO)

The 'Learning Outcomes using IWB' (LO) scale was developed by the researcher based on the "Bloom's Revised Taxonomy of Learning Objectives" (Anderson et al., 2001) to explore the perceptions of the students regarding the impact of IWB on the quality of their learning outcomes. There were six sub-scales in this scale which were developed based on the six levels of Bloom's taxonomy. Each sub-scale had four items each, so there were total of 24 items in the original LO scale developed by the researcher. Some of the items in this scale were negatively worded, so the recoded form of these items was used during the reliability and factor analysis. Table 7.21 provides the summary of the sub-scales of LO scale along with the item-code and item-description for the items in each sub-scale.

Table 7.21: Summary of sub-scaling for Learning Outcomes using IWB Scale

Scale	Sub-scale	Item-code	Item Description
Learning Outcomes using IWB (LO)	Creating	LO6R	Learning on IWB does not help me to improve my creative power
		LO12	I find that working on IWB in front of the class helps me to express my creativity
		LO18	I have noticed that learning on IWB helps me generate new knowledge out of my understanding
		LO24	When various facts and ideas are represented in a lesson using IWB it helps me to synthesize new concepts out of it
	Evaluating	LO5	Learning a topic using IWB helps me to make critical judgments
		LO11	It is easier to understand the significance of a topic taught on IWB
		LO17R	It is hard to make judgments about the overall significance of a given idea when it is represented using IWB
		LO23	I could deeply evaluate any idea or concept when represented on IWB
	Analyzing	LO4	When new topics are introduced by my teacher using IWB, it helps me to make connections with my previous learning
		LO10	I can easily explore relationships between different concepts of a topic which I learn with IWB
		LO16	Making comparisons between two different ideas learnt on IWB is always easier for me
		LO22R	I always find it hard to organize the different concepts represented on IWB in my own way
	Applying	LO3	When I learn about a new topic using IWB, I can think of its use in my day to day life very easily
		LO9R	When a lesson is taught using IWB, I find it very hard to use my previous knowledge in it
		LO15	Learning about a concept using IWB helps me to think of ways of implementing that concept to various situations
		LO21	Learning using IWB helps me to think that how can I apply the knowledge of one subject to another subject area
	Understanding	LO2R	I do not understand the lessons when my teacher uses an IWB
		LO8	When two separate concepts or ideas are represented using IWB, I usually find myself comparing them to see the similarities or differences between them
		LO14	Using audio and visual materials with IWB helps me understand lessons better
		LO20	I find it easier to summarize at the end of a lesson which is taught with the use of IWB
	Remembering	LO1	I find it easier to recall a topic which is taught by my teacher using IWB
		LO7	I think I can remember a topic more easily when taught using IWB rather than simple board
		LO13R	I find it hard to remember the information which is represented on IWB
		LO19	The learning material represented using verbal, visual and kinesthetic features of IWB is easy to remember

7.6.1 Reliability of the Scale

As an initial step of the validating process, the reliability analysis was undertaken for full LO scale using SPSS software. The reliability coefficient was 0.892 for full LO scale which showed a highly reliable scale. Further the Cronbach's alpha coefficient for each sub-scale was calculated separately. For 'Creating' sub-scale, the reliability coefficient was 0.589; for 'Evaluating', 0.477; for 'Analyzing', 0.548; for 'Applying', 0.423; for 'Understanding' 0.519 and for 'Remembering', 0.619. As, reliability analysis was just the first step in the process of validation of the scales, so initial reliability findings were treated as indication to the presence of some possible misbehaving items in the scales. But it was not possible to identify these misbehaving items without conducting the factor analysis, so in spite of the low reliability coefficients, all the scales were retained for the initial factor analysis which was done using SPSS software.

7.6.2 Factor Analysis

The findings of the factor analysis of full LO scale and then separate sub-scales showed that the factor loadings for negatively worded (recoded) items in all the six sub-scales were low as compared to the other items in the sub-scales i.e., LO6R (-0.033), LO17R (-0.424), LO22R (-0.351), LO9R (-.533), LO2R (-.246), LO13R (-.063).

7.6.3 Dropping the Items

The findings of the factor analysis using SPSS depicted that the negative items in all the sub-scales were not loading well. So keeping in mind the low reliability coefficients for all the sub-scales and low factor loadings shown by the negatively worded (recoded) items, it was decided to drop all the recoded items from all the six sub-scales.

7.6.4 Final Reliability Analysis using SPSS

After dropping the recoded items from the LO scale, the reliability analysis was again done and the Cronbach's alpha for the full scale was 0.949 which indicated a very high reliability of LO scale. As a next step, the reliability analysis was done using for all six sub-scales. The results of this analysis are summarized in the Table 7.22. It is clear from this table that, after removing the negatively worded items, the reliability coefficients for all the sub-scales had increased with all values above 0.70 which is considered as the recommended value for considering a scale as reliable.

Table 7.22: Summary of the Cronbach's Alpha Coefficients for sub-scales of LO scale

Scale	Sub-scale	Cronbach's alpha
Learning Outcomes using IWB (LO)	Creating	0.798
	Evaluating	0.782
	Analyzing	0.836
	Applying	0.785
	Understanding	0.753
	Remembering	0.806

7.6.5 Factor Analysis using SPSS

The factor analysis was also redone using SPSS for the full scale and the sub-scales separately after removing the recoded items. The SPSS output showed high factor loadings for the full scale and most importantly, the results generated during this analysis of separate sub-scales showed even higher factor loadings which are summarized in the Table 7.23. All the items obtained loadings of 0.80 or above.

7.6.6 Confirmatory Factor Analysis using AMOS

The final confirmatory factor analysis was done using AMOS and five hypothesized measurement models were made and compared on the basis of the values of fit indexes which are given in the Table 7.24. As the table shows that the 6 correlated factor model and the hierarchical models were better fitting as compared to the other three models because their χ^2/DF and RMSEA values were within the acceptable range and the TLI and CFI values were also better than the other three. Again the hierarchical model was selected as the final model because it was easier and simpler to handle in the later analysis.

Table 7.23: Factor loadings for Learning Outcomes using IWB (LO) scale

Scale	Sub-scale/Factor	Items/Variables	Factor Loadings
Learning Outcomes using IWB (LO)	Creating	LO12	0.809
		LO18	0.854
		LO24	0.871
	Evaluating	LO5	0.846
		LO11	0.847
		LO23	0.812
	Analyzing	LO4	0.880
		LO10	0.850
		LO16	0.874
	Applying	LO3	0.827
		LO15	0.836
		LO21	0.848
	Understanding	LO8	0.799
		LO14	0.809
		LO20	0.846
	Remembering	LO1	0.831
		LO7	0.871
		LO19	0.846

Table 7.24: Fit Index: Model Fit Summary for Learning Outcomes using IWB (LO) scale

S.No	Model	χ^2/DF	TLI	CFI	RMSEA
1	1 Factor	4.453	.805	.846	.114
2	6 Orthogonal Factor	12.858	.329	.470	.210
3	6 Correlated Factor	3.110	.880	.916	.089
4	Hierarchical	3.991	.831	.872	.106
5	Nested	4.184	.820	.877	.109

The factor loadings given in the Table 7.25 clearly shows that all the first order factors obtained very high factor loadings onto the single second order factor or the common construct i.e. Learning Outcomes using IWB.

Table 7.25: Factor loadings for Learning Outcomes using IWB (LO) scale

Scale (Second order factors)	Sub-scale (First order factors)	Loadings	Items (Indicators)	Factor loadings
Learning Outcomes using IWB (LO)	Creating (F1)	0.90	LO12	.716
			LO18	.770
			LO24	.787
	Evaluating (F2)	0.97	LO5	.729
			LO11	.825
			LO23	.642
	Analysing (F3)	0.96	LO4	.800
			LO10	.762
			LO16	.819
	Applying (F4)	0.93	LO3	.771
			LO15	.741
			LO21	.713
	Understanding (F5)	0.99	LO8	.756
			LO14	.630
			LO20	.730
	Remembering (F6)	0.88	LO1	.712
			LO7	.825
			LO19	.751

Further, the 18 items (indicators) also showed high factor loadings onto their respective first order factors. 16 items obtained very high factor loadings between the ranges of 0.712- 0.825; two items obtained loadings of 0.630 and 0.642 which are also considered good or moderate loadings. So overall, on the basis of the factor loadings outcome, it was clear that the items were good indicators of the six first order factors. The figure of the final measurement model (hierarchical model) which was chosen for this scale is given on the next page (See Figure 7.5).

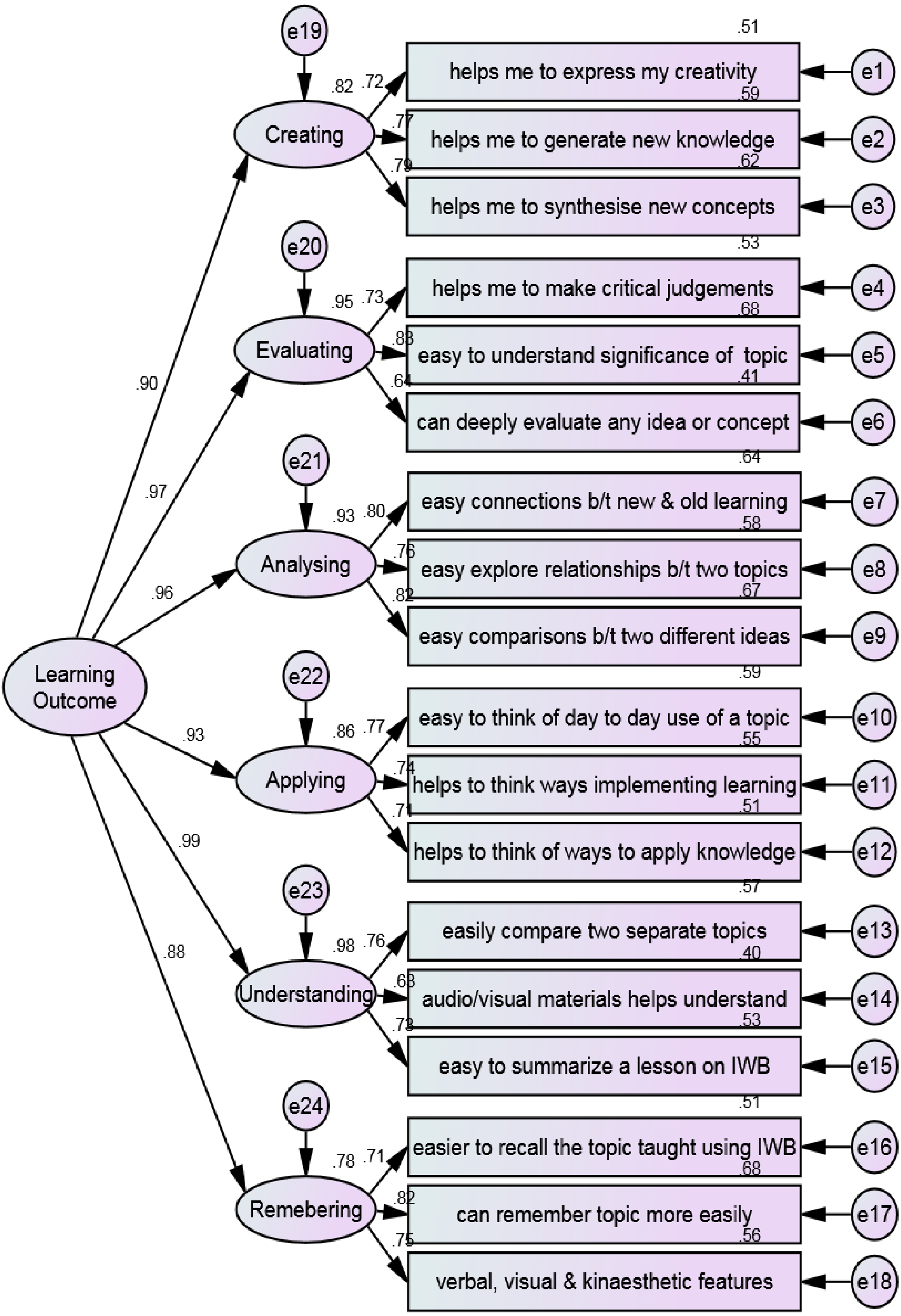


Figure 7.5: Hierarchical model for the LO scale of Student Questionnaire

7.7 Summary

This chapter presents the findings from the statistical analysis undertaken for the validation of the student questionnaire used in this study. SPSS software was used for reliability analysis and initial factor analysis and AMOS software was used for the final confirmatory factor analysis. A detailed account about these statistical techniques, and the steps used to conduct these analyses using above stated software, is given in this chapter along with the findings of the reliability measures and the factor analysis for each scale of the student questionnaire.

Chapter 8
Single Level Path Analysis: Teacher Level

8.1 Introduction

After establishing the construct validity of all the constructs used in teacher and student questionnaires using various statistical techniques (see Chapter Six and Seven), the next step was to develop the models depicting the inter-relationships between the observed (manifest or indicators) and latent (factors or constructs) variables and also among the different latent variables used in this study at Adoption, Utilization and Output phases of IWB use (Figure 2.7: Theoretical Framework). Further, it was necessary that the interactions among the variables must also be explored separately for the teacher level and the student level. For the data collected at the teacher level, the main purpose was to identify the factors which impact the classroom interactions among teachers and students using IWB. For the student level, the purpose was to form an understanding, of how various factors 'interact' with each other, and how they might affect students in terms of their learning approach and outcomes. Therefore, with the aim of investigating the relationship among the various factors for each level, a single level path analysis technique was used. In the following paragraphs, a detailed account about the process of path analysis is given followed by the description of the variables used, and the findings of the teacher level path analysis.

8.2 Path Analysis

Path Analysis technique, that uses a structural equation modeling (SEM) procedure, was considered appropriate and employed using AMOS software package (version 18), to investigate the path models including observed and latent variables. Path analysis is a technique that involves setting up a model showing the way in which three or more variables are associated with one another (Cramer, 2003, p. 89) and SEM is a procedure which is used to examine a series of dependence relationships among these variables simultaneously. SEM is "particularly useful when one dependent variable becomes an independent variable in subsequent dependence relationships" (Darmawan, 2003, p. 82). Path analysis, which is similar to the multiple regression, calculates the strength of the relationships among different variables by using a correlation or covariance matrix as input (Hair et al., 2013, p. 592).

Further a general Structural Equation Model (Figure 8.1) incorporates both the measurement models and the structural models. The measurement model is used to depict the relationship between several indicators or observed variables and a single latent variable and the structural model is used to depict the nature and magnitudes of the relationships among the latent variables (Byrne, 2010, p. 7; Hair et al., 2013, p. 642). In other words, the structural model is used to see how the independent (predictor) and dependent (criterion) latent variables are related to one another. "In such situations, theory, prior experience, or other guidelines allow the researcher to distinguish which independent variables predict each dependent variable" (Darmawan, 2003, p. 83). In the present study the recursive (specifies influence from one direction only) type of path models was used (Byrne, 2010, p. 7) and the direction of the influence among the variables was shown from left to right. The details of the specifications of the path diagram are given in the following paragraphs.

8.2.1 Model Specification using a Path Diagram

A Path diagram is a schematic representation of a SEM model (Byrne, 2010, p. 9): that is a visual representation of the assumed relationships among the variables used in a study (Byrne, 2010, p. 9). To draw the path diagram using AMOS software, four different types of geometric symbols are used i.e., ellipse, rectangle, single-headed arrow and double-headed arrow. Each symbol represents a particular type of variable and the relationships among different variables in the model (Figure 8.1). The ellipse represents the latent variable; the rectangle represents observed variable; the single-headed arrow represents the impact of one variable on the other (causal relationships); and the double-headed arrow represents covariance between two variables (Byrne, 2010, p. 9). Further a single-headed arrow going from an ellipse to a rectangle represents a path coefficient for regression of an observed variable onto a latent variable, and if it goes from one ellipse to another ellipse then it represents a path coefficient for regression of one latent variable (also called a construct) onto another latent variable (Byrne, 2010, p. 9).

It is important to mention that a measurement error term is associated with each observed variable which represent the error in measuring an underlying factor. Similar to this, a residual term is associated with latent variable which represents the error in predicting an endogenous (dependent) variable from an exogenous (independent) variable (Byrne, 2010, p. 10). Exogenous variable is the one which has no single-headed arrow pointing to it and only has one or more single-headed arrows departing from it and the endogenous variable is one which has single-headed arrows pointing to it and also has single-headed arrows departing from it (Darmawan, 2003, p. 83). It is also necessary to note that in most of the SEM models, there is usually more than one endogenous variable, and each endogenous variable can work as both a predictor and a criterion in a model (Hair et al., 2013, p. 642).

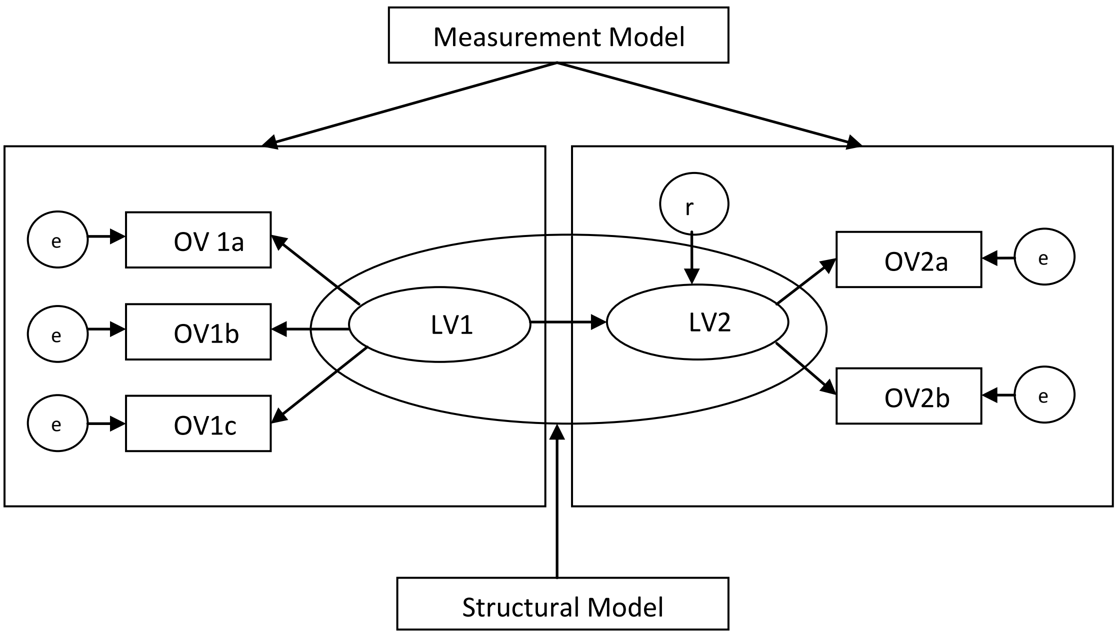


Figure 8.1: A general structural equation model (adapted from Byrne (2010, p. 13)
LV: Latent Variable; OV: Observed Variable; e: Measurement Error; r: Residual Error

Also, the effect of one variable can either be direct, shown by a single-headed arrow from one variable to another, or it can be indirect when there is an intervening or mediating variable coming between two variables, and where the direction of effect is shown by a series of multiple arrows (Hair et al., 2013, p. 646). The multiplication of the path coefficient between two or more dependent variables by the path coefficient between one of the dependent variables and the independent variable gives the estimation of this kind of indirect effect (Cramer, 2003, p. 96). After specifying the path diagram, analysis of the model is done using the SEM procedure to find the strength of the relationships among the variables and to see how well the data fits the model (Hair et al., 2013, p. 561). This is done by comparing the estimated covariance matrix (theory) with the observed covariance matrix (reality) followed by selecting the best model fit based on the goodness-of-fit statistics (Hair et al., 2013, p. 576).

8.2.2 Trimming the path model

A necessary step of model trimming is used in this study to obtain a parsimonious model which fits the data reasonably well (Kline, 1998, p. 132). The model trimming of teacher level and student level path models was done by starting with the hypothetical models which were the full model with all recursive paths (also called the just-identified model) (Garbin, n.d.), and these were then simplified by eliminating pathways (Kline, 1998, p. 132). The criterion used for trimming the models was Critical Ratio (C.R) (Darmawan, 2003, p. 84). C.R. is obtained by dividing the covariance estimate by its standard error with any C.R. exceeding 1.96 being considered significant (p-value < 0.05) (Arbuckle, 2009, p. 30). The pathways with C.R. less than 1.96 were removed along with the insignificant correlations. The hypothetical model for the teacher level path analysis is shown in Figure 8.2.

8.3 Variables used in the Teacher Level Path Analysis

It is important to mention here that all the variables for the teacher level path model were treated as observed variables. This was necessary because the sample size for teachers was small (n=30), so it was not possible to use the latent variables in this

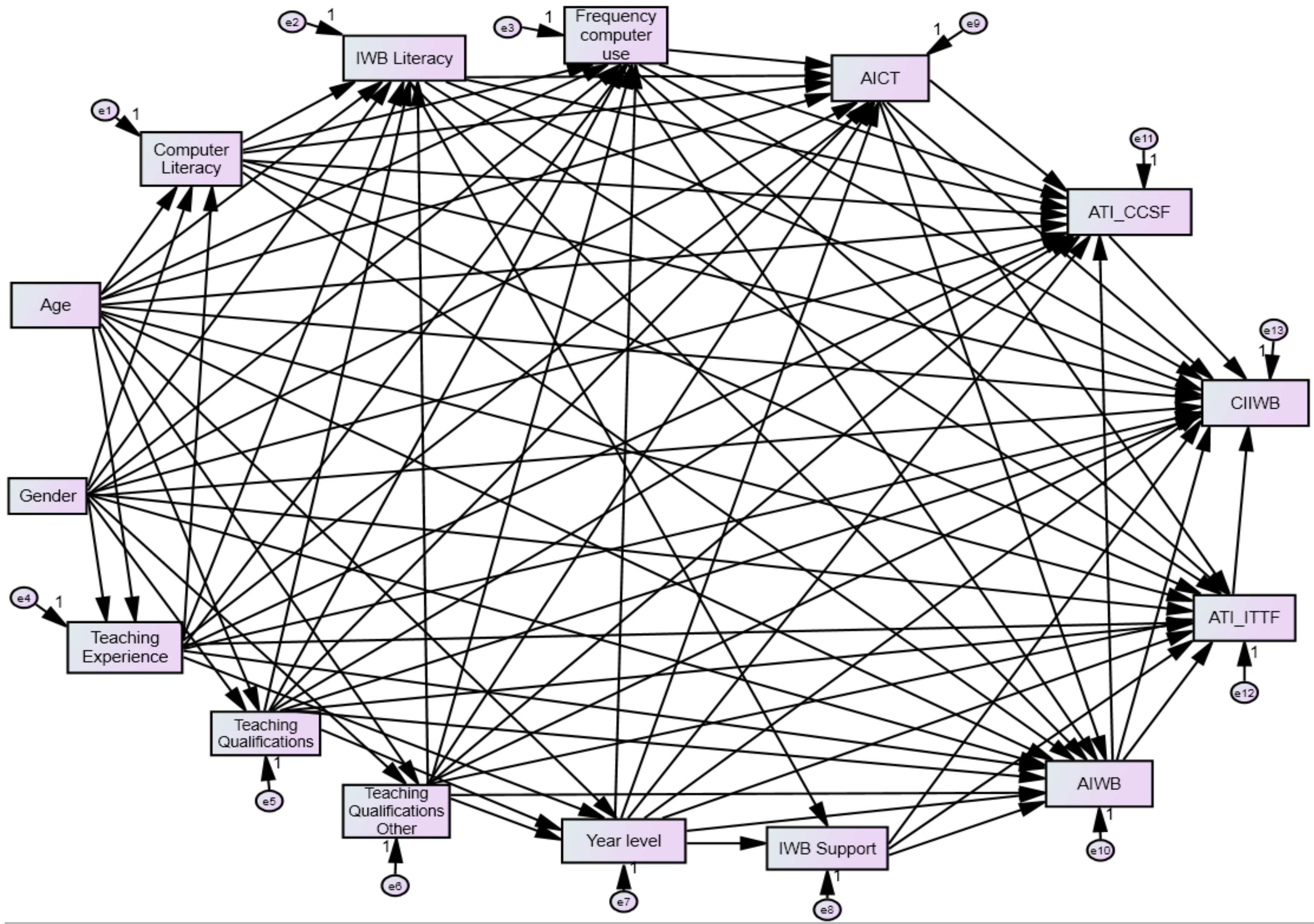


Figure 8.2: Hypothetical Model at Teacher Level

model (Kenny, 2014). These observed variables were developed with factor scoring technique using SPSS software (DiStefano, Zhu, & Mindrila, 2009) with which the items were compressed into the 'manipulated subscales', and then these subscales were further compressed to derive the observed variables (composite variables) used in this model.

There were total of 15 observed variables in the hypothetical model, two of these i.e. Age and Gender were treated as exogenous variables and all other 13 variables were treated as the endogenous variables in the hypothetical model. The list of these variables with their description is given in Table 8.1.

Table 8.1: Variables used in the teacher level path model

Observed Variables	Description
Gender	Gender of the teachers (0=Male; 1=Female)
Age	Age of the teachers (1=20-25; 2=26-30; 3=3-35; 4=36-40; 5=4-45; 6=46-Above)
Teaching Qualifications	Qualifications of the teachers (1=Bachelor of Teaching; 2=Graduate Diploma in Education; 3=Other)
Teaching Qualifications Other	Other Teaching Qualifications mentioned by the Teachers
Year Level	Year level to whom they teach using IWB (Year 7-Year 12)
Frequency Computer Use	Frequency of classroom computer use by teacher (0=Never; 1=Occasionally; 2=Once in a week; 3=Almost twice a week; 4=Daily)
IWB Support	IWB technical support; IWB workshops; Encouragement to use IWB; and IWB help by school
IWB Literacy	IWB competence; IWB confidence; and IWB experience of the teacher
Computer Literacy	Computer experience; Computer competency; and Computer confidence of the teacher
Teaching Experience	Teaching experience of the teachers (1=less than year; 2=1-5years; 3=6-10years; 4=11-15 years; 5=16-20years; and 6=21-above)
AICT	Attitudes of teachers towards ICT
AIWB	Attitudes of teachers towards IWB (general; teaching; motivational; and training)
ATI_CCSF	Conceptual Change Student Focused teaching approach
ATI_ITTF	Information Transmission Teacher Focused teaching approach
CIIWB	Classroom interactions using IWB(Supported didactic; Interactive; and enhanced interactive)

The variable named 'IWB Support' was developed by compressing four items related to the kind of IWB support the teachers get from their schools. These four items were IWB technical support, IWB workshops, Encouragement to use IWB and IWB help. Similarly, an endogenous variable named 'IWB Literacy' was developed by compressing IWB competence, IWB confidence and IWB experience of the teachers. Another variable which was named as 'Computer literacy' was developed by compressing three items i.e., computer experience, computer competency and computer confidence of the teachers.

As it is already discussed in Chapter Six, One Factor Model was chosen as the final model for 'Attitudes towards ICT' (AICT) scale, so all the items for this scale were compressed together to form one AICT observed variable to be used in the teacher level path model. Similarly, for both 'Conceptual Change/Student Focused teaching approach' and 'Information Transmission/ Teacher Focused teaching approach' scales, all the items were compressed using factor scoring technique to form ATI_CCSF and ATI_ITTF variables respectively. Further, 'Attitudes towards IWB' (AIWB) was a variable developed by compressing four manipulated subscales i.e. general, teaching, motivational and training, and 'Classroom Interactions using IWB' (CIIWB) was developed by compressing three manipulated subscales, Supported Didactic, Interactive or enhanced interactive.

Referring to the variables described in the Table 8.1, it should be noted that three variables i.e., 'Teaching Qualifications', ‘Teaching Qualifications Other’ and 'Year Level' were excluded from the final model because the path coefficients obtained by these variables were not significant (p-value > 0.05). In the final structure of teacher level path model, there were a total 12 variables among which four were treated as exogenous variables i.e. Age, Gender, ‘Frequency Computer Use’ and ‘IWB Support’. The other eight endogenous variables were ‘IWB Literacy’, ‘Computer Literacy’, ‘Teaching Experience’, AICT, AIWB, ATI_CCSF, ATI_ITTF, and CIIWB. The final structure of the teacher level path diagram is shown in Figure 8.3.

8.4 Results of Teacher Level Path Analysis

As already mentioned above (Introduction), the single level path analysis technique was used in this study to examine the causal relationships among the different variables at the teacher level. The results of the teacher level path analysis includes only the structural models as no latent variables were used in this model.

8.4.1 Structural Model results at the teacher level

Eight different types of indices were used to present the results of the path analysis used to examine the relationships among the different variables at the teacher level. These indices are unstandardised estimates or unstandardised path coefficients (b), standard error (s.e.) which informs about the variability of the estimates, critical ratio (C.R.) which is the value obtained by dividing the unstandardised estimate by its standard error (b/s.e.) and any C.R. exceeding 1.96 (p-value< 0.05): a value considered significant (Arbuckle, 2009, p. 30). The next index is the two tailed *p* value which is used to present the statistical significance of the relationships. Standardised estimates or Standardised path coefficient (β) is the fifth index. Standardised Indirect Effect (ie) index gives the estimates of the relationship between the predictor and a criterion variable through one or more mediating variables. It is also written as "ie" and is calculated by multiplying the path coefficients obtained by the variables involved in the sequence of the relationships. The seventh index is the Total effect (te) is the obtained by adding the direct and indirect effect coefficients (Tuijnman & Keeves, 1994). Apart from these, the eighth index is Squared Multiple Correlation (R^2) which indicates the percent of variance of criterion variable accounted for by the predictor variables (Arbuckle, 2010, p. 144).

The results are interpreted based on the recommendations provided by Cohen (1988) according to which the effect size of the path coefficients between the range of 0.02-0.15 is considered as small; 0.15-0.35 is medium and above 0.35 is large. The effect size below 0.02 is not considered relevant for interpretation (Cohen, 1988). The results of the structural models are displayed in Table 8.2 and the relationships among the variables are shown in Figure 8.3.

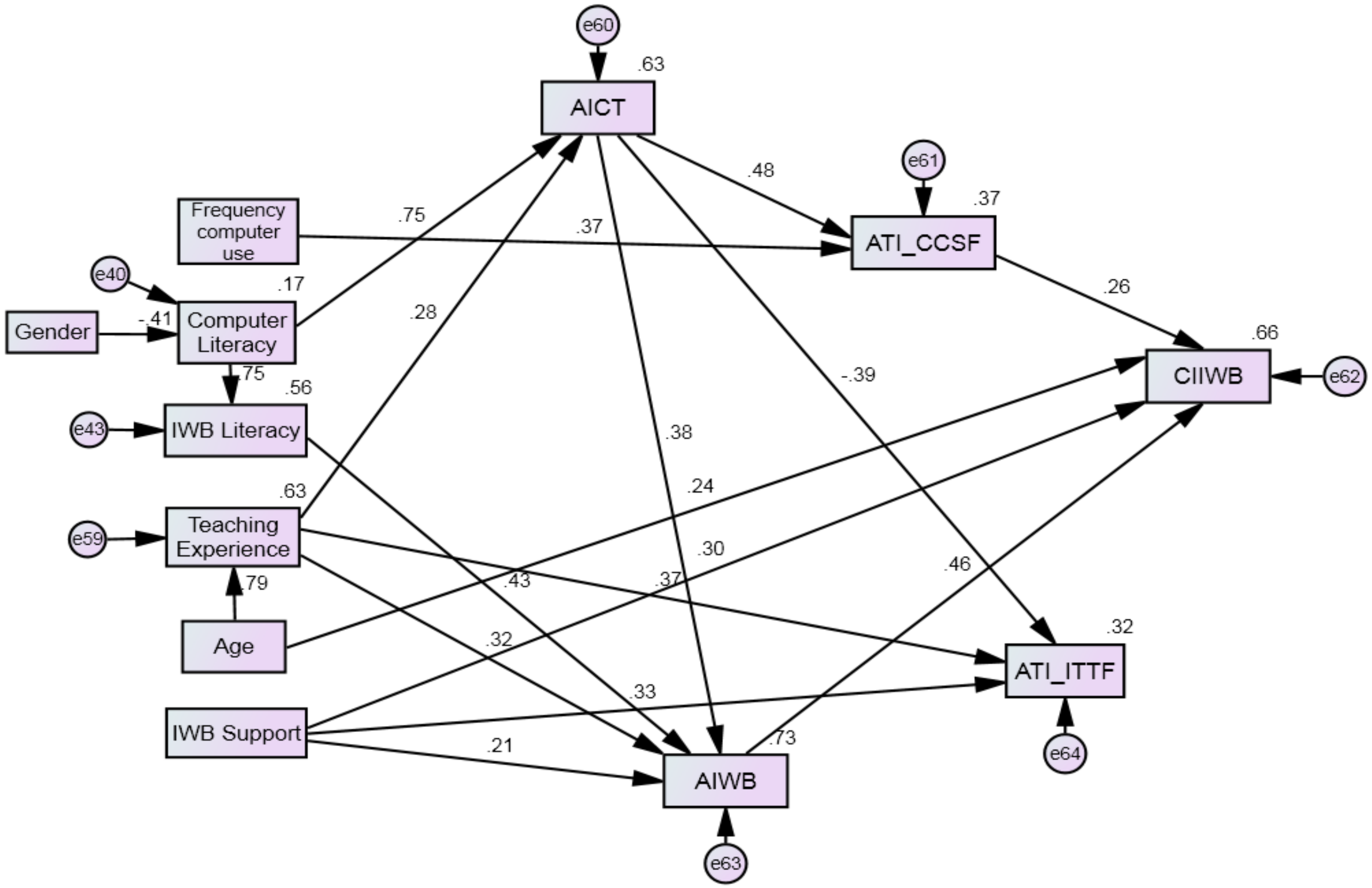


Figure 8.3: Single Level Path Model at Teacher Level

Table 8.2: Results of structural model at the teacher level

Variables		Direct effect					StdInd. effect	Total effect
Criterion	**Predictor**	**Unstd Est. (b)**	**s.e.**	**C.R.**	***p***	**StdEst (β)**	**(ie)**	**(β + ie)**
Computer Literacy **R^2= 0.17**	Gender	-0.82	0.34	-2.41	0.02	-0.41	-	-0.41
IWB Literacy **R^2= 0.56**	Computer Literacy	0.75	0.12	6.11	***	0.75	-	0.75
	Gender	-	-	-	-	-	-0.31	-0.31
Teaching Experience **R^2= 0.63**	Age	0.68	0.10	6.99	***	0.79	-	0.79
AICT	Computer Literacy	0.73	0.11	6.62	***	0.75	-	0.75
	Teaching Experience	0.17	0.07	2.45	0.01	0.28	-	0.28
R^2= 0.63	Gender	-	-	-	-	-	-0.30	-0.30
	Age	-	-	-	-	-	0.22	0.22
AIWB	Teaching Experience	0.18	0.06	3.16	0.002	0.32	0.11	0.43
	IWB Literacy	0.39	0.11	3.62	***	0.43	-	0.43
R^2= 0.73	AICT	0.36	0.12	3.12	0.002	0.38	-	0.38
	IWB Support	0.20	0.09	2.21	0.03	0.21	-	0.21
	Computer Literacy	-	-	-	-	-	0.61	0.61
	Age	-	-	-	-	-	0.34	0.34
	Gender	-	-	-	-	-	-0.25	-0.25
ATI_CCSF	AICT	0.47	0.14	3.27	0.001	0.48	-	0.48
	Frequency computer use	0.49	0.19	2.52	0.01	0.37	-	0.37
R^2= 0.37	Computer Literacy	-	-	-	-	-	0.36	0.36
	Gender	-	-	-	-	-	-0.15	-0.15
	Teaching Experience	-	-	-	-	-	0.13	0.13
	Age	-	-	-	-	-	0.10	0.10
ATI_ITTF	AICT	-0.42	0.17	-2.42	0.01	-0.39	-	-0.39
	IWB Support	0.35	0.16	2.13	0.03	0.33	-	0.33
R^2= 0.32	Teaching Experience	0.24	0.10	2.32	0.02	0.37	-0.11	0.26
	Computer Literacy	-	-	-	-	-	-0.29	-0.29
	Age	-	-	-	-	-	0.21	0.21
	Gender	-	-	-	-	-	0.12	0.12
CIIWB	AIWB	0.50	0.13	3.66	***	0.46	-	0.46
	Age	0.13	0.06	2.05	0.040	0.24	0.18	0.42
R^2= 0.66	IWB Support	0.30	0.11	2.69	0.007	0.30	0.10	0.40
	ATI_CCSF	0.27	0.12	2.24	0.025	0.26	-	0.26
	Computer Literacy	-	-	-	-	-	0.37	0.37
	AICT	-	-	-	-	-	0.30	0.30
	Teaching Experience	-	-	-	-	-	0.23	0.23
	IWB Literacy	-	-	-	-	-	0.20	0.20
	Gender	-	-	-	-	-	-0.15	-0.15
	Frequency Computer Use	-	-	-	-	-	0.10	0.10

Note: Three asterisks (***) next to P values indicate that the *p*-value is <0.001

b= Unstandardised Estimate; s.e.= Standard Error; C.R.= Critical Ratio; *p*= Probability;

β= Standardised Estimate; ie= Standardised Indirect Effect

The results of the variables given in the above table are discussed in the following sections.

8.4.1.1 Computer Literacy

'Computer Literacy' is an endogenous variable which indicated the computer related experience, competency and confidence of the teachers. As shown in the Table 8.2, the computer literacy of the teachers is directly influenced by gender (0=male, 1=female) of the teachers. The value and sign of path coefficient (β= - 0.41) between 'Gender' and 'Computer Literacy' indicates a strong negative influence of gender on the computer literacy of the teachers, meaning that the male teachers in the sample tended to be more computer literate than the female teachers. Further, the value of squared multiple correlations i.e. R^2 (0.17) indicates that 17% of the variance of 'Computer Literacy' has been accounted for by the 'Gender' variable.

8.4.1.2 IWB Literacy

One factor i.e. 'Computer Literacy' (β=0.75) was found to have a direct effect on the IWB literacy (in terms of IWB competence; IWB confidence; and IWB experience) of the teachers. The path coefficient value between 'Computer Literacy' and 'IWB Literacy' shows that the association between these two variables is very strong which means that the teachers with higher computer literacy are much more likely to have higher IWB literacy. The R^2 value (0.56) indicates that 56% of variance of 'IWB Literacy' has been accounted for by 'Computer Literacy' variable in the model.

Further, 'Gender' (ie= - 0.31) is the factor which had indirect effect on 'IWB Literacy'. The negative sign of the path coefficient between gender and 'IWB Literacy' indicates that male teachers are likely to have higher IWB literacy compared with female teachers. This association is mediated by 'Computer Literacy'. It is already mentioned in the above section that the male teachers tend to be more computer literate than the female teachers, and also there is strong association between the 'Computer Literacy' and the 'IWB Literacy' of the teachers.

So, it is likely that, as the male teachers have higher computer literacy, they are also likely to be more IWB literate as compared to female teachers.

8.4.1.3 Teaching Experience

'Age' is the only factor found to be affecting 'Teaching Experience' and path coefficient β=0.79 is a clear indication of very strong relationship between these two variables. Positive sign indicates that it is highly likely that older teachers have more teaching experience. It can be seen that 63% of variance of 'Teaching Experience' (R^2= 0.63) was explained by the 'Age' factor.

8.4.1.4 Attitudes towards ICT (AICT)

Attitudes of the teachers towards ICT (AICT) is a main construct in the model and, as it can be seen in Figure 8.3 and Table 8.2, it is directly influenced by two factors which are 'Computer Literacy' (β=0.75) and 'Teaching Experience' (β=0.28). Among these two variables, 'Computer Literacy' shows very large positive effect, meaning that the teachers with higher computer literacy are also highly likely to have positive or favourable attitudes towards use of ICT in their teaching. 'Teaching Experience' showed a medium value for path coefficient which indicates that there is a moderate positive association between teaching experience of the teachers and their attitudes towards ICT. The teachers with higher teaching experience are likely to have favourable attitudes towards ICT. The value of R^2 (0.63) indicates that 63% of variance of AICT has been accounted for by involvement of the 'Computer Literacy' and 'Teaching Experience' variables in the model.

'Gender' (ie= - 0.30) and 'Age' (ie=0.22) are two other factors impacting the attitudes of teachers towards ICT with both of these variables showing a medium value of path coefficients. The 'Gender' having the negative effect means that the male teachers tend to have more favourable attitudes towards ICT as compared to the female teachers, an influence mediated by 'Computer Literacy' which shows that because male teachers tend to have higher computer literacy. This could be the reason behind them having more favourable attitudes towards ICT because

'Computer Literacy' is very strongly and directly associated with AICT. The positive effect of 'Age' (mediated by 'Teaching Experience') means that older teachers who tend to have longer teaching experience were more likely to have favourable attitudes towards ICT use in education.

8.4.1.5 Attitudes towards IWB (AIWB)

AIWB (general, teaching, motivational, and training) was also used as a main construct in the teacher level path model. It was found to be directly influenced by four variables: 'Teaching experience', 'IWB Literacy', AICT and 'IWB Support'. 'Teaching Experience' of the teachers impacted AIWB both directly (β=0.32) and indirectly (ie=0.11, mediated by AICT) and the total path coefficient was 0.43, a high range of effect size. This clearly indicates that it is highly likely that the teachers with more teaching experience have more favourable attitudes towards IWB use in their teaching.

Similarly, 'IWB Literacy' (β=0.43) and AICT (β=0.38) showed high path coefficients. The positive signs for both of these variables indicate that they have strong positive association with AIWB. In other words, the teachers who are highly IWB literate are more likely to possess positive attitudes towards IWB. Further, the teachers with more favourable attitudes towards ICT were seen to have more positive attitudes towards IWB. 'IWB Support' (β=0.21) is the fourth variable to impact AIWB directly with the path coefficient having medium and positive value. So it can be said that the teachers who get proper IWB support (in terms of IWB technical support, IWB workshops, Encouragement to use IWB, and IWB help) from the school tend to have more positive attitudes towards IWB use in teaching. It can also be seen in the Figure 8.3 and Table 8.2 that 73% (R^2= 0.73) of variance of AIWB is accounted for by 'Teaching Experience', 'IWB Literacy', AICT and 'IWB Support' variables.

'Computer Literacy' (ie=0.61, mediated by AICT and 'IWB Literacy'), 'Age' (ie=0.34, mediated by 'Teaching Experience' and AICT) and 'Gender' (ie= -0.25, mediated by 'Computer Literacy', AICT and 'IWB Literacy') are the three factors which had indirect effect on AIWB. 'Computer Literacy' had a strong positive effect; 'Age' had a medium positive effect; and 'Gender' a medium negative effect. Thus it is highly likely that greater computer literacy among the teachers lead to more favourable attitudes towards ICT and a higher IWB literacy which ultimately leads to more favourable attitudes towards IWB among teachers. Similarly, older teachers who have more teaching experience and more positive attitudes towards ICT are more likely to have more favourable attitudes towards IWB. Lastly, the male teachers who are more computer literate have more positive attitudes towards ICT, are more highly IWB literate, also tend to have more positive attitudes towards IWB as compared to the female teachers.

8.4.1.6 Conceptual Change/Student Focused Teaching Approach (ATI_CCSF)

Figure 8.3 clearly shows that ATI_CCSF is directly influenced by AICT ($\beta=0.48$) and 'Frequency Computer Use' ($\beta=0.37$) and both these factors have positive and large path coefficients. Teachers who have more favourable attitudes towards ICT are more likely to use a student-focused (conceptual change) teaching approach, and, similarly, the teachers who use computers more frequently are also likely to have a more student-focused approach. Further, the R^2 value (0.37) clearly indicates that 37% of variance of ATI_CCSF has been explained by these two variables i.e. AICT and 'Frequency Computer Use'.

'Computer Literacy' (ie=0.36, mediated by AICT), 'Gender' (ie=-0.15, mediated by 'Computer Literacy' and AICT), 'Teaching Experience' (ie=0.13, mediated by AICT) and 'Age' (ie=0.10, mediated by 'Teaching Experience' and AICT) are the factors showing an indirect effect on ATI_CCSF. The positive sign of the path coefficient of 'Computer Literacy' and its effect size (just above the medium range) suggests that the computer literacy of the teachers has a moderate effect on their student-focused teaching approach. And, as its influence is mediated by AICT, it can be seen that the teachers with high computer literacy tend to have more favourable attitudes towards ICT, which ultimately leads these teachers toward a more student-focused approach. Further, male teachers tend to use a more student-focused approach than the female teachers. The teaching experience and the age of the teachers also showed a small positive effect, indicating that the older teachers, with more teaching experience, use a student-focused teaching approach slightly more than younger teachers with less teaching experience.

8.4.1.7 Information Transmission/Teacher Focused Teaching Approach (ATI_ITTF)

This is another key construct in the teacher level path model (Figure 8.3). Three variables were found to have direct effects on ATI_ITTF. The first variable was AICT and the path coefficient for this association was -0.39, so the influence of AICT on ATI_ITTF is strong and negative. This means that the more positive the attitudes of the teachers towards ICT, the less likely they are to use teacher-focused (Information Transmission) approach in their teaching.

'IWB Support' (β=0.33) and 'Teaching Experience' [te=0.26(β=0.37+ie=-0.11)] showed a medium positive effect on ATI_ITTF. The indirect effect of 'Teaching Experience' included a path with AICT as a mediating factor. So these findings suggest that the teachers who have more IWB support at school tend to use a more teacher-focused teaching approach. Further it indicates that more experienced teachers are more likely to use more teacher-focused approach. Referring back to the findings in the ATI_CCSF, it should be noted that the effect of 'Teaching Experience' on ATI_ITTF is stronger than it on ATI_CCSF (indirect effect). Thus more experienced teachers tend to use teacher-focused approach as compared to a student-focused approach. As far as the R^2 value is concerned, it can be seen that 32% of ATI_ITTF variables' variance has been accounted for by AICT, 'IWB Support' and 'Teaching Experience'.

The factors which are indirectly associated with ATI_ITTF were 'Computer Literacy' (ie=-0.29, mediating factor= AICT), 'Age' (ie=-0.21, mediating factors= 'Teaching Experience' and AICT) and 'Gender' (ie=0.12, mediating factors= 'Computer Literacy' and AICT). It is important to mention here that the indirect effect of 'Age' is comprised of two paths (Figure 8.3); one with only 'Teaching Experience' as a mediating factor and other with two mediating factors i.e. 'Teaching Experience' and AICT. There was a moderate negative association between 'Computer Literacy' and ATI_ITTF which means that more computer literate teachers would have more positive attitudes towards ICT which then leads to a tendency to use less teacher-focused approach in their teaching. These findings are also in-line with the findings in the ATI_CCSF section i.e. more computer literate teachers tend to use a more student-focused approach in their teaching.

Similar to 'Teaching Experience', the effect of 'Age' on ATI_ITTF is stronger than on ATI_CCSF. This means that older teachers are more inclined towards using teacher-focused teaching approach. The gender of the teachers is positively associated with ATI_ITTF. Although the association is small, it shows that the female teachers are slightly more inclined to use teacher-focused approach in their teaching as compared to the male teachers.

8.4.1.8 Classroom Interactions using IWB (CIIWB)

'Classroom interactions using IWB' (CIIWB) is the main key factor in the teacher path model. It is clearly depicted in Figure 8.3 and Table 8.2 that four variables were identified as having direct effects on CIIWB. The first variable is AIWB, which showed a large and positive value of path coefficient i.e. $\beta=0.46$. So there is a strong association between the attitudes of the teachers towards IWB and their way of using it. Thus it is highly likely that the teachers with more positive attitudes towards IWB use it more interactively in their classrooms. The second factor is 'Age' which influence CIIWB in both direct ($\beta=0.24$) and indirect (ie=0.18) ways, so the total effect (te) is 0.42, which comes in the high range of effect size. This indicates that older teachers are more likely to use IWB in interactive or enhanced interactive ways. The indirect effect included three different paths with different mediating factors. The first path was mediated by 'Teaching Experience', AICT and AIWB, and the second through 'Teaching Experience', AICT and ATI_CCSF. The third path included 'Teaching Experience' and AIWB as the mediating factors.

The third factor i.e. 'IWB Support' also had direct ($\beta=0.30$) and indirect (ie=0.10 mediated by AIWB), influences (Figure 8.3) with the total value for path coefficient (te) to be 0.40. This is a clear indication that the teachers who get better IWB support (in terms of IWB technical support, IWB workshops, encouragement to use IWB and IWB help) from their schools are more likely to use IWB in interactive or enhanced interactive ways. ATI_CCSF was the fourth variable which had a medium direct effect (β=0.26) on CIIWB. This means that the teachers who have a student-focused approach towards teaching tend to use IWB in a more interactive or enhanced interactive manner. The above four variables i.e. AIWB, 'Age', 'IWB Support' and ATI_CCSF accounted for 66% variance of CIIWB as shown by the R^2 value (0.66) in the Figure 8.3 and Table 8.2.

Six more factors were found to have an indirect effect on CIIWB. One factor having a high influence was 'Computer Literacy' (ie=0.37) mediated by AICT, ATI_CCSF, 'IWB Literacy' and AIWB. There are three paths involved in this indirect association (Figure 8.3). The first one included AICT and ATI_CCSF as the mediating factors. The second one had AICT and AIWB and third path included 'IWB Literacy' and AIWB as mediating factors. The positive sign of the path coefficient indicates that the teachers with high computer literacy are likely to use IWB more interactively.

Three factors had medium range effect sizes, AICT (ie=0.30), 'Teaching Experience' (ie=0.23) and 'IWB Literacy' (ie=0.20). Figure 8.3 shows that the influence of AICT on CIIWB is mediated by AIWB in one path and ATI_CCSF in the second path towards CIIWB. The positive sign of the path coefficient shows that the teachers who had a more positive attitude towards ICT tend to use IWB in a more interactive or enhanced interactive manner. Further, the influence of 'Teaching Experience' on CIIWB included three paths (Figure 8.3): the first path had AICT and ATI_CCSF as mediators; second path included AICT and AIWB; and third path has AIWB as a mediating factor. The positive sign is the indication that teachers with more teaching experience tend to use IWB more interactively. 'IWB Literacy' is the factor whose moderate and positive influence on CIIWB is mediated by AIWB and indicates that more IWB literate teachers tend to use IWB in more interactive or enhanced interactive ways.

'Gender' and 'Frequency Computer Use' showed small effect sizes i.e. -0.15 and 0.10 respectively. Figure 8.3 clearly shows that there are three paths which connected 'Gender' to CIIWB. The first path included 'Computer Literacy', AICT and

ATI_CCSF; the second path was comprised of 'Computer Literacy', AICT and AIWB as mediating factors; and third path had 'Computer Literacy', 'IWB Literacy' and AIWB as mediators between 'Gender' and CIIWB. The negative indirect association between the gender of the teacher and CIIWB shows that male teachers are slightly more inclined towards using IWB in an interactive way as compared to the female teachers. Further, ATI_CCSF is the mediating factor between 'Frequency Computer Use' and CIIWB, meaning the teachers who use the computer more frequently are slightly more inclined to use IWB in a more interactive or enhanced interactive way.

8.4.2 Model Fit Summary for Student Level Path Model

The goodness of fit of the teacher level path model was assessed to find out how the model fitted the data. The fit indexes described in Chapter 6 were used for this purpose. These indexes are χ^2/DF (chi-square divided by the number of degrees of freedom), GFI (goodness-of-fit-index), TLI (Tucker-Lewis Index), CFI (comparative fit index), and RMSEA (root mean square error of approximation).

The Model Fit Summary obtained in the Output of the teacher level path analysis revealed that this model had $\chi^2/DF = 0.789$ which is much lower than the upper limit of the χ^2/DF (>5) (Darmawan, 2003, p. 96) and this is an indication that this model fits the data very well. The values obtained for other indices were: GFI (0.84); TLI (1.09); and CFI (1.00). According to (Byrne, 2010, pp. 77-79), a good fit model has all these values close to 0.90. Further, as TLI is "nonnormed" index, so its value can be above 1 or slightly below 0 (Newson, 2005). So all these indexes indicate an adequate model fit. RMSEA value (0.00) also clearly shows that the model is fitting the data very well (Darmawan, 2003, p. 96).

8.5 Summary

Single level path analysis was used to examine the relationships among different variables at the teacher level. The findings showed that there is a strong positive association between the attitudes of the teachers towards IWB and the way they use

IWB in their classrooms. The teachers with more positive attitudes towards IWB are more likely to use IWB in a more interactive or enhanced interactive way. Further, IWB related support (in terms of IWB technical support, IWB workshops, Encouragement to use IWB, and IWB help) provided by the school also play major role in the way IWB is used by the teachers in their classrooms. More support tends to lead to more interactive use of IWB. It is found that the teachers who are older are also likely to use IWB in more interactive or enhanced interactive way. The teachers who are more inclined towards the student-focused teaching approach are also likely to be more interactive or enhanced interactive users of IWB in their classrooms.

Further a student-focused teaching approach is very strongly influenced by attitudes of the teachers towards ICT and their frequency of using the computers at school, and this influence is positive in nature meaning teachers who use computers more frequently, and also who have positive attitudes towards ICT, are more likely to favour the student-focused approach in their teaching. Further their attitudes towards ICT are very strongly and positively influenced by their computer literacy i.e. highly computer literate teachers are highly likely to have more favourable attitudes towards ICT.

The attitudes of the teachers towards ICT also directly and strongly influence their attitudes towards IWB in a positive way, which means that the teachers with more positive attitudes towards ICT are also more likely to have positive attitudes towards IWB. Apart from this, their IWB literacy also seems to play major role in their attitudes towards IWB. It is found that it is highly likely that the teachers with high IWB literacy have a more favourable attitude towards IWB. IWB literacy is in turn very strongly and positively influenced by the ICT literacy of the teachers. It is highly likely that the teachers who have high ICT literacy also have high IWB literacy. The teaching experience of the teachers and the IWB Support they receive from the school are the other factors found to have a direct and positive influence on their attitudes towards IWB. More experienced teachers and those who obtain IWB related support from their schools tend to have more favourable attitudes towards IWB.

Chapter 9
Single Level Path Analysis: Student Level

9.1 Introduction

It was mentioned in Chapter Eight that a Path analysis technique, using a structural equation modeling (SEM) procedure, was employed in this study to investigate the path models, including observed and latent variables using version 18 of AMOS software package. Also, the data for this study was collected from the participants at two different levels i.e., teachers and students, so the interactions among the variables at these two levels were explored separately. The purpose of the student level path analysis was to gain an understanding, based on the data gathered, of how the various variables at this level interact with one another and how they might affect students' perception of their learning in terms of their perceived learning approaches and outcomes. The description of the path analysis technique, including specification and trimming of the model were given in the Chapter Eight along with the findings of the teacher level path analysis. In this chapter, the findings of the student level path analysis, along with the detailed description of the variables used at student level path model, are given.

9.2 Variables used in the Student Level Path Analysis

The hypothetical path model which was used for student level path analysis is shown in Figure 9.1. The student level path model consisted of six key constructs which were treated as the latent (unobserved) endogenous variables (LVs) in the model and are shown in the ellipses. Table 9.1 shows the description of each of these six latent variables (LVs) along with 20 observed variables (OVs). It should be noted that the values for these observed variables were calculated with factor scoring techniques using SPSS software which is a way of compressing the items into subscales to make the 'manipulated subscales' (OVs in this case). These manipulated subscales were then used in the model instead of using all the items.

This helped in easy development, management and understanding of the path model.

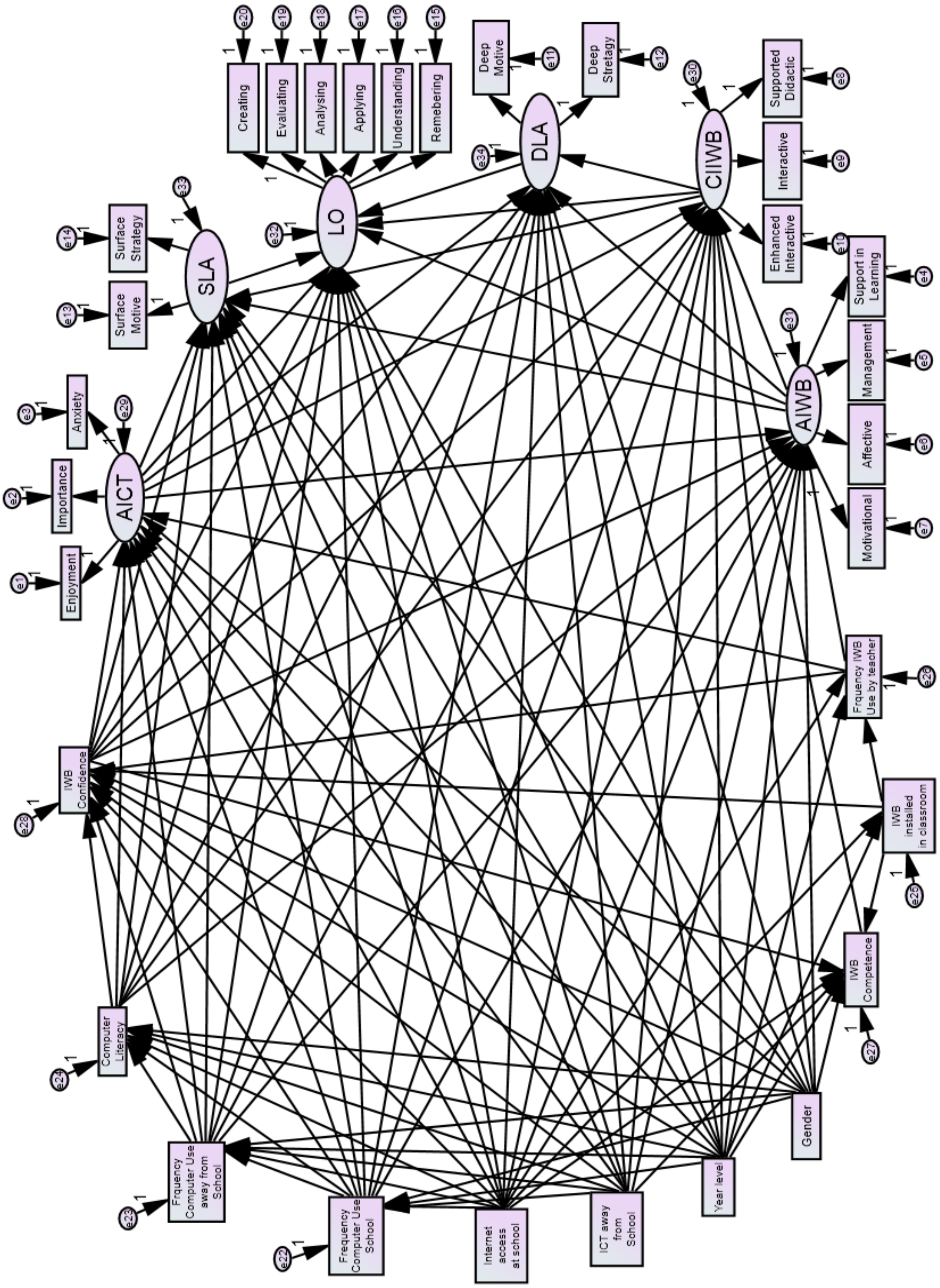


Figure 9.1: Hypothetical Path Model at the Student Level

Table 9.1: Latent variables used in the student level path model

Latent variables (LVs) (endogenous)	Description	Observed variables (OVs)
AICT	Attitudes of the Students towards ICT	Enjoyment Importance Anxiety
AIWB	Attitudes of the Students towards IWB	Motivational Affective Management Support in Learning
CIIWB	Classroom Interactions using IWB	Supported Didactic Interactive Enhanced Interactive
SLA	Surface Learning Approach of the Students using IWB	Surface Motive Surface Strategy
DLA	Deep Learning Approach of the Students using IWB	Deep Strategy Deep Motive
LO	Learning Outcomes of the students using IWB	Creating Evaluating Analysing Applying Understanding Remembering

Apart from the variables given in the above table, there were 11 more variables in the model which represented the demographic factors of the student participants. Seven of these 11 variables were the endogenous observed variables and four were treated as exogenous observed variables. All these variables are shown as rectangles in the final model. Table 9.2 shows the description of these variables.

The variable named 'Computer literacy' was developed by compressing three items i.e., computer experience, computer competency, and computer confidence. Similarly, 'ICT away from school' was developed by compressing three items i.e., own a computer; computer access away from school; and internet access away from school, using factor scoring technique. This was also done to make the model easy to manage and understand. The final structure of the student level path diagram is shown in Figure 9.2.

Table 9.2: Other Observed variables used in the student level path model

Observed Exogenous variables	Description
Gender	Gender of the students (0=Male; 1=Female)
Year level	Year level of the students (Year 7 to Year 12)
Internet access at school	Students have internet access at school
ICT away from school	Students own a computer; have computer and internet access away from school
Observed Endogenous variables	**Description**
Frequency Computer Use School	Frequency of computer use by students at school
Frequency Computer Use away from School	Frequency of computer use by students away from school
Computer literacy	Computer experience, computer competence and computer confidence of the students
IWB installed in classroom	IWB installed in their classroom
Frequency IWB Use by teacher	How often their teacher uses IWB for teaching
IWB competence	Competence of the students in using IWB
IWB confidence	Confidence of the students in using IWB

9.3 Results of Student Level Path Analysis

It was mentioned in the introduction section to this chapter that the single level path analysis technique was used to examine the inter relationships among the different variables at the student level with the aim of understanding their impact on the students' perceived learning approaches and outcomes. The results of the student level path analysis, including both measurement and structural models are given in the following sections.

9.3.1 Measurement model results at the student level

The results of the measurement model are shown in Figure 9.2 and Table 9.3. The output of the analysis using AMOS 18 gave four different types of indices which were used to understand the relationships between the LVs and OVs in the student level path model. These indices were unstandardised estimates (b), standard errors (s.e.), critical ratio (C.E.), standardized estimates (β) and two tailed *p* value. The unstandardized estimate is a value which gives the strength of relationships between LVs and OVs (Arbuckle, 2009, p. 29). Standard error is the indication the variability of estimates (Arbuckle, 2009, p. 29).

Table 9.3: Results of measurement model at the student level

Latent variables	Observed variables	UnstdEst. (b)	s.e.	C.R.	StdEst. (β)	*p*
AICT	Enjoyment	1.00	0.00	0.00	0.99	***
	Importance	0.54	0.52	10.42	0.54	***
	Anxiety	-0.77	0.40	-19.32	-0.77	***
AIWB	Motivational	1.00	0.00	0.00	0.90	***
	Affective	0.80	0.59	13.57	0.71	***
	Management	0.90	0.55	16.22	0.80	***
	Support in Learning	0.87	0.56	15.35	0.77	***
CIIWB	Supported Didactic	1.00	0.00	0.00	0.36	***
	Interactive	2.30	0.44	5.27	0.86	***
	Enhanced Interactive	1.87	0.35	5.26	0.69	***
SLA	Surface Motive	1.00	0.00	0.00	0.97	***
	Surface Strategy	0.73	0.15	4.99	0.72	***
DLA	Deep Strategy	1.00	0.00	0.00	0.95	***
	Deep Motive	0.82	0.05	17.19	0.77	***
LO	Creating	1.00	0.00	0.00	0.84	***
	Evaluating	1.05	0.05	19.00	0.89	***
	Analysing	1.01	0.06	17.57	0.85	***
	Applying	1.01	0.06	17.55	0.85	***
	Understanding	0.93	0.06	15.53	0.79	***
	Remembering	0.87	0.06	13.93	0.73	***

Note: Three asterisks (***) next to P values indicate that the *p*-value is <0.001

The third index, i.e. critical ratio, is the value obtained by dividing the estimate by its standard error and according to Arbuckle (2009, p. 30), "using a significance level of 0.05, any critical ratio that exceeds 1.96 in magnitude would be called significant". The fourth index given the table is the standardized estimate which is also called factor loading and gives a better indication of the strength of relationship between LVs and OVs. It is already mentioned in Chapter 6 that factor loadings above 0.30 are considered practically significant (Hair et al., 2013, p. 115). The last index, which is represented as P in the table 9.3, "gives an approximate two-tailed *p* value for testing the null hypothesis that the parameter value is 0 in the population" (Arbuckle, 2009, p. 30). The results recorded in the above table are discussed in the following sections.

9.3.1.1 Attitudes towards ICT (AICT)

'Attitudes towards ICT' (AICT) was the first key construct in the student level path model and reflected by three observed variables i.e., Enjoyment, Importance and Anxiety. The loadings for these three variables were 0.99, 0.54 and -0.77 respectively. As all these observed variables showed absolute value of factor loadings above 0.30, this indicates they are good reflectors of the AICT construct.

9.3.1.2 Attitudes towards IWB (AIWB)

'Attitudes towards IWB' (AIWB) was the second key construct in the model and was reflected by four observed variables. The variables and their loadings are Motivational (0.90), Affective (0.71), Management (0.80) and Support in Learning (0.77). All the observed variables showed loadings well above 0.30 which indicated that these observed variables are strong reflectors of the AIWB construct.

9.3.1.3 Classroom Interactions using IWB (CIIWB)

The third construct in the model was 'Classroom Interactions using IWB' (CIIWB) which was indicated by three observed variables named Supported Didactic (0.36), Interactive (0.86) and Enhanced Interactive (0.69). Again the loadings obtained by these variables were above 0.30 which showed these are good reflectors of the CIIWB construct.

9.3.1.4 Surface Learning Approach using IWB (SLA)

In the measurement model, the construct 'Surface Learning Approach using IWB' (SLA) was reflected by two observed variables i.e., Surface Motive (0.97) and Surface Strategy (0.72) and both of these are strong reflectors of this construct.

9.3.1.5 Deep Learning Approach using IWB (DLA)

Deep Strategy (0.95) and Deep Motive (0.77) were the two indicators of the construct 'Deep Learning Approach' (DLA) and both of them obtained high factor loadings as shown in the Table 9.3.

9.3.1.6 Learning Outcomes using IWB (LO)

Learning Outcomes using IWB (LO) was the sixth construct in the student path model. It was reflected by six observed variables. These variables were Creating (0.84), Evaluating (0.89), Analysing (0.85), Applying (0.85), Understanding (0.79) and Remembering (0.73). All these variables had high factor loadings on LO, so these were considered as strong reflectors of the LO construct.

9.3.2 Structural Model results at the student level

The results of the structural model are given in the Figure 9.2 and Table 9.4. Eight different types of indices were used to present the results of the path analysis used to examine the relationships among those variables assumed to be influencing student learning. These indices are same as those used to examine the relationships among the different variables at the teacher level and the description about these indices is given in the Section 8.4.1 of Chapter 8.

The results were interpreted based on the recommendations provided by Cohen (1988) according to which the effect size of the path coefficients between the range of 0.02-0.15 is considered as small; 0.15-0.35 is medium and above 0.35 is large. The effect size below 0.02 is not considered relevant for interpretation (Cohen, 1988). The results of the structural models are displayed in Table 9.4 and the relationships among the variables are shown in Figure 9.2.

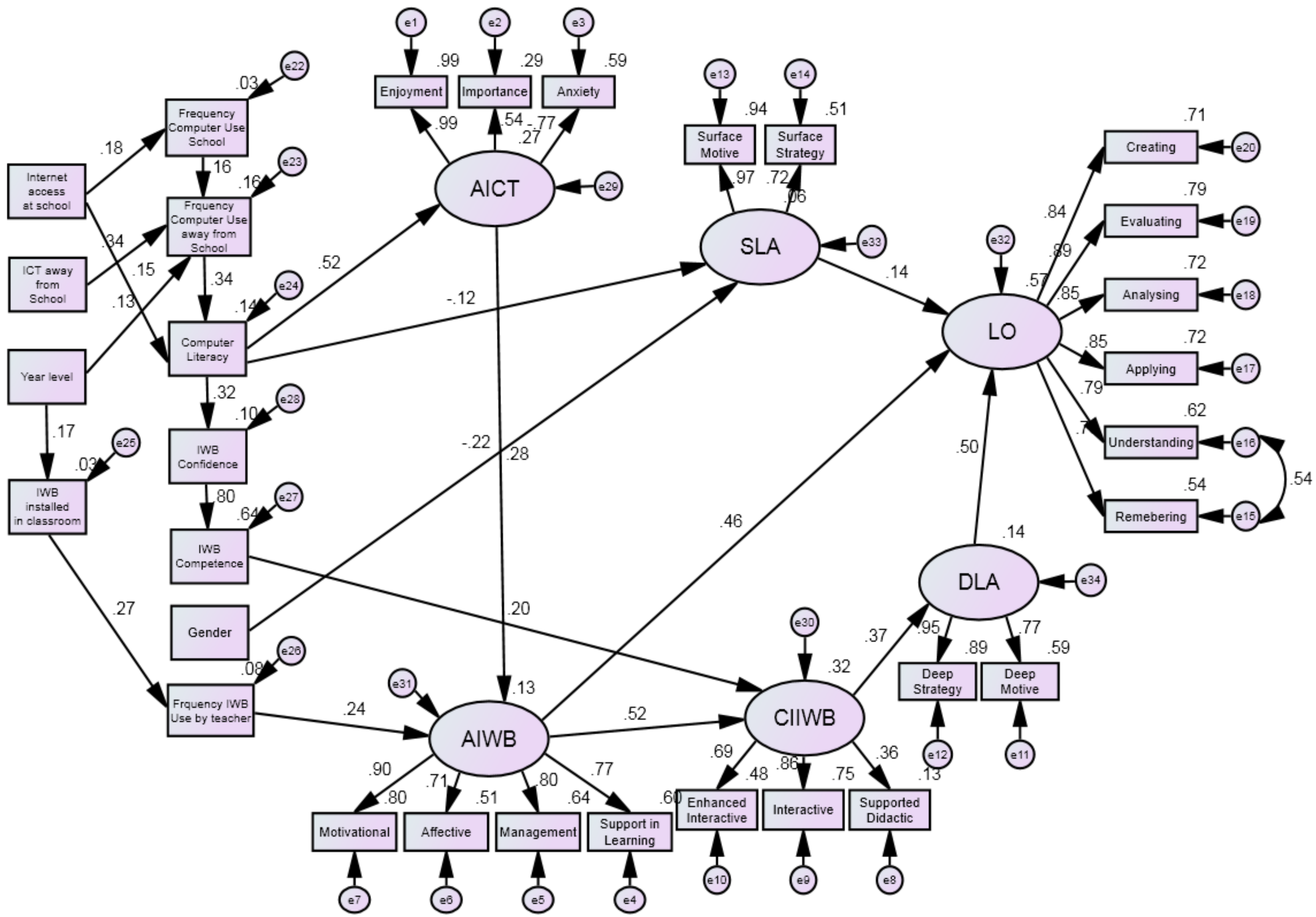


Figure 9.2: Student Level Path Model at Student Level

Table 9.4: Results of structural model at the student level

Variables		Direct effect					StdInd. effect	Total effect
Criterion	**Predictor**	**UnstdEst. (b)**	**s.e.**	**C.R.**	***p***	**StdEst (β)**	**(ie)**	**(β + ie)**
IWB installed in classroom **R^2= 0.03**	Year level	0.04	0.01	2.80	.005	0.17	-	0.17
Freq IWB use by teacher	IWB installed in classroom	1.20	0.26	4.68	***	0.27	-	0.27
R^2=0.08	Year level	-	-	-	-	-	0.05	0.05
Freq Computer Use School **R^2= 0.03**	Internet access at school	2.61	0.85	3.07	.002	0.18	-	0.18
Freq Computer Use away from School	ICT away from school	0.29	0.05	6.08	***	0.34	-	0.34
	Freq Computer Use School	0.16	0.05	2.93	.003	0.16	-	0.16
	Year level	0.08	0.03	2.40	.016	0.13	-	0.13
R^2= 0.16	Internet access at school	-	-	-	-	-	0.03	0.03
Computer Literacy	Freq Computer Use away from school	0.40	0.07	6.01	***	0.34	-	0.34
	Internet access at school	2.45	0.93	2.64	.008	0.15	0.01	0.16
R^2= 0.14	ICT away from school	-	-	-	-	-	0.12	0.12
	Freq Computer Use School	-	-	-	-	-	0.05	0.05
	Year level	-	-	-	-	-	0.04	0.04
IWB confidence	Computer Literacy	0.74	0.13	5.56	***	0.32	-	0.32
	Freq Computer Use away from school	-	-	-	-	-	0.11	0.11
R^2= 0.10	Internet access at school	-	-	-	-	-	0.05	0.05
	ICT away from school	-	-	-	-	-	0.04	0.04
	Freq computer use school	-	-	-	-	-	0.02	0.02
	Year level	-	-	-	-	-	0.01	0.01
IWB competence	IWB confidence	0.80	0.04	22.02	***	0.80	-	0.80
	Computer literacy	-	-	-	-	-	0.26	0.26
R^2= 0.64	Freq Computer Use away from school	-	-	-	-	-	0.09	0.09
	Internet access at school	-	-	-	-	-	0.04	0.04
	ICT away from school	-	-	-	-	-	0.03	0.03
	Freq computer use school	-	-	-	-	-	0.01	0.01
	Year level	-	-	-	-	-	0.01	0.01
AICT	Computer Literacy	0.51	0.05	9.84	***	0.52	-	0.52
R^2= 0.27	Freq Computer Use away from school	-	-	-	-	-	0.18	0.18

Table 9.4: Results of structural model at the student level (continued)

Variables		Direct effect					StdInd. effect	Total effect
Criterion	Predictor	Unstd Est.(b)	s.e.	C.R.	*p*	StdEst (β)	(ie)	(β + ie)
AICT	Internet access at school	-	-	-	-	-	0.08	0.08
	ICT away from school	-	-	-	-	-	0.06	0.06
	Freq Computer Use School	-	-	-	-	-	0.03	0.03
	Year level	-	-	-	-	-	0.02	0.02
AIWB	AICT	0.25	0.05	4.52	***	0.28	-	0.28
	Freq IWB use by teacher	0.13	0.03	3.90	***	0.24	-	0.24
R^2= 0.13	Computer Literacy	-	-	-	-	-	0.14	0.14
	IWB installed in classroom	-	-	-	-	-	0.06	0.06
	Freq Computer Use away from school	-	-	-	-	-	0.05	0.05
	Internet access at school	-	-	-	-	-	0.02	0.02
	ICT away from school	-	-	-	-	-	0.02	0.02
	Year level	-	-	-	-	-	0.02	0.02
	Freq Computer Use School	-	-	-	-	-	0.01	0.01
CIIWB	AIWB	0.21	0.04	4.62	***	0.52	-	0.52
	IWB competence	0.03	0.01	2.89	.004	0.20	-	0.20
R^2= 0.32	IWB confidence	-	-	-	-	-	0.16	0.16
	AICT	-	-	-	-	-	0.14	0.14
	Computer literacy	-	-	-	-	-	0.13	0.13
	Freq IWB use by teacher	-	-	-	-	-	0.12	0.12
	Freq Computer Use away from school	-	-	-	-	-	0.04	0.04
	IWB installed in classroom	-	-	-	-	-	0.03	0.03
	Internet access at school	-	-	-	-	-	0.02	0.02
	ICT away from school	-	-	-	-	-	0.01	0.01
	Year level	-	-	-	-	-	0.01	0.01
	Freq computer use school	-	-	-	-	-	0.01	0.01
SLA	Gender	-0.42	0.12	-3.57	***	-0.22	-	-0.22
	Computer Literacy	-0.11	0.06	-1.96	***	-0.12	-	-0.12
R^2= 0.62	Freq Computer Use away from school	-	-	-	-	-	-0.04	-0.04
	Internet access at school	-	-	-	-	-	-0.02	-0.02
	ICT away from school	-	-	-	-	-	-0.01	-0.01
	Freq Computer Use School	-	-	-	-	-	-0.01	-0.01
	Year level	-	-	-	-	-	-0.005	-0.005
DLA	CIIWB	0.95	0.24	3.97	***	0.37	-	0.37
	AIWB	-	-	-	-	-	0.19	0.19
R^2= 0.14	IWB competence	-	-	-	-	-	0.07	0.07
	IWB confidence	-	-	-	-	-	0.06	0.06

Table 9.4: Results of structural model at the student level (continued)

	Variables	Direct effect					StdInd. effect	Total effect
Criterion	**Predictor**	**Unstd Est.(b)**	**s.e.**	**C.R.**	***p***	**StdEst (β)**	**(ie)**	**(β + ie)**
DLA	AICT	-	-	-	-	-	0.05	0.05
	Computer literacy	-	-	-	-	-	0.05	0.05
	Freq IWB use by teacher	-	-	-	-	-	0.04	0.04
	Freq Computer Use away from school	-	-	-	-	-	0.02	0.02
	Internet access at school	-	-	-	-	-	0.01	0.01
	IWB installed in classroom	-	-	-	-	-	0.01	0.01
	ICT away from school	-	-	-	-	-	0.005	0.005
	Year level	-	-	-	-	-	0.004	0.004
	Freq computer use school	-	-	-	-	-	0.003	0.003
LO	AIWB	0.44	0.05	8.57	***	0.46	0.10	0.56
	DLA	0.46	0.05	9.64	***	0.50	-	0.50
R^2= 0.57	SLA	0.12	0.05	2.66	.088	0.14	-	0.14
	CIIWB	-	-	-	-	-	0.18	0.18
	AICT	-	-	-	-	-	0.16	0.16
	Freq IWB use by teacher	-	-	-	-	-	0.13	0.13
	Computer Literacy	-	-	-	-	-	0.07	0.07
	IWB competence	-	-	-	-	-	0.04	0.04
	IWB installed in classroom	-	-	-	-	-	0.04	0.04
	IWB confidence	-	-	-	-	-	0.03	0.03
	Gender	-	-	-	-	-	-0.03	-0.03
	Freq Computer Use away from school	-	-	-	-	-	0.02	0.02
	Internet access at school	-	-	-	-	-	0.01	0.01
	Year level	-	-	-	-	-	0.01	0.01
	ICT away from school	-	-	-	-	-	0.01	0.01
	Freq Computer Use School	-	-	-	-	-	0.004	0.004

Note: Three asterisks (***) next to P values indicate that the *p*-value is <0.001

9.3.2.1 IWB installed in classroom

This was an observed endogenous variable which indicated the availability of IWB in the classroom. As shown in the Table 9.4 it can be seen that the factor named 'Year level', which indicated the year level (year 7-year 12) of the students, had a direct medium effect (β= 0.17) on the availability of the IWB in the classroom. The positive sign indicated that the students in the higher year levels are likely to have slightly more availability of IWB in their classrooms. Although the value of squared multiple correlations (R^2= 0.03) indicates that 'Year Level' only accounted for 3% of the variance of 'IWB installed in classroom variable'.

9.3.2.2 Frequency IWB Use by Teacher

The availability of IWB in the classroom (IWB installed in classroom) was found to have a medium direct effect (β=0.27) on the 'Frequency of IWB use by teacher'. This shows that whether the classroom is installed with an IWB or not could play a key role in making the teachers to use IWB in their teaching. The positive sign indicated that the teachers tend to use IWB more frequently when they have access to classrooms which have IWB installed in them. Although, the R^2 value (0.17) indicates that only 8% of the variance of 'Frequency IWB Use by Teacher' has been accounted for by the 'IWB installed in classroom' variable.

Secondly, the 'Year level' of the students (year 7-12) showed a small indirect effect (ie=0.05) on the frequency of IWB use by the teacher. The positive sign indicated that the teachers of higher year levels use IWB slightly more than the teachers in the lower year levels. However, the effect of 'Year level' was indirect and 'IWB installed in classroom' played as a mediating factor.

9.3.2.3 Frequency Computer Use School

The frequency of computer use by students at school was found to be directly impacted by the internet access at school (β=0.18). The effect size of 'Internet access at school' on the 'Frequency Computer Use School' was in the medium range and positive which means that the students tend to use computers slightly more frequently at school if they have access to the internet at school. Again, the R^2 value (0.03) reveals that the percentage of variance of 'Frequency Computer Use School' explained by 'Internet access at school' was only 3%.

9.3.2.4 Frequency Computer Use away from school

'Frequency Computer Use away from school' was also an observed endogenous variable which referred to the use of computers by the students outside the school. It can be seen in the Table 9.4 that three factors were showing a direct effect on this variable. These were 'ICT away from school' (β=0.34), 'Frequency Computer use school' (β=0.16), 'Year level' (β=0.13). 'Internet access at school', which was an exogenous variable, was found to have very small indirect effect (ie=0.03) mediated by the 'Frequency computer use school' factor.

As already mentioned in Section 3 of this chapter 'ICT away from school' was an exogenous variable, comprised of factor scores of three items i.e., own a computer, computer access away from school, and internet access away from school. So the positive sign of the path coefficient (β=0.34) indicated that the students tend to use computers more if they have more ICT available to them away from school i.e. if they own a computer or have computer access and also have internet access away from school.

Apart from this, the frequency of computer use at school and the year level of the students also showed positive path coefficients. Although the value of path coefficients for both variables indicated only small effect sizes, those students who used computers more frequently at school, and the students in the higher year levels, tended to use computers slightly more frequently away from school. Further, the R^2 value (0.16) clearly indicates that 16% of variance of 'Frequency Computer Use away from School' has been accounted for by three variables in the model i.e. 'ICT away from School', 'Frequency Computer Use School' and 'Year level'.

9.3.2.5 Computer Literacy

'Computer Literacy', an endogenous variable, was developed by compressing three items i.e., computer experience; computer competency; and computer confidence. There were two factors which were seen to have direct effect on the computer literacy of the students. These were 'Frequency Computer Use away from school' (β=0.34) and 'Internet access at school' (te=0.16).

The positive sign of path coefficient for the first factor indicated that the students who use computers more frequency away from school tend to have higher computer literacy. The second factor i.e. 'Internet access at school' also showed a positive path coefficient with a medium effect size (te=0.16). It should be noted that this factor was affecting the 'Computer Literacy' both directly (β=0.15) and indirectly (ie=0.01) through 'Freq Computer Use School' and 'Freq Computer Use away from school' as mediating factors. This result suggests that the students tend to be slightly more computer literate if they get more internet access at school. As far as the R^2 value (0.14) is concerned, it can be seen in Figure 9.2 and Table 9.4 that 14% of variance of 'Computer Literacy' has been accounted for by the 'Frequency Computer Use away from school' and 'Internet access at School' variables in the model.

Further, there were three more factors i.e. 'ICT away from school' (ie=0.12), 'Freq Computer Use School' (ie=0.05) and 'Year level' (ie=0.04) which yielded small indirect positive effects on 'Computer Literacy'. All these three factors were mediated by 'Freq Computer Use away from school'. This suggests that the students in the higher year levels, and those with more ICT available away from school, and those who use computer at school more frequently tend to have slightly higher computer literacy.

9.3.2.6 IWB confidence

'IWB confidence' was measured on the scale of 0 (no confidence) to 10 (very confident) and was treated as an observed endogenous variable in the student path model. One factor i.e., 'Computer Literacy' was found to have a medium direct positive effect (β= 0.32) on IWB confidence of the students. This indicated that the students with higher computer literacy tend to have higher confidence in using IWB. 10% of variance (R^2 = 0.10) of IWB confidence has been accounted for by 'Computer Literacy' variable.

Five other factors yielded a small indirect effect on 'IWB confidence'. The first factor among these was 'Freq Computer Use away from school' (ie=0.11) which was mediated by 'Computer Literacy'. This indicated that higher frequency of computer use by students away from school led to a slight increase in their IWB confidence. A second factor was 'Internet access at school' (ie=0.05), and this was mediated by 'Freq Computer Use School', 'Freq Computer Use away from school' and 'Computer Literacy'. This means that the access to the internet at school is likely to slightly increase the IWB confidence of the students. Two more factors named 'ICT away from school' (ie=0.04), 'Freq computer use school' (ie=0.02) were mediated by 'Freq Computer Use away from school' and 'Computer Literacy'. Any increase in these factors was related to a slight increase in the IWB related confidence of the students. 'Year level' (ie=0.01) is not included in the interpretation because its effect size was below the minimum significant value (ie=0.02) for path coefficient.

9.3.2.7 IWB competence

'IWB competence' was also measured on the scale of 0 to 10 (0=Novice and 10=Highly competent) and was used as an observed endogenous variable in the path model. Figure 9.2 clearly illustrates that 'IWB confidence' is the factor which has a very large (highest in student path model) direct positive effect on 'IWB competence' (β=0.80), clearly showing that students with higher IWB confidence are highly likely to have higher competence in using IWB. Further it is also shown in the Figure 9.2 and Table 9.4 that 64% of variance of 'IWB competence' has been accounted for by the 'IWB confidence' variable in the model (R^2= 0.64).

Table 9.4 also shows that there are six other factors which were found to have an indirect effect on 'IWB competence'. The first factor among these was 'Computer literacy' which had medium effect (ie=0.26) through 'IWB Confidence'. The positive sign indicated that students who are more computer literate tend to be more competent with IWB.

The other factors which had indirect positive effects on 'IWB competence' are 'Freq Computer Use away from school' (ie=0.09, mediated by 'Computer Literacy' and 'IWB Confidence'), 'Internet access at school' (ie=0.04, mediated by 'Freq

Computer Use School', 'Freq Computer Use away from School', 'Computer Literacy' and 'IWB Confidence'), 'ICT away from school' (ie=0.03, mediated by 'Freq Computer Use away from School', 'Computer Literacy' and 'IWB Confidence'), 'Freq computer use school' (ie=0.01, mediated by 'Freq Computer Use away from School', 'Computer Literacy' and 'IWB Confidence') and 'Year level' (ie=0.01, mediated by 'Freq Computer Use away from School', 'Computer Literacy' and 'IWB Confidence'). Among these, only the first three factors showed path coefficients above the minimal value of 0.02 which is considered to be relevant for interpretation. It is evident that these three factors had a very small effect size, thus any increase in the availability of ICT to students away from school, or in the frequency of computer use by students away from school, or in their internet access at school has only a slight positive impact on their IWB competence. The last two factors are not considered for interpretation because their values are less than 0.02.

9.3.2.8 Attitudes towards ICT (AICT)

AICT (in terms of Enjoyment, Importance and Anxiety) was treated as a key construct in the student level path model. As depicted in Figure 9.2, 'Computer literacy' had a large direct effect (β=0.52) on AICT. The sign is positive which suggests that the students with higher computer literacy are highly likely to have more positive attitudes towards the use of ICT in educational settings. The R^2 value (0.27) indicates that 27% of variance of AICT has been accounted for by 'Computer Literacy' variable in the model.

Further, Table 9.4 and Figure 9.2 displays five more factors indirectly associated with AICT. Among these 'Freq Computer Use away from school' had a path coefficient value of 0.18 and its association with AICT was mediated by 'Computer Literacy'. This indicates that the students who use computer away from school more frequently tend to have more favourable attitudes towards ICT. A second factor is 'Internet access at school' which showed a small path coefficient (ie=0.08), its effect being mediated by 'Freq Computer Use School', 'Freq Computer Use away from school' and 'Computer Literacy'. It indicated that access to the internet at school is likely to make the attitudes of students slightly more positive towards ICT. 'ICT away from School' (ie=0.06), 'Freq Computer Use School' (ie=0.03) and 'Year level' (ie=0.02) were found to have very small positive effects on AICT and all were mediated by 'Freq Computer Use away from school' and 'Computer Literacy', meaning the students who have more availability of ICT away from school, and those who use computers more frequently at school, and also those who are in higher year level, are likely to have slightly more favourable attitudes towards ICT.

9.3.2.9 Attitudes towards IWB (AIWB)

AIWB was another key construct in the path model and it is clearly depicted in Figure 9.2 that two factors i.e. 'Attitudes towards ICT' (AICT) and 'Freq IWB use by teacher' were found to have direct effects on the attitudes of students towards IWB (in terms of Motivational, Affective, Management and Support in Learning).

The value of the path coefficient of AICT (β=0.28) and its positive sign indicated that AICT had a medium effect on AIWB. This means that the students with more positive attitudes towards ICT also tend to have more positive attitudes towards IWB. The path coefficient of 'Freq IWB use by teacher' (β=0.24) also indicated medium effect size and its positive sign suggested that the attitudes of the students tend to be more favourable towards IWB use when their teachers use IWB more frequently. Further, the R^2 value (0.13) indicates that 13% of variance of AIWB has been accounted for by these two variables i.e. AICT and 'Freq IWB use by teacher'.

'Computer Literacy' was a factor which had a small indirect positive effect (ie=0.14) on AIWB. AICT acted as the mediating factor in between 'Computer Literacy' and AIWB. The effect size was small, so it can be said that higher computer literacy among the students leads to slightly better attitudes towards IWB.

There were five more factors which showed very small associations with AIWB. These were 'IWB installed in classroom' (ie=0.06), 'Freq Computer Use away from school' (ie=0.05), 'Internet access at school' (ie=0.02), 'ICT away from school' (ie=0.02) and 'Year level' (ie=0.02). All these factors were positively associated with AIWB which means that any increase in these factors had a slight positive indirect impact on the attitudes of the students towards IWB. The association between 'Freq

Computer Use away from school' and AIWB was mediated by 'Computer Literacy' and AICT. 'IWB installed in classroom' and AIWB had 'Freq IWB Use by teacher' as mediating factor. Further 'Internet access at school' was associated with AIWB through 'Freq Computer Use School', 'Freq Computer Use away from school', 'Computer Literacy' and AICT. 'ICT away from school' and 'Year level' factors had 'Freq Computer Use away from school', 'Computer Literacy' and AICT as mediating factors.

It is important to mention that the factor 'Freq Computer Use School' was not considered for interpretation in spite of showing some association with AIWB because its path coefficient value (ie=0.01) was below the 0.02 which was considered as the minimum value to be used in interpretation.

9.3.2.10 Classroom Interactions using IWB (CIIWB)

'Classroom interactions using IWB' (CIIWB) including the students and the teachers (in terms of Supported Didactic, Interactive or enhanced interactive) was found to be directly impacted by two variables, 'Attitudes towards IWB' (AIWB) and 'IWB competence'.

AIWB was an endogenous latent variable which showed a large direct positive effect (β=0.52) on CIIWB. This provided evidence that classroom interactivity using IWB is greatly influenced by the attitudes of the students towards IWB. In other words, it is highly likely that the classroom environment, including the interactions between the teacher and the students, as well as among the students, when using an IWB will be more interactive or enhanced interactive when the students have a more positive attitudes towards IWB.

'IWB competence' of the students also played a significant role in the shifting the use of IWB from didactic to enhanced interactive way. This is evident in the Table 9.4 which shows that the path coefficient value between 'IWB competence' and CIIWB was 0.20. As this has a positive sign, it means that IWB is likely to be used in more interactive or enhanced interactive ways in the classroom when the students have more competence in the use of IWB. It can also be seen in the Figure 9.2 and

Table 9.4 that 32% (R^2= 0.32) of variance of CIIWB is accounted for by AIWB and 'IWB competence' variables in the model.

The factors which had an indirect effect on CIIWB were 'IWB confidence', AICT, 'Computer Literacy', 'Freq IWB use by teacher', 'Freq Computer Use away from school' and 'IWB installed in classroom' and 'Internet access at school'. All these factors yielded a positive effect on CIIWB.

'IWB confidence' (mediated by 'IWB competence') was found to have medium influence on CIIWB (ie= 0.16). This means that when the students are more confident users of IWB, the classroom interactions between the teachers and their students using IWB tend to be more interactive or enhanced interactive.

Further, factors like AICT (ie= 0.14, mediated by AIWB), 'Computer literacy' (ie=0.13, mediated by 'IWB confidence', 'IWB competence', AICT and AIWB), 'Freq IWB use by teacher' (ie=0.12 mediated by AIWB), 'Freq Computer Use away from school' (ie=0.04 mediated by 'Computer Literacy', 'IWB confidence', 'IWB competence', AICT and AIWB) and 'IWB installed in classroom' (ie=0.03, mediated by 'Freq IWB Use by teacher' and AIWB) and 'Internet access at school' (ie=0.02, mediated by 'Freq Computer Use School', 'Freq computer use away from school', 'Computer Literacy', 'IWB confidence', 'IWB competence', AICT and AIWB) were found to have only a small effect on CIIWB. Thus the computer literacy of the students, their computer use away from school, the availability of IWB in their classrooms, frequency of IWB use by their teachers and access to the internet at school slightly impact the classroom interactions among the students and their teachers in a positive way.

Three more factors, 'ICT away from school' (ie=0.01), 'Year level' (ie=0.01) and 'Freq computer use school' (ie=0.01), had impact on CIIWB, but these impacts were negligible as their path coefficients were below 0.02. So these factors are not included in the interpretation.

9.3.2.11 Surface Learning Approach using IWB (SLA)

'Surface Learning Approach using IWB' (SLA) of the students (in terms of Surface Motive and Surface Strategy) was a key construct in the path model depicted in Figure 9.2. Table 9.4 shows that it was directly influenced by two factors, Gender (students) and 'Computer Literacy'. Both these factors showed a negative association with SLA.

Gender (male=0, female=1) of the students showed a medium value of path coefficient (β= -0.22), the negative sign meaning that the male students are likely to be more inclined towards using a surface learning approach as compared to the female students when IWB is used.

The second factor i.e. 'Computer Literacy' yielded in a small negative direct effect (β= -0.12) meaning that students who considered themselves to be more computer literate were less likely to use a surface learning approach (in terms of surface motive and surface strategy) when IWB is used. In other words, less computer literate students tend use more surface learning approach when taught using IWB. These two variables i.e. Gender and 'Computer Literacy' accounted for 62% variance of SLA as shown by the R^2 value (0.62) in the Figure 9.2 and Table 9.4.

There were two other factors which were found to have a very small indirect effect on SLA. Both these factors had a negative sign of path coefficient. These factors were 'Freq Computer Use away from school' (ie= -0.04, mediated by 'Computer Literacy') and 'Internet access at school' (ie= -0.02, mediated by 'Freq Computer Use School', 'Freq Computer use away from school' and 'Computer Literacy'). This means that those students who use computers more frequently away from school, and those who have internet access at school, are slightly less likely to use surface learning approach when taught using IWB.

Three factors, 'ICT away from school'(ie= -0.01), 'Freq Computer Use School' (ie= -0.01) and 'Year level' (ie= -0.005) showed less than the minimum value for path coefficient, so they are excluded from the interpretation.

9.3.2.12 Deep Learning Approach using IWB (DLA)

Results presented in Table 9.4 show that there was one factor which was found to have direct effect on the perceived 'Deep Learning Approach using IWB' (DLA) of the students. This factor was CIIWB (Classroom interactions using IWB, β= 0.37). The positive sign of the path coefficient means that when students experience more interactive or enhanced interactive use of IWB in the classrooms, they are more likely to choose a deep approach towards learning (in terms of deep motive and deep strategy). Further, the R^2 value (0.14) indicates that 14% of the variance of DLA has been accounted for by the CIIWB variable in the model shown in the Figure 9.2.

Apart from this, 'Attitudes towards IWB' (AIWB) was found to have a significant indirect effect on DLA (ie= 0.19). Its effect was mediated by CIIWB and the positive sign indicated that the students with more positive attitudes towards IWB tend to adopt a more deep learning approach when the IWB is used.

There were six more factors which had a small indirect effect on DLA. The first two among these were 'IWB competence' (ie=0.07, mediated by CIIWB) and 'IWB confidence' (ie= 0.06, mediated by 'IWB competence' and CIIWB). This indicates that higher competence level, and higher confidence level in using IWB, is associated with the students to use more deep learning approach when taught using IWB.

The indirect association of AICT (ie= 0.05, mediated by AIWB and CIIWB) and 'Computer Literacy' (ie=0.05, mediated by 'IWB confidence', 'IWB competence', AICT, AIWB and CIIWB) with DLA was very small and indicated that positive attitudes of students towards ICT and high computer literacy encourage the students slightly towards using a deeper approach to learning when IWB is used. 'Freq IWB use by teacher' also impacted DLA, although its impact was also very small (ie=0.04, mediated by AIWB and CIIWB). Thus teachers use IWB more frequently in the classroom, is associated with a deeper learning approach.

Similarly frequency of computer use by students away from school (ie= 0.02) also had a slight positive influence on DLA through 'Computer Literacy', 'IWB confidence', 'IWB competence', AICT, AIWB and CIIWB.

The factors which were not considered for interpretation (path coefficient less than 0.02) were 'Internet access at school' (ie=0.01), 'IWB installed in classroom' (0.01), 'ICT away from school' (ie=0.005), 'Year level' (ie=0.004) and 'Freq computer use school' (ie= 0.003).

9.3.2.13 Learning Outcomes using IWB (LO)

'Learning Outcomes using IWB' (LO) was the final construct in the student path model, and it refers to the students' perception of the quality of learning outcomes when taught using IWB in terms of Remembering, Understanding, Applying, Analysing, Evaluating and Creating. It can be seen in Table 9.4 that three factors were found to have direct effect on LO. These were 'Attitudes towards IWB' (AIWB), 'Deep Learning Approach using IWB' (DLA) and 'Surface Learning Approach using IWB' (SLA). All these constructs showed a positive influence on LO. AIWB had both direct (β=0.46) and indirect (ie=0.10) effects on LO resulting in a large total path coefficient, te=0.56. This is clear evidence that attitudes of the students towards IWB have a strong effect on student's perception of their learning outcomes using IWB: students with more favourable attitudes towards IWB are more likely to have higher level perceived learning outcomes when taught using IWB. The R^2 value (0.57) clearly indicates that 57% of variance of LO has been accounted for by AIWB, DLA and SLA variables including in single level path model for students as shown in Figure 9.2.

Among two other latent variables, it was clear that DLA (β=0.50) yielded a much higher path coefficient as compared to SLA (β=0.14). So the influence of DLA on LO was much stronger than the influence of SLA. This indicates that when IWB is used, the perceived deep learning approach of the students influenced their perceived learning outcomes more than their perceived surface learning approach. It is highly likely that the deeper the learning approach chosen by the students using

IWB the better are their perceived learning outcomes using IWB. But, on the other hand, students' perceived surface learning approach using IWB only had small positive influence on the perceived learning outcomes of the students.

Further, there were two more factors which were found to have medium indirect effects on LO: these were 'Classroom Interactions using IWB' (CIIWB, ie=0.18) and 'Attitudes towards ICT' (AICT, ie=0.16). Among these, CIIWB was mediated by DLA and this association suggests that when the IWB is used in the classroom in an interactive or enhanced interactive way, it is likely to yield better perceived learning outcomes. The indirect effect of AICT on LO included two pathways; the first one included only AIWB as a mediator and the second included AIWB, CIIWB and DLA as mediating factors. This association shows that students with more positive attitudes towards ICT tend to have the perception of better learning outcomes when using IWB.

Seven more factors were identified which had small indirect influences on LO. 'Freq IWB use by teacher' was the first among them with a path coefficient of 0.13 (mediated by AIWB, CIIWB and DLA). Next was 'Computer Literacy' which showed a very small path coefficient i.e. 0.07 (mediated by AICT, AIWB, CIIWB, DLA and SLA). Both these coefficients had a positive sign which shows that the students who consider themselves highly computer literate, and whose teachers use IWB more frequently in classrooms, are likely to have slightly better perceived learning outcomes.

'IWB competence' (ie=0.04, mediated by CIIWB and DLA), 'IWB installed in classroom' (ie=0.04, mediated by 'Freq IWB use by teacher', AIWB, CIIWB and DLA) and 'IWB confidence' (ie=0.03, mediated by 'IWB competence', CIIWB and DLA) were also found to have only a small positive influence on LO, meaning that the perceived learning outcomes, when using IWB, are slightly likely to be better whose IWB is installed in their classrooms and when students are more competent and confident in using IWB.

The gender of students also showed a very small indirect path coefficient (ie= -0.03). Its effect was mediated by 'Surface Learning Approach using IWB' (SLA). Its negative sign indicates that when IWB is used, male students tend to believe they have slightly better learning outcomes than female students, although this difference was tiny. 'Freq Computer use away from school' was also found to have a very small effect (ie=0.02) on LO through 'Computer Literacy', 'IWB confidence', 'IWB competence', CIIWB, DLA, AICT and AIWB. The positive sign is an indication that students who used more computers away from school perceive slightly better learning outcomes when taught using IWB.

The factors not included in the interpretation, due to path coefficient values less than 0.02, were 'Internet access at school' (0.01), 'Year level' (0.01), ICT away from school' (0.01) and 'Freq Computer Use School' (0.004).

9.3.3 Model Fit Summary for Student Level Path Model

The goodness of fit of the student level path model was assessed in order to determine how the model fitted the data. The fit indexes described in Chapter 6 were used for this purpose. These indexes were χ^2/DF (chi-square divided by the number of degrees of freedom), GFI (goodness-of-fit-index), TLI (Tucker-Lewis Index), CFI (comparative fit index), and RMSEA (root mean square error of approximation).

The Model Fit Summary obtained in the Output for this student level path model (Figure. 9.2) showed a χ^2/DF value of 2.194 which is lower than the upper limit of the χ^2/DF (>5) (Darmawan, 2003, p. 96) and indicated that this model fitted the data well. The other indices i.e., GFI (0.81), TLI (0.86) and CFI (0.87) also indicated a good fit for the model because their values were close to 0.90 (Byrne, 2010, pp. 77-79). Further, a good fit for this model was also indicated by RMSEA value (0.07) which was close to zero (Darmawan, 2003, p. 96).

It is also important to mention a small modification (arrow between error terms) which was made to improve the model based on the modification indices suggested by the AMOS program. As can be seen in Figure 9.2, two error terms, e15 and e16 are correlated to each other (0.54) and have positive associations, which were statistically significant at $p<0.001$.

9.4 Summary

Single level path analysis was used to examine the relationships among different variables at the student level. The results of the measurement models showed that the observed variables (OVs) showed significant loadings on their corresponding latent variables (LVs) meaning that all the LVs (AICT, AIWB, CIIWB, SLA, DLA and LO) were well represented by their OVs.

The results of structural model showed that when IWB is used, the perceived learning outcomes of the students were strongly and positively influenced by their attitudes towards IWB and by their perceived deep learning approach. Furthermore, when the students were taught using IWB, their inclination towards deep learning approach also had a strong positive effect on their perceived learning outcomes. Also, when IWB was used, the tendency of the students to adopt a surface learning approach had a much smaller influence on their perceived learning outcomes in comparison to deep learning approach.

Further the perceived deep learning approach was very strongly influenced by the kind of interactions taking place between the students and teachers. This influence was positive in nature, meaning that if the IWB is used in an interactive or enhanced interactive way, the students see themselves adopting a deeper approach of learning. The classroom interactions using IWB were positively influenced by the attitudes of the students towards IWB which was positively affected by the attitudes of the students towards ICT. Apart from this, various demographic factors including year level, gender, computer literacy, IWB competence and confidence also showed small effect on the deep learning approach and learning outcomes of the students through classroom interactions using IWB. Along with these was the impact of environmental factors like internet access at school, frequency of computer use at and away from school, ICT availability away from school, availability of IWB in the classroom and frequency of IWB use by teachers.

These findings provides an understanding of the students' perception of their learning (approaches and outcomes) using IWB, how these are impacted by their attitudes towards IWB and ICT, and most importantly by different kinds of IWB use in the classrooms, along with various other factors which show similar but lesser effects on it.

Chapter 10
Hierarchical Linear Modeling

10.1 Introduction

It was mentioned in Chapter Three that the data for this study came from three different levels i.e. School level, Teacher level and Student level. The variables at these levels were likely to have multi-level relationships among each other. In Chapters Eight and Nine, single level path analyses were undertaken, using AMOS software, to explore the relationships among the variables at Teacher and Student level separately. The single level path analysis for School level was not conducted because of the very small number of units (12) at this level. These single level analyses did not take into consideration the hierarchical nature of the data and so did not provide any findings regarding the multi-level relationships among the nested variables present at different levels of investigation (Kaplan, 2009). So, with the purpose of investigating the relationships among the variables at different levels, another statistical technique i.e. Hierarchical Linear Modeling (abbreviated as HLM) was used in this study (Darmawan & Keeves, 2009). HLM is a technique which is used to analyse the variables at different levels (three levels in this study) "simultaneously in order to find out the factors that affect the outcome variable (the dependent variable)" (Darmawan, 2003, p. 158). The statistical software used for this purpose was Hierarchical Linear Modeling (HLM) program (version 6.08) (Raudenbush, Bryk, & Congdon, 2009).

In this chapter, the results of the HLM analysis (three-level modeling) undertaken in this study are given, and these include findings related to the direct effects from various levels and also the interaction effects between the variables at three different levels i.e. student level, teacher level and school level. It should be noted that the sample size at student level was 269; teacher level was 18; and at school level, the sample size was 9. The findings related to two separate three-level models are given i.e. Three-Level Deep Learning Approach using IWB Model, in which students' perceived deep learning approach using IWB (DLA) is an outcome variable and

Three-Level Learning Outcomes using IWB Model, in which students' perceived learning outcomes using IWB (LO) is an outcome variable. The decision of selecting these two models was based on the fact that this research was aimed to investigate the impact of IWB use on student learning and deep learning approach (DLA) and learning outcomes (LO) were the two most important factors identified in the research literature to represent student learning (Biggs et al., 2001; Krathwohl, 2002), so it was decided to further explore both these two factors using HLM techniques. The surface learning approach (SLA), which was another learning related factor, was not used because it is a well-known fact that surface learning approach is not associated with better quality of learning outcomes (Biggs et al., 2001) and secondly, there was no link found between any kind of classroom IWB use and the surface learning approach in the student level path analysis. Before discussing the findings, a description about the HLM procedure is given which also includes details about the model building and trimming process used in HLM analysis.

10.2 Hierarchical Linear Modeling (HLM)

Hierarchical linear modeling (HLM) is a regression technique that was particularly designed to handle the hierarchical structure of educational data (Raudenbush & Bryk, 1986). HLM is also called multilevel modeling because this technique is used to investigate the hierarchical nature of data collected at multiple levels. HLM is designed to overcome the limitations of single-level data analysis techniques, such as single level path analysis where the aggregation or disaggregation of data leads to either the loss of information or the violation of the assumption of independent observations (Darmawan, 2003, p. 86). Further, single-level procedures also do not estimate the interaction effects across levels (Darmawan, 2003, p. 86). HLM can explain the effects by (1) improving the estimation of individual effects; (2) modeling cross-level effects; (3) partitioning variance-covariance components among different level of variables (Bryk & Raudenbush as cited in Darmawan, 2003, p. 86).

The main assumptions of HLM procedure are that the researched variables are independent, and normally distributed (Darmawan, 2003, p. 86). So HLM requires a properly specified model in order to avoid biased estimates of relationships. Further the outcome is a linear function of the regression coefficients. It also assumes that the independent errors are normally distributed (Bryk & Raudenbush as cited in Darmawan, 2003, p. 86). There are also some technical problems associated with using the HLM technique. The first problem is that HLM does not allow the construction of latent variables, so it is necessary to combine the observed variables outside HLM, using factor scoring or other such techniques, to develop constructs. Secondly, "HLM does not permit the modeling of indirect effects between variables"(Darmawan, 2003, p. 86). Further, in HLM analysis, only one dependent variable can be analysed at one time (Darmawan, 2003, p. 159).

10.2.1 Model Building and Specification in HLM

According to Bourbour and Bjorklund (2014), the data analysis using HLM requires four steps:

1. The type of model to be fitted must be decided on.
2. An appropriate Multivariate Data Matrix (MDM) file must be created.
3. The model is specified and various statistical and output options specified.
4. The model is run, after which model-based graphs can be obtained.

As mentioned above, the data for this study were collected at three different levels i.e. School level, Teacher level and Student level, so a three-level HLM model was developed and examined using the HLM6/3L program.

After deciding the type of model, the next step was to build the Model which began with creating an MDM file. It should be noted that three SPSS data files (one for each level) were used to construct the MDM file. These files were linked to each other by common Level-2 and Level-3 unit ID (Darmawan, 2003, p. 87). This MDM file was then used as an input file for all the subsequent analyses because it helped in faster computation (Bourbour & Bjorklund, 2014).

The next step was to specify the model. In HLM, the basic model specification includes five steps (Bourbour & Bjorklund, 2014):

1. Specifying the level-1 model: this defines a set of level-1 coefficients to be computed for each level-2 unit.
2. Specifying a level-2 structural model to predict each of the level-1 coefficients.
3. Specifying the level-1 coefficients to be viewed as random or non-random.
4. Specifying the level-3 structural model to predict each of the level-2 coefficients.
5. Specifying the level-2 coefficients to be viewed as random or non-random.

A linear model was obtained after completing the above stated five steps. The next phase of model specification was to select the type of outcome variable (Bourbour & Bjorklund, 2014). As the focus of this research was to investigate the impact of adoption and utilization of IWB on the student learning, which included both the learning approach and learning outcomes, the 'Deep Learning Approach using IWB' and 'Learning Outcomes using IWB' were selected to be the outcome (dependent) variables for two separate three-level analyses. Therefore, two three-level HLM models were tested in this study:

a) Perceived 'Deep Learning Approach using IWB' as the dependent variable i.e. Three-Level Deep Learning Approach using IWB Model.
b) Perceived 'Learning outcomes using IWB' as the dependent variable i.e. Three-Level Learning Outcomes using IWB Model.

10.2.2 Model Trimming in HLM

Model trimming of both the above stated three-level models was performed in the same way. Firstly, the output file was examined to check the reliability estimates for random coefficients. The relationships which were showing low reliability i.e. below 0.05 were treated as fixed because the low reliability estimates of a relationship is an indication that there is too much error associated with the relationship (Darmawan, 2003, p. 87). Secondly, the variance components were examined in the 'Final estimation of variance components' table and a comparison was made with the figures generated in the output of so-called 'fully unconditional' or 'null' model.

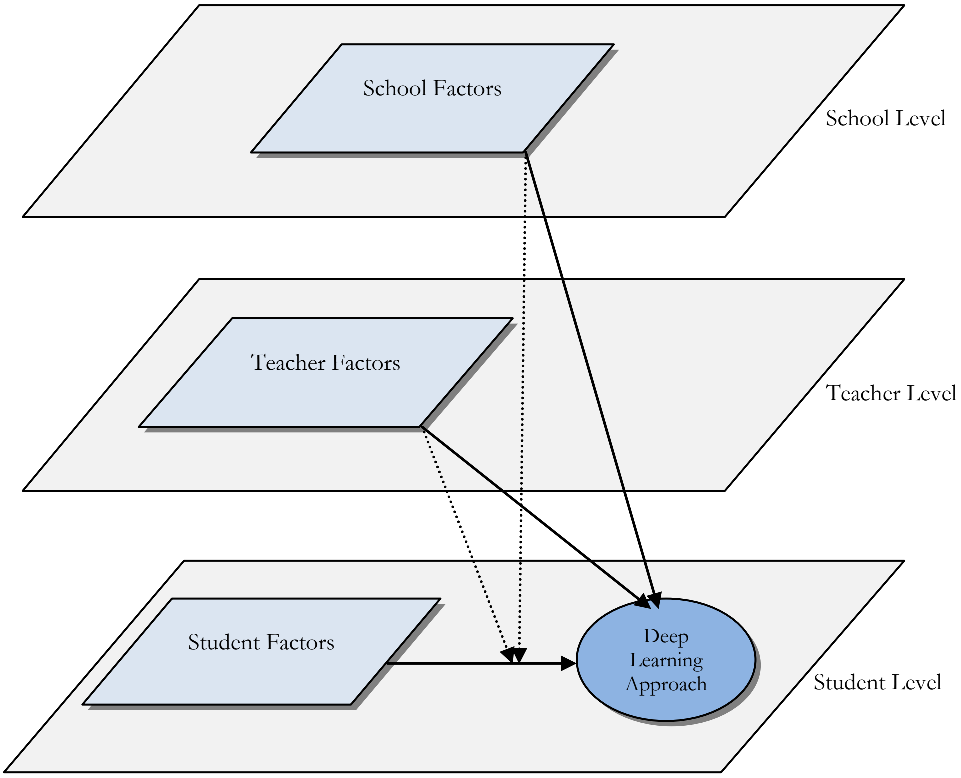


Figure 10.1: Three-Level Deep Learning Approach using IWB Model

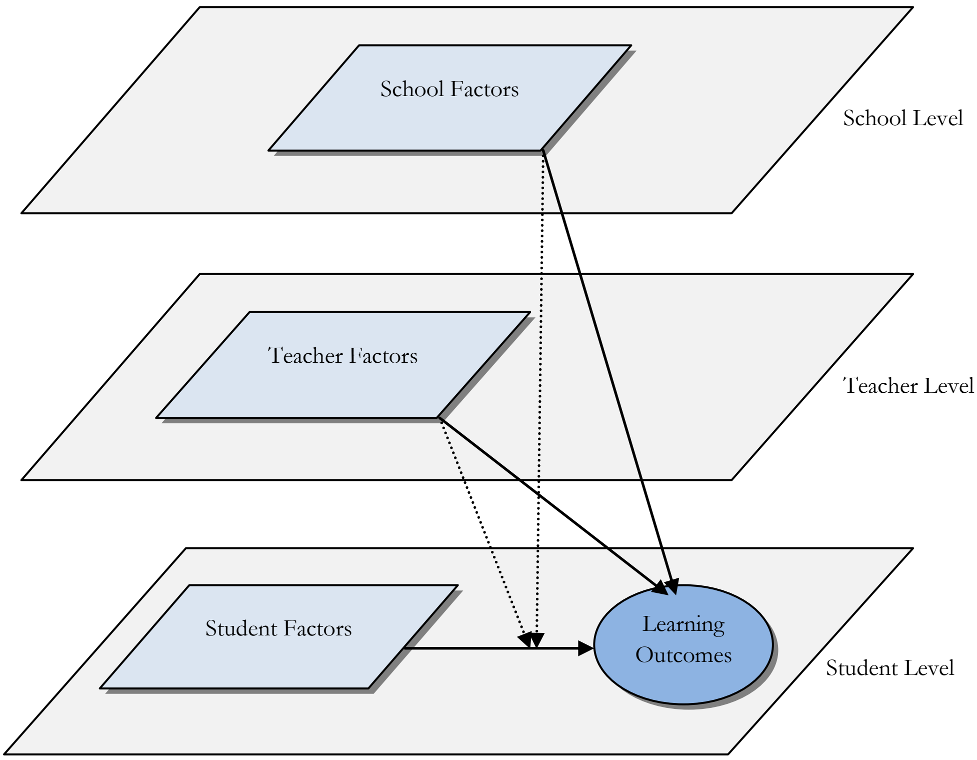


Figure 10.2: Three-Level Learning Outcomes using IWB Model

This provides the indication of the amount of variance explained by the predictor variables at each level: these variables with low or minimum amount of variance explained by the predictors were removed (Bryk & Raudenbush, 2002). The third criterion which was used was the estimation of the gamma (γ) coefficients which was given in the 'Final estimation of fixed effects' table. It is important to mention that the estimation of the gamma (γ) coefficients were also interpreted as metric path coefficients (Darmawan, 2003, p. 87). The significance of gamma coefficients was showed by their corresponding t-ratio. Any variable which showed a t-ratio below 1.64 at p-value > 0.10 was removed from the model before moving on with further analysis (Popham & Sirotnik, 1992).

10.3 Conceptual HLM models

The main purpose of using HLM techniques in analysing the data in this study was to investigate what factors at student, teacher and school levels influence the perceived learning outcomes and deep learning approach of the students when IWB is used, and also how these factors interact with one another (Darmawan & Keeves, 2002). As the intention was to examine the direct and the cross level interaction effects on two outcome (dependent) variables, so two hierarchical models were developed; Three-Level Deep Learning Approach using IWB Model and Three-Level Learning Outcomes using IWB Model. The conceptual models depicting hierarchical linear modeling for these two outcome variables are given in Figure 10.1 and Figure 10.2 respectively.

10.4 Variables Used in Three-level HLM Models

The selection of variables for the student level and teacher level of the three-level HLM was based on the findings of single-level path analysis conducted using AMOS. For the school level, all the variables present at that level were used because the single-level path analysis was not conducted for schools. Further, it was mentioned above that HLM does not allow the construction of the latent variables. To tackle this issue, the composite variables were used which were constructed by calculating the factor scores for each construct involved in the HLM model using the factor scoring technique with SPSS software (Cox, 2010). Further, it should be noted that these variables were in the standardised form and allowed the direct comparison of coefficients of variables within the model (Pedhazur as cited in Darmawan, 2003, p. 159). Apart from the composite variables there were many unity mode variables used in both Deep Learning Approach using IWB and Learning Outcomes using IWB hierarchical models.

The list of all the variables used in HLM models in this study is given in Table 10.1 along with their description. It is necessary to point out that all the variables at the school level were the unity mode variables. At the teacher level, there were four unity mode variables; AGE, GENDER_T, TEACHING and GICU9. Further, at student level, there were nine unity mode variables, GENDER, YEARLEVEL, GICU3_1, GICU6_1, GICU7_1, GIWBU1_1, GIWBU2_1, GIWBU3_1, GIWBU4_1. Apart from these, all other variables were developed using the factor scoring technique. The detailed description of these variables can be seen in Table 10.1.

Table 10.1: List of Variables used in Three-Level HLM models

Level	Variable name	Description
School Level	TEACHERS	Total number of Teachers in School
	STUDENTS	Total number of Students in School
	ICTIL	Level of ICT integration in the classrooms *(1=Very low; 2=Below Average; 3=Average; 4=Above Average; 5=High; 6=Very High)*
	IWBALL	IWBs installed in all classrooms *(1=Yes; 2=No)*
	CWIWB	Number of classrooms with IWB installed
	YLAIWB	Year levels that can have access to IWBs at a given time *(1=Only One; 2=Less than Half; 3=Half; 4=More than Half; 5= All of them)*
	TST	On-site Technical support to the teachers *(1=Yes; 2=No)*
	TSS	On-site Technical support to the students *(1=Yes; 2=No)*
	BIC	Broadband Internet connection at school *(1=Yes; 2=No)*
	TIA	Number of teachers with access to Internet *(0=None; 1=Less than Half; 2=Half; 3=More than Half; 4=All of them)*
	SIA	Number of students with access to internet *(0=None; 1=Less than Half; 2=Half; 3=More than Half; 4=All of them)*
	ETUSA	School encourages teachers to use more ICT *(1=Yes; 2=No)*

Table 10.1: List of Variables used in Three-Level Models (Contd.)

Level	Variable name	Description
School Level	SASH	Students have full access to software and hardware *(0=Not at all; 1=Rarely; 2=Sometimes; 3=Half of the time; 4=Frequently; 5=All the times)*
	EPDSA	School encourages teachers' ICT professional development *(1=Yes; 2=No)*
	SIWBTS	School runs IWB training sessions *(0=Not at all; 1=Yearly; 2=Half Yearly; 3=Quarterly; 4=Monthly; 5=Fortnightly; 6=Weekly; 7=Twice in a week; 8=Daily)*
	TASH	Teachers have full access to software and hardware *(0=Not at all; 1=Rarely; 2=Sometimes; 3=Half of the time; 4=Frequently; 5=All the times)*
Teacher Level	AGE	Age of the teacher *(1=20-25; 2=26-30; 3=31-35; 4=36-40; 5=41-45; 6=46-Above)*
	GENDER_T	Gender of the teacher *(0=Male; 1=Female)*
	TEACHING	Teaching Experience of the teacher *(1=less than one year; 2=1-5 years; 3=6-10 years; 4=11-15 years; 5=16-20 years; 6=21-above)*
	GICU9	Frequency of computer use at school by the teacher *(0=Never; 1=Occasionally; 2=Once in a week; 3=Almost twice a week; 4=Daily)*
	IWB_SUPP	IWB support available to the teacher *(IWB technical support; IWB workshops; Encouragement to use IWB; and IWB help by school)*
	COMP_LIT	Computer literacy of the teacher *(Computer experience; Computer competency; and Computer confidence of the teacher)*
	IWB_LITE	IWB literacy of the teacher *(IWB competence; IWB confidence; and IWB experience of the teacher)*
	AICT	Attitude of the teacher towards ICT
	AIWB	Attitude of the teacher towards IWB *(General; Teaching; Motivational; Training)*
	ATI_INFO	Information Transmission/Teacher focused Teaching Approach
	ATI_CONC	Conceptual Change/Student focused Teaching Approach
	CIIWB	Classroom Interactions using IWB *(Supported didactic; Interactive; Enhanced interactive)*
Student Level	GENDER	Gender of the student *(0=Male; 1=Female)*
	YEARLEVEL	Year Level of the student *(Year 7-Year 12)*
	GICU3_1	Internet access available to the student at School *(0=No; 1=Yes)*
	GICU6_1	Frequency of computer use by the student at School *(0=Never; 1=Occasionally; 2=Once in a week; 3=Almost twice a week; 4=Daily)*
	GICU7_1	Frequency of computer use by the student away from School *(0=Never; 1=Occasionally; 2=Once in a week; 3=Almost twice a week; 4=Daily)*
	GIWBU1_1	IWB installed in classroom *(0=No; 1=Yes)*
	GIWBU2_1	Frequency of IWB use by students' teacher *(1=Occasionally; 2=Fortnightly; 3=Once in a week; 4=Almost twice a week; 5=Daily)*
	GIWBU3_1	IWB competence of the student *(0=Novice; 10=Highly Competent)*

Table 10.1: List of Variables used in Three-Level Models (Contd.)

Level	Variable name	Description
Student Level	GIWBU4_1	IWB Confidence of the student *(0=No Confidence; 10=Very Confident)*
	ICT_AW_1	ICT available to the student away from School *(Students own a computer; have computer and internet access away from school)*
	COMP_L_1	Computer literacy of the student *(Computer experience, computer competence and computer confidence of the students)*
	AICT	Attitude of the student towards ICT *(Enjoyment; Importance; Anxiety)*
	AIWB	Attitude of the student towards IWB *(Affective; Management; Support in Learning)*
	CIIWB	Classroom interaction using IWB *(Supported Didactic; Interactive; Enhanced Interactive)*
	DLA	Deep Learning Approach of the student using IWB *(Deep Strategy; Deep Motive)*
	SLA	Surface Learning Approach of the student using IWB *(Surface Motive; Surface Strategy)*
	LO	Learning Outcomes of the student using IWB *(Remembering; Understanding; Applying; Analysing; Evaluating; Creating)*

10.5 Hypothesised Models

As mentioned above, two HLM models were analysed in this study; one with deep learning approach using IWB as outcome variable and the other with learning outcomes using IWB as an outcome variable. The hypothesised variables for three-level deep learning approach using the IWB model are shown in Figure 10.3 which shows 16 variables at school level, 12 variables at teacher level and 15 variables at student level. Figure 10.4 shows the hypothesised model for learning outcomes using IWB, and this contained 16 variables at school level, 12 variables at teacher level and 17 variables at the student level. All these variables were hypothesised to influence the deep learning approach using IWB of the students.

It is necessary to mention here that in this chapter, the terms level-1 and micro-level are used for the student level model. The other terms which are used for the teacher level model are level-2 and meso-level, and for the school level model the terms level-3 and macro-level are used interchangeably.

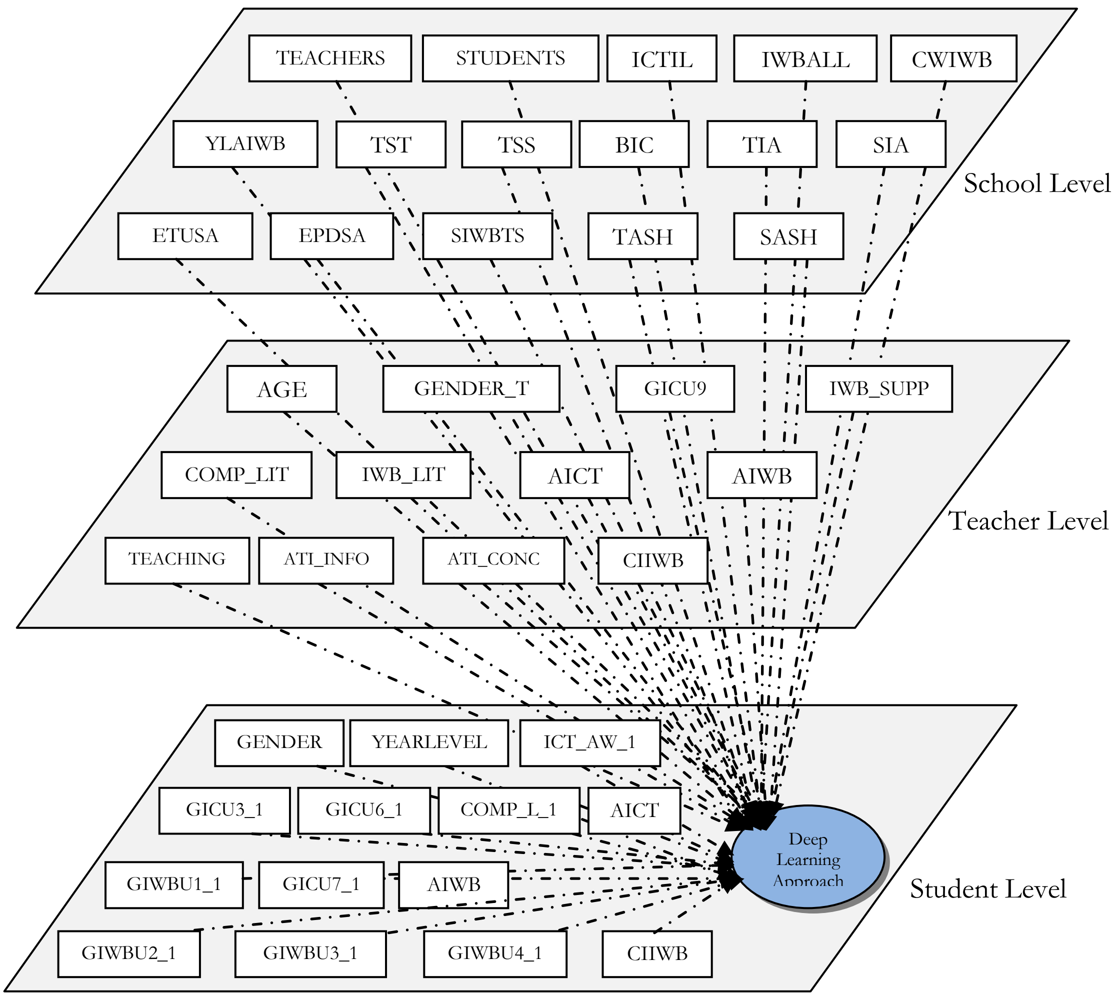


Figure 10.3: The hypothesised variables of the three-level Deep Learning Approach using IWB model

10.6 Three-Level Model Results

The findings for both the HLM models in this study, i.e. three-level deep learning approach using IWB and three-level learning outcomes using IWB, are given separately in the following sections of this chapter. For each model, the results of the null (fully unconditional) model are given first followed by the model specification for each level and the findings of the full model.

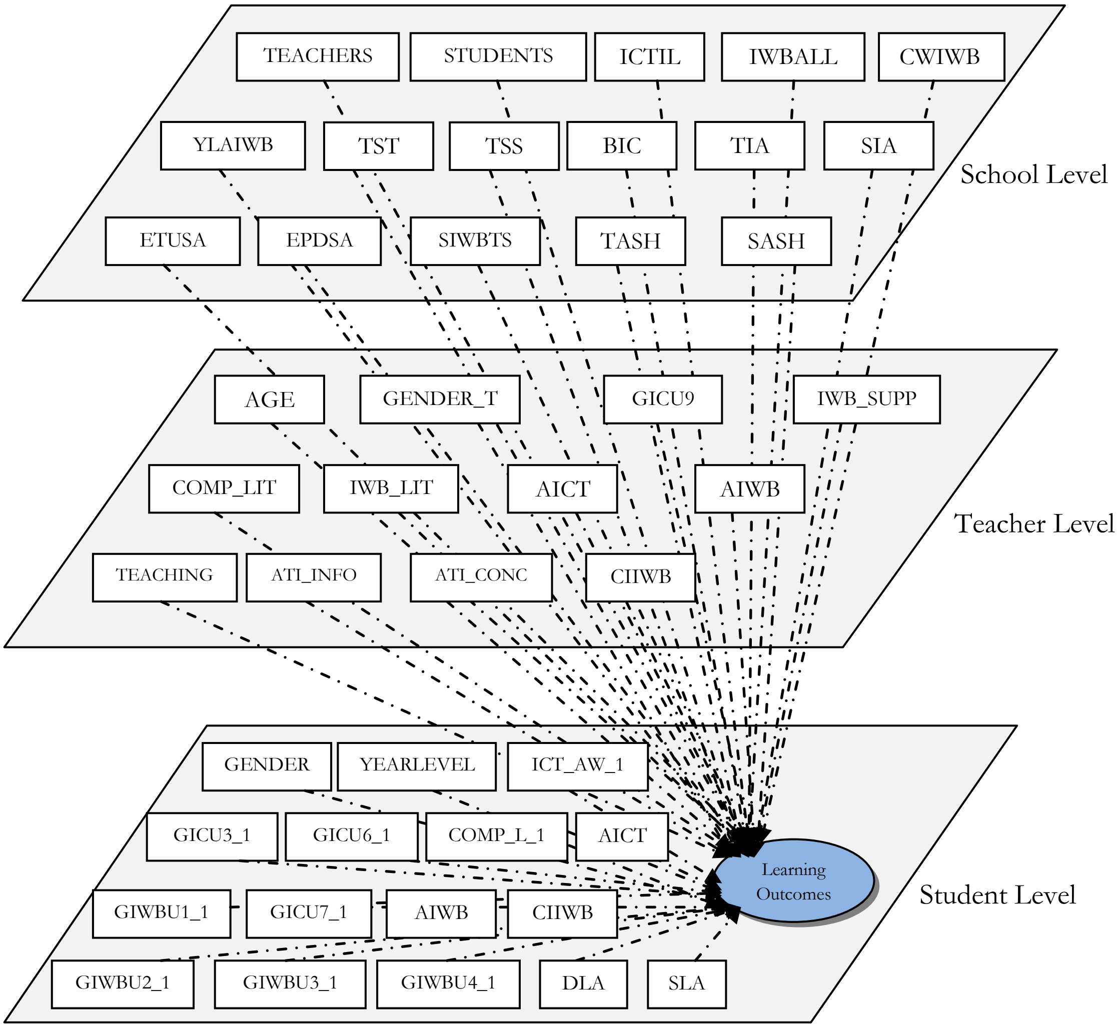


Figure 10.4: The hypothesised variables of the three-level Learning Outcomes using IWB model

10.6.1 Three-Level Deep Learning Approach using the IWB Model

With the purpose of investigating the effect of different factors present at student, teacher and school level on the deep learning approach of the students' outcomes using IWB, a three-level deep learning approach using IWB model was developed and analysed. The findings of this analysis are given in the following sections:

10.6.1.1 Null Model

In the three-level deep learning approach model, the null represents the amount of variance in deep learning approach using the IWB variable that is allocated across student, teacher and school level.

The equations representing fully unconditional model at all the three levels are given below.

10.6.1.1.1 Level-1 Model

Level-1 model is specified using the following equation:

$$Y_{ijk} = \pi_{0jk} + e_{ijk} \quad [1]$$

where:

Y_{ijk} is the perceived deep learning approach using IWB of student i under teacher j in school k;

π_{0jk} is the mean score of student perceived deep learning approach using IWB under teacher j in school k; and

e_{ijk} is a random error student effect, that is, the deviation of student ijk's score from the teacher mean.

In the above equation, the perceived deep learning approach using IWB of student i under the teacher j in the school k is considered to be equivalent to the teacher mean plus a random error. In other words, the fully unconditional model assumes no differences in the perceived deep learning approach using IWB between students within schools at level-1. It is assumed that each level-1 error, e_{ijk}, is normally distributed with the mean of zero and a constant level-1 variance, σ^2 (Bryk & Raudenbush, 2002).

The indices i, j, and k denote student, teacher and school where there are

$i = 1, 2, ..., N_{jk}$ students under teacher j in school k;

$j = 1, 2, ..., J_k$ teachers within school school k; and

$k = 1, 2, ..., K$ schools.

10.6.1.1.2 Level-2 Model

Level-2 model is specified using the following equation:

$$\pi_{0jk} = \beta_{00k} + r_{0jk} \quad [2]$$

where:

π_{0jk} is the mean perceived student deep learning approach using IWB of teacher j in school k;

β_{00k} is the mean perceived deep learning approach using IWB in school k; and

r_{0jk} is the random teacher effect, that is, the deviation of teacher jk's mean from the school mean.

In the level-2 equation, no predictors are specified that could contribute to explain difference between teachers, and the mean perceived student deep learning approach using IWB under teacher is considered to be equivalent to the mean perceived deep learning approach using IWB for that school plus random error. It is assumed that the random effect associated with teacher jk, r_{0jk}, is normally distributed with the mean of zero and the variance τ_{π}. With each of the K schools, the variability between teachers is assumed to be the same.

10.6.1.1.3 Level-3 Model

Level-3 model is specified using the following equation:

$$\beta_{00k} = \gamma_{000} + u_{00k} \quad [3]$$

where:

β_{00k} is the mean deep learning approach using IWB in the school k;

γ_{000} is the grand mean deep learning approach using IWB across schools; and

u_{00k} is the random school effect, that is, the deviation of the school k's from the grand mean.

It is assumed that the random effect associated with school k, u_{00k}, is normally distributed with the mean of zero and variance τ_{β}.

10.6.1.1.4 Variability of Outcome variable

The estimation of the proportions of variation in perceived deep learning approach using IWB among students, among teachers within schools and among schools can be calculated using the null model results as follows:

At level-1,

$\sigma^2 / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance that exists among students; [4]

At level-2,

$\tau_\pi / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among teachers within schools; and [5]

At level-3,

$\tau_\beta / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among schools. [6]

Table 10.2 shows the results for null model with deep learning approach using IWB as the outcome variable.

Table 10.2: Null Model Results: Three-Level Deep Learning Approach using IWB Model

Final estimation of fixed effects (with robust standard errors):					
Fixed effects	**Coefficient**	**Standard Error**	**T-ratio**	**Approx. d.f.**	**P-value**
For INTRCPT1, P0 For INTRCPT2, B00 INTRCPT3, G000	-0.014	0.08	-0.17	8	0.872

Final estimation of level-1 and level-2 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance component**	**df**	**Chi-square**	**P-value**
INTRCPT1, R0	0.003	0.01	0.0002	9	7.43	>.500
LEVEL-1, E		0.99	0.98			

Final estimation of level-3 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance component**	**df**	**Chi-square**	**P-value**
INTRCPT1/ INTRCPT2, U00	0.385	0.15	0.023	8	16.40	0.037

Statistics for current covariance components model	
Deviance	761.86
Number of estimated parameters	4

10.6.1.2 Final Model

The next step was to estimate the final model. The process of specifying the final model for the three-level deep learning approach using the IWB model is described below along with the equations used for this purpose.

10.6.1.2.1 Final Level-1 Model

In the process of specifying the level-1 (student-level) model for deep learning approach using IWB (DLA) as the outcome variable, the single-level path analysis findings for student level (Chapter 9) were used as a guideline to choose the possible predictors.

To specify level-1 model, all the predictors that were found in AMOS analysis to be influencing DLA were entered at once. Then the predictors which were not showing significant path coefficients were removed one by one. It has been mentioned above in the model trimming section of this chapter that the significance of path coefficients is determined by the value of their corresponding t-ratio and the predictors which obtain t-ratio below 1.64 at p-value < 0.10 are considered insignificant and removed from the model before further analysis. In this analysis a step down approach of model trimming was used where the insignificant predictors were removed one at a time, starting from the one with the lowest t-ratio. The analysis was run each time after removing one predictor and this process was repeated until those variables left showed significant path coefficient.

10.6.1.2.2 Final Level-2 model

After specifying the level-1 model, an exploratory analysis was done to check whether each level-2 (teacher-level) variable should be included in the model. The variables which obtained t-values greater than 2.00 were entered at level-2 and the model trimming process explained in the above section was used to remove the variables with insignificant path coefficients and to generate the final level-2 model.

10.6.1.2.3 Final Level-3 Model

Level-3 (school-level) model was also specified in a similar way to the level-2 model. The variables at level-3 were entered based on the t values obtained in exploratory analysis, and the step down approach was used to drop the variables with insignificant coefficients. This process was repeated until a final three-level model was obtained.

10.6.1.2.4 Final Three-Level Model

The final three-level deep learning approach using IWB model is specified by the following equations:

Level-1 model

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}\,(\text{CIIWB}) + e_{ijk} \quad [7]$$

Level-2 model

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}\,(\text{IWB\_SUPP}) + r_{0jk} \quad [8]$$

$$\pi_{1jk} = \beta_{10k} + \beta_{11k}\,(\text{AGE}) + \beta_{12k}\,(\text{IWB\_LITE}) + \beta_{13k}\,(\text{COMP\_LIT}) \quad [9]$$

Level-3 model

$$\beta_{00k} = \gamma_{000} + \gamma_{001}\,(\text{ICTIL}) + u_{00k} \quad [10]$$

$$\beta_{01k} = \gamma_{010} \quad [11]$$

$$\beta_{10k} = \gamma_{100} + \gamma_{101}\,(\text{SASH}) \quad [12]$$

$$\beta_{11k} = \gamma_{110} \quad [13]$$

$$\beta_{12k} = \gamma_{120} \quad [14]$$

$$\beta_{13k} = \gamma_{130} \quad [15]$$

By substituting level-3 equations (Equations 10 to 15) into level-2 equations (Equations 8 and 9), level-2 equations are represented by:

$$\pi_{0jk} = \gamma_{000} + \gamma_{001}\,(\text{ICTIL}) + \gamma_{010}\,(\text{IWB\_SUPP}) + u_{00k} + r_{0jk} \quad [16]$$

$$\pi_{1jk} = \gamma_{100} + \gamma_{101}\,(\text{SASH}) + \gamma_{110}\,(\text{AGE}) + \gamma_{120}\,(\text{IWB\_LITE}) + \gamma_{130}\,(\text{COMP\_LIT}) \quad [17]$$

By substituting level-2 equations (Equations 16 and 17) into the level-1 equation (Equation 7), the final model is represented by:

$Y_{ijk} = \gamma_{000} + \gamma_{001}$ (ICTIL) + γ_{010} (IWB_SUPP) + γ_{100} (CIIWB) + γ_{101} (SASH) (CIIWB) + γ_{110} (AGE) (CIIWB) + γ_{120} (IWB_LITE) (CIIWB) + γ_{130} (COMP_LIT) (CIIWB) + $u_{o0k} + r_{0jk} + e_{ijk}$ [18]

This equation illustrates that the students' perceived deep learning approach using IWB may be viewed as a function of the overall intercept (γ_{000}), three main effects, four cross-level effects and a random error ($u_{00k} + r_{0jk} + e_{ijk}$). The main effects are the direct effects from classroom interactions using IWB (CIIWB) from level-1; IWB support available to teacher (IWB_SUPP) from level-2; and level of ICT integration in the classrooms (ICTIL) from level-3 of the model. The cross level interaction effect involves the interaction of the age of the teachers (AGE), IWB literacy of the teachers (IWB_LITE) and computer literacy of the teachers (COMP_LIT) from level-2 and frequency of full access to software and hardware to students (SASH) from level-3 with CIIWB from level-1.

Table 10.3 shows the final model results for three-level deep learning approach using IWB model and it can be seen that one level-1 variable i.e. CIIWB had an effect on the perceived deep learning approach of the students. Further, one level-2 variable i.e. AGE interacted with CIIWB in influencing a deep learning approach as did one level-3 variable i.e. SASH.

Table 10.3: Final Model results: Three-Level Model of Deep Learning Approach using IWB

Final estimation of fixed effects (with robust standard errors):					
Fixed Effect	**Coefficient**	**Standard Error**	**T-ratio**	**Approx d.f.**	**P-value**
For INTRCPT1, P0					
For INTRCPT2, B00					
INTRCPT3, G000	-0.072222	0.050740	-1.423	7	0.198
ICTIL, G001	0.285673	0.055797	5.120	7	0.001
For IWB_SUPP, B01					
INTRCPT3, G010	0.185125	0.030197	6.131	16	0.000
For CIIWB slope, P1					
For INTRCPT2, B10					
INTRCPT3, G100	0.443546	0.043075	10.297	261	0.000
SASH, G101	0.112187	0.030876	3.633	261	0.001
For AGE, B11					
INTRCPT3, G110	0.043204	0.016086	2.686	261	0.008
For IWB_LITE, B12					
INTRCPT3, G120	-0.206296	0.081588	-2.529	261	0.012
For COMP_LIT, B13					
INTRCPT3, G130	0.194380	0.053715	3.619	261	0.001

Final estimation of level-1 and level-2 variance components:

Random Effect		Reliability	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1,	R0	0.001	0.00735	0.00005	8	9.47349	0.303
level-1,	E		0.89401	0.79925			

Final estimation of level-3 variance components:

Random Effect	Reliability	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1/ INTRCPT2, U00	0.002	0.00670	0.00004	7	10.52140	0.160

Statistics for current covariance model

Deviance	703.14
Number of estimated parameters	11

The results given in the above table are also illustrated in Figure 10.5 in the form of a three-level model.

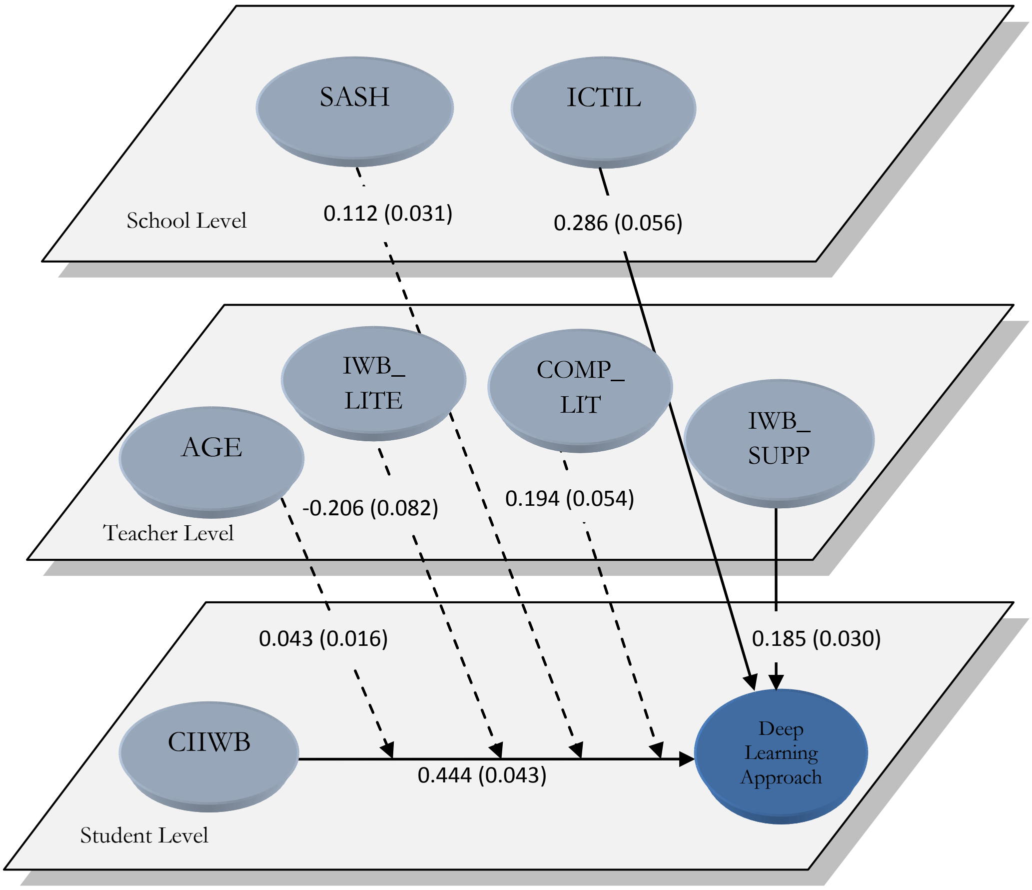


Figure 10.5: Three-Level Model of Deep Learning Approach using IWB

It can be seen in this model that students' perceived classroom interaction using IWB (CIIWB, 0.444) has a direct positive and strong effect (Cohen, 1988) on their perceived deep learning approach (DLA). It is a clear indication that the students who experience a more interactive or enhanced interactive classroom environment using IWB are very likely to adopt more perceived deep learning approach. These findings are consistent with the findings of single-level path analysis for students (Chapter 9), where CIIWB was found to have a direct positive effect on DLA.

The second direct predictor for DLA comes from level-2, which is the IWB support (IWB_SUPP, 0.185) available to the teachers at their schools in the form of IWB technical support; IWB workshops; encouragement to use IWB; and IWB help. The positive sign of the coefficient indicates that the more the teachers have IWB related support from the school, the more likely it is for the students to adopt a deeper learning approach when taught using IWB. The third direct predictor is from level-3, which represents the level of ICT integration in the classrooms (ICTIL, 0.286). The positive sign of the coefficient indicates that it is likely that the higher the level of ICT integration in the classroom the deeper is the learning approach adopted by the students using IWB. Both the level-2 and level-3 predictors point out that the ICT infrastructure of the school, in the form of ICT integration and IWB related support available to the teachers, plays an important role in encouraging the students to adopt a deep approach to learning when taught using IWB.

10.6.1.3 The Cross-Level Interaction Effects

Apart from the direct effect of predictors from all the three levels, it can be seen in Figure 10.5, that three variables from level-2 (AGE, IWB_LITE and COMP_LIT), and one variable from level-3 (SASH), are showing cross-level interaction effect on DLA (outcome variable). This cross-level interaction effect of each of these variables is discussed separately in the following sections.

10.6.1.3.1 Interaction Effect of age of the teachers (AGE) with students' perceived classroom interactions using IWB (CIIWB)

In order to discuss this interaction effect in details, parts of equation for the final model [18] involving AGE and CIIWB are taken and the remaining terms set to zero.

$$Y_{ijk} = \gamma_{000} + \gamma_{100} \text{ (CIIWB)} + \gamma_{110} \text{ (AGE) (CIIWB)} \quad [19]$$

Where (see Table 10.3)

$\gamma_{000} = -0.072$

$\gamma_{100} = 0.443$

$\gamma_{110} = 0.043$

Hence:

$$Y_{ijk} = -0.072 + 0.443 \text{ (CIIWB)} + 0.043 \text{ (AGE) (CIIWB)} \quad [20]$$

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on CIIWB and AGE (i),
b) one standard deviation above average on CIIWB and one standard deviation below the average on AGE (ii),
c) one standard deviation below the average on CIIWB and one standard deviation above the average on AGE (iii),
d) one standard deviation below the average on CIIWB and one standard deviation below the average on AGE (iv),
e) average on CIIWB and one standard deviation above the average on AGE(v),
f) average on CIIWB and one standard deviation below the average on AGE (vi).

Consequently, the coordinates were:

i. more AGE and high CIIWB (AGE = 1.87; CIIWB =1)

   Y (DLA) = -0.072 + 0.443 (1) + 0.043 (1.87) (1) = 0.451

ii. more AGE and low CIIWB (AGE = 1.87; CIIWB =-1)

   Y (DLA) = -0.072 + 0.443 (-1) + 0.043 (1.87) (-1) = -0.595

iii. less AGE and high CIIWB (AGE = -1.87; CIIWB =1)

   Y (DLA) = -0.072 + 0.443 (1) + 0.043 (-1.87) (1) = 0.291

iv. less AGE and low CIIWB (AGE = -1.87; CIIWB =-1)

   Y (DLA) = -0.072 + 0.443 (-1) + 0.043 (-1.87) (-1) = -0.435

v. average AGE and high CIIWB (AGE = 0; CIIWB =1)

   Y (DLA) = -0.072 + 0.443 (1) + 0.043 (0) (1) = 0.371

vi. average AGE and low CIIWB (AGE = 0; CIIWB =-1)

   Y (DLA) = -0.072 + 0.443 (-1) + 0.043 (0) (-1) = -0.515

These coordinates were used generate Figure 10.6.

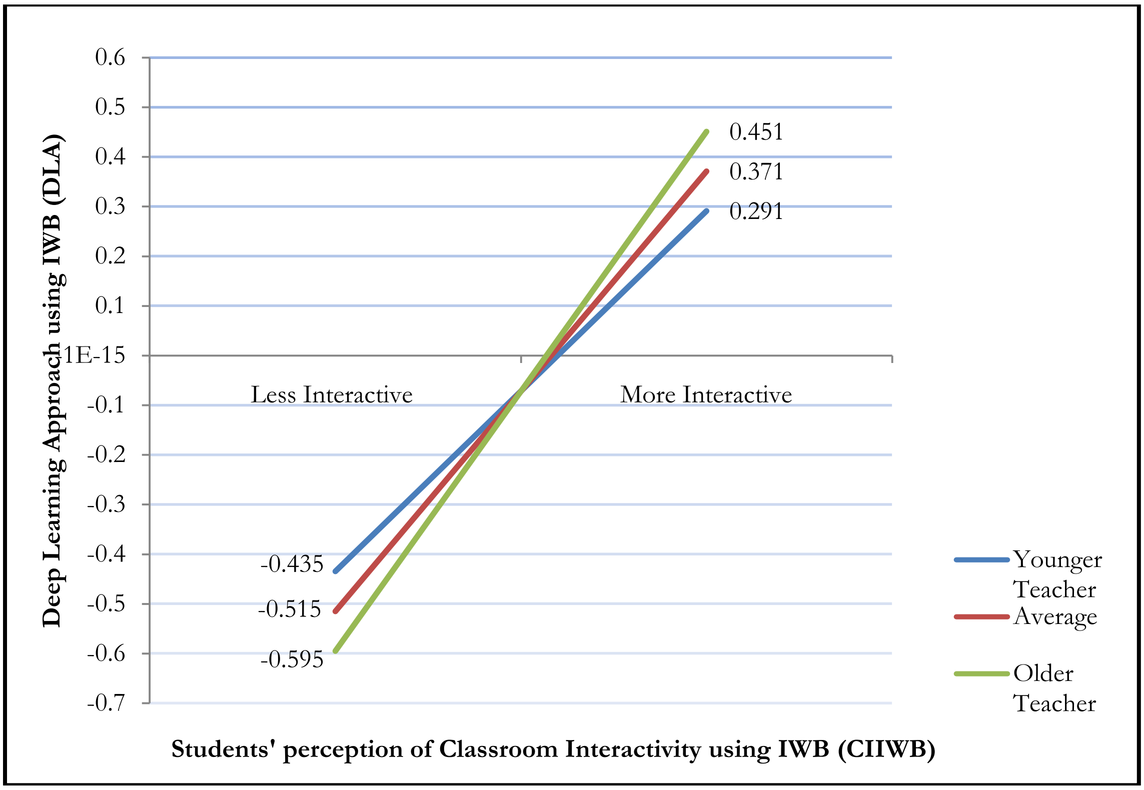


Figure 10.6: Interaction Effect of age of the teachers (AGE) with students' perceived classroom interactions using IWB (CIIWB)

The results in the Table 10.3 and the Figure 10.5 show that the average age of the teachers (AGE) interacted with students' perceived classroom interactions using IWB (CIIWB) with an interaction effect coefficient, $\gamma = 0.043$. This suggests that, in general, the age of the teachers has the positive effect on the slope of the students' perceived classroom interactions using IWB. And CIIWB has positive influence on the students' perceived deep learning approach using IWB (DLA) i.e. when the students experience more interactive or enhanced interactive classroom environment using IWB, they tend to adopt a deeper learning approach.

The graph depicting the cross-interaction effect of AGE with CIIWB in the Figure 10.6 shows that the strength of the effect of CIIWB on DLA varies according to the difference in the age of the teachers. When the students are taught by older teachers using IWB, the effect of CIIWB on their DLA is stronger than average, but when they are taught by younger teachers the effect of CIIWB on DLA becomes weaker.

10.6.1.3.2 Interaction Effect of IWB literacy of the teachers (IWB_LITE) with students' perceived classroom interactions using IWB (CIIWB)

In order to discuss this interaction effect in details, parts of equation for the final model [18] involving IWB_LITE and CIIWB are taken and the remaining terms set to zero.

$$Y_{ijk} = \gamma_{000} + \gamma_{100} (CIIWB) + \gamma_{120} (IWB\_LITE) (CIIWB) \quad [21]$$

Where (see Table 10.3)

$\gamma_{000} = -0.072$

$\gamma_{100} = 0.443$

$\gamma_{120} = -0.206$

Hence:

$$Y_{ijk} = -0.072 + 0.443 (CIIWB) - 0.206 (IWB\_LITE) (CIIWB) \quad [22]$$

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on CIIWB and IWB_LITE (i),
b) one standard deviation above average on CIIWB and one standard deviation below the average on IWB_LITE (ii),
c) one standard deviation below the average on CIIWB and one standard deviation above the average on IWB_LITE (iii),
d) one standard deviation below the average on CIIWB and one standard deviation below the average on IWB_LITE (iv),
e) average on CIIWB and one standard deviation above the average on IWB_LITE (v),
f) average on CIIWB and one standard deviation below the average on IWB_LITE (vi).

Consequently, the coordinates were:

i. more IWB_LITE and high CIIWB (IWB_LITE = 1; CIIWB =1)
   $Y (DLA) = -0.072 + 0.443 (1) - 0.206 (1) (1) = 0.165$
ii. more IWB_LITE and low CIIWB (IWB_LITE = 1; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) - 0.206 (1) (-1) = -0.309

iii. less IWB_LITE and high CIIWB (IWB_LITE = -1; CIIWB =1)

Y (DLA) = -0.072 + 0.443 (1) - 0.206 (-1) (1) = 0.577

iv. less IWB_LITE and low CIIWB (IWB_LITE = -1; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) - 0.206 (-1) (-1) = -0.721

v. average IWB_LITE and high CIIWB (IWB_LITE = 0; CIIWB =1)

Y (DLA) = -0.072 + 0.443 (1) - 0.206 (0) (1) = 0.371

vi. average IWB_LITE and low CIIWB (IWB_LITE = 0; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) - 0.206 (0) (-1) = -0.515

These coordinates were used generate Figure 10.7.

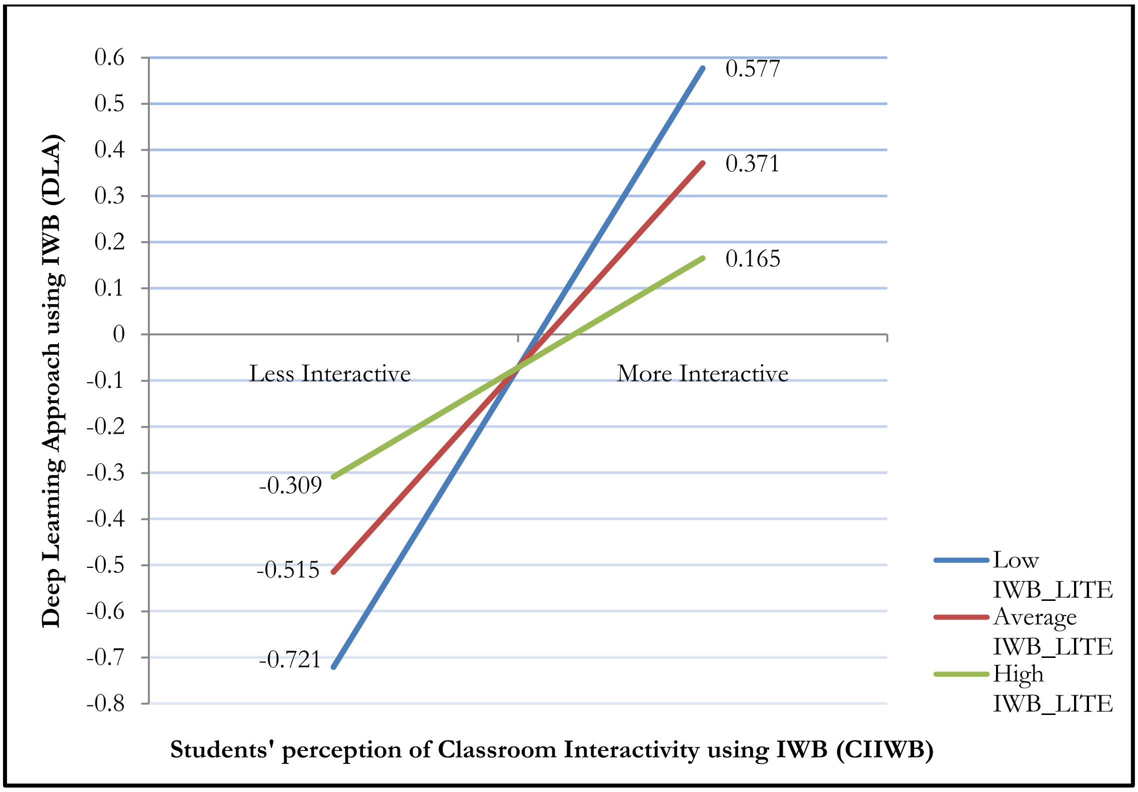


Figure 10.7: Interaction Effect of IWB literacy of the teachers (IWB_LITE) with students' perceived classroom interactions using IWB (CIIWB)

It was already mentioned in the above section that students' perceived classroom interactions using IWB (CIIWB) had a positive influence on the students' perceived deep learning approach using IWB (DLA) (Table 10.3 and Figure 10.5): that is, when the students experience a more interactive or enhanced interactive classroom environment using IWB, they tend to adopt a deeper learning approach. Further it can also be seen in Table 10.3 and Figure 10.5 that the average level of IWB literacy of the teachers (IWB_LITE) interacted with students' perceived classroom interactions using IWB (CIIWB) with an interaction effect coefficient, γ = -0.206. This suggests that, in general, the average level of IWB literacy of the teachers has a negative effect on the slope of the students' perceived classroom interactions using IWB (CIIWB) which leads to students' perceived deep learning approach (DLA). The graphical representation of this cross-level interaction effect in the Figure 10.7 reveals that the strength of the effect of CIIWB on LO varies according to the levels of the IWB literacy of the teachers. It shows that when the IWB literacy of the teacher is high, the effect of CIIWB on LO is weaker. On the other hand, when the IWB literacy of the teachers is low, the effect of CIIWB on LO becomes stronger.

10.6.1.3.3 Interaction Effect of computer literacy of the teachers (COMP_LIT) with students' perceived classroom interactions using IWB (CIIWB)

In order to discuss this interaction effect in details, parts of equation for the final model [18] involving COMP_LIT and CIIWB are taken and the remaining terms set to zero.

$$Y_{ijk} = \gamma_{000} + \gamma_{100}\,(CIIWB) + \gamma_{130}\,(COMP\_LIT)\,(CIIWB) \qquad [23]$$

Where (see Table 10.3)

γ_{000} = -0.072
γ_{100} = 0.443
γ_{130} = 0.194

Hence:

$$Y_{ijk} = -0.072 + 0.443\,(CIIWB) + 0.194\,(COMP\_LIT)\,(CIIWB) \qquad [24]$$

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on CIIWB and COMP_LIT (i),

b) one standard deviation above average on CIIWB and one standard deviation below the average on COMP_LIT (ii),
c) one standard deviation below the average on CIIWB and one standard deviation above the average on COMP_LIT (iii),
d) one standard deviation below the average on CIIWB and one standard deviation below the average on COMP_LIT (iv),
e) average on CIIWB and one standard deviation above the average on COMP_LIT (v),
f) average on CIIWB and one standard deviation below the average on COMP_LIT (vi).

Consequently, the coordinates were:

i. more COMP_LIT and high CIIWB (COMP_LIT = 1; CIIWB =1)
   Y (DLA) = -0.072 + 0.443 (1) + 0.194 (1) (1) = 0.565
ii. more COMP_LIT and low CIIWB (COMP_LIT = 1; CIIWB =-1)
   Y (DLA) = -0.072 + 0.443 (-1) + 0.194 (1) (-1) = -0.709
iii. less COMP_LIT and high CIIWB (COMP_LIT = -1; CIIWB =1)
   Y (DLA) = -0.072 + 0.443 (1) + 0.194 (-1) (1) = 0.177
iv. less COMP_LIT and low CIIWB (COMP_LIT = -1; CIIWB =-1)
   Y (DLA) = -0.072 + 0.443 (-1) + 0.194 (-1) (-1) = -0.321
v. average COMP_LIT and high CIIWB (COMP_LIT = 0; CIIWB =1)
   Y (DLA) = -0.072 + 0.443 (1) + 0.194 (0) (1) = 0.371
vi. average COMP_LIT and low CIIWB (COMP_LIT = 0; CIIWB =-1)
   Y (DLA) = -0.072 + 0.443 (-1) + 0.194 (0) (-1) = -0.515

These coordinates were used generate Figure 10.8.

As mentioned above, when the students experience a more interactive or enhanced interactive classroom environment using IWB they tend to adopt a deeper learning approach. Further, the results in the Table 10.3 and the Figure 10.5 show that the average level of computer literacy of the teachers (COMP_LIT) interacted with students' perceived classroom interactions using IWB (CIIWB) with an interaction effect coefficient, $\gamma = 0.194$. This suggests that, in general, the average level of computer literacy of the teachers has the positive effect on the slope of the students' perceived classroom interactions using IWB (CIIWB) leading to students' perceived deep learning approach using IWB(DLA).

The graph in the Figure 10.8 shows that the strength of the effect of CIIWB on DLA varies according to the categories of the computer literacy of the teachers. When the computer literacy of the teacher is high, the effect of CIIWB on DLA is stronger. In other words, the more the students experience interactive or enhanced interactive classroom environment using IWB, the more they tend to adopt a deeper learning approach using IWB. On the other hand, when the computer literacy of the teachers is low, the effect of CIIWB on DLA becomes weaker.

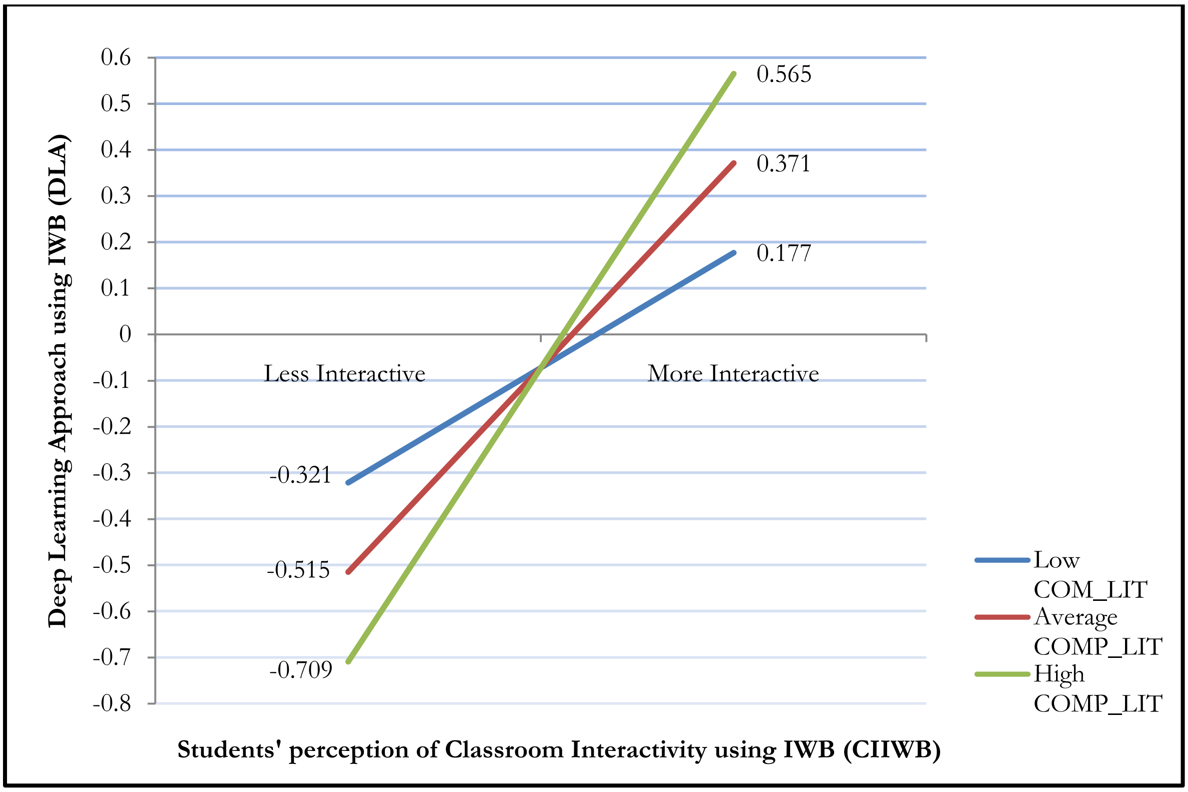


Figure 10.8: Interaction Effect of computer literacy of the teachers (COMP_LIT) with students' perceived classroom interactions using IWB (CIIWB)

10.6.1.3.4 Interaction Effect of Students' full access to software and hardware (SASH) with students' perceived classroom interactions using IWB (CIIWB)

In order to discuss this interaction effect in detail, parts of equation for the final model [18] involving SASH and CIIWB were taken and the remaining terms set to zero.

$Y_{ijk} = \gamma_{000} + \gamma_{100}$ (CIIWB) $+ \gamma_{101}$ (SASH) (CIIWB) [25]

Where (see Table 10.3)

$\gamma_{000} = -0.072$

$\gamma_{100} = 0.443$

$\gamma_{101} = 0.112$

Hence:

$Y_{ijk} = -0.072 + 0.443$ (CIIWB) $+ 0.112$ (SASH) (CIIWB) [26]

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on CIIWB and SASH (i),
b) one standard deviation above average on CIIWB and one standard deviation below the average on SASH (ii),
c) one standard deviation below the average on CIIWB and one standard deviation above the average on SASH (iii),
d) one standard deviation below the average on CIIWB and one standard deviation below the average on SASH (iv),
e) average on CIIWB and one standard deviation above the average on SASH (v),
f) average on CIIWB and one standard deviation below the average on SASH (vi).

Consequently, the coordinates were:

i. high SASH and high CIIWB (SASH = 1.81; CIIWB =1)

   Y (DLA) = -0.072 + 0.443 (1) + 0.112 (1.81) (1) = 0.574

ii. high SASH and low CIIWB (SASH = 1.81; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) + 0.112 (1.81) (-1) = -0.718

iii. low SASH and high CIIWB (SASH = -1.81; CIIWB =1)

Y (DLA) = -0.072 + 0.443 (1) + 0.112 (-1.81) (1) = 0.168

iv. low SASH and low CIIWB (SASH = -1.81; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) + 0.112 (-1.81) (-1) = -0.312

v. average SASH and high CIIWB (SASH = 0; CIIWB =1)

Y (DLA) = -0.072 + 0.443 (1) + 0.112 (0) (1) = 0.371

vi. average SASH and low CIIWB (SASH = 0; CIIWB =-1)

Y (DLA) = -0.072 + 0.443 (-1) + 0.112 (0) (-1) = -0.515

These coordinates were used generate Figure 10.9.

The graph in the Figure 10.9 shows a cross-level interaction effect of frequency of full access to software and hardware to the students (SASH) provided by schools, with students' perceived classroom interaction using IWB (CIIWB) which leads to students' perceived deep learning approach (DLA). Table 10.3 and Figure 10.5 reveal that the interaction effect coefficient (γ) of average SASH on CIIWB is 0.112 which means that in general the average frequency of full access to software and hardware of students at schools has the positive effect on the slope of the students' perceived classroom interactions using IWB (CIIWB).

Further, the strength of the effect of CIIWB on DLA varied according to the categories of SASH, and the graphical representation of this is shown in Figure 10.9. It is clear from this graph that when SASH is high i.e. when the schools provide full access to software and hardware more frequently to the students, the effect of CIIWB on DLA is stronger but when SASH is less i.e. less frequency of full access to software and hardware for students by schools, the effect of CIIWB on LO becomes weaker and drops below average.

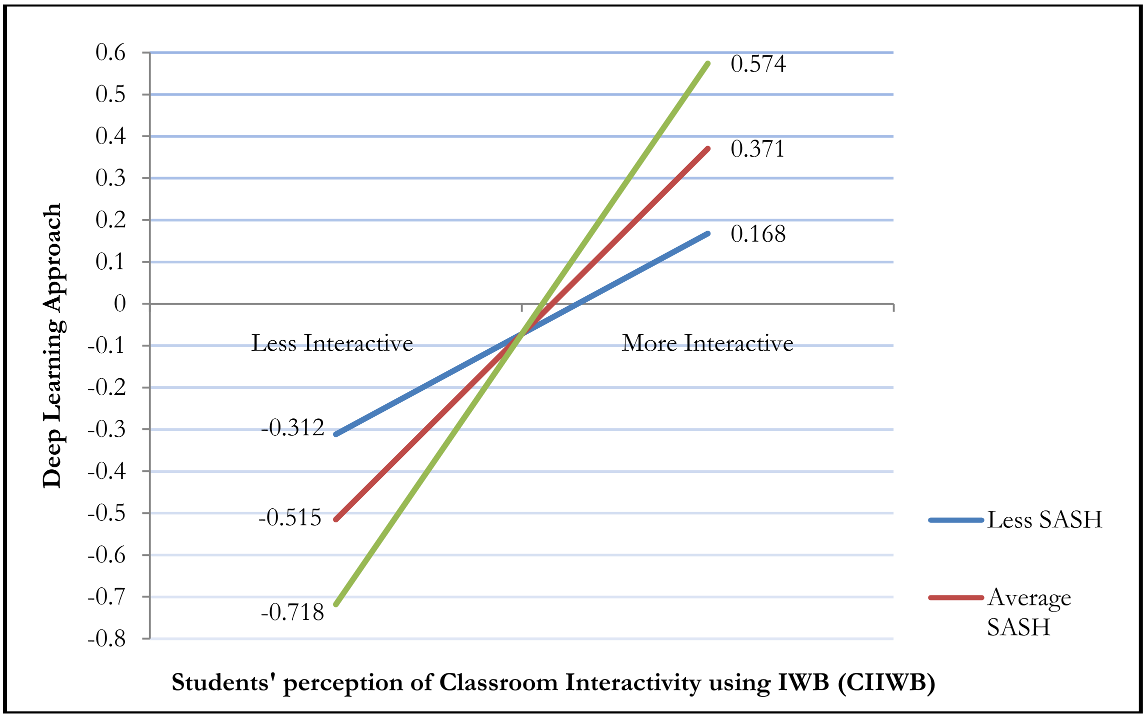


Figure 10.9: Interaction Effect of Students' full access to software and hardware (SASH) with students' perceived classroom interactions using IWB (CIIWB)

10.6.1.4 Estimates of Variance components

In this study, the estimates of variance in perceived deep learning approach using IWB were obtained during the analysis of fully unconditional and the final deep learning approach using IWB models. These estimates are given in the first panel of Table 10.4. It can be seen in the second panel of Table 10.4 that there is 97.68% of the variance in the perceived deep learning approach using IWB can be attributed to student differences, and less than 0.02% can be attributed to differences between teachers and 2.30 % is between the schools. The information regarding the variance explained in this model is given in the third panel of this table. It shows that this model explained 18.23% of the variance between students, 76.19% of the variance is explained between teachers and 99.82% of variance is explained between the schools.

Table 10.4: Estimation of the Variance Components: Three-Level Deep Learning Approach Model

Model	Estimation of Variance components between student (n = 269)	between teacher (n = 18)	between school (n = 9)
fully unconditional model	0.97746	0.00021	0.02299
final model	0.79925	0.00005	0.00004
Variance at each level			
between student	0.97746/(0.97746 + 0.00021 + 0.02299) = 0.9768 = 97.68%		
between teacher	0.00021/(0.97746 + 0.00021 + 0.02299) = 0.0002 = 0.02%		
between school	0.02299/(0.97746 + 0.00021 + 0.02299) = 0.0230 = 2.30%		
Proportion of variance explained by final model			
between student	0.97746 - 0.79925/0.97746 = 0.1823 = 18.23%		
between teacher	0.00021 - 0.00005/0.00021 = 0.7619 = 76.19%		
between school	0.02299 - 0.00004/0.02299 = 0.9982 = 99.82%		
Proportion of total available variance explained			
(0.1823 x 0.9768) + (0.7619 x 0.0002) + (0.9982 x 0.0230) = 0.2013 = 20.13%			

Overall, there is 20.13% of total available variance has been explained by the final model at all the three levels. Among this, 17.81% was the student variance (0.1823 x 0.9768 = 0.1780), so this suggests that there are many other student differences i.e. many more student variables not included in the model. Further, the deviance was also found to be reduced by 58.72 with an additional 7 degrees of freedom when the results of fully unconditional model were compared with the final model results.

10.6.2 Three-Level Learning Outcomes using IWB Model

The second hierarchical model in this study was three-level learning outcomes using the IWB model. This model was developed and analysed with the purpose of investigating the effect of different factors present at student, teacher and school level on the perceived deep learning outcomes of the students when IWB is used. The analysis procedure adopted for this model was same as used for the three-level deep learning approaches using IWB model. The findings of this analysis are given in the following sections:

10.6.2.1 Null Model

The first step of HLM analysis was carried out by running a null (fully unconditional) model. This was a necessary step to obtain the estimates of the amount of variance available to be explained in the model (Bourbour & Bjorklund, 2014). A fully unconditional model is a model where no variables are entered into the equations at any level i.e. the model consists of only the outcome variable, and no independent variables (predictors) are specified. This model represents the amount of variance in the outcome variable allocated across the different levels in the model (Bryk & Raudenbush, 2002). In three-level learning outcomes using IWB model, the null represents the amount of variance in learning outcomes using the IWB variable that is allocated across student, teacher and school level. The equations representing fully unconditional model at all the three levels are given below.

10.6.2.1.1 Level-1 Model

Level-1 model is specified using the following equation:

$$Y_{ijk} = \pi_{0jk} + e_{ijk} \qquad [27]$$

where:

Y_{ijk} is the perceived learning outcomes using IWB of student *i* under teacher *j* in school *k*;

π_{0jk} is the mean score of students' perceived learning outcome using IWB of teacher *j* in school *k*; and

e_{ijk} is a random error student effect, that is, the deviation of student *ijk*'s score from the teacher mean.

In the above equation, the perceived learning outcomes using IWB of student *i* under the teacher *j* in the school *k* is considered to be equivalent to the teacher mean plus a random error. In other words, the fully unconditional model assumes no differences in the perception of learning outcomes when using IWB between students within schools at level-1. It is assumed that each level-1 error, e_{ijk}, is normally distributed with the mean of zero and a constant level-1 variance, σ^2 (Bryk & Raudenbush, 2002).

The indices *i*, *j*, and *k* denote student, teacher and school where there are

i = 1, 2, ..., N_{jk} students under teacher *j* in school *k*;
j = 1, 2, ..., J_k teachers within school school *k*; and

k = 1, 2, ..., K schools.

10.6.2.1.2 Level-2 Model

Level-2 model is specified using the following equation:

$$\pi_{0jk} = \beta_{00k} + r_{0jk} \quad [28]$$

where:

π_{0jk} is the mean perceived student learning outcomes using IWB under teacher *j* in school *k*;

β_{00k} is the mean learning outcomes using IWB in school *k*; and

r_{0jk} is the random teacher effect, that is, the deviation of teacher *jk*'s mean from the school mean.

In the level-2 equation, no predictors are specified that could contribute to explain difference between teachers, and the mean perceived student learning outcomes using IWB under a teacher is considered to be equivalent to the mean perceived student learning outcomes using IWB for that school plus random error. It is assumed that the random effect associated with teacher *jk*, r_{0jk}, is normally distributed with the mean of zero and the variance of τ_π. Within each of the *K* schools, the variability between teachers is assumed the same.

10.6.2.1.3 Level-3 Model

Level-3 model is specified using the following equation:

$$\beta_{00k} = \gamma_{000} + u_{00k} \quad [29]$$

where:

β_{00k} is the mean student learning outcomes using IWB in the school *k*;

γ_{000} is the grand mean learning outcome using IWB across schools; and

u_{00k} is the random school effect, that is, the deviation of the school *k*'s from the grand mean.

It is assumed that the random effect associated with school *k*, u_{00k}, is normally distributed with the mean of zero and variance τ_β.

10.6.2.1.4 Variability of Outcome variable

The estimation of null model produces a point estimate and confidence interval for the grand mean, γ_{000}. Further, it provides the important information about the variability of the outcome variable at each level (Darmawan, 2003, p. 163). According to Bryk and Raudenbush (2002), the σ^2 parameter represents the student level variability, τ_π gives teacher level variability and τ_β captures school level variability. Additionally, the estimation of the proportions of variation among students, among teachers within schools and among schools can be calculated using the null model results as follows:

At level-1,

$\sigma^2 / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance that exists among students; [30]

At level-2,

$\tau_\pi / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among teachers within schools; and [31]

At level-3,

$\tau_\beta / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among schools. [32]

Table 10.5 below shows the results for null model with learning outcomes using IWB as the outcome variable.

Table 10.5: Null Model Results: Three-Level Learning Outcomes using IWB Model

Final estimation of fixed effects (with robust standard errors):					
Fixed effects	**Coefficient**	**Standard Error**	**T-ratio**	**Approx. d.f.**	**P-value**
For INTRCPT1, P0					
For INTRCPT2, B00					
INTRCPT3, G000	0.005	0.05	0.09	8	0.930

Final estimation of level-1 and level-2 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance component**	**df**	**Chi-square**	**P-value**
INTRCPT1, R0	0.062	0.07	0.005	9	13.55	0.139
LEVEL-1, E		0.99	0.99			

Final estimation of level-3 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance component**	**df**	**Chi-square**	**P-value**
INTRCPT1/ INTRCPT2, U00	0.002	0.01	0.00009	8	6.96	>.500

Statistics for current covariance components model	
Deviance	762.36
Number of estimated parameters	4

10.6.2.2 Final Model

The process of specifying the final model for three-level learning outcomes using IWB model is described below along with the equations used for this purpose.

10.6.2.2.1 Final Level-1 Model

In the process of specifying the level-1 (student-level) model, the single-level path analysis findings for student level (Chapter 9) were used as a guideline to choose the possible predictors at this level in HLM model. This use of AMOS analysis results as guidelines could have a consequence leading to misspecification of the model, but there is little research available to be used as the theoretical basis for specification of the hierarchical model (Darmawan, 2003, p. 164). So, AMOS analysis results were considered to be appropriate to use for HLM analysis.

To specify the level-1 model, all the predictors that were found in the AMOS analysis to be influencing the student learning outcomes using IWB were entered at once. Then the predictors which were not showing significant path coefficients were removed one by one. It was mentioned previously, in the model trimming section of this chapter that the significance of path coefficients is determined by the value of their corresponding t-ratio and the predictors which obtain t-ratio below 1.64 at p-value > 0.10 are considered insignificant and removed from the model before further analysis. In this analysis the step down approach to model trimming was used where the insignificant predictors were removed one at a time, starting from the one with the lowest t-ratio. The analysis was run each time after removing one predictor and this process was repeated until only those variables were left which obtained significant path coefficients.

10.6.2.2.2 Final Level-2 model

After specifying the level-1 model, an exploratory analysis was done to check the possibility of each level-2 (teacher-level) variable being included in the model. The variables which obtained t-values greater than 2.00 were entered at level-2 and the model trimming process, explained in the above section, was used to remove the variables with insignificant path coefficients to generate the final level-2 model.

10.6.2.2.3 Final Level-3 Model

The Level-3 (school-level) model was also specified in a similar way as the level-2 model. The variables at level-3 were also entered based on the t values obtained in exploratory analysis and the step down approach was used to drop those variables with insignificant coefficients. This process was repeated until a final three-level model was obtained.

10.6.2.2.4 Final Three-Level Model

The final three-level learning outcome using IWB model is specified by the following equations:

Level-1 model

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}\,(\text{GENDER}) + \pi_{2jk}\,(\text{AIWB}) + \pi_{3jk}\,(\text{CIIWB}) + \pi_{4jk}\,(\text{DLA}) + \pi_{5jk}\,(\text{SLA}) + e_{ijk} \qquad [33]$$

Level-2 model

$\pi_{0jk} = \beta_{00k} + \beta_{01k}$ (AGE) $+ r_{0jk}$ [34]

$\pi_{1jk} = \beta_{10k} + r_{1jk}$ [35]

$\pi_{2jk} = \beta_{20k} + r_{2jk}$ [36]

$\pi_{3jk} = \beta_{30k} + \beta_{31k}$ (COMP_LIT) $+ r_{3jk}$ [37]

$\pi_{4jk} = \beta_{40k} + \beta_{41k}$ (GENDER_T) [38]

$\pi_{5jk} = \beta_{50k}$ [39]

Level-3 model

$\beta_{00k} = \gamma_{000} + u_{00k}$ [40]

$\beta_{01k} = \gamma_{010}$ [41]

$\beta_{10k} = \gamma_{100} + \gamma_{101}$ (SASH) [42]

$\beta_{20k} = \gamma_{200} + u_{20k}$ [43]

$\beta_{30k} = \gamma_{300} + u_{30k}$ [44]

$\beta_{31k} = \gamma_{310}$ [45]

$\beta_{40k} = \gamma_{400}$ [46]

$\beta_{41k} = \gamma_{410}$ [47]

$\beta_{50k} = \gamma_{500} + u_{50k}$ [48]

By substituting level-3 equations (Equations 40 to 48) into level-2 equations (Equations 34 to 39), level-2 equations are represented by:

$\pi_{0jk} = \gamma_{000} + \gamma_{010}$ (AGE) $+ u_{00k} + r_{0jk}$ [49]

$\pi_{1jk} = \gamma_{100} + \gamma_{101}$ (SASH) $+ r_{1jk}$ (SASH) [50]

$\pi_{2jk} = \gamma_{200} + u_{20k} + r_{2jk}$ [51]

$\pi_{3jk} = \gamma_{300} + \gamma_{310}$ (COMP_LIT) $+ u_{30k} + r_{3jk}$ [52]

$\pi_{4jk} = \gamma_{400} + \gamma_{410}$ (GENDER_T) [53]

$\pi_{4jk} = \gamma_{500} + u_{50k}$ [54]

By substituting level-2 equations (Equations 49 to 54) into the level-1 equation (Equation 33), the final model is represented by:

$Y_{ijk} = \gamma_{000} + \gamma_{010}$ (AGE) $+ \gamma_{100}$ (GENDER) $+ \gamma_{101}$ (SASH) (GENDER) $+ \gamma_{200}$ (AIWB) $+ \gamma_{300}$ (CIIWB) $+ \gamma_{310}$ (COMP_LIT) (CIIWB) $+ \gamma_{400}$ (DLA) $+ \gamma_{410}$ (GENDER_T) (DLA) $+ \gamma_{500}$ (SLA) $+ u_{00k} + u_{20k}$ (AIWB) $+ u_{30k}$ (CIIWB) $+ u_{50k}$ (SLA) $+ r_{0jk} + r_{1jk}$ (SASH) (GENDER) $+ r_{2jk}$ (AIWB) $+ r_{3jk}$ (CIIWB) $+ e_{ijk}$ [55]

This equation illustrates that the students' perceived learning outcomes using IWB may be viewed as a function of the overall intercept (γ_{000}), six main effects, four cross-level effects and a random error (u_{00k} + u_{20k} (AIWB) + u_{30k} (CIIWB) + u_{50k} (SLA)+ r_{0jk} + r_{1jk} (SASH) (GENDER) + r_{2jk} (AIWB) + r_{3jk} (CIIWB) + e_{ijk}). The six main effects are the direct effects from gender of the student (GENDER), attitudes of students towards IWB (AIWB), students' perceived classroom interactions using IWB (CIIWB) and students' perceived deep learning approach using IWB (DLA), students' perceived surface learning approach using IWB (SLA) and age of the teachers (AGE). Among these variables, AGE is from level-2 (teacher-level) and all other variables are from level-1 (student-level) of the model. The cross level interaction effect involves the interaction of computer literacy of teachers (COMP_LIT) from level-2 with CIIWB from level-1, gender of the teachers (GENDER_T) from level-2 with DLA of level-1 and frequency of full access to software and hardware for students (SASH) from level-3 with GENDER from level-1.

Table 10.6 shows the final model results for three-level learning outcomes using the IWB model and it can be seen that five level-1 variables i.e. AIWB, CIIWB, GENDER, DLA and SLA had an effect on the perceived learning outcomes, when using IWB, of the students. Further, two level-2 variables i.e. COMP_LIT and GENDER_T interacted with CIIWB and DLA respectively, and one level-3 variable i.e. SASH interacted with GENDER in influencing students' perceived learning outcomes using IWB. The relationships among all these variables are also illustrated in Figure 10.10.

Table 10.6: Final Model Results: Three-Level Model of Learning Outcomes using IWB

Final estimation of fixed effects:					
Fixed Effect	**Coefficient**	**Standard Error**	**T-ratio**	**Approx d.f.**	**P-value**
For INTRCPT1, P0					
For INTRCPT2, B00					
INTRCPT3, G000	0.110178	0.050146	2.197	8	0.059
For AGE, B01					
INTRCPT3, G010	-0.049636	0.022436	-2.212	16	0.042
For GENDER slope, P1					
For INTRCPT2, B10					
INTRCPT3, G100	-0.305418	0.097915	-3.119	17	0.007
SASH, G101	0.090563	0.049990	1.812	17	0.087
For AIWB slope, P2					
For INTRCPT2, B20					
INTRCPT3, G200	0.354194	0.058242	6.081	8	0.000
For CIIWB slope, P3					
For INTRCPT2, B30					
INTRCPT3, G300	0.301341	0.059121	5.097	8	0.000
For COMP_LIT, B31					
INTRCPT3, G310	0.107071	0.044885	2.385	16	0.030
For DLA slope, P4					
For INTRCPT2, B40					
INTRCPT3, G400	0.256314	0.056391	4.545	259	0.000
For GENDER_T, B41					
INTRCPT3, G410	0.133861	0.079002	1.694	259	0.091
For SLA slope, P5					
For INTRCPT2, B50					
INTRCPT3, G500	0.146847	0.049080	2.992	8	0.018

Final estimation of level-1 and level-2 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance Component**	**df**	**Chi-square**	**P-value**
INTRCPT1, R0	0.012	0.02461	0.00061	6	8.62466	0.195
GENDER slope, R1	0.216	0.19684	0.03875	15	8.07623	>.500
AIWB slope, R2	0.250	0.11878	0.01411	7	2.50967	>.500
CIIWB slope, R3	0.124	0.07847	0.00616	6	6.01820	0.422
level-1, E		0.60658	0.36794			

Table 10.6: Final Model Results: Three-Level Model of Learning Outcomes using IWB (Contd.)

Final estimation of level-3 variance components:						
Random Effect	**Reliability**	**Standard Deviation**	**Variance Component**	**df**	**Chi-square**	**P-value**
INTRCPT1/ INTRCPT2, U00	0.002	0.00552	0.00003	8	3.60363	>.500
AIWB/ INTRCPT2, U20	0.149	0.06993	0.00489	8	7.65630	>.500
CIIWB/ INTRCPT2, U30	0.216	0.08445	0.00713	8	8.50501	0.386
SLA/ INTRCPT2, U50	0.303	0.08315	0.00691	8	12.11938	0.145
Statistics for current covariance model						
Deviance			514.82			
Number of estimated parameters			31			

It can be seen in Figure 10.10 that the attitudes of the students towards IWB (AIWB, 0.354) has a positive effect on students' perceived learning outcomes (LO) when IWB is used. This shows that students who have more positive attitudes towards the use of IWB in education are likely to have better perceived learning outcomes when taught using IWB. This finding is consistent with the results of the single-level path analysis for students (Chapter 9) which also found out that attitudes of students towards IWB has strong positive influence on their perception of their learning outcomes using IWB.

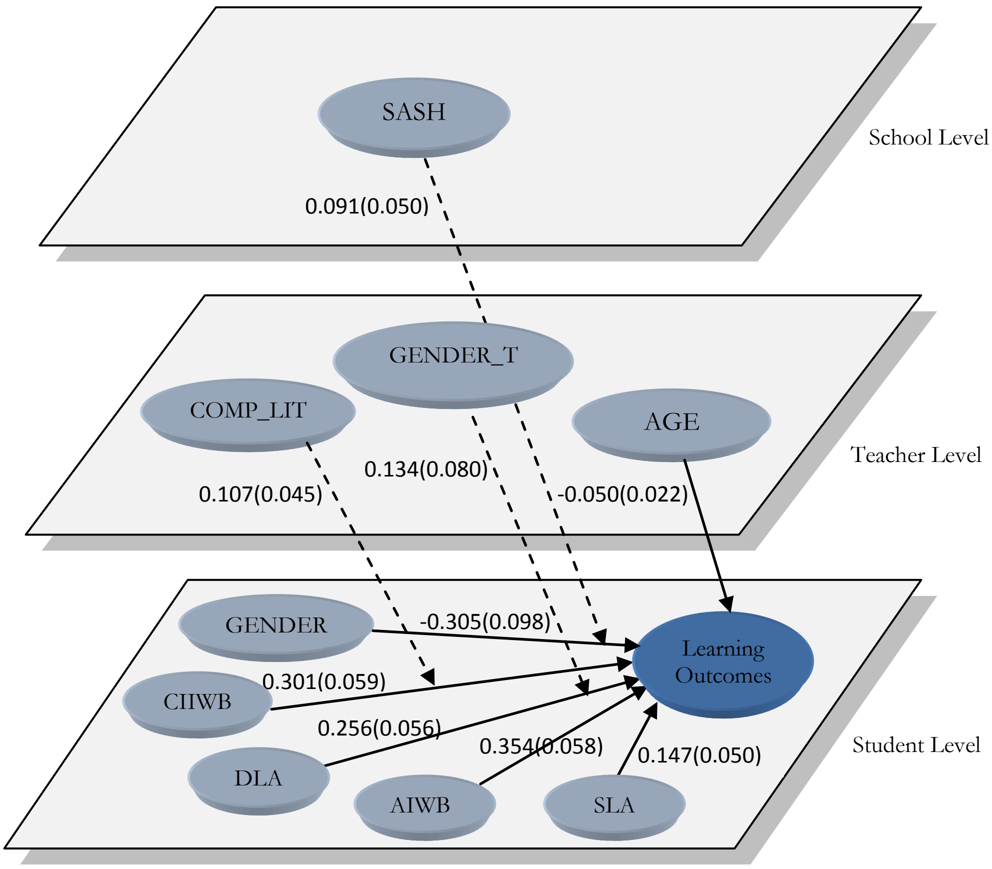


Figure 10.10: Three-Level Model of Learning Outcomes using IWB

The second predictor at level-1 was the students' perceived deep learning approach using IWB (DLA, 0.256), which also showed direct positive effect on the outcome variable (LO). This indicated that the students who adopt a deeper learning approach also tend to have better perceived learning outcomes when taught using IWB. Along with this, a third predictor, students' perceived surface learning approach using IWB (SLA, 0.147), was also seen to influence their perceived learning outcomes in direct and positive manner, although the effect of SLA is smaller than the influence of DLA. This means that when IWB is used, the perceived learning outcomes tend to be much better when a deep learning approach is adopted by the students as compared to the surface learning approach. These findings are also consistent with the single-level path analysis for the students (Chapter 9) where the deep learning approach of the students was found to have strong direct effect on their perceived learning outcomes when IWB is used, and this effect was also found to be greater than the effect of the perceived surface learning approach.

The next predictor from the level-1 of this three-level learning outcomes model was classroom interactions using IWB (CIIWB, 0.301). This also produced a direct and positive influence on the perceived learning outcomes of the students. The positive sign of the coefficient shows that it is likely that the students who perceive their classroom interactions using IWB to be more interactive or enhanced interactive also tend to have better perceived learning outcomes. Again these findings are consistent with the findings of single-level path analysis for students (Chapter 9), where CIIWB was found to have positive effect on LO.

The fifth predictor from level-1 was the gender of the students (GENDER, -0.305) and it showed the negative influence on LO. This means that when taught using IWB, male students tend to have better perceived learning outcomes as compared to the female students. Single-level path analysis for students (Chapter 9) also showed similar findings related to the gender of the students, so these findings are also consistent with single-level path analysis for the students.

This last main predictor in this model is the age of the teachers (AGE, -0.050) when it showed a small negative coefficient on LO. This indicates that when the students are taught by younger teachers using IWB, they tend to perceive better learning outcomes.

10.6.2.3 The Cross-Level Interaction Effects

Apart from the direct effect of level-1and level-2 predictors on LO (Figure 10.10), it can be seen that two variables from level-2 (COMP_LIT, 0.107 and GENDER, 0.134), and one variable from level-3 (SASH, 0.091), showed cross-level interaction effect on LO (outcome variable). The cross-level interaction effect is an effect that involves three variables i.e. the outcome variable, the level-1 variable which is affecting the outcome variable and a level-2 or level-3 variable which is influencing the effect of level-1 variable on the outcome variable. The interaction effect of each of these variables is discussed separately in the following sections.

10.6.2.3.1 Interaction Effect of teachers' computer literacy (COMP_LIT) with students' perceived classroom interactions using IWB (CIIWB)

In order to discuss this interaction effect in details, parts of equation for the final model [55] involving COMP_LIT and CIIWB are taken and the remaining terms set to zero since GENDER, AIWB, DLA and SLA are not involved and there is no loss in generality.

$$Y_{ijk} = \gamma_{000} + \gamma_{300}\,(\text{CIIWB}) + \gamma_{310}\,(\text{COMP\_LIT})\,(\text{CIIWB}) \qquad [56]$$

Where (see Table 10.6)

$\gamma_{000} = 0.110$

$\gamma_{300} = 0.301$

$\gamma_{310} = 0.107$

Hence:

$$Y_{ijk} = 0.110 + 0.301\,(\text{CIIWB}) + 0.107\,(\text{COMP\_LIT})\,(\text{CIIWB}) \qquad [57]$$

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on CIIWB and COMP_LIT (i),
b) one standard deviation above average on CIIWB and one standard deviation below the average on COMP_LIT (ii),
c) one standard deviation below the average on CIIWB and one standard deviation above the average on COMP_LIT (iii),
d) one standard deviation below the average on CIIWB and one standard deviation below the average on COMP_LIT (iv),
e) average on CIIWB and one standard deviation above the average on COMP_LIT (v),
f) average on CIIWB and one standard deviation below the average on COMP_LIT (vi).

Consequently, the coordinates were:

i. high COMP_LIT and high CIIWB (COMP_LIT = 1; CIIWB =1)

   Y (LO) = 0.110 + 0.301 (1) + 0.107 (1) (1) = 0.518

ii. high COMP_LIT and low CIIWB (COMP_LIT = 1; CIIWB =-1)

   Y (LO) = 0.110 + 0.301 (-1) + 0.107 (1) (-1) = -0.298

iii. low COMP_LIT and high CIIWB (COMP_LIT = -1; CIIWB =1)

   Y (LO) = 0.110 + 0.301 (1) + 0.107 (-1) (1) = 0.304

iv. low COMP_LIT and low CIIWB (COMP_LIT = -1; CIIWB =-1)

   Y (LO) = 0.110 + 0.301 (-1) + 0.107 (-1) (-1) = -0.084

v. average COMP_LIT and high CIIWB (COMP_LIT = 0; CIIWB =1)

   Y (LO) = 0.110 + 0.301 (1) + 0.107 (0) (1) = 0.411

vi. average COMP_LIT and low CIIWB (COMP_LIT = 0; CIIWB =-1)

   Y (LO) = 0.110 + 0.301 (-1) + 0.107 (0) (-1) = -0.191

These coordinates were used generate Figure 10.11.

The results in the Table 10.6, and the Figure 10.10, show that the average level of computer literacy of the teachers (COMP_LIT) interacted with students' perceived classroom interactions using IWB (CIIWB) with an interaction effect coefficient, $\gamma = 0.107$. This suggests that, in general, the average level of computer literacy of the teachers has a positive effect on the slope of the students' perceived classroom interactions using IWB (CIIWB), which further has positive influence on the students' perceived learning outcomes using IWB (LO).

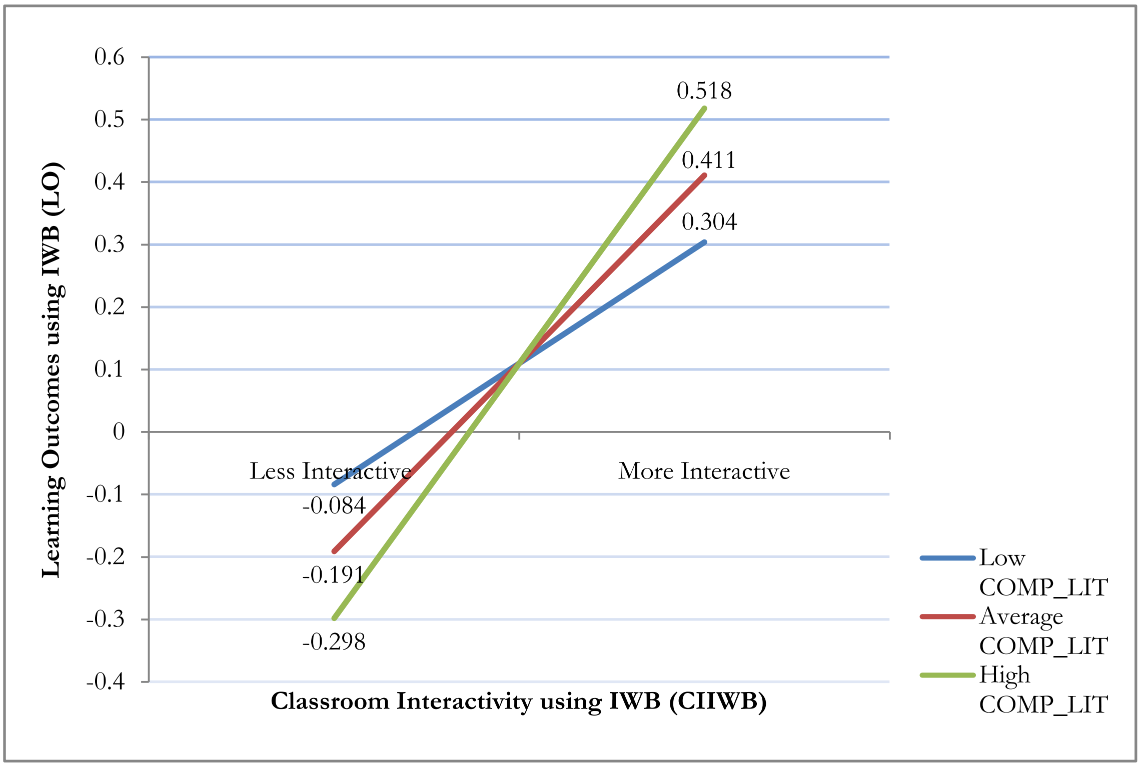


Figure 10.11: Interaction Effect of teachers' computer literacy (COMP_LIT) with students' perceived classroom interactions using IWB (CIIWB)

Further, the graph in the Figure 10.11 shows that the strength of the effect of CIIWB on LO varies according to the categories of the computer literacy of the teachers. When the computer literacy of the teacher is high, the effect of CIIWB on LO is stronger. . In other words, the more the students experience interactive or enhanced interactive classroom environment using IWB, the more they tend to perceive better learning outcomes using IWB. On the other hand, when the computer literacy of the teachers is low, the effect of CIIWB on LO becomes weaker.

10.6.2.3.2 Interaction Effect of teachers' gender (GENDER_T) with students' perceived deep learning approach using IWB (DLA)

In order to discuss this interaction effect in details, parts of equation for the final model [55] involving GENDER_T and DLA were taken and the remaining terms set to zero since GENDER, CIIWB, AIWB and SLA were not involved and there is no loss in generality.

$Y_{ijk} = \gamma_{000} + \gamma_{400}$ (DLA) + γ_{410} (GENDER_T) (DLA) [58]

Where (see Table 10.6)

$\gamma_{000} = 0.110$

$\gamma_{400} = 0.256$

$\gamma_{310} = 0.133$

Hence:

Y_{ijk} = 0.110 + 0.256 (DLA) + 0.133 (GENDER_T) (DLA) [59]

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on DLA and GENDER_T (i),
b) one standard deviation above average on DLA and one standard deviation below the average on GENDER_T (ii),
c) one standard deviation below the average on DLA and one standard deviation above the average on GENDER_T (iii),
d) one standard deviation below the average on DLA and one standard deviation below the average on GENDER_T (iv),

Consequently, the coordinates were:

i. Female and high DLA (GENDER_T = 0.498; DLA =1)
   Y (LO) = 0.110 + 0.256 (1) + 0.133 (0.498) (1) = 0.432
ii. Female and low DLA (GENDER_T = 0.498; DLA =-1)
   Y (LO) = 0.110 + 0.256 (-1) + 0.133 (0.498) (-1) = -0.212
iii. Male and high DLA (GENDER_T = -0.498; DLA =1)
   Y (LO) = 0.110 + 0.256 (1) + 0.133 (-0.498) (1) = 0.300
iv. Male and low DLA (GENDER_T = -0.498; DLA =-1)
   Y (LO) = 0.110 + 0.256 (-1) + 0.133 (-0.498) (-1) = -0.08

These coordinates were used generate Figure 10.12.

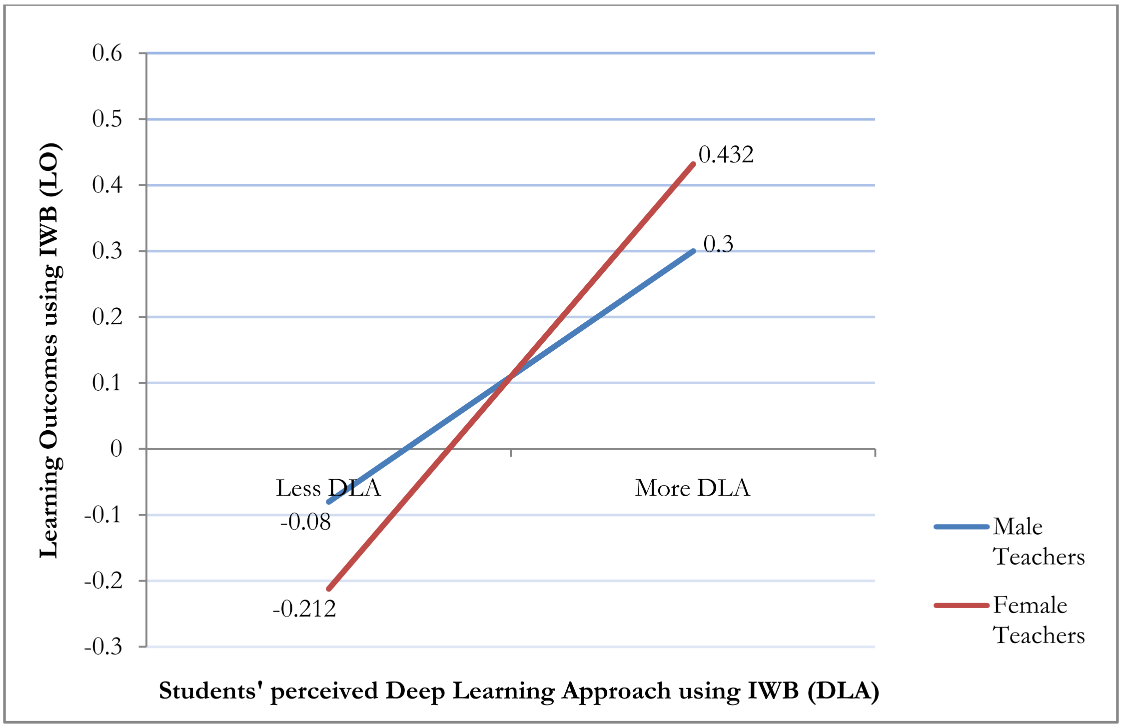


Figure 10.12: Interaction Effect of teachers' gender (GENDER_T) with students' perceived deep learning approach using IWB (DLA)

It can be seen in the Table 10.6 and the Figure 10.10 that the gender of the teachers (GENDER_T) interacted with students' perceived deep learning approach using IWB (DLA) with an interaction effect coefficient, $\gamma = 0.134$. This suggests a positive effect of GENDER_T on the slope of DLA which leads to students' perceived learning outcomes using IWB (LO). The graph in the Figure 10.12 shows that the strength of the effect of DLA on LO varies according to the gender of the teacher. When the students are taught by the female teacher, the effect of DLA on LO is stronger. In other words, when IWB is used, the more the students adopt deep learning approach the more they tend to perceive better learning outcomes. On the other hand, when the students are taught by a male teacher, the effect of DLA becomes weaker on LO.

10.6.2.3.3 Interaction Effect of frequency of access to software and hardware for students (SASH) with the gender of the students (GENDER)

In order to discuss this interaction effect in details, parts of equation for the final model [55] involving SASH and GENDER were taken and the remaining terms set to zero since CIIWB, AIWB and DLA were not involved and there is no loss in generality.

$$Y_{ijk} = \gamma_{000} + \gamma_{100} (GENDER) + \gamma_{101} (SASH) (GENDER) \quad [60]$$

Where (see Table 10.6)

$\gamma_{000} = 0.110$

$\gamma_{100} = -0.305$

$\gamma_{101} = 0.091$

Hence:

$$Y_{ijk} = 0.110 - 0.305 (GENDER) + 0.091 (SASH) (GENDER) \quad [61]$$

Further, the coordinates for this equation were calculated to provide the graphical representation of this expression:

a) one standard deviation above the average on GENDER and SASH (i),
b) one standard deviation above average on GENDER and one standard deviation below the average on SASH (ii),
c) one standard deviation below the average on GENDER and one standard deviation above the average on SASH (iii),
d) one standard deviation below the average on GENDER and one standard deviation below the average on SASH (iv),
e) average on GENDER and one standard deviation above the average on SASH (v),
f) average on GENDER and one standard deviation below the average on SASH (vi).

Consequently, the coordinates were:

i. high SASH and Female (SASH = 1.81; GENDER =0.49)

   $Y (LO) = 0.110 - 0.305 (0.49) + 0.091 (1.81) (0.49) = 0.042$

ii. high SASH and Male (SASH = 1.81; GENDER =-0.49)

   $Y (LO) = 0.110 - 0.305 (-0.49) + 0.091 (1.81) (-0.49) = 0.178$

iii. low SASH and Female (SASH = -1.81; GENDER =0.49)

$Y (LO) = 0.110 - 0.305 (0.49) + 0.091 (-1.81) (0.49) = -0.12$

iv. low SASH and Male (SASH = -1.81; GENDER =-0.49)

$Y (LO) = 0.110 - 0.305 (-0.49) + 0.091 (-1.81) (-0.49) = 0.34$

v. average SASH and Female (SASH = 0; GENDER =0.49)

$Y (LO) = 0.110 - 0.305 (0.49) + 0.091 (0) (0.49) = -0.039$

vi. average SASH and Male (SASH = 0; GENDER=-0.49)

$Y (LO) = 0.110 - 0.305 (-0.49) + 0.091 (0) (-0.49) = 0.259$

These coordinates were used generate Figure 10.13.

It was mentioned earlier that the gender of the students (GENDER) had a negative effect on the perceived learning outcomes of the students using IWB (LO) (Figure 10.10 and Table 10.6) which means that when taught using IWB, female students perceived lower learning outcomes as compared to the male students. Further, Table 10.6 and Figure 10.10 clearly show the interaction effect coefficient (γ) for the average frequency of full access to software and hardware to students (SASH) from level-3 interacted with the gender of the students (GENDER) is 0.091.

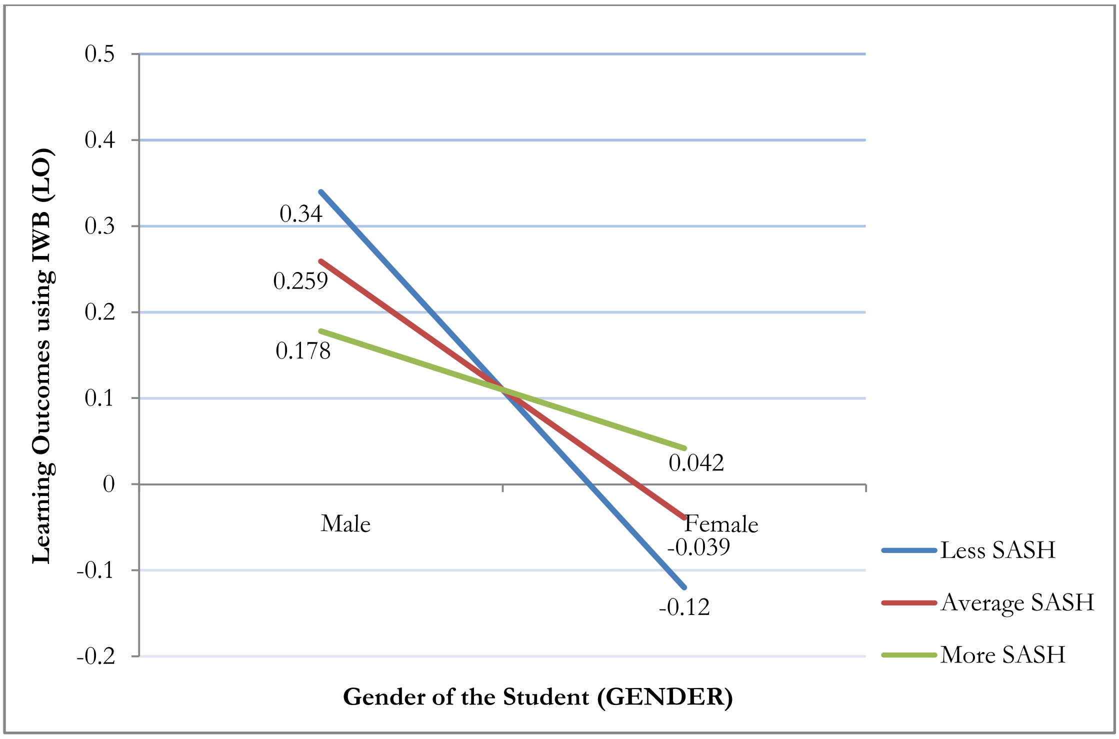


Figure 10.13: Interaction Effect of frequency of access to software and hardware for students (SASH) with the gender of the students (GENDER)

This suggests that in general the average frequency of full access to software and hardware to students has a positive effect on the slope of the gender of the students which has negative influence on students' perceived learning outcomes (LO). In the graphical representation of this cross-level interaction effect in the Figure 10.13, it can be seen that the frequency level of SASH affects the strength of the influence of GENDER on LO. When SASH is high, that is, more full access to software and hardware is provided to the students by the school, the difference between the perceived learning outcomes of female and male students become less, but still lower in female than male students. On the other hand, the difference between the perceived learning outcomes of female and male student become greater, that is, the female students' perceived learning outcomes are lower than average when the students do not get full access to IT software and hardware facilities more frequently at their school.

10.6.2.4 Estimates of Variance components

It is mentioned in the section related to null model in this chapter that the analysis of fully unconditional model provides the estimates of variance in outcome variable available to be explained at each level. So, in this study, the estimates of variance in perceived learning outcomes using IWB were obtained during the analysis of fully unconditional and the final learning outcomes using IWB model. These estimates are given in the first panel of Table 10.7.

Further it can be seen in Table 10.7, under the 'Variance at each level' panel, that there is 99.54% of the variance in the perceived learning outcomes using IWB between students, and only less than 1% can be attributed to differences between teachers (0.45%) and the schools (0.01%). The information regarding the variance explained in this model is given in the third panel of this table. It shows that this model explained 62.90% of the variance between students, 86.67% of the variance is explained between teachers and 66.67% of the variance is explained between the schools.

Table 10.7: Estimation of Variance Components: Learning Outcomes using IWB

Model	Estimation of Variance components between student (n = 269)	between teacher (n = 18)	between school (n = 9)
fully unconditional model	0.9918	0.0045	0.00009
final model	0.3679	0.0006	0.00003
Variance at each level			
between student	0.9918/(0.9918+0.0045+0.00009) = 0.9964= 99.54%		
between teacher	0.0045/(0.9918+0.0045+0.00009) = 0.0045 = 0.45%		
between school	0.00009/(0.9918+0.0045+0.00009) = 0.00009 = 0.01%		
Proportion of variance explained by final model			
between student	(0.9918 - 0.3679)/ 0.9918 = 0.6290 = 62.90%		
between teacher	(0.0045 - 0.0006)/ 0.0045 = 0.8667 = 86.67%		
between school	(0.00009 - 0.00003)/0.00009 = 0.6667 = 66.67%		
Proportion of total available variance explained by final model			
(0.6290 x 0.9964) + (0.8667 x 0.0045) + (0.6667 x 0.00009) = 0.6306 = 63.06%			

Overall, there is 63.06% of total available variance has been explained by the final model at all the three levels. Further, the deviance was also found to be reduced by 247.54 with an additional 27 degrees of freedom when the results of fully unconditional model were compared with the final model results.

10.7 Summary

In this chapter, three-level analyses were presented for two different models. These models were used to analyse the nested variables i.e. variables present at student, teacher and school levels of investigation. The HLM technique was used which allowed this multi-level analysis to discover the variables which affect the outcomes (dependent) variable. Two separate outcome variables were used for the two models i.e. Perceived Deep Learning Approach using IWB and Perceived Learning Outcomes using IWB.

The results shows that the students' perceived deep learning approach using IWB (DLA) was directly and positively influenced by three major predictors, one from each level i.e. student, teacher and school levels. The predictor at the student level (level-1) was classroom interactions using IWB (CIIWB); IWB support available to teachers (IWB_SUPP) was the predictor at teacher level; and level of ICT integration in the classrooms (ICTIL) was the predictor at the school level. There were three more predictors at the teacher level which were providing the cross-level interaction effects with classroom interactions using IWB (CIIWB) on DLA (outcome variable). These were age of the teachers (AGE), computer literacy of the teachers (COMP_LIT) and IWB literacy of the teachers (IWB_LITE). One predictor from school level also provide interaction effect with CIIWB, which was frequency of full access of software and hardware to students (SASH).

The results of three-level learning outcomes using IWB model shows that students' perceived learning outcomes using IWB (LO) were influenced directly by five predictors at the student level (level-1), which were gender of the student (GENDER), their attitudes towards IWB (AIIWB), classroom interactions using IWB (CIIWB), students' perceived deep learning approach using IWB (DLA) and students' perceived surface learning approach using IWB (SLA). Among these, GENDER showed a negative coefficient meaning male students perceive better learning outcomes using IWB. All other variables showed positive coefficients. Further one predictor from teacher level (level-2) was also affecting LO: the age of the teachers (AGE). It provided a negative coefficient indicting that students taught by younger teachers perceive better learning outcomes using IWB. There were two more predictors at the teacher level which provided cross-level interaction effects on LO (outcome variable). These were the interaction effect of computer literacy of the teachers (COMP_LIT) with classroom interactions using IWB (CIIWB), and the interaction effect of gender of the teachers with the perceived deep learning approach of the students using IWB (DLA). Further, one predictor from the school level provided an interaction effect with the gender of the students (GENDER). This predictor was the frequency of full access of students to software and hardware (SASH).

The variance components of both the models were also examined, and these indicated that the full deep learning approach using IWB model explained 20.13% of total available variance and full learning outcomes using IWB model explained 63.06% of total available variance.

Chapter 11
Qualitative Findings

11.1 Introduction

This chapter presents the detailed findings from the qualitative phase of the present study which included the data collected during the face-to-face interviews of the participating teachers. The description about the process of qualitative data analysis including data preparation, data coding and theme generating processes are given in the beginning of the chapter which is followed by the details about the sample used for the qualitative phase and finally the findings from the qualitative data analysis.

11.2 Data Analysis

Qualitative data analysis is a process of organising the data in a manner which brings out any patterns, themes, forms and qualities from the field notes, interview transcripts, open-ended questionnaires, diaries, images etc. (Labuschagne, 2003). The key feature of this kind of data analysis is that it is not strictly a standardised process (Neuman, 2006, p. 458) so the decision of choosing an appropriate approach of data analysis depends upon the researcher. The steps of qualitative data analysis used in this research are described in the sections below.

11.2.1 Data Preparation

It is already mentioned in Chapter 3 that the qualitative data for this study were collected from the secondary schools teachers in South Australian schools who used IWB in their teaching and were willing to participate in the qualitative phase of this research. Face-to-face one-on-one interview method was used to collect the data from 16 teachers and these data were recorded using a digital audio recorder. As an initial step of analysis, the audio tape recorded data were transferred to computer and saved in different folders which were categorised based on the name of the schools and the names of the participating teachers from each school. Further, the transcriptions of the interview data were prepared before starting the actual analysis of data.

11.2.2 Coding

In this research, open-coding technique was used by the researcher for analysing the data obtained in the form of responses to the interview questions (Gibson, 2006; Neuman, 2006, pp. 460-464). The data were analysed by hand because the researcher wanted to have a hands-on feel for it (Creswell, 2005). Codes are a kind of labels which are used to categorise information which is collected from the participants during a study and are usually assigned to words, phrases, sentences or whole paragraphs (Miles & Huberman, 1994, p. 56). The ultimate aim of coding is to group together related sets of data under one umbrella term (Gibson, 2006) which allows speedy analysis of data (Miles & Huberman, 1994, p. 65).

In the initial stage of data analysis, the responses were read carefully by the researcher to obtain a general sense of the information given by the participants. During the next couple of reads of the responses, keywords were marked which were ultimately used as indicators for coding. Further, after reading through the responses several times, the researcher created a total of 28 codes or categories from them.

11.2.3 Theme generating

After assigning codes, the next step was to combine related codes to generate themes (Aronson, 1994). Themes are similar codes aggregated together to form a major idea in the database (Creswell, 2005). All the 28 codes which were developed during open coding process were examined, organised and linked to discover the key themes from them (Neuman, 2006, p. 462). Along with linking or combining the codes with each other, links were also made between the codes and the research questions which ultimately generated seven themes. These themes were:

- Positive factors contributing to the adoption of IWB by teachers
- Classroom interactions/student involvement

- Gradual evolvement of IWB use by teachers
- Negative issues related to IWB use by teachers
- Impact on student learning
- Future use of IWB by teachers
- Recommendations for novice IWB users

11.3 Sample

It is already mentioned above that out of 30 secondary school teachers who participated in this research, 16 teachers participated in face-to-face interviews: 8 males and 8 females. Table 11.1 shows the details about the various subject-areas taught by the teachers using IWB.

Table11.1: Subject-areas taught by the participating teachers using IWB

Subject Area	Number of Teachers
Science	5
Science and Mathematics	3
Languages	2
Arts	1
Media	1
Literacy	1
Design & Technology	1
Curriculum Support	1
English, Society & Environment, Christian Studies	1

There were eight teachers out of these 16 participants who teach Science subject using IWB and three among these eight were also teaching Mathematics along with Science. Two participants were Language teachers, one of them taught Modern Greek and one was a French language teacher. One participant taught three subjects using IWB: English, Society & Environment and Christian Studies. There were five other teachers from five different subject areas: Arts, Media, Literacy, Design & Technology and Curriculum Support.

The first interview question asked to all the participating teachers was about the duration of time they had been using IWB i.e., their IWB experience. Table 11.2

underneath gives the details about the IWB experience of the teachers who participated in the interviews.

Table 11.2: IWB Experience of the participating teachers

Experience in using IWB	Number of participants
7-8 years	3
5 years	3
3 years	3
2 years	3
1year	3
1 term	1

There were three participants who had been using IWB from the last seven to eight years; three had five years of experience of using the IWB in their teaching; three teachers were using IWB from last three years; three teachers had been using IWB from two years; three teachers were using them from only almost a year and one teacher who was interviewed on the last day of the fourth term of the school said that he has started using IWB from the beginning of that term only. So there was a mixed cohort of teachers, some of them had long experience (7-8 years) of teaching with IWB, some moderate experience (3-5 years) and some were novice with their experience ranging from only term of use up to 1-2 years of experience.

11.4 Findings

The findings from the analysis of interview data are described in the following sections. This section is divided into seven sub-sections based on the emergent themes which were generated during the data analysis and are listed in the 'Theme generating' section above. Under each of these sub-sections, the findings from the analysis of the interview data are discussed.

11.4.1 Positive factors contributing to the adoption of IWB by teachers

The initial focus of the interview was to understand the reasons behind the decision of teachers to start using the IWB technology in their teaching. Various factors/reasons were highlighted by the teachers during the interviews which are described below:

11.4.1.1 Availability of IWB

The analysis of interview data revealed that the most prominent factor which made the teachers think about starting to use IWB in their teaching was the availability of IWB in their classrooms.

A Science and Mathematics teacher clearly mentioned stated:

> *Well, they were just available. And we had a few introductory sessions about them and I just saw they had a lot of potential to use, so I started using them.*

Similarly, a Design and Technology teacher with more than 5 years of IWB experience stated:

> *The reason I start to use them was that I found them in the classrooms, so I have been very fortunate. The majority of schools that I worked in have had IWB.*

Another teacher who teaches Languages shared her experience:

> *Well, when I was in my last school, they didn't use them at all, then I came here, and lot of the classrooms have boards in them and I became curious about how to use them if it's there in the classroom.*

A Science teacher who was purposefully selected by school to provide IWB in her classrooms revealed:

> *Well, I had always been using a lot of technology. So this was, my board, was the first one in the school that was installed and they decided that they will use my classroom because they thought that I would use it straight away.*

There was another Science teacher who said:

> *I used projectors, then I was given the option of using IWB and I used it in every lesson and loved it.*

11.4.1.2 Perception of teachers about IWB to improve Teaching and Learning

The availability of IWB in their classrooms was the factor which gave the opportunity to the teachers to think about this technology, but the factors which actually played a role in convincing most of the participating teachers was their perceptions about the usefulness of IWB to improve the way of teaching and also the learning of the students. It is important to mention here that most of the teachers talked about both aspects of IWB when giving examples to share their experience about IWB as an effective teaching and learning tool.

A Science teacher, when asked about the reason for starting to use IWB, said:

> *Well, ok this is probably the way I explain to other teachers that it is good way of going from normal whiteboard to recorded whiteboard, that's it. Also it means that if I am doing stuff like looking at three-dimensional shape on the board, I can grab it, move it and kids can understand it that way.*

Also a Science and Mathematics teacher clearly mentioned some of the advantages of using IWB by saying:

> *Well, I think they should be in every single classroom. They definitely make you think about the way you teach things, make you be a little bit more dynamic. I mean teachers get arrested in their way, you know, just read the text or do this work and do that. I mean, I don't even get the kids read the textbooks anymore because I have it all on my laptop, you know, so they don't have to carry anything around. So I can put it up on the whiteboard. It easily transfers the information. You don't have to worry about the whiteboard pen running out in the lesson, It's just there and you know, and the kids love watching, like, video images, they love having them on the big screen. We have got TVs in the lots of the classrooms but as far as comparison, the whiteboard is five times bigger than the TV and it makes it easier to see things.*

The teaching and learning aspects of IWB, as described by different teachers are discussed in separate sections:

11.4.1.2.1 Perceived Improvement in Teaching (Teacher-focused)

When asked to compare the teaching and learning aspects of IWB and to suggest which aspect among these played major role in convincing them to start using IWB, the majority of the participants revealed that the teaching aspect of IWB was more prominent when this technology was first made available to them.

An Arts teacher shared his initial thoughts about IWB saying:

> *I went to a demonstration that we had one afternoon at school and that's where, when I saw the demonstration, that it was, the IWB was doing things that I was hoping to do.*

A Design and Technology teacher also mentioned clearly:

> *I believe that I perceived it originally as another tool to help me do my job and I suppose to help the learning of the children.*

A Science teacher who exclusively uses IWB in her teaching said:

> *It was going to be more convenient for me because I wasn't going to have to carry around and plug in a projector in every lesson. You don't have to worry about all of those things but I also thought of it being a useful tool, being able to have the internet and show the students sites, to be able to run through a particular program and show them how to use it. For example, for Nutrition, we use a program called Foodwork. So I was being able to show them as a class before I send them to the computers. So I think it helps the students as well, but ultimately, my first thought was that this is going to be good, this is going to give me another tool.*

A Science teacher who took the initiative of introducing IWB technology in his school explained in a very elaborative way:

> *Once you have made a lesson on it, you have got all you pictures, you have got all your theories and you have got, you know, a wide range of resources on it which you already know. It's like organizing your lesson before you even get into the class. You don't have to*

think too much about what you are going to include because you have already done that before-hand and you think about how can I make it more interesting, how I can illustrate the concept in a new way. So, it helps you with organisation.

He further highlighted some other key features:

Like during the lessons, you can hop on to YouTube if you want to show video of what you are talking about or you can do whatever you like on it. The visuals are in front of the kids and they can't really ignore and that makes it a lot, it makes teaching much more easier, I think.

A Science teacher who had only one year experience of using IWB expressed her views:

It gives me, as the teacher, a lot more flexibility and sort of instantaneously been able to do stuff, I can write on it, I can get websites up on that, I can search things and I am doing that openly so that students can, sort of, see what I am doing.

Another Science teacher who was very enthusiastic regarding her use of IWB said:

It's just wonderful because of the visual images you could put up illustrating the work to the students and I am using more of the internet now than I did then.

A Literacy teacher who was also a new user (almost one year) of IWB stated:

Also for my personal presentation processes, I feel that, you know, I can, you can use electronic data in a good way, you know, you can use fade in-fade out stuff, you can use sliders and things like that to make it interesting to students. They are very visual these days as compared to the way I was brought up which was more auditory.

Some teachers also shared simple yet very important aspects of the usefulness of IWB for teaching as mentioned by a Science and Mathematics teacher:

Well, you can do so many great diagrams in the geometry area of the whiteboard. You can get the perfect circle; you can line up tangents beautifully.

Similarly, a Science teacher also shared her personal experience along with talking about some general advantages of IWB in teaching:

> *I was hoping that it would be easier, like, to keep kids engaged and also because whiteboard markers, regular whiteboard markers run out all the time, so if you can just write it with electronic ink, you don't waste all that, yeah, don't waste ink.*

One another teacher said:

> *Yah, from teacher point of view, it is also helpful. My whiteboard writing is not neat and I think it's important that students see a very structured neatly presented work especially in Mathematics, so this gives me the opportunity to set that work up beforehand so they can see easily typed up examples and things. I might just reveal it bit by bit or I might have just a question up there and then just write up or to type up on the screen as you go through the work.*

Apart from this, few teachers highlighted another unique feature of IWB as an Arts teacher shared his perception by giving an example:

> *I suppose that it is very helpful tool for teaching like being able to, you are able to record what you have written on the Board on the previous occasions and being able to bring it back up again to refer back to it is incredibly important and is a very powerful tool.*

A Science teacher gave exactly similar kind of examples while justifying his perception about IWB as an effective teaching tool. He said:

> *I used to use IWB every day to write my notes and one day I had to go to a normal whiteboard room, and I wrote my notes on the board, the normal whiteboard and I picked up my eraser and when I rubbed it off, it's gone. In the IWB, it's always there and I always start my lesson at the beginning of the topic. Like I say, you remember we have done this and you can flip all the sheets that you have done so they realize that how much work they have already done, and as you go past some kids might say, oh I don't remember that, so you can go back, revise the topic as you have done it before, but in normal whiteboard, you say ok remember this board is white. So very good for that and also at the*

end of the topic, I can save the file as a pdf and email it to all my students and therefore students have the copy of all my notes, it's awesome, so easy.

He further pin-pointed some features of IWB and how these can be helpful in motivating the teachers who are reluctant to use technology. He explained:

The biggest thing is it converts older style teachers to recording their notes, their writings and that's the biggest impact, which is not very much different from what we are doing, but at least we get older style teachers to start using the whiteboard, they go, wow, I have got all my stuff recorded and the next year it's easier because they are already recorded and also with time they start enhancing it and so after a couple of years, they start getting some very very good lectures and also they can download lectures, you know, interactive PowerPoint or stuff like that.

A Media teacher, with 7 years of IWB experience, made a comparison between traditional and modern style of teaching and said:

There are many many teachers who stick with paper and pencil and pen and for particularly motivated class, they will not stay as engaged with traditional methods these days because technology is all around them. They use higher level of technology on their phones than some of the classrooms, so it's inevitably going to be less engaging. It's bringing their world to their classrooms.

As it is evident from the above statements, the participating teachers consider IWB an effective tool for improving their teaching and this is one of the main factors which encouraged them to start using IWB, but it is also essential to highlight here that there was one teacher who expressed slightly different views. When asked about her perspectives regarding the potential of IWB to help a teacher to teach in a better way, this Science and Mathematics teacher with 7-8 years of IWB experience made it clear that IWB itself is just a tool and the effectiveness of teaching does not depend on it but on the effectiveness of the teacher. She responded:

No, it doesn't change, it doesn't, like, make you teach better or anything because you've still got to know how to use it, but it just gives, makes lessons probably a little bit more dynamic.

11.4.1.2.2 Perceived Improvement in Learning (Student-focused)

The second factor which played decisive role in the adoption of IWB by the participating secondary school teachers was their perception that IWB facilitates learning. A deep analysis of the responses of the teachers to explore their attitudes towards the learning aspect of IWB revealed that all the teachers strongly believed that being able to assist a multimodal style of learning, and with features like annotation on the visuals, manipulation of the text and visuals on the screen, flexibility, instant internet access etc. facilitates learning of the students by making it more engaging, enjoyable, fun, easy, dynamic, motivating, interesting and encouraging.

A Science teacher, who was the first teacher in his school to use IWB, recalled his first thoughts about IWB:

> *I had seen them being used in the primary school at the school I was at and I thought I could use this in the way that could help my teaching to improve visual learning in the students.*

All the teachers highlighted different features of IWB in their statements. A teacher, who was also an ICT coordinator in a school and had personally done research to collect information regarding the usefulness of IWB for teaching and learning, said:

> *I think, whenever you have a multimodal style of learning, where its visuals, auditory, text and now so much more like animations as well an interactive web technology, that definitely in my perception is higher level of engagement, whenever that's used.*

When asked to compare between the teaching and learning aspects of IWB, some teachers said that they choose to use IWB just because of its learning aspect. One such Language teacher said:

> *It just makes language learning more accessible to the students, more fun. I don't just use that, but I think it's good to have that when I teach vocabulary like what they need to know, that's really good to practice. It's a good way to make the students playing little*

games and doing these little activities, the learning, it's not that boring word learning, but actually doing something that is fun, that's what I like about it.

Another teacher explained:

In some cases, it is more engaging I would say because you actually use the images and that could be more provocative. I think in lot of things the insides are hard to see, so if you can show a video of what's going on or some sort of interactive stuff, then they can hopefully understand the concept better.

One teacher expressed her views:

I don't think it changes what they are learning but it just makes it lot more visual, if anything, it just encourages the students to feel a bit more positive that they are using technology. They all wanted to be using technology all the time, whether its iPods or anything like mobile phones.

Likewise, a Science and Mathematics teacher discussed the learning advantage of IWB in a very elaborative manner and highlighted many unique features of IWB that facilitate learning:

Mainly student-focused, I would say the visual thing that you can collect things visually that they can look at, those I already prepared and display them. I know that you can do that in other mean like in PowerPoint and things like that but this is far more flexible and you could annotate over the pictures, you could bring pictures up with text and so on. Secondly, the main reason that I have noticed that you could involve the students that can come out and move, manipulate things and they could write on the board very easily. Also just having things on the whiteboard, you know the picture things, the diagrams, ability to move objects around and reveal things is much more flexible.

A teacher who teach Curriculum Support in a school and has 8 years of experience of using IWB said:

I think it helps the students to be able to see when you demonstrate something on the screen and then you can actually, rather than just explain to them what they need to do, but you can actually show them, makes a huge difference and showing them not just pictures but *actually showing, when you click this, this will happen, and they see it happen, makes a huge difference. I mean, originally I was teaching web design and coding. So when you show a bit of code and then instantly show that that changes colour and that changes font size and they see that immediately, you got students engaged and they want to learn more.*

A teacher, while making a comparison between traditional approach and modern approach (use of technology) of language learning, stated:

By using these technologies, you enhance your delivery of the subject of languages and the students love this approach, they do prefer, instead of using the traditional approaches of learn the language, they do prefer the new technology, and new technology is very close to them and they do like it, they do like it. And you can compare when you follow a traditional approach for the language and at the same time the modern one using the technologies, you can see a big difference.

When asked to explain his point of view by giving an example, he said:

By using this technology, we are connected with the University of Greece and the University of Greece in the last 13 years has put together lots of software, software in the languages component and this software can be brilliant when you have the IWB and the students love it.

Further, another language teacher mentioned:

It's a good way to making the students playing little games and doing these little activities, the learning, it's not that boring word learning, but actually doing something that is fun, that's what I like about it.

11.4.1.3 Encouragement, Training and Support to use IWB

The teachers were asked to comment upon the kind of encouragement and support they receive from their schools and also provide information about the type of IWB training they had received. The purpose of these questions was to get an idea about the impact of this kind of support and training in the use of IWB by these teachers.

11.4.1.3.1 Encouragement by the schools

As far as the encouragement is concerned, all the teachers mentioned that they get appropriate encouragement, initiation and push from their schools to start using this technology, and are also getting on-going support when needed.

As a Science teacher stated that:

> *I was told we had money in the budget and I applied for money to get Interactive Whiteboard and it came through so that was very encouraging and I started working on it.*

A Design and Technology teacher mentioned about the initiation by the school to put IWB in classrooms. He said:

> *In my case the IWB arrived two years ago, so I taught one year without it and then in second year it arrived. And that was just the school decision that they were getting new IWB and just wonder which people to get it.*

An Arts teacher also revealed that the school took the initiative to install the IWB in classrooms of interested teachers:

> *When they first had, they had three Promethean boards installed in the school and I put a request to get one into music, and at first they just told that they were going to put them somewhere else but then they came to me and said that the plan is changed and so it is coming to you and I was very happy about that.*

Another teacher who teaches Greek language explained the reason about the kind of support and encouragement provided by the school:

> *It's a two way story. The school is following this path of e-learning and in the Greek department here and the Greek faculty, we are using, we are connected with some overseas universities, universities in Greece and in other countries and that's why we are following the path of e-learning at the moment in this school and the school encourages this path.*

Further a Science teacher indicated:

> *Well, I guess, they are encouraging us to use them but there hasn't really been anything else apart from that. I guess apart from providing us computers on all of them, yeah, I think, and also giving us the software, yeah, I guess.*

A very similar kind of situation was mentioned by a Literacy teacher:

> *Yeah, they do. There are more and more IWBs in the school. There is, yeah, that is up to the individual to find the way to make them use. There have been some short courses in their use.*

11.4.1.3.2 Training to use IWB

This is another factor which played an equal role as the initial encouragement to make teachers convinced and willing to use IWB in their classrooms. Most of the teachers noted that they received just a preliminary kind of training which was usually provided by the company which installed IWB in their schools. These companies provided some initial basic training in the form of couple of essential information sessions. These teachers also revealed that after getting some basic knowledge about IWB during these training sessions, they made their own effort to explore the IWB and to train themselves to use it more and more effectively. Some teachers also mentioned that their schools provide continuous on-going training related to various aspects of IWB.

A Design and Technology teacher said:

> *However, this school has been very good, they have provided or they promoted quite a lot of training and they do peer to peer support within the school, which is pushed quiet strongly, however in the school every Wednesday morning, we have an IT session where you just work on technology.*

Similarly, an Arts teacher appreciated the kind of training provided by the school:

> *Yeah, they, we were provided with training and development in the use of the software which took me and other two teachers outside of school and I think it was 2-3 whole days*

and then a couple of catch-up sessions for about 3-4 hrs each. Yeah, so it was very good support.

Another teacher said that training in her school is available on the request by the teachers:

> *As the boards have been installed through the school, teachers that have requested training, a lot of them have been sent to training. So the school does support that.*

A Science talked about the on-going IWB training by the school:

> *Yeah, they do encourage it. Then we got it frequently probably, especially once or twice a term, there is been, yeah, there is an email sent out if anybody is interested to come and do this training.*

However, most of the teachers received only the basic training, usually from the IWB Company which installed IWB in their schools. One such teacher said:

> *Yeah, when we first got the one in the library, we had a lady coming out to show us how to use it. And that quite prompted my interest, but that's all the training I really had on it. So I picked it up and most of it, I did it myself.*

And another teacher stated:

> *Only little bit like we had couple of trainers coming up to the school to teach it to us. The courses were good, but I think you need to have more practice.*

A similar statement was given by a Science and Mathematics teacher:

> *We had couple of sessions for couple of hours. Most of that is just self- taught, self-exploring and then I did an online course on the Promethean site.*

A Science teacher very clearly mentioned:

> *Mainly, a little bit from the school. So that was sort of basic training from the school and the little bit I had from the university while I was doing my degree. It's sort of a little bit here, a little bit there, but plus when you actual been able to use it, you learn a lot as well.*

And so did another Science teacher:

> *Not from the school, but from the people that put the whiteboard here, they gave us, and I think it was like 2-3 hours of PD to teach us how to use that.*

Some of these teachers also later on voluntarily took the role to train other teachers. An ICT-Coordinator of a school who also did some research on the issue of IWB in teaching and learning clearly mentioned:

> *Certainly I have taken the role of training other staff and I have also have another staff member here, music teacher, who is very good at this technology and he has also taken some of the training sessions for us at the school. And also the company that supply the boards did some training initially and then some follow-up training, like train the trainers about the top model.*

And another Science teacher who took the initiative of introducing this technology at secondary school level said:

> *Na, I mean they didn't train until I gave the training to other teachers after I figured out how to use it.*

Another Science teacher explained:

> *Ok, I am kind of a training person. But originally, I had some training from Promethean, I went to Mimio training, I took the effort to do it, so when I was trained up, I trained other people.*

When asked about the kind of support provided by school, he said:

> *Yeah, they paid to me to go on the training. We have also had Promethean come into to do the training sessions here. We have done that couple of times.*

Further an Arts teacher pointed out:

> *Not since then, but I help in delivering staff training and development course on IWB use in Monday afternoon sessions. So I did three or four sessions with some staff who volunteered for that.*

It is also important to mention that some of these participating teachers didn't get any IWB related training at all. When asked about the training, a teacher stated:

> *I didn't get any training only because I didn't ask for any training. I have got quite a good ICT skills and all I wanted to do was to play with it.*

A very similar situation was mentioned by another teacher:

> *And I didn't get any specific training at the time, it was just, this is your classroom there happened to be an IWB and they couldn't find the manual, so I said ok, and so in the lunch time I went in and played with it and worked out what I could use it for.*

Both these teachers considered themselves to be technologically savvy and one among them was from ICT background.

11.4.1.3.3 Peer support

Some teachers specified the kind of support they receive from their colleagues who helped them to deal with some issues related to the use of IWB in their teaching. Different teachers mentioned different kinds of peer support and it played a very important role for them, and some of them went on to voluntarily take the role to help and support other teachers.

A Language teacher shared her initial experiences:

> *You know what you need to do more, you need to practice. So I got together with one of the language teachers and we started spending time with it and because there are some teachers that do know where the resources are, it makes it lot easier to use.*

Similarly another teacher mentioned about the support from a colleague:

> *Yeah, Mr. X, he is very good. If you have got any issues or want any sort of particular training or anything like that, he would very happily either provide that or chase it up for you, so, yeah I don't feel like I have got nothing and I have to do it myself. Yeah, I definitely feel like if I needed a hand with anything, I can go and get it.*

An English teacher also described about the kind of peer support she get:

> *I guess the teacher that I work with is quite capable with the IWB, so if I want something to, if I wanted to do something, I can go and ask him for a help and get advice and then I have used some of the online tutorials for help a little bit as well.*

A Mathematics and Science teacher, who himself had been using IWB for almost 2 years said that providing support to other teachers also helped him to learn more about effective the use of IWB. He said:

> *I just give other people a lesson a week to help other people to use it. I guess it is also a way of learning it to teach other people too and it made me to get on the top of it because other people rely on me, so I had one lesson a week last year to do that.*

There were couple of teachers who had talked about a very exceptional kind of support i.e., support from their students. One language teacher clearly stated:

> *But the students are good, because they help. If I make a mistake and ask them, can you come and help me, they do help me and they love it.*

Another teacher also mentioned about student support:

> *The students from the primary school, they know a lot more about them than you do and they tell you where the things are hidden and I know there is a lot more on it that I haven't found yet. So it's a growing thing but they like it very much.*

11.4.1.4 Other factors

Apart from the factors like availability/easy access to IWB technology and the perceptions about its value for effective teaching and learning, some teachers also mentioned about other reasons of using IWB in their teaching. These are discussed below:

11.4.1.4.1 Expectations of others

Some teachers acknowledged that the actual reason why they start using IWB was that they were expected to use it by the students, school and even other teachers. As mentioned by a teacher:

> *Initially when I started teaching, I was an IT teacher. And therefore it was an expectation to use the board in the IT class; you give demonstration for the students before they went onto the computer.*

Another teacher who first started using IWB during her teaching practicum also shared similar experience:

> *Probably just because the teacher who had that class for the time wanted me to use the Board, so the students expected to see it in the use and I just carried on, I guess, very similarly to what he had been doing.*

She further emphasized on the expectations by the school authorities:

> *As a teacher again probably I think, there are some expectations to use it because the school has gone that way, they have equipped the classrooms with it so I feel, again, yeah, if you don't use it, it's like just not using the resource.*

A Literacy teacher who felt the need to keep up with technological advances said:

> *We have the facility in place to use it and I felt that I needed to know more about them because it was keeping up with the, if you like, the technological advancements of student learning.*

A Science and Mathematics teacher also gave same reason:

> *It's just keeping up with technology. You know, it's an innovative technology, you know, to keep up- to- date, you know, what the kids are doing, the kids, they like using technology in the classroom and if they can see a teacher using it as well and using it to access other things, they are going to be a bit more willing to learn.*

11.4.1.4.2 Behaviour Management

Some teachers also linked the use of IWB to a very important issue, its helpfulness in managing the class better, especially dealing with students with problem behaviour.

This is pointed out by a Science teacher in very clear words:

> *You have to spend some time making all this stuff beforehand and getting organised but it makes it easier in the class to deal with kids, especially the kids that can be more difficult.*

He further explained more:

> *They don't have to worry about me writing the stuff on the board and they lagging behind and I can really watch them while they are learning. So, it really helps with behaviour management as well. It's very handy having it.*

A Language teacher also expressed same kind of views:

> *Even the naughty students that normally cause trouble in the class, they don't really like to sit back and write, they get involved so it helps in classroom management with some students, and they enjoy.*

Another Language teacher compared it with traditional way of teaching and said:

> *By using these technologies, you enhance your delivery of the subject of languages. And you can manage the classrooms using the new technologies easier than in the traditional approach.*

11.4.1.4.3 Unique Factors

There were couple of teachers who mentioned some exceptional reasons to start using IWB. One such teacher while discussing about the reason of starting to use IWB explained:

We have organised distance classes in other schools in other continents. We have three classes, one in Johannesburg and other two classes in Toronto in Canada and we are using the IWB when we are linked with these classes.

Another teacher who was reluctant to use IWB in the beginning described:

I think, I started as being a sceptic about IWB. I learnt a lot about it in my role as a teacher- training role and became more and more convinced, seeing good use of it by some very good teachers, that it was a worthwhile investment if the teachers are supported well and are motivated to use, it can be a very engaging technology. I started out believing that it was overpriced and probably not worth the investment, but then I changed my mind.

A Science Teacher who had recently started using IWB also mentioned:

Yes, I think when the students see you using this equipment, they realize that, sort of realize that this is real, this is relevant. They sort of respect you more for actually using this equipment when they are more engaged.

11.4.2 Classroom Interactions/Student involvement

After exploring the factors leading to the adoption of IWB by teachers, the next issue addressed in the interviews was the different types of interactions in a classroom where the teacher uses IWB for teaching. The questions were asked to gain in-depth understanding and the main focus of these questions was on the students' involvement or interaction with the IWB i.e., whether the students are involved; what kind of involvement and how the students are involved. The teachers were also asked to elaborate their responses by giving some examples from their day to day teaching. The majority of the teachers indicated that they involve their students while teaching using IWB in one way or another. The teachers who don't let their students interact with IWB, or who had stopped letting them use it, gave the reasons or justification for doing this. Some responses from the teachers are given below.

A Media teacher with 7 years IWB experience gave an example to explain the type of Student-IWB interaction in his classroom:

> *They all present information on the board, they would show examples of how they are progressing. Like in the area of Media production, students would get up to demonstrate how they can choose something like a software, and it's certainly easier for the students to see how it is happening when they are physically touching the board or the software to see what they taking on rather than just sitting in the projectors or data projector style. Mostly, it is to do with student sharing work, showcasing what they are doing.*

A Science teacher also described by giving an example:

> *This morning I had some Year 9 students doing some transformation rotation and I gave them a graph paper and a pencil so they can draw figure that is given in the text book, so they had to come up and put there a mark where the centre of rotation was, so they wrote there how many degrees and things like that.*

Another science teacher explained in a very elaborative way about his student's direct interaction with the board. He said:

> *Yes. On one of the SMART Boards there is this program called Frog Guts which is, it's where basically you can do a dissection of the frog without having a real frog there and cut it out and kids of all year levels love that because you have got an animated frog there and you can pin it down and you can cut it open and you are getting the students up there to find the bits and pieces. So rather than just being talking, you can get them up and get them touching the board, playing around.*

A Language teacher explained different kinds of interaction for different year levels. Talking about the junior level students, she said:

> *For the juniors, when you are doing different topics, like if you are learning about clothes, there are different activities that they can come and join, they can pick the word, matches, so they come up, one by one and they come up, they can speak that word or they can come directly to the board and change it, so they are really getting involved.*

She also gave example of how she involves senior students in teaching with IWB:

> *With the seniors, they can come in and type in their sentences that are more advanced, because they are the higher level, so they like to come up and write on the Board and get involved because they have got small classes. Suppose they have to write three hundred words in French, we can do that together, we can sit and words can be suggested by each student, with all of them being involved. They can all be involved in writing up on the board, which is good too.*

When asked about whether he allows his students to use IWB, a Design and Technology teacher revealed:

> *Yeah. Quite often in my home group, I have problems keeping them off it because they find it so engaging and they love to get on there.*

He further added:

> *They come along and take over from me and do things on the whiteboard and if they are working in groups, one group might come to the whiteboard and they interact with it, or even work within a group, so instead of working on a piece of paper, they actually come along take over the board and work on the board.*

Some teachers also mentioned about using some technological tools along with IWB which help the students to interact in a better way. A Learning Support teacher gave example of one such tool that comes with IWB:

> *Yes, they get to use the pen and they go up because that engages them even more if they can go up there and control what they are doing rather than me doing it all the time.*

Another teacher highlighted the advantage of using some ICT tools/technologies along with IWB which leads to a different type of student involvement where students do not need to leave their seats to interact with the IWB. He said:

> *Well, the Promethean whiteboard has a slate that you can hand it out or something like that, so you hand it around to the kids and they can write on the board, without getting out of their seat. And it does, like it does sort of, encourage them to put their answers on the board without actually physically getting up in front of the class which some of them*

find quite daunting. With the Hitachi boards that we have, we don't have that slate, but the kids are quiet keen to get up and have a go because it's a novelty and they quickly get up to play with the board.

A very similar point was put forward by a Science teacher who said:

There is couple of ways, the boring way is that I write notes and they copy it, that's one way. There are other things that you can use like drag and drop, so I have all different shapes out there and kids can come to the board and do it. My favourite way is doing practical experiments, again students need to come to the board to do that, however now they have iPads, they can basically keep working at their desks, they are copying their notes, they can share it to a wall, I share it on my wall, things like that, so we actually don't need to go to the IWB.

Another Science teacher who had recently started using IWB pointed out about the responsibility of a teacher to make sure the IWB is used properly by the students for educational purposes rather than considering it as a technological toy to play with:

Well, you have to set up rules because obviously they are not playing with thing, so yeah I only allow them to use it when I am actually, when I am there or when I am supervising it. They are actually generally pretty good with it, they love coming up, it actually encourage them to get up out of their seats and to come in front of the class and write on stuff. If you have quiz set up or something like that, you suddenly get eager volunteers to come up and do it rather than having to, sort of, pick them for doing it. So yeah, it does give them a platform to be able to, sort of, to feel comfortable to get up and come in front, be involved.

Another teacher who initiated the use of IWB in his school highlighted the practical issues faced by him:

Because this interactive board being one only in the school, we are very sensitive at the beginning how to use it and try to teach the students how to use it, but I would prefer the students to be the centre of the classroom and the students to use this technology. I encourage the students, I mean if I can practically, I call one one students to fill in some gaps in the interactive whiteboard using the software I mentioned before.

Another teacher admitted that he needed to improve the involvement of students in his classroom and also made a comparison between the willingness of the students, at primary and secondary school level, to get directly involved in using IWB in the classrooms:

> *I think its one area where I would like to still improve myself. I think there is still more scope for students to get up and to do more. There is a lot to do with the confidence of individual students to feel ok by getting up and to come in the front of the class and certainly for the 13-14 year old, that's not always what they want to do, primary school, junior primary kids are often quite happy to. They are bit more self-conscious at a higher school level but those who have got confidence, get up quite regularly.*

During the analysis of interview data it was also evident that not all the teachers allow their students to use the IWB. Different reasons were given by these teachers which are discussed below.

An English teacher expressed her concerns regarding involving the students by highlighting one of the limitations of involving the students to use IWB in the classroom:

> *I think, like, I am seeing what IWB can do and while I think it's good, I can't get away from the fact that it tends to just include one or two students at a time and that's for me, as a teacher, is one of the biggest concerns.*

A Science teacher who had stopped involving her students in using IWB gave her reasons by saying:

> *We tried it times. Initially, the kids wanted to come and write on the Board and things like that but then they discovered that it was lot harder than they thought.*

Another Science teacher pin-pointed few issues regarding the use of IWB by students which highlighted the need for a strong learning environment in the classroom in order to successfully involve the students to use IWB in a proper manner:

Well they, usually they don't want to use the board, but, I try to ask them to come to the board and write an answer on the board or move an answer or things like that, they usually always refuse and then the ones that do agree to come up usually want to come up for the wrong reasons so that they can, like, destroy it, like move everything in the wrong place or just open things that shouldn't be opened, so things like that. So I, sort of, more reluctant to let people come up now because I know that they are going to be silly, that's the year 8, 9. Usually with the year 11, 12, they just find a chore to go up and go to the board; usually I don't make them do that anymore.

A Literacy teacher also stated the possible management issues related to student-IWB interactions:

If there are some students being a little disruptive or they do something which is probably a little bit inappropriate in terms of use and the care of the equipment, yeah, so that is something that one has to just keep an eye up for, yeah.

There was another Mathematics and Science teacher who had stopped involving students because she had changed the way she use IWB. Her comments provided in-sights to a very crucial difference between the use of IWB in a traditional (teacher-centered/lecture method) approach of teaching and a constructivist (student-centered/student-involvement) approach of teaching. She said:

Yeah. I probably don't, I don't use students much now. I use it more now, like the whiteboard, like I have my textbook up on, rather than the kids having to carry their textbooks all the time, I have the textbooks up on there, you know, the information in there when they need it. So now I basically, I probably just use it like an overhead projector, you can have the information there, also use it, like, to show videos. So, I have my laptop connected to it all the time and so I use a lot of multimedia stuff anyway, so it's the textbooks and then video or word documents depending upon what the kids are doing in the class.

11.4.3 Gradual evolvement of the use of IWB

This question was asked to the teachers to understand any changes in the way of use of IWB with time and also to get some useful ideas or hints for the teachers who are either willing to use IWB, or are in the beginning stage of its use. It is essential to keep in mind that the different teachers were at different stages of using the IWB at the time of interview, with some being very well experienced (6-8 years) ; some with reasonable experience (3- 5 years); and some novice (6 months to 2 years). So another purpose of asking this question was to see any difference in IWB use between new teachers and those teachers which are well experienced. All the teachers started using the IWB in a very simple way and gradually moved towards using it in more and more interactive and advanced way, although, the speed with which they evolved was different for different teachers. There were various factors highlighted by the teachers which impacted the gradual evolvement of their IWB use.

The ICT coordinator and a Media teacher shared his progress of IWB use as:

> *I, probably at the starting point having done the research to know and also because I am the ICT coordinator at the school, using the technology a lot, I didn't feel held back, and so I was able to get into the higher level use of it probably much quicker than some people would. I actually certainly use the IWB in every lesson every day.*

A Science teacher who took the initiative of introducing IWB technology in his school said:

> *Initially when we got it, it was just basically a nice way to put up notes, an easy way to do PowerPoint. But then I started finding gallery tools and other bits and pieces which can be incorporated with programs that can help you with the learning. You start off with very simple bits and pieces then you get very very complicated when you incorporate audio or interactive elements into the classes, so you get the students up and playing with the board. Yeah, once you figured out how to use bits and pieces then it makes it lot easier for you.*

Another Science teacher who had recently stated using IWB revealed:

> *I probably had gone from just using, for example, simple PowerPoint, like, just using as a data projector to being more interactive user. In that I will be using it as a whiteboard and data projector simultaneously. I have multiple tabs up so that I can switch between the internet or research or quizzes or stuff like that. So, you have got a lot more flexibility with the multimedia that you are using.*

Further another Science teacher and a novice IWB user shared her experience:

> *Well, it is actually evolving too quickly. Originally, I was using it as a whiteboard, you know, just writing words on it and then I started doing more interesting things with pictures and videos and now I have nearly started preparing things before-hand so that then I can show them and now I am kind of at the point where I would really prefer to have the board all the time. Like now, with the room out of action, I am not very happy. It's like I would rather have the board there.*

A Mathematics and Science teacher commented about his evolvement as an IWB user:

> *Hard to say how it evolved. I just did experiments, I guess, with various things. In the end I am putting the whole science units onto it. By that time it was just a trialing with a lesson and then the couple of lessons to the extent that it now may be a whole topic that's completely build around whiteboard presentation, interactive things with the kids coming out and doing things and lot of links to work like YouTube videos, things like that.*

A Language teacher explained by giving some examples:

> *When I first started, it was really just typing in, like little activity, little things like that but then, now it has more evolved to finding the different links and conversations. You have got people having conversations on there and then you can take it and then they can have the conversations, or you can go on games, all different activities, grammar, linking, lots to do with different topics whatever topic you are doing and like I said, it could be music or anything like you go on YouTube, you can find songs, it can be anything, can be a fun.*

A well experienced (in IWB use) Science teacher emphasized that she has stated to use more internet in her teaching now. She stated:

> *For the last three years, I think first I was probably doing very similar work to another whiteboard except using it for illustrations and diagrams, but here at the Science area it's just wonderful because of the visual images you could put up illustrating the work to the students and I am using more of the internet now than I did then.*

A novice user of IWB and a Literacy teacher showed his concern about not being able to use the IWB in an advanced manner:

> *Initially, I had a colleague who showed me a few things about the use of IWB, and then I just started to use some of the things that he had shown me. Unfortunately, I couldn't take it to the point where I could pull files out to put up on the board or I could, sort of, input pictures of anything like that, more sophisticated stuff but I could use it to write on and I could use it to, sort of, bring up clips, video clips and things like that but also run a particular program that were developed through IWB.*

Another well experienced Science teacher said that she started using IWB in an interactive way from the very beginning of its use:

> *I didn't really evolve. I just started using it straight away and so when they put it in the classroom and from that point on I haven't use the other whiteboard. So it's a case of straight away. As I said that I got to use the PowerPoint, I write on it, I save all my notes, I save the lessons; I use it for internet, so all those sorts of things. Straight away into it, because it was installed at this time of the year and I had time to play. Beginning of the next year when all my classes were there, yeah, that was it, I use it all the time.*

Further another Science teacher, who was also using IWB from a long time, had moved into an opposite direction as far as the use of IWB is concerned. He clearly mentioned:

> *Honestly, IWB is a waste of time. They will be faded out in five years. They are good to go from this whiteboard style of writing to recorded writing but the worst thing about IWB that you are still standing in the back of the class so if I have got an iPad or a tablet, I*

can do writing on my tablet and connect it to the computer and it just being projected on to the board. So I can walk anywhere in the room, I can write on the tablet, I can pass it to the students, the students can write on the tablet and it's on the board. So it helps you control the class better, it helps you move around in the class. In IWB, not every kid can go on to the board and also if you are standing in front of the board, you are also casting a shadow. So I am more likely to use my tablet, actually I have my iPad connected to my Mac, so I can write on my iPad and it just show it on my Mac.

11.4.4 Impact on Student Learning

Based on the theoretical framework developed by the researcher; the learning of the students is divided into two aspects i.e., Learning Approach and Learning Outcomes. During the interviews, the teachers were also asked separate questions regarding both these aspects of student learning. The aim was to understand or explore teacher's views regarding the significance of IWB in student learning. This is a very important issue because the teachers were not asked about the student learning in the quantitative questionnaire, so this was the only chance to get any kind of information from the teachers in this regard.

11.4.4.1 Learning Approach/Attitudes

The teachers were asked to comment upon the possible significance or impact of IWB use on the approach or attitudes of students towards learning. All the teachers declared that the approach of students towards learning has improved in one way or another with the use of IWB. The teachers reported students to be more motivated, engaged, attracted and involved in learning; produce better quality work and enjoy learning; are more active, happier, curious, positive and keen to learn.

A teacher talked about an improvement in student learning approach by making a comparison between his teaching with a projector and an IWB:

I had started out teaching in this room mainly with only a data projector and I have noticed an improvement, certainly an improvement in engagement and involvement and *probably the level of the work from the students is high because they are actually, I think, getting better quality of instruction.*

A Greek Language teacher compared his teaching with and without IWB and elaborated:

We have five contact hours a week in languages and from these five hours we devote one to two hours with IWB and if you compare these three hours without interactive with the two hours with interactive board, you can see the students love the second part, the interactive one and they are very active in the classroom, very active and they communicate in the language, they love to be involved in the delivery of the lesson where as in the other classroom, in the traditional approach, they try to avoid it. I mean, my argument is that using technologies or this technology, IWB, in language classrooms, you enhance your delivery and the students are happier and you have better results, even students with some problems following the lesson in the IWB, they feel happy, they feel free, they are involved and they contribute to the class, to the learning.

A Media teacher explained the kind of impact of IWB use on student learning approach by giving an example:

Mostly, since they are less likely to be distracted, they are more involved in the class, in the lesson and the activity that is happening. So, yes I think with the higher level of interest and involvement. The students involve with any kind of technology but the IWB certainly helps in it. Only just today, I had a teacher from another learning area come and show me 'stop and stare' animation film made by a wonderful artist and I straight away was able to show it to the students because I had some students doing 'stop and play' animations in the classroom. And it is very quick way to show them how it is done and to show examples to them. So it's very motivating, very quicker.

A Science and Mathematics teacher drew attention to a very important issue when she gave example about low ability students and how IWB help them to overcome the barriers and to learn better:

I just took a relief lesson of a lower ability in Mathematics class just before I came and they were doing the linear relationship and just being able to do it on the whiteboard's big *screen, they were curious, what would it look like, how we can do tables. We can put different colours in it and because they are less able to handle curriculum, the attractiveness of what you are offering them is much more alluring to attract them and getting them involved. So they were copying things down in their book and then trying things for themselves.*

A Science and Mathematics teacher particularly mentioned about the role IWB plays in encouraging the special needs students. She said:

Enormous, because in my Year 10 Mathematics Application class, I have got two visually-impaired students, they find this electronic whiteboard so much easy to read because of the thickness of the line and bright contrast. I can use any colour and they can see it, even though they are visually-impaired, on the IWB and that makes it so much more interesting to them.

Another teacher (Society and Environment) who started using IWB during her teaching practice and taught indigenous students at that time recalled about her unique experience:

If it's there in the room, it add a value I guess and it is centered strictly with those students as I said, they were, they were kids who had very limited exposure to schooling before and it was something that took their attention even the use of colour, you know, little things like animations and that sort of stuff, they quite like it. So is also that it is also attention grabbing for those particular students.

A Science teacher gave example about the senior year levels:

The other thing is especially with the senior classes, say Year 12, once you have made the lessons, you can export, so all the students can have their own copy of the lesson, they can print that out. So when they get in the class, they can add their notes to it. That means I can have my whole year of Chemistry course ready, I can give that to the students in the start of the year and when they are going through it during the year they can add to that and do the other bits and pieces and I find the Year 12 especially, they enjoy that. They like having all notes ready for them. So it's not just, you know, copying down, it's much *easier. It helps them because they have got another way of looking at the information, I think.*

Another teacher talked about its impact on Language learning:

I think it makes it more, I think with language you can do lot of things like writing, singing, rhyming and by using that you can add another dimension to that. And the more different experience they get, going to be better for them in the long run. Like they are hearing French, they are singing it, they can rhyming in it and so they are getting lots of practice and many students that normally the student who usually sit back and hide, they like it, so something like that.

A Science teacher also gave similar comment by saying:

Yeah, I think it has improved. It has given another dimension to teaching; another dimension to classroom which I think is a good thing, yeah.

An Arts teacher clearly mentioned that the attitudes of the students have become more positive:

Especially music, musical notation is fairly graphic symbol itself, so it's just not being able to say that three plus three is a six, you have got to give them the answer that can actually give them a visual answer. With that old fashioned whiteboard, I would draw it up on the whiteboard whereas with the IWB, they can get much more defined view of the answer, so the comparison between their answer and the given answer is more accurate, so that's what the kids like, "aa ah this is better than this one, like that sort of stuff. So their attitude becomes more positive with that because they can see that how they are getting feedback, if they don't know that how they go, they can get confused. So when they know that they are on the right track, they are keener to go and it probably reinforces them to learn.

A Science teacher emphasised the engagement aspect of IWB use:

I find that the year 8, 9 are very difficult to engage, what I have recently been doing is showing graphic images or provocative images that hopefully will get them to listen, so I guess, one would be engagement.

A teacher who had only been using IWB from last one year was not sure about the impact of IWB on her students but she gave reference of another Mathematics teacher:

> *Well, I don't actually know because I have only used it really with my science classes and that's already a subject where the students are very receptive to all different types of stuffs. I know that one of my colleagues has had one installed in her Mathematics class and I think she has been, just from what she said, she is really happy with it too because the students have actually became more engaged with that, but I have actually used it with my science class but yeah, it has been pretty positive.*

Further, a Design and Technology teacher was also not in the position of commenting about the impact on student learning. He said:

> *I haven't noticed it from a student's perspective but from my perspective it's been much easier, especially if I am, because I work a lot on program with software, so not only do I teach IT but I also teach things like electronics where we actually do a lot of design work on computer and it's normal to show to the students that what it is, what they can do so that they can follow step by step.*

There was another teacher who teaches Curriculum support did not think that IWB had any impact in making the students more interested in learning.

> *Not always. I mean, I would like to say it makes the difference when they go out and they want to learn everything in all their other subjects but they don't.*

A Science teacher who uses IWB on regular basis said that IWB cannot be a substitute for a good teacher:

> *I think that it's a tool, like any other tool, like the use of computers, like the use of, you know, any other ICT. So I think it makes the students more interested but at the same stage, I have been using it for long now, and they just expect it when they come in. So I don't think, personally I don't think that a board in the classroom is going to make a bad teacher suddenly a good teacher. So I think a lot still comes back to the teacher rather than*

what tools they have. But if you have got tools that help the students to be a little bit more engaged, then that is an advantage.

A Mathematics and Science teacher who thought IWB has no direct impact on student learning said:

Well, it hasn't had a great impact at all. It's just another piece of technology. They are so use to having new technologies coming in all the time. It hasn't impacted them, if anything just shows them that school is keeping up-to-date with the technology and so they are on the right track.

11.4.4.2 Learning Outcomes

The second aspect of student learning addressed in this research is the learning outcomes. In order to make an attempt to find a link between the IWB use and the learning outcomes of the students and also to gather understanding of kind of impact, the teachers were asked to comment upon the kind of impact of IWB use have they noticed on the student learning. The teachers were also asked if they have ever noticed any kind of impact on the students' learning achievements as well. Most of the teachers stated that they were not in the position to comment about the impact of IWB use on student outcomes in the form of student achievements because it is hard for them to isolate the impact of IWB without doing a comparative kind of study and also there are so many other factors which could play role in it.

Like a Media teacher who is also an ICT coordinator at a School said:

It's very hard to say that because you can't really do that with one group of students by comparing in contrast that how they would have gone otherwise. And all my teaching, because I work in the lab with computers, is very heavily focused on the use of technology. It's a subject you can't really imagine teaching without it, so it is hard to say.

And another explained:

I think it's difficult to tell because it's not one class to another. The class that I teach as a group is quite a bright group of students, it is also, a sort of higher than average anyway, so *it is hard to say whether the use of IWB made them higher than that, so it's difficult or unless I could have that same group of students work without IWB and then with the use of IWB , so, difficult to say, but approach towards learning has definitely improved.*

A Science teacher said pin-pointing impact of IWB alone is difficult because other technologies are also used:

I haven't actually really looked into that very much. All our students have, it's a little bit, I guess, unique here in that all our students have their own personal laptops anyway. They are sitting there watching me, what I am doing up there, then they are doing what they need to do on their own, so I think they would have impact to it if I could compare whether the IWB has actually that much impact. It's hard to pinpoint what is making that happen.

But couple of teachers did mention about their attempts to evaluate the impact of their IWB use on the learning achievements of their students and found out that IWB had positive impact on the learning outcomes of the students. For example, a Science teacher who actually tried to compare the results of students (with and without using IWB) saw some improvement. He said:

Yeah. I looked at a presentation about some people that they could use it (IWB) if it's beneficial, so I looked at the grades and I tried to do as much as I could, I tried to normalize it by removing the students who didn't do any work on it and I saw about 2 point sort of, like B to A- kind of improvement across the whole class.

Similarly a Mathematics a Science teacher, who actually did not do any study but just thought about the results of his previous year students (did not have IWB) with his current year students, reported an improvement:

That's very hard to tell that to what extent that is to do with IWB. There is no objective study done about that, personally I sense in Mathematics and Science the kids going through, without being able to point to a data, I would say have better results. The latest measurement results, for example, thinking of this cohort and last year's cohort, in the way that the students, in the way that they set their work out, I think, would have a fair bit to do with the way they learnt through the whiteboard, see it on the whiteboard.

Further, there were also some teachers who revealed that they had noticed improvement in some of the basic learning aspects of the students (mostly regarding the understanding aspect) which could be connected to the improved cognitive ability of the students and hence better outcomes of learning (Blooms's Revised Taxonomy, Krathwohl, 2002). These teachers also provided elaborated examples from their day-to-day use of IWB to explain the kind of impact they had noticed on the students' learning outcomes. For example, a Mathematics teacher provided an example to justify that the use of IWB improves the understanding of the students regarding otherwise difficult to understand concepts. He stated that:

> *One example is of doing Pythagoras, I was doing Pythagoras with three-dimensional shapes, looking at the angle across the cube and you can actually turn the shape, so it looks like a triangle and they go, oh I know how to do that and then when you turn the shape the other way, they go, oh I know that now and that was year 9 and I was doing ten-dimension Pythagoras and they find it much more easier by just seeing it on the board.*

Similarly a Science teacher also gave couple of examples to justify her point of view:

> *I think learning perspective is wonderful because I like the one that focus lots on visuals, it's so much clear and the diagrams you can draw, you know, the structure of the battery, how it generates, like, you know, rotating magnets inside the coil of wire and being able to do diagrams like that is great and being able to google the information to answer the students' questions. You can go straight on to the internet to find things out and to have visuals up there. If you are looking at genetics and animal mutations, they can sit back and see what you are talking about, why you are talking about and it gives the immediacy, it gives them great visuals on the big board, not just writing on the whiteboard.*

Another Literacy teacher also expressed similar views regarding the understandings of the concepts by the students:

> *I think it's not easy to evaluate that because you don't have tested for the learning outcomes in that sense. I think that they do pick up on concepts fairly well with, you know, with particularly sort of educational games.*

Further, a Literacy teacher who was in his first year of using IWB in his teaching gave an example to point out that the use of IWB can develop the abstract learning skills among the students when it was used in an interactive way in the classroom to include the students in their learning process. This kind of learning can lead to the development of higher order learning skills and ultimately to improved learning outcomes. This teacher elaborated by saying:

> *I can give you an example, the one where this particular program that they have, a game about the abstract of the proper or a common or the collective noun and so what they have learnt that if they get it right, it makes one sound and if they get it wrong, it makes one sound, sort of negative sound. So they learn what a collective noun is by that game. Now that hasn't been tested, but it's good revision, it's sort of, it's good repetition in the sense that they are doing abstract now which you can't see or touch but you can experience and so yeah, I think, there is this virtue in the IWB. That's, yeah, that's one example.*

Another Mathematics and Science teacher gave very valuable example to demonstrate the interactive use of IWB by the students to construct their own knowledge (another higher order thinking skill). He said:

> *Probably it's more interactive in Science where there might be a diagram where its labels are covered, so they come out and reveal that, so they tell the name before they reveal it and they might follow up from that. Like the example, let's say the structure of the cell and the purposes or the functions of each part of the cell, so when the part is revealed and the name is there, another student might come up and link up the part to its function and that way it contribute building on their own collective knowledge, the ideas rather than me just telling them.*

Based on the above stated findings, it can be said most of the teachers emphasized that the use of IWB in the classrooms help the students to understand the concepts quickly and in better way and some of the teachers also pointed out about the abstract learning and the construction of their knowledge. According to Bloom's Revised Taxonomy (Krathwohl, 2002) which was used in the theoretical underpinnings for evaluating the learning outcomes of the students for this research, understanding on the part of students falls in the lower categories and abstract learning and construction of knowledge falls in the higher categories of thinking skills. So, these findings provide some evidence of the positive impact of the IWB on the learning outcomes of the students but this evidence is just based on the perspectives of the teachers.

11.4.5 Negative issues related to IWB use by teachers

Apart from understanding the factors leading to the successful and effective adoption and use of IWB, it was also necessary to investigate about the factors that can be responsible for making teachers reluctant to use this technology. The teachers were asked to talk about the barriers or constraints they face, if any, during the use of IWB in their teaching and also about any negative aspect of IWB use which they perceive. The findings related to these questions are given underneath.

11.4.5.1 Barriers/Constraints of using IWB

Lack of time on the part of teachers was the prominent issue highlighted by almost all the teachers. Apart from this, technical difficulties and cost & readiness/willingness to use IWB are the kind of barriers suggested by some teachers as well.

A Science teacher shared her experience:

> *Lack of time; time to find out, like, really how much of it that you can use and what you can use with it.*

Another teacher who also provides IWB training in his school expressed his concern by saying:

> *Teachers have, always have problems with time, they are always very very busy. They are working day and night, many of us and we always need to learn new things and there are so many things we could be learning. I think in teaching, juggling a lot of competing demands and it is very difficult to do it all very well. So, most people complain, not much time. It's not easily fixed either. It's not just about training; you can supply training if they can find the time to attend it too.*

Talking about the other possible reasons behind teachers being reluctant to use IWB, he said:

> *Well I think teachers who have been doing teaching for a very long time in the same approach which they have find effective to work are reluctant to change. I have seen in the high profile private schools, as well as the government schools, there is probably even less motivation for teachers who are getting higher results with senior secondary students. So they are less motivated to change because they think they are getting the good results, everyone is happy with the work, why bother change if it's working and I don't really agree with that approach, but then that's what some will say.*

Similarly another well experienced Science teacher talked about the constraints which he faces:

> *I think initially setting it up and making sure it work, making sure the laptop that you are using is compatible. We are a Mac school and in my previous school we had Mac as well, but using Mac with this Board didn't work too well. Yeah, I think the other thing is spare time. I have lot of spare time which I can spend getting all things ready which not everyone can.*

He further explained:

> *So time is probably the biggest problem, I think because it does take a lot of time, it might take an hour or so for a 40 mins lesson, so to find that time and how many 40 minutes lessons you have and all that stuff. Time I think is the biggest constraint. It's not a big barrier to getting people into it, because they acknowledge this is worthwhile, they say that it's really useful and they can see why kids really enjoy it but then it's just how do I do it and where do I find the time to do it. That's one challenge that I found. Cost is barrier too. I mean you have to spend 6000 dollars. You wouldn't get it much cheaper, I mean you can get cheaper but the cheaper you go, the worse the programs are that come along with the Board, so that is not good.*

A Mathematics and Science teacher said:

> *Just that it's very time-consuming to prepare that sort of stuff and to use it effectively. You can use it just like a straight whiteboard of course and then that's a very expensive whiteboard and it's very time-consuming to prepare interactive material, very hard to set it up to use it. That's one of the biggest things.*

An arts teacher highlighted some technical issues by making comparison between two kinds of boards:

> *The only thing is that the Promethean Boards are designed to use with the pen, which is whole lot of trouble, you always have to use a pen. With the Hitachi Board is a lot better in the way that you don't have to always pick the pen, and your finger will work on it. And the set up time is a bit longer, if you have to come and there is a whiteboard there but there is no computer connected to it, and so you need your computer, like all the teachers in the school have got laptops. So if you prepare your material on your laptop then you have to plug it in. And sometimes, some things can go wrong, It's technology and it could be frustrating, like your computer freezes and you have restart it, it can wastes five or ten minutes, so the main drawback is unreliability.*

A Mathematics and Science also mentioned about the technical problems:

> *There have been lot of problems with IWBs and that actually scared the lot of people off, they haven't been prepared to sort through that. They get into a classroom and the IWB is not working, they get frustrated and I always have the idea of having plan B. A lot of people get frustrated through the technical difficulties.*

Similarly a Science teacher said:

> *Sometimes the technology does, and it's usually the computer, it's not the Board but the computer that's running it, sometimes that locks up and we have to restart, so that can be a little bit delay and I can imagine the teacher that is less confident might feel that they would throw them. I just, as I said, I just say, ok, I think the board having a bit of freak, lets switch it off and start again sort of thing.*

Sharing his views, another Science teacher said:

> *For me personally, it's a double work, it's frustrating; it's a double connect, it's frustrating; it has to recalibrated every time, it's frustrating; I have to have my back to the kids which is bad, I mean it's not so bad in this school, but in the other school you can't stand having your back to the students. I always have to be at the board, like I am standing over here and I have to write something, I have to go to the board, the light can be blinding, there is lots of things that go wrong with them, they are good things as well, but they are painful.*

Problem of slow internet connection had also been mentioned by some teachers. A teacher commented about this:

> *I guess it's not so much the board but when I am using the internet, if it becomes very slow, then that causes an issue because then it effects what I am displaying on the board and so yeah, there are times when our internet becomes incredibly slow and then I give up and like, don't worry about it, we going to have to go back to the books because it's just too time consuming.*

And another one said:

> *You know, the internet goes down here and there, that could be frustrating.*

A Literacy teacher mentioned about another kind of problem:

> *So the other thing about the IWB is that the writing, I find, isn't as good as the just writing on the whiteboard. It's ok to indicate a few things, but I think if I am trying to write notes on the whiteboard, it doesn't look very neat at all and I haven't go to the stage where I can very effectively or quickly type up.*

Similar problem was pointed out by another teacher:

> *I guess the problems with writing on them sometimes, although the technical support at the school is very good. For me the biggest thing has been, as we now have a very short lesson of 30-40 minutes, so if you are coming into the class and the Board is not On, then by the time you start the board up, you actually end up with more reduced lesson and so, that's one of the things, I think, particularly being a secondary school teacher. And I guess that's quite time consuming.*

A Language teacher revealed:

> *I guess, sometimes for me, it's that fear of making mistakes. And also to know more where to find those links and not make them all up by you because that takes time. If you can find that's already been done, that's a great help. Yeah, at the school you are really busy doing all the things and that just adds to it.*

Another language teacher who had recently started using IWB said:

> *At the moment, I mean I am using that, as I mentioned before, for one term only. No, in this short time, I had no problem, I mean, a part of, I mean there is a certain software to be installed in the computers to do some special features on this IWB and it yet has not been installed in our computers but we still use it.*

11.4.5.2 Negative aspects of IWB use

Some of the negative aspects of the use of IWB which were brought up by some teachers are over-crowding of information for students leading to fatigue or irritation; changed expectations of the students; and extra responsibility on the part of teachers.

A Science teacher who wa s new user of this technology expressed her concerns by saying:

> *I have to be a lot more vigilant as regards to, you know, what students do on the whiteboard or whether they, because obviously if kids come up and writing stuff on that, it's very public, like the whole class can see it , things like that. It's a, the potential is there for it to be another medium for harassment, that is a thing you have got to be aware of, because it is so public. But as long as you are aware of that, you can make sure that it doesn't happen or minimize it. And you have to make sure that the students are aware of the fact that it does cost money and they need to respect, to take care of it you know, all that sort of stuff. So that side of it, you are responsible for an expensive piece of technology.*

She also added:

> *They can get fatigue. If you just have theory theory theory with the pictures then it's just like watching PowerPoint and you know they can get irritating for anybody, and boring. Kids need to get more of discussions, or watching video and that sort of stuff. If you can use it, make sure you do that, otherwise it just like watching PowerPoint after PowerPoint and probably they don't learn that much.*

A Media teacher presented his perspective as an ICT coordinator of the school:

> *The biggest negative is cost, it's still, it's still an expensive technology. The other inevitable part of that is the staff readiness, teacher's readiness to take on technology as well as IWB. It is very very varied, from people who are very involved and use it a lot to those who don't or absolutely minimum and this has always been a problem with education and this has not always related to the age, I be one of the oldest teacher here and I use it more than almost anyone.*

Another teacher put forward his views and concerns by saying:

> *Yes, my concern is that as teachers, of course the students also, but as teachers we need continuous training of this technology, continuous training of this technology and of course, I mean every day something new appears in this IT area, the students have to be encouraged to use all this technology.*

An English teacher drew attention to possible negative impact of IWB on the development of students learning behaviours:

> *I think that their expectations have changed a little bit. I think in some ways there are some negatives things that have developed as they are becoming more passive learners. Sometimes I feel that sometimes, you know there expectations that they will be given information. It's a good thing and they should except that but then you just take away those prompts and they will have quite a bit of difficultly because I wonder that's because they are not training their brains to be able to adapt but I don't know.*

Another Language teacher also showed similar concern:

> *And, I mean, I don't think that I could just use it, I like that to supplement what I am doing. I think, we are heading towards times where kids won't have pens and papers. We have to get use to it. We can't just go from that to that, you know, we have to make that transition for the students get used to it. You know, they don't have to carry their books around, they can have everything in something like little iPad.*

When asked about the negative impact of IWB on learning of students, a teacher who had recently started using IWB:

> *I don't think so; no I wouldn't say it has a negative impact on learning, no.*

Another teacher, who had long experience with IWB, also gave same answer but from teacher's perspective of IWB use:

> *I haven't found a single negative thing yet. It's just been all perfect for me.*

11.4.5.3 Overcoming Barriers

In order to gain some new ideas or suggestions to deal with the negative factors which lead to reluctance on the part of the teachers, as far as IWB use is concerned, the teachers were also asked to share their experiences or ideas which can be helpful in overcoming the barriers in the effective use of IWB. Many teachers who had long experience with IWB shared some very valuable ideas which can be adopted by the schools and even the individual teachers who are novice users of IWB.

An ICT coordinator talked about the strategic plan executed by his school to encourage the teachers to use IWB and to overcome the hesitation shown by the teachers to use IWB in their teaching. He said:

> *Look, one of the first thing, after we had a three year strategic plan at the school, the very first thing that we did was to give laptops to teachers because there is no chance for the teacher to get students actively using technology, if they don't, if the teacher doesn't know how to use it themselves and so that has been a big success at this school because now every teacher uses the laptop for marking attendance, they use it for marking, well assessing*

work. The last assessment was all done in the same way by using the laptops. And it's a way of getting teachers onboard because they had access to the technology, they are made to get comfortable to the point that they start to getting expand on that.

He also mentioned about the Government strategy/funding which had helped their school in going on the path of introducing more technologies in the classrooms.

I think the central government 'Digital Revolution' has had a bigger impact on the school, on our school. We have a lot more technology, not just computers but certainly a lot of computers and a very good wireless network so you can get internet anywhere in the school. We are always looking up for new opportunities. So the school has done quite well out of the federal funding. We also have very good IT support staff who are open to new ideas and very helpful staff.

A Language teacher shared her method of dealing with problems related to IWB use by saying:

Speaking to the other people, I think it's good to speak to other language teachers, because they might have made up their own resources, and it can be shared, like if I have made something, I can give it to someone else and they can give me their things or can suggest if they find some links. Like there is another language teacher, she found some useful links in French, which I could use in French and that really help.

A Science teacher, who thinks, remaining calm and comfortable is necessary while facing a technical problem related to IWB, said:

Yeah and when the things go wrong, I am also comfortable with it. That ok, looks like the board has a bit of bad mood or whatever. We going to have to turn it off and start again. That's the thing. I have got no problems with that. If things happen, you know, if something happened, there is whiteboard still in place; I mean the ordinary whiteboard, so I could go back to doing that. I just don't like it that much, but I could do that.

11.4.6 Future Use of IWB by teachers

All the teachers had shown their willingness to keep on using the IWB in future except for one teacher who said:

> *I would, as I said, I would probably stay away from the interactive whiteboard and go for something in my hand the interactive connected to the whiteboard. So rather forcing me to stand there, I would be walking more and become more student-centered rather than being teacher- centered which would be lot better.*

The other teachers were very keen to keep exploring and learning about the new possible use of IWB and to keep using the IWB in their teaching. One such teacher who had recently started using IWB stated:

> *I want to keep up with it, I would like to be more effective and more efficient with it but it's how do I do that and how do it formalize, I am not sure.*

Another teacher said:

> *Well, I just want to use it more and just want to learn how to use it more effectively.*

A Science teacher revealed:

> *I would definitely. I always am looking to make sure that I could use it in a better, more effective way, more out of what its potential is, yeah. It's going to be a fundamental part of what I do, yeah.*

Similarly another Science teacher expressed his willingness by saying:

> *I am going to use it as long as it is available. And for me helping out other people I guess can be the other way to go. I am sharing resources. I can have the faculty, so I can share the resources with them once I make them. But yes definitely keep using it, trying to find new ways of using it as well and new ways of putting stuff in to make it, even more interesting for the children. Technology gets developed and you get new ways of doing things and you don't usually want to keep doing it in the older way and not get stuck in the old way.*

Another teacher who was very positive about keep on using it said:

> *I could not imagine if I could teach without that. I don't even carry a whiteboard maker with me now. I always used to have a pen and a whiteboard marker in my pocket, no more whiteboard marker for me now. So I would feel disadvantaged if I would walk into a room without an IWB in it.*

A language teacher who initiated the use of IWB in his school clearly stated:

> *From the very first moment I joined this school, my report I submitted to the principal was on this way, on this path, I mean to get more and more IWB and we have at least one in each class. This is my point and for next year my report was to at least to have IWB in the classrooms where we deliver language.*

A Science teacher also said:

> *Well as I said I use it in every lesson all the time, so I don't see that changing. I don't see me using it less. It's more like if there room to use it more. I have looked and see what other learning objects and things out there that are available to use with it but again because my focus is sort of year 11 and 12 Chemistry, they are less available at that sort of level than say in the primary school, so I don't see a lot changing but I definitely don't see me using it less.*

Another Language teacher expressed the willingness of keep on learning about better use of IWB:

> *I think, I want to keep on learning because I remember when I first learnt few things in the first year, I felt like I need to learn bit more and this year I feel like that even more. And the colleagues share what they know with each other and that's good that they share, and then I share what I know with someone else and its good, passing on what I have learnt to someone else.*

An English teacher showed some concern about her progress in future use of IWB:

> *I feel like when I first got introduced to it, I move quite quickly. I learnt, I got quite few skills quite quickly and I now I feel like it's sort of stopped and I am not pushing out much forward, much more forward probably because it's fulfilling the needs of the*

curriculum. I feel that now I have got to this skill level, it will take quite a bit of time and effort to move on with it and that's probably what's holding me back, and I am sort of sitting in there a little bit at the moment. I guess, what's going to push me out of that. I will probably have to be pushed by probably something school directed.

A Media teacher talked about some technologies that could accompany IWB in future and said:

Look I think, I just recently when I had a look at a thing called as Virtable, it's a table with IWB like camera that can rotate down to the table top and you can use it as a desk where the people are around the desk and interacting with the computer environment, much likely the Microsoft interactive desk. And I think we will see a lot those kinds of interactive technologies as the technology improves. We have already seen the tablet type technology, you know, with touch screen and only the news this morning that the Microsoft projects the future where there will be laptops with the interactive devices that you wear etc and I find with the iPhone, you can talk to the iPhone and it will do things, so changing our whole tradition of the way that we think of a computer. So I see, you know, with students coming with their iPhones, which they do and all sorts of different application, I have an application free one on my iPhone called 'Dragon Dictation' that I have been trying and show to the people. So you talking to it and it type the text with very good accuracy. So everything is changing, and the IWB is one component that is one of many for the future.

And a Design and technology teacher also gave a very elaborative example of the way he wants to use IWB in future:

I would, I would be most frustrated because I don't have IWB with multi-touch function and I find it very frustrating because I want to expand things, I want to use the multi-touch functions and it's hard. And that's because I am now use to tablets and other multi-touch devices but certainly one of the areas that I am wanting to develop is my understanding of the software and that's basically what it is, an understanding of just learning how this software works. So how much I will be able to use that, one example I can think of is quiet often I do build and program a line tracking robot and explain to the students how they are going to program it so it will follow a line. Traditionally, I would *always draw a big black line on to the whiteboard and then draw the robot on the white area or black area, its movement. So if I was more competent with the IWB, I will actually be able to develop a learning practice for kids where I would actually colour simulation of the robot and actually tracking on it and explain it to the students that for the robot to be able to detect this, it must do this and things like that. One of the really frustrating things I find with the whiteboards is that there is only one because I would love to, I normally work on two screens and I often like to have the ability to project on one that what we are doing and then demonstrate on the other one.*

11.4.7 Recommendations for novice IWB users

Towards the end of the interview, all the teachers were asked to give some suggestions for other teachers to help them to successfully adopt IWB technology in their teaching. All the teachers suggested that teachers who are new users of IWB need to spend time just to play around with it, especially when they get access to the board without having the students in the class, so that they can explore the functions of the board without any pressure and always ask for help, if needed.

An experienced teacher very clearly stated:

> *Look I think they have to understand that there is a typical process that they will go through and that they start out simply as a projection device and then they go to the stage of ok we can do all that and now I want to do more, I want to be able to interact with the board more and they will start to go down on that path and eventually they will see more and more classrooms where the students are using the Board, so I think, that's a normal progression and you can't really skip steps easily, you can't go from a beginner to end high user straight away.*

A Language teacher suggested:

> *Not to be scared, just play around. And you know I always do this in my computer on my desk, before I go into the classroom just to find things and play around with them before so that I can be more prepared with it when I go into the classroom. So yeah, just have a go, go with things.*

A Mathematics and Science teacher said that practicing on the board when no students in the class can help the teachers to be more efficient user of IWB:

> *Have a go, try, play around, experiment, explore. Play around with its software in your own time. Go into a classroom when there no class there and then try it.*

An Arts teacher also emphasised on this point of doing practice when there are no students around:

> *I think I will give an advice to have a go with it, have a play with that. And also, don't try to learn how to use the IWB at the same time when you teach the class. Because if you are not familiar with the technology and you hit a button and things gone wrong which you don't know how fix then you are frustrated in the classroom and kids start to misbehave and you are too busy thinking about the whiteboard and are not thinking about the lesson. So to the teachers who thinking of using the IWB, I would say, try it when you do not have the class and spend a session to stay around and to fix things, so that when you hit that button and everything goes blank, It's no drama.*

Similar advice was given by a Science teacher:

> *Well look I think that they need to keep playing with that and that's what I said to staff here when they had problems, I said just sit there and try things and obviously they do that in a situation where you have got access to the classroom without the students but a lot of people, just like computers, a lot of people get stressed about, oh I don't want to do this because I might damage, but in reality if it locks up you just switch it off and restart. So, be prepared to actually just fly and play with that and have fun.*

A Design and Technology teacher recommended attending the training sessions:

> *The best advice is to practice, attend training sessions, they are really really useful. And the only way that you get competent at it is by using it.*

Another teacher also highlighted the importance of attending training courses:

> *Probably just push yourself to go to the some of the worth courses. They are useful because they show you the technology; they show what you can do with that, that is helpful. That's probably the biggest help as a teacher for me.*

A teacher who teaches Language limited his suggestions for only Language teachers. He said:

> *My advice is for this, I mean there are different kinds of teachers. All teachers, I mean, follow their own approaches in their own subjects, I would speak only for language teachers. Yes, I mean, my advice is that they will solve many many behaviour problems in their classrooms if they use the technology. That's my one point and second point is they have in front of them, the whole world in IWB, internet, links with other classes. For example, we had video conference with, currently with five different schools in different countries and it did work perfectly with IWB. I mean, my advice, yes I encourage all teachers is to use IWB, this is my advice because of many reasons.*

A Literacy teacher suggested that it is mandatory for teachers to go for IWB training because the educational scenario is becoming more technology integrated:

> *I think that the, I think they probably need to be, kind of alerted to the fact that this is the way education is going and that probably some basic training in it wouldn't hurt to get them going because in the actual, kids can show you a bit themselves about how to use them because they had them in the primary school for long time and they also probably know roughly that the technology for it to be operative. What else could I tell, that you know, you need to, sort of, keep practicing it and try to use it regularly because otherwise if you will not use it, you will lose it.*

A Science teacher emphasised on the need of asking for help whenever needed:

> *I think, have a look, it would be a good idea to have a look what other people are doing with it and if you don't know how to do stuff then ask how to do it, go to a conference like the one I went to and then importantly actually do it like, have a go, even if you can't use it very well to start with, you will just get better by using it more and more.*

Another Science teacher also had similar suggestions:

> *Use it. You can have somebody who knows how to use it nearby to help you out. If possible, you should see lessons. You should see lessons that people already have done using*

them and how to pace the lesson with the board. But if you don't have the support to learn to use it or understanding, how to use it, that can be tricky.

Also a teacher suggested taking help from students as well:

Well, my suggestion would be, to have a go and also to actually let the kids teach you. Because a lot of them are very savvy about how to use the technology and it's great to actually get them to feel involved, you know and it's there for actually get the students to feel involved and yeah, have a go and get the students to teach you as well. It's a two way thing.

A Curriculum Support teacher talked about her concerns regarding the lack of resources for secondary school level teaching and also gave her suggestions. She said:

I guess the best thing is to, you know, I would be go and talk to other teachers that have already been using them, just to see the potential, first of all and I would certainly say, go to a workshop. And you know, again I have been to a workshop, that are been here, that are been run and the unfortunate thing is, it was all based in primary, so I stop going because it was, the resources that they were showing, I think that I can't use any of those so I think how can I adapt it. But for other teachers, I would certainly, you know, engage with other teachers who are using them currently, share their resources, get those resources, see how they work because It's only then they are going to be encouraged to make their own resources and so yeah, go for it.

11.5 Conclusion

Availability or easy access to IWB, proper support and training are the pre-requisites to encourage the teachers to adopt IWB in their teaching. The main factor which contributes towards the positive attitudes of teachers and their willingness to use this technology is its advantages for teaching in an easy, interesting and better way. The features, such as being able to use multimodal style of teaching, record the lessons, provide instantaneous access to internet and various interactive resources, and the ability to write/annotate on the screen are some of the advantages mentioned by the teachers. The second key factor which plays a role in the adoption of IWB by the participating teachers is their perception about the potential of IWB to make learning better for the students by making it more interesting, engaging, dynamic and easy for the students. Most of the teachers recognised that if used properly, IWB can be very helpful in being able to cater for different styles of learning, motivating students to learn, to initiate and participate in classroom discussions (constructive learning) and also help the teacher to deal with the classroom management problems.

It was clear from the responses of the teachers that majority of teachers allow their students to interact with the IWB in one way or another, but some teachers who are reluctant to let students use the IWB identified classroom management issues, limited option of physical interaction with the board at one time are mentioned by the teachers as a main reasons for not doing so. Also the kind of interaction at the secondary school level is different from that of primary level students, mainly due to the differences in the type of curriculum at both levels. Teachers have clearly recognised the positive change in the approach towards learning of the students, especially highlighting the increased interest and the engagement level of the students when taught using IWB. Some teachers also mentioned about connection between IWB use and improvement in the learning approaches of the special need students and students with lower ability. Few teachers also mentioned about link between use of IWB and improvement in the learning outcomes of the students i.e., improved understanding of the concepts, especially the difficult one. Couple of them associated the abstract learning and construction of new knowledge by the students to the impact of IWB use, though only two teachers mentioned a slight improvement in the learning achievements of students due to use of IWB based on their own observations. Most of the teachers suggested that a longitudinal or comparative kind of study is needed to investigate the impact of IWB on the learning outcomes of the students.

Lack of time to learn about effective use of IWB, lack of ready-made resources and technical difficulties are the main barriers indicated by the teachers. Teachers also drew attention to some negative aspects of IWB use, including a need of continuous training on the part of the teachers, the possible overloading of information, fatigue and changed expectations of learning methods by the students. When asked to give recommendations for other teachers who are new to IWB use, all the teachers suggested that effective use of IWB is a step by step process which starts with simple and basic use of this technology to supplement teaching, and can reach up to the point where the lessons are planned around the IWB technology using various kinds of available resources. They also stressed the need to attend IWB training sessions or workshops and to ask for help from others whenever needed.

Chapter 12
Discussion and Conclusion

12.1 Introduction

This chapter presents a discussion of the findings of the present study including both the quantitative and qualitative findings. These findings are discussed in relation to the research questions and a comparison with the previous research findings is also made. This is followed by the description of practical and theoretical implications of these findings, the limitations of this study, and recommendations for future research. The last section of this chapter is comprised of the final conclusion of this study.

12.2 Achieving the Research Aims

This study was conducted with the overall objective of investigating the impact of the use of the Interactive Whiteboard (IWB) on the learning approaches and outcomes of secondary school students in South Australia. More specifically the study was aimed at exploring several factors related to the adoption and utilization of IWB to see how these factors interact with one another and ultimately impact the learning approach and outcomes of the students. Apart from this overall objective, the specific aims of this research were: to analyse the adoption of IWB by teachers and students in the South Australian secondary schools along with the factors affecting it; to explore the classroom interactions using IWB as an educational tool; and to investigate the effect of the IWB adoption level and IWB classroom interactions on the learning of the secondary school students. To fulfill these aims, the study addressed the following general research questions:

1. How do the environmental, personal and attitudinal features of the teachers, and their general approaches towards teaching, influence the adoption of IWB and the classroom interactions when IWB is used?

2. How do the environmental, personal and attitudinal features of the students influence their reception of IWB, and their classroom interactions using it?
3. How do various school, teacher and student level factors interact with one another and what are their impact on the students' learning approach and outcomes?

These general questions further led to specific questions under three categories, namely school level, teacher level and student level. The specific questions for each category are listed in Chapter One.

The available research literature in the field of IWB use in education is comprised mostly of small-scale qualitative studies which include school-based (predominately primary school level) research projects such as case-studies and action research, together with discussion papers addressing various and different factors related to IWB use (Bennett & Lockyer, 2008; Glover, Miller, Averis, & Door, 2007; Holmes, 2009; Kelley, Underwood, Potter, Hunter, & Beveridge, 2007; Miller & Glover, 2006; Mohon, 2008; Murcia, 2010; White, Barnes, & Lawson, 2012). So there is serious lack of IWB research studies which have brought these critical factors together (including student learning) into a single model to understand their interaction with one another, and also of studies which have made an effort to link the use of IWB to student learning (learning approaches and outcomes), in an attempt to provide generalized conclusions regarding this critical aspect of the educational use of IWB technology. Further, the IWB research studies done in the Australian context are negligible, so the present study was designed with an intention to address these gaps in the previous literature.

The data for this research were collected using both quantitative and qualitative methods. For quantitative data collection survey questionnaires were used for school, teacher and student participants of the study. The qualitative data was collected only from the teacher participants using the face-to-face interview method. Both the quantitative and qualitative findings of this study were used to understand the relationship among various factors related to IWB educational use and to find answers to the research questions (RQs). Along with the summarised findings, a comparison is also made here with the findings of previous research studies and then the key findings of this research are given in the conclusion section.

Further, the limitations of this study; implications of the findings for the field of education and educational research; and suggestions regarding the possible direction for future research, are also given in this chapter. The findings of this study are discussed in the following sections. These sections are developed based on the themes generated by using the research questions (general and specific, Chapter 1) and the theoretical framework (Figure 2.8) as guidelines.

12.3 ICT and IWB related facilities

Under this section, the findings of this study related to the ICT facilities available to the teachers and the students, and the level of IWB integration into the classrooms in the participating schools, are discussed.

In relation to the available ICT related facilities at the participating schools, it was found that the level of ICT integration ranged from above average to very high, but none of the schools had IWB installed in all of its classrooms. Other ICT facilities available at schools included the availability of broadband internet connection and full internet access for the teachers and students, with the exception of one school where only about half of the teachers had internet access. Full access to software and hardware for the teachers was found to be provided by the majority of schools and half of the schools were found to provide full access to software and hardware to the students as well. In addition, all schools provided the on-site technical support to both teachers and students. It was also found that IWB related training sessions were run by almost all the schools in an effort to encourage the teachers to incorporate more ICT in their teaching.

12.4 Adoption of IWB by teachers

The findings regarding the factors which influenced the decision of the participating teachers to adopt IWB technology are discussed in this section.

The findings from the qualitative analysis of the interview data of the teacher participants of this research revealed that the availability of IWB to the teachers was the factor which played the most important role in making them think about starting to use this technology in their teaching. Availability of the technological sources have been pointed out by many researchers as an essential precursor to the adoption of any kind of technology by teachers (Albirini, 2006; Mumtaz, 2000). Smith, Higgins, Wale, and Miller (2005) in their literature review related to IWB educational research also pointed out that the easy availability or access to the IWB is a crucial factor for its adoption by teachers.

The findings from the interview responses of the teachers further highlighted other crucial factors which had contributed towards the adoption of IWB. It was found that, apart from its availability, the factors which convinced most of the participating teachers to adopt IWB in their teaching were their perceptions about the usefulness of IWB for improving the way of teaching as well as its usefulness for improving the learning of the students. Among these two factors, the teachers' perception regarding the improved teaching aspect of IWB was the more prominent one. This finding is very similar to previously reported (Albirini, 2006; Cox et al., 2003; Higgins & Moseley, 2001; Mumtaz, 2000; Sendecka, 2006; Teo, 2009; Xu & Moloney, 2011) findings regarding a strong positive relationship between teachers' perceived usefulness of technology (as an educational tool) and their positive attitudes towards using that technology in their teaching.

Most of the teachers talked about the facility of catering for different learning styles by using multi-modal presentations, flexibility, instantaneous availability of resources (internet), annotation and manipulation of text and visuals on-screen, the facility to save their work for later use and classroom behaviour management as some of the advantages which they thought would be helpful to them in their teaching. These advantages of IWB for teaching have been widely recognised and reported in the IWB educational research literature which is mostly at the primary school level (Betcher & Lee, 2009; Bourbour & Bjorklund, 2014; Hennessy & London, 2013; Higgins, Beauchamp, & Miller, 2007; Kelley et al., 2007; Kennewell & Higgins, 2007; Lee & Boyle, 2003; Littleton, 2010; Mohon, 2008; Murcia, 2010;

Shi, Yang, Yang, & Liu, 2012; Smith et al., 2005). So the findings of this study not only were in agreement with the previously reported findings but also contributed towards the IWB research literature by providing results from the secondary school level use of IWB.

Secondly, a deep analysis of the responses of the teachers also revealed that all the teachers strongly believed that the use of IWB in their teaching facilitates learning of the students by making it more engaging, enjoyable, fun, easy, dynamic, motivating, interesting, interactive and encouraging. Most of the research done on the issue of IWB integration into the education sector (mostly primary level) has concluded similar kinds of advantages of IWB technology for the students (Beeland, 2002; Hall & Higgins, 2005; Hodge & Anderson, 2007; Kennewell & Beauchamp, 2007; Knight, Pennant, & Piggott, 2005; Schuck & Kearney, 2007; Shi et al., 2012; SMART, 2006; Smith et al., 2005; White et al., 2012; Xu & Moloney, 2011; Yanez & Coyle, 2011). Again, the results from the present study can be considered as useful input to the research literature because this research focused on the teachers and students from the secondary school level.

Along with the above stated findings, it was also revealed by the teachers that the encouragement, training, on-going support provided by the schools, together with peer-support, were also the crucial factors which influenced their decision to start using IWB. These findings are in line with the findings of a studies done by Miller and Glover (2010) and Xu and Moloney (2011) which pointed to the positive impact of teacher professional development, or IWB related training, on the acceptance and use of this technology by the teachers, together with another study by Lai (2010) which concluded that the teachers recognise the value of IWB in their teaching and also the importance of attending IWB training workshops in order to learn to use it in a meaningful way. Apart from this, it was also found that some teachers started using IWB only because of the fact that it was expected by their schools, other teachers and even their students.

12.5 Attitudes towards ICT

This section discusses the findings of this study related to the factors which influenced the ICT related attitudes of teacher and student participants.

12.5.1 Teachers

As far as the teachers' attitudes towards ICT were concerned, the single level path analysis findings revealed that the teachers with higher perceived computer literacy, which included computer experience, computer competence and computer confidence, were highly likely to have more positive attitudes towards ICT. Mumtaz (2000) in her critical review of literature related to the factors affecting the use of ICT by the teachers, Higgins and Moseley (2001) in their study related to the teachers' thinking about ICT and learning and Jamieson-Proctor, Burnett, Finger, and Watson (2006) in their study related to ICT integration and teacher confidence all identified these critical factors (computer literacy and attitudes towards ICT) as playing important roles in the adoption and utilization of technology by teachers. Another research study by Albirini (2006) also drew attention to the possible positive impact of computer competence on the attitudes of teachers towards computers. But, this research further extended this knowledge by presenting evidence regarding the strong positive influence of computer confidence, competence and experience of the teachers on their attitudes towards ICT.

The path analysis findings revealed that there were two more factors which had indirect impact on the attitudes of the teachers towards ICT: these were the gender of the teachers and their age. The gender of the teachers impacted their ICT attitudes through the computer literacy factor with male teachers tending to have more positive attitudes towards ICT as compared to the female teachers. This accords with previous research (Kusano et al., 2013) comparing ICT related attitudes of teachers from the U.S. and Japan which concluded that male teachers from Japan had more positive attitudes towards ICT than female teachers. The second indirect factor, i.e. age of the teachers, showed the influence through the teaching experience factor, with older teachers more likely to have more positive

ICT attitudes. However, Kusano et al. (2013) found that the younger U.S. teachers had more positive attitudes towards the use of ICT in education than the older teachers. So the age related findings of the current study are in contrast with this previous research evidence. This result calls for further study.

12.5.2 Students

The findings of single level path analysis of student responses revealed that, just like teachers, the most prominent factor which showed a strong direct influence on the attitudes of the students towards ICT was their perceived computer literacy (computer experience, computer competence and computer confidence of the students): students with high perceived computer literacy were highly likely to have more favourable attitudes towards ICT. Similar results were reported by Levine and Donitsa-Schmidt (1998) and OECD (2006) which also suggested about the positive link between computer related competence, confidence and experience and the computer-related attitudes. But the present study provided an additional aspect on this issue by pointing out that the positive influence of the high computer literacy not only relates to computers but also to ICT as a whole, including many different types of technological tools.

Further, the frequency of computer use by the students at school and frequency of computer use away from school were two factors found to have an indirect effect on their attitudes towards ICT. This impact was mediated by the computer literacy of the students. It was indicated that the impact of students' computer use away from school on their ICT related attitudes was much stronger (medium impact) as compared to their frequency of computer use at school (very small impact), although both of these factors had positive influence. A study conducted in Western Australian government schools regarding the influence of students' school and home environment on their ICT related attitudes and behaviours also highlighted that home ICT environment of the students as having a positive impact on their ICT related attitudes at school (Cavanagh, Reynolds, & Romanoski, 2004). Similarly another research study conducted by Alamhaboub in 2000 which included 562 students from 10 public schools in Kuwait, reported that the availability of computers at home correlated with more positive attitudes towards computers

(Knezek & Christensen, 2002). Along with confirming these previous research findings, the present study again provided the findings related to attitudes towards ICT as a whole rather than just the computer attitudes.

Along with this, the path analysis results indicated that the attitudes of the students towards ICT were also indirectly influenced by the ICT related facilities available to them both at school and away from school. At school, it was found that more access to the internet tended to make their attitudes slightly more positive towards ICT, and this impact was mediated by students' frequency of computer use at school which was further linked to their computer literacy. Secondly, the students who had more ICT access away from school (students owned a computer and had internet access) were also likely to have slightly more favourable attitudes towards ICT. The indirect impact of this factor was mediated by the frequency of computer use away from school and computer literacy. Hopson, Simms, and Knezek (2001) reported the findings of a study which investigated the effect of technology-enriched classroom on student computer related attitudes and found out that the availability of technology in the classrooms (school) has positive impact on the students computer related attitudes. So the current study presents similar findings.

Apart from this, the single level path analysis findings also indicated that the students in higher year levels tended to have slightly more positive ICT related attitudes as compared to the students in the lower year levels, although the difference was extremely small. These findings are in contrast with the findings reported by Knezek and Christensen (2002) where the computer related attitudes showed a slight decline from lower grade levels to higher grade levels. Although it is important to note that the previous study was focused on the primary year levels whereas the present study involved secondary grade levels.

Thus this study revealed that the more the availability of ICT related facilities at school and away from school, the more is the frequency of computer use by the students both at and away from school which is linked to more computer literacy in the form of computer related experience, competence and confidence, and this further has positive impact on the attitudes of the students towards ICT as a whole.

12.6 Attitudes towards IWB

In this section, the findings of this study related to the factors which showed influence on the IWB related attitudes of the participating teachers and the students are discussed.

12.6.1 Teachers

In this study, the findings of single level path analysis for teachers' data showed that teachers' perceived IWB literacy (IWB competence, IWB confidence and IWB experience) and their teaching experience were the two most prominent factors which were found to have strong and positive influence on their IWB related attitudes. It was interesting that the effect size for both these factors was same, although the total effect size for teaching experience consisted of both direct and indirect effect. The indirect influence was seen to be mediated by the attitudes of the teachers towards ICT as a whole. So the current study revealed that the participating teachers who had more teaching experience were highly likely to have more positive attitudes towards the use of IWB in their teaching. These findings are very similar to the findings of impact of teaching experience on teachers' attitudes towards ICT i.e. in both cases, the influence of teaching experience is positive. This similarity can be explained by considering the fact that IWB is one manifestation of ICT (a broader term used to includes different educational technologies) and so it is more likely that the teachers who possess favourable attitudes towards ICT as a whole also possess favourable attitudes towards IWB in general.

Secondly, the direct positive and strong relationship between teachers' IWB literacy and their attitudes towards IWB clearly indicated that the teachers who perceived they were highly IWB literate were also very likely to have more positive attitudes towards IWB. Thus teachers who feel competent, and confident and are experienced users of IWB are also likely to develop more positive attitudes towards this technology, something other researchers have also started to point out (Hockly, 2013; Kennewell & Beauchamp, 2007; Kennewell & Morgan, 2003; Lai, 2010; Miller & Glover, 2010). And it has been widely noted that the attitudes of the teachers towards any technology plays a central role in its adoption and utilization (Albion, 1999; Albirini, 2006; Cox et al., 2003; Donnelly, McGarr, & O'Reilly, 2011; Higgins & Moseley, 2001; Knezek & Christensen, 2002; Kusano et al., 2013; Mumtaz, 2000; Scrimshaw, 2004; Sime & Priestley, 2005; Somekh, 2008; Steketee, 2005; Teo, 2009; Xu & Moloney, 2011). So the current study corroborates the findings of previous research.

The findings of path analysis also showed that the teachers' IWB related attitudes were directly influenced by the IWB support the teachers had from their schools, including technical support, workshops, encouragement and help to use IWB, with the teachers who had better IWB related support from their schools tending to have more positive attitudes towards the use of IWB in their teaching. As already mentioned in the above section related to adoption of IWB, the teachers in their interviews had also pointed out the important role played by the IWB support in making their attitudes favourable towards starting to use IWB technology in their teaching. So these findings of the path analysis are consistent with the findings of the qualitative data analysis of the interview data.

Apart from this, the results of the single level path analysis also highlighted the strong influence of teachers' attitudes towards ICT on their attitudes towards IWB, where teachers with more positive attitudes towards ICT were also likely to have more positive IWB related attitudes. This can be explained by the fact that IWB is one form of ICT available in the educational sector, and it is not surprising that the two are related.

Among the factors influencing IWB attitudes of the teachers, in an indirect manner, was the perceived computer literacy (computer experience, competency and confidence) of the teachers which had a very strong (strongest among all the factors) positive influence. Other indirect factors included the age of the teachers mediated by teaching experience, with older teachers tending to have more positive attitudes towards IWB. These findings are in contrast to the findings of a comparative study done to investigate the effect of ICT environment on teachers' attitudes, which found that the younger teachers in the developed country (U.S.)

had more favourable attitudes towards ICT, including IWB (Kusano et al., 2013). Among the male and female teachers, male teachers were found to have more favourable IWB attitudes as compared to the female teachers. It was found that the relationship between the gender of the teachers and their IWB attitudes was mediated by computer literacy and the attitudes of the teachers towards ICT. A similar findings related to gender differences in the attitudes of teachers towards technology has been reported by Kusano et al. (2013).

The findings of the interview data of the teachers also highlighted factors identified as reasons for them developing positive attitudes towards IWB. These factors were the teachers' perceptions about the usefulness of IWB technology for improving their approach to teaching, and also their perception about its usefulness for helping the students to learn in a better way. Both these factors, according to the teachers, played a crucial role in making them start thinking about using this technology. This kind of relationship between teachers' perceived usefulness of technology (as an educational tool), and their positive attitudes towards using that technology in their own teaching, has been reported widely in the ICT research literature (Albirini, 2006; Cox et al., 2003; Higgins & Moseley, 2001; Mumtaz, 2000; Teo, 2009; Xu & Moloney, 2011) and the findings of this research confirms that same kind of relationship also exists in the case of IWB technology.

12.6.2 Students

The results from the single level path analysis showed that students' attitudes towards ICT was an important factor which influenced their attitudes towards IWB. This impact was direct and at a medium level meaning that, like teachers, the students who had more favourable attitudes towards ICT also tended to have more positive attitudes towards IWB. Again, this impact of the students' ICT related attitudes on their attitudes towards IWB can be understood as IWB is a form of ICT (a broader term used to includes different educational technologies).

The second factor found to have direct impact on students' attitudes towards IWB was the frequency of IWB use by the teachers. The results from the path analysis clearly showed that the more frequently the IWB was used by the teacher, the more the students tended to develop positive attitude towards the IWB. This was an interesting finding because no previous IWB research study was found to have reported this kind of relationship between the students' IWB related attitudes and the frequency of IWB use by their teacher. However, White et al. (2012) in their study done to explore the attitudes of the secondary students at one South Australian school, did report students demanding increased use of IWB by their teachers.

Further it was found that the personal factors of the students such as their perceived computer literacy (computer experience, competency and confidence), the frequency of computer use by them at school and away from school, and their year level influenced their IWB related attitudes in an indirect manner. The findings revealed that the students with high perceived computer literacy also tended to have more positive IWB related attitudes. The impact of computer literacy was mediated by the students' attitudes towards ICT. This is again similar to the findings from the teacher participants in this study.

The frequency of computer use by students away from school was also found to have a small positive impact on the IWB related attitudes of the students, meaning students who used more computers away from school tended to be slightly more positive towards IWB. Apart from this, the availability of IWB was also found to have a slight impact i.e. more availability of IWB in the classrooms tended to make students' attitudes slightly more favourable towards IWB. Along with these, the access to the internet at school, and the availability of ICT away from school, also had extremely small indirect positive influence on students' attitudes towards IWB. All these findings collectively indicates that the availability and use of ICT related facilities including IWB, access to internet at school and use of computers and availability of ICT and internet facilities away from school can lead to make the attitudes of the students slightly more positive. All these factors were found to be influencing the IWB attitudes through computer literacy and ICT related attitudes of the students which is not an unexpected finding keeping in mind that IWB is a technology which falls under the broad category of ICT tools which can be used in educational sector. Moreover, the extremely small positive impact of year level of the students i.e. the students in higher year levels tended to have slightly more favourable attitudes towards IWB technology, was also similar to the impact of year level on their attitudes towards ICT.

12.7 Teaching Approaches

This section deals with the findings of this study related to the factors impacting the teaching approaches of the participating teachers. These approaches were studied as two separate factors, a conceptual change/student-focused (CCSF) approach and information transmission/teacher-focused (ITTF) approach. The findings for both of these are discussed below.

12.7.1 Conceptual Change/Student Focused Teaching Approach

Path analysis showed that the teachers' attitudes towards ICT had a direct, strong and positive influence on a conceptual change/student-focused teaching approach i.e. the teachers who were more positive towards ICT were highly likely to use a conceptual change/student-focused approach in their teaching. Also, the frequency of computer use by the teachers was directly and strongly related to their student-focused teaching approach in a positive manner. The third factor impacting the student-focused approach strongly, but indirectly, was teachers' perceived computer literacy: the more computer literate teachers were the more likely were they to use student-focused teaching approaches. These findings are in line with the findings reported by Voogt (2010) that teachers who are confident users of technology, and make extensive use of it in their classroom, tend to have a more student-centred teaching approach.

Apart from the above factors, there were others which had small indirect impact on the student-focused teaching approach of the teachers. First was the gender of the teachers, with male teachers being slightly more likely to use the student-focused approach. This relationship was mediated by the perceived computer literacy of the teachers and their attitudes towards ICT. Similarly, the teachers with more teaching experience were also slightly more likely to adopt the student-focused approach in their teaching. The impact of this factor was mediated by teachers' attitudes towards ICT. The age of the teachers also had indirect (mediated by teaching experience and attitudes towards ICT) but very small impact on the student-focused teaching approach with older teachers tended to be slightly more inclined towards using student-focused teaching approach.

12.7.2 Information Transmission/Teacher Focused Teaching Approach

As far as the information transmission/teacher-focused approach of teaching was concerned, it was evident in the single level path analysis that the attitudes of teachers towards ICT, and their computer literacy, both showed a strong but negative association with it: thus teachers with more positive attitudes towards ICT and more computer literate were less likely to use the information transmission/teacher-focused approach of teaching. This result is congruent with the relationship of attitudes to ICT and student-focused teaching approach in the previous section.

Interestingly, factors such as age and teaching experience showed similar association with the teacher-focused approach as they showed with the student-focused teaching approach, but the impact size for both these factors was higher in the case of teacher-focused approach. Thus older teachers, with more teaching experience, were more likely to use a teacher-focused approach than a student-focused approach in their teaching. The indirect association between the gender of the teacher and teacher-focused approach revealed that the female teachers were more likely to use the teacher-focused approach.

Interestingly, it was also found that the teachers who had more IWB support from their schools also tended to use a more teacher-focused approach. This result is rather surprising, as it might be expected that high levels of support would enable teachers to provide more variety in their lessons in a student-centred way. However it is possible that the teachers who were less computer literate and had less favourable attitudes towards the ICT were the ones that needed to receive more IWB support from the schools and had not developed skills to use the full potential of IWBs. However this association between IWB support and a teacher-focused approach could be an indication of a more complicated scenario which has not yet been addressed in the field of IWB educational research. So these findings may indicate a need for further research on this topic to understand the complex nature of the factors involved.

12.8 Classroom Interactions using IWB

This section deals with the discussion of the findings of this study related to the factors impacting the classroom interactions using IWB of the participating teachers and the participating students.

12.8.1 Teachers

In this study, it was found in the single level path analysis that the attitude of the teachers towards IWB was one of the major factors which had a strong, direct and positive impact on their classroom interactions using IWB, with teachers who had more positive attitudes towards IWB were highly likely to use IWB in an enhanced interactive way in their classrooms. This influence of the IWB related attitudes of the teachers and effectiveness of its use (more interactive use) by them has previously been reported in other studies (Hall & Higgins, 2005; Xu & Moloney, 2011). So the findings of present study are in line with the previously reported findings.

Another finding was that the attitudes of the teachers towards ICT had a positive, but indirect (mediated by attitudes towards IWB) and medium range of effect, on teachers' classroom interactions, meaning it was likely that the more positive the teachers' attitudes towards ICT as a whole the more interactive were their classrooms using IWB. These findings about the teachers' attitudes towards ICT and IWB and their impact on IWB classroom interactions confirms the previously widely documented ICT educational research findings that the attitudes of the teachers towards technology play a vital role in its successful integration by the teacher into the classroom (Albion, 1999; Albirini, 2006; Cox et al., 2003; Higgins & Moseley, 2001; Knezek & Christensen, 2002; Kusano et al., 2013; Mumtaz, 2000; Scrimshaw, 2004; Sime & Priestley, 2005; Somekh, 2008; Steketee, 2005; Teo, 2009).

It was also seen that the teachers who were more inclined to use the student-focused or conceptual change kind of approach in their teaching also tended to use IWB in such a way which could allow enhanced interactivity in the classrooms including them, their students and the IWB There was a positive, direct and medium effect shown by the student-focused teaching approach factor on the classroom interactions using IWB factor in the single level path analysis for teachers. This was also evident in the findings from the interviews of the teachers where many teachers mentioned that they use various IWB related activities in their classrooms in order to help their students to construct their own knowledge, and most of these activities allow their students to interact with the IWB along with their interaction with each other and the teacher. This is a very crucial finding of this study because it provides the evidence that if the teacher has a student-focused approach to teaching, then IWB can be used in an enhanced interactive way in the classroom. Jenkins (1999), Trucano (2005), K. L. Dix (2007), Kennewell, Tanner, Jones, and Beauchamp (2008), Higgins et al. (2007) and Voogt (2010) had previously mentioned about the relationship between the teachers' student-centred teaching approach and the effectiveness with which they use different technological tools in their teaching. Along with this Hennessy and London (2013), in their recent working paper for OECD, highlighted that the teachers' pedagogical approaches and their beliefs regarding student learning are decisive factors for their particular kind of use of all educational technology including the IWB. Hockly (2013) in his extensive review of IWB research literature presented this issue in a different way by mentioning findings from some studies showing that IWB can also be used by the teacher as a tool to support a teacher-centred or information transmission kind of pedagogical practices if they do not receive training to explore the alternative (student-focused) approaches of teaching with IWB. So the findings of the present study corroborate previous research findings that if the teacher has student-centred approach of teaching, then IWB can be used in an effective and enhanced interactive way in the classrooms.

The age of the teacher was another factor found to have impacted the classroom interactions of the teachers using IWB in a strong and positive manner. It is important to mention that the influence of age on the classroom interactions was comprised of both direct and the indirect (mediated by teaching experience, attitudes towards ICT and IWB and student-centered teaching approach) effect. So, based on these findings, it is reasonable to say that the older teachers who tend to have more teaching experience and more positive attitudes towards ICT and IWB along with student-centered approach in their teaching are more likely to use IWB in more interactive manner in their classrooms. The influence of age and teaching experience of the teachers on their classroom interactions using IWB has not been studied extensively before, so these findings indicate a need for follow-up studies to test these interactions and also explore and understand other factors which might play role in this. These kinds of studies are needed to inform the IWB related professional development programs in order to help the teachers to develop the effective pedagogical practices to use IWB to its full potential.

Further, it was revealed that the IWB related support provided by the schools was also directly, strongly and positively associated with the classroom interactions of the teachers using IWB, meaning that the teachers who had more IWB related support were more likely to use IWB in more interactive manner in their classroom. These findings are consistent with previous research studies (Albirini, 2006; Bourbour & Bjorklund, 2014; Glover et al., 2007; Hockly, 2013; Miller & Glover, 2010; Schmid, 2010; Shi et al., 2012; Smith et al., 2005; Sweeney, 2010; White, 2007) which also emphasised the importance of availability of resources, IWB related professional development and the on-going IWB support as the crucial factors for an effective and enhanced interactive use of IWB by the teachers. The possible reason behind this could be that the teachers who receive more IWB support actually have more opportunity to find, explore, exchange or develop the IWB related interactive resources which in turn can help them to make their classroom use of IWB interactive or enhanced interactive.

Apart from this, the perceived computer literacy and the perceived IWB literacy of the teachers were the other personal factors which had shown indirect strong and medium influences on the classroom interactions using IWB respectively. The more computer and IWB literate a teacher is, the better are the chances of IWB being used in an enhanced interactive way in the classroom. In a previous research study by Miller and Glover (2010), it was reported that the mathematics teachers who had high 'IWB technology proficiency' were more likely to adopt an interactive pedagogy. Another study by Schmid (2010) documented similar findings for English language teachers. Since the current study included the teachers from several subject areas, the findings from this study can be considered as an extension to the earlier findings (not just confined to one subject area).

Among the male and female teachers, it was found that male teachers used IWB in a slightly more interactive way as compared to female teachers. It is important to note that the impact of gender in this case was mediated by computer literacy and ICT related attitudes of teachers, so it is possible that these gender differences are a result of these mediating factors, because it has already been mentioned above that male teachers were found to be more computer literate, and had more positive attitudes towards ICT, as compared to female teachers. Research literature in general also shows a similar picture. Thus in a study conducted by Jamieson-Proctor et al. (2006), it was reported that male teachers were more confident in using ICT with their students for teaching and learning. Further it was found that the teachers who use computers more frequently at school also tended have slightly more interactive classroom when using IWB.

Based on all the above discussed findings, it is clear that the teachers' attitudes towards IWB, their age and the IWB support they received from schools were the most important factors to impact the classroom interactivity using IWB with the teachers who had more positive attitudes towards IWB, were older in age, and received more IWB support from the school were most likely to use IWB in enhanced interactive way in their classrooms. Apart from this the level of computer literacy, the attitudes towards ICT, student-centered teaching approach, teaching experience and IWB literacy of the teachers also had positive impact on their classroom interactivity using IWB. Along with this, some gender differences were seen with male teachers tended to use IWB in slightly more interactive way and the teachers who used computer more frequently also tended to use IWB in slightly more interactive way in their classrooms.

The findings from the interview data of the teachers provided the insights into their classroom interactions using IWB, with the main focus on the involvement of the students during the interactions. It was found that a majority of teachers had involved the students while teaching using the IWB. While most of the teachers allowed the students to interact directly with the board, a few of them used different technological tools like slates, iPads and student response systems etc. which allowed the students to interact with the board while remaining seated. This kind of interaction had previously been mentioned by Vallis and Williamson (2009) and Hennessy and London (2013) where they also talked about the use of handheld computers, wireless pen tablets, remote pointers (clickers, wireless mice) and wireless keyboards to help the students to connect and interact with the interactive brightboard. It was also found that some teachers did not allow the direct interaction of the students with the boards because of behavioural issues on the part of the students, and also limited participation of the students at any given time. Hennessy, Deaney, Ruthven, and Winterbottom (2007) raised these concerns while reporting the findings of their study to explore the pedagogical implications of using IWB in Science at secondary school level. Two teachers also mentioned about the unwillingness of the secondary school students to come in front of the class to interact with the board. All these issues were identified by Smith et al. (2005) in their critical review of IWB use in education. Further a few teachers also mentioned that they use IWB mostly for an information transmission purpose which is basically a teacher-focused approach of teaching, and so did not use IWB in an interactive manner. So the interview findings highlighted some of the issues which can have negative impact on the use of IWB to its full potential by the teachers.

12.8.2 Students

It was clear from the results of the single level path analysis of student data that the attitudes of the students towards IWB was the main factor which had direct, positive and strong influence on the classroom interactions using IWB. In other words, the attitudes of the students towards IWB could play a crucial role in deciding how the students experience the interaction in the classroom using IWB, as the students with more positive attitudes were highly likely to experience more or enhanced interactivity using IWB. Hall and Higgins (2005) had reported about similar results, but their study involved the students from the primary year level only. As the student participants for the present study came from the secondary level of schooling, these findings provides further contribution to the literature related to the IWB educational research. Further, it was also found that attitude of the students towards ICT also impacted the classroom interactions indirectly as the students with more positive attitudes towards ICT also tended to have better interactions using IWB. The mediating factor between the ICT related attitudes of the students and their classroom interactions using IWB was their attitudes towards IWB. Zimitat (2004) had reported that the attitudes of the students towards technology plays a significant role in the adoption and use of an educational tools by the students, and these current findings show a similar picture.

The students' competence level in using IWB was another factor to obtain a direct, medium and positive impact i.e. the students with high IWB competency tended to experience (in terms of both teacher and student use of IWB) more or enhanced IWB interactively in their classrooms. Apart from the IWB competence, IWB confidence was also shown to have positive but indirect impact on the classroom interactions involving IWB which means that the students who were more confident in using IWB also likely to use it in more interactive manner. These findings are not surprising because past research has already shown that students' technological competence and confidence play an important role in their adoption and effective use of that technology (Schrum & Hong, 2002). Secondly, it was also noted in the present study that there was a very strong association between the IWB competence and IWB confidence of the students with IWB competence being very strongly influenced by their IWB confidence.

The other personal factors of the students which were found to have positive influence on the classroom interactions they experience using IWB were their computer literacy (small impact) and the frequency with which they use computers away from school (very small impact). In the path analysis, it was seen that computer literacy of the students was influenced by their frequency of computer use away from school. So the students who were more computer literate and those which use computers more frequently away from school reported slightly better interactions in the classroom using IWB. Kent and Facer (2004) mentioned about similar factors in their study comparing home and school ICT use by students.

The frequency of IWB use by the teacher and the availability of the IWB in the classroom also showed small and very small positive influences on students' IWB related classroom interactions respectively. The availability of IWB was also found to influence the frequency of IWB used by the teachers. So, the students' classroom interactions using IWB were tended to enhance slightly with the increase in the frequency of IWB use by their teacher along with the more availability of IWB in the classroom. The results are similar to those reported by Christensen (2002) which stated that the teachers' level of use of a technological tool greatly influence the classroom use of that tool by the students. The access to the internet at school was also seen to have very small positive impact i.e. the classroom interactions using IWB tended to be slightly better if the students had more access to the internet. The availability of ICT related facilities was stated in some previous studies as one of the factors which play a role in the adoption and use of a technology by the students (Cavanagh et al., 2004; Hopson et al., 2001).

12.9 Student Learning Approaches

In this section the findings of this study related to the factors impacting the learning approaches of the students from the participating teachers' and students' point of views are discussed.

12.9.1 Teachers

Student learning approaches was one of the two aspects of student learning addressed in this study and the teachers were asked during the interviews to comment about the possible impact of the use of IWB on the learning approach of their students. The findings from the analysis of the interview data of the teachers revealed that in teachers' perception (majority of teachers), the overall approach of students towards learning had improved, although the teachers were only in the position of commenting about the learning related behaviours of the students which they had noticed during the use of IWB in their classrooms. Based on their responses it was found that the improved student engagement was the most common learning behaviour reported by the teachers when talking about the learning activities in the classroom where IWB was used.

Apart from this, increase in the level of interest in learning; increased involvement and active contribution in the learning activities; increased motivational level; improved quality of students' work and improved interest by the students with lower ability and those with any kind of disability were other kinds of improvements stated by the teachers while talking about their perceptions of the impact of IWB use on student learning approaches. So the teachers in this study linked the above stated learning behaviours with the possible improvement in the students' overall approach towards learning. These findings from the interview responses of the teachers are in line with a large number of previous IWB research studies which had reported about similar findings (Becta, 2004; Beeland, 2002; Hall & Higgins, 2005; Hennessy et al., 2007; Hennessy & London, 2013; Higgins et al., 2007; Hodge & Anderson, 2007; Kennewell & Beauchamp, 2007; Kennewell & Morgan, 2003; Knight et al., 2005; Murcia & Sheffield, 2010; Schuck & Kearney, 2007; Shi et al., 2012; SMART, 2006; Smith et al., 2005; Wall, Higgins, & Smith, 2005; White, 2007; White et al., 2012; Xu & Moloney, 2011; Yanez & Coyle, 2011) but these studies provided scattered and incomplete evidence of impact of IWB use on student learning approaches because none referred to all the above stated learning behaviours or strategies together.

12.9.2 Students

Similar to the teaching approaches of the teachers, the learning approaches of the students were studied as two separate factors: the deep learning approach and the surface learning approach. So, the findings for both these factors are discussed in separate sections below.

12.9.2.1 Deep Learning Approach

The results of the single level path analysis showed that the deep learning approach of the students was positively influenced by the kind of classroom interactions they experience using IWB, i.e. the students who experienced interactive and enhanced interactive use of IWB in their classrooms were more likely to adopt the deep approach in their learning. It should be noted that the classroom interactions of the students using IWB was the only factor which had a direct and strong influence on their deep learning approaches.

Further, the results of the hierarchical linear modelling (HLM) analysis also indicated that the classroom interactions the students experience using IWB was influencing their deep learning approach in a direct, positive and strong manner. This finding is consistent with the results from the single level path analysis. Although, interestingly, the strength of this relationship between these two factors varied between the findings of path analysis and HLM, with HLM showing larger impact size. The critical role of teaching environment or leaning context on the learning approaches of the students has been reported in the educational research literature (Phan & Deo, 2007; Serife, 2008), but none of the previous IWB research studies exclusively investigated the issue of role of IWB integrated learning environments on development of deep learning approaches among the students, although some of the IWB studies have pointed out that the development of collaborative and interactive learning environment using IWB encourage the students to actively participate in classroom learning activities including discussions (Bennett & Lockyer, 2008; Bourbour & Bjorklund, 2014; Hennessy et al., 2007;

Jones & Vincent, 2006; Littleton, 2010; Mercer, Hennessy, & Warwick, 2010; Murcia & Sheffield, 2010; White, 2007; Xu & Moloney, 2011).

However, in HLM analysis, it was further revealed that the effect of students' classroom interactions using IWB was moderated by the age of the teachers (a factor from the level-2 (Teacher level) of the model) meaning that the impact of the kind of classroom interactions students experience using IWB was stronger on their deep learning approach when they are taught by an older teacher. Two more teacher level predictors were found to have a moderating effect on the relationship between students' classroom interactions and their deep learning approach: these were the IWB literacy and the computer literacy of the teachers. The impact of students' classroom interactions using IWB on their deep learning approach was stronger when the teachers had greater computer literacy. On the other hand, it was surprising to find that the impact of students' classroom interactions on their deep learning approaches was weaker when the students were taught by the teachers who perceived themselves as being more IWB literate.

Along with the moderating effects from the teacher level factors, a factor from the level-3 (School level) (i.e. full access to software and hardware to students) was also found to be impacting the relationship between students' classroom interactions using IWB and their deep learning approach. It was evident that the more the schools provide the students with full access to software and hardware the stronger is the impact of their classroom interactions using IWB on their deep approach towards learning.

In summary based on all these findings, it can be said that students' experiences in their classrooms while interacting using IWB can play a key role in the development of the deep learning approaches among the students, with students tending to develop a deeper learning approach when they experience interactive or enhanced interactive classroom environments using IWB. And this likelihood of adopting a deeper approach to learning can be increased if the students are taught by older teachers and by teachers who are more computer literate, along with having full access to software and hardware facilities. This is very crucial finding of this study which provided the strong evidence for a relationship between the use of IWB in the classroom and the deep learning approach of the students, and fills gaps in the literature regarding the impact of IWB use on learning.

Further, the single level path analysis also revealed another factor i.e. the attitudes of the students towards IWB to have medium, positive but indirect influence on the students' deep learning approaches, meaning that the students with more positive attitudes towards IWB tended to use deep approach in their learning. This influence was mediated by students' classroom interactions using IWB, so it could mean that the students with more positive attitudes towards IWB tend to experience enhanced classroom interactions using IWB which is more likely to make them to use deep approach in learning. The evidence of the relationship between students' attitudes towards IWB and their deep learning approach is a new finding which has not been reported in the past research literature and hence is a new input into ICT and IWB research literature.

There were a few other factors found to have small but positive impact on the deep approaches to learning of the students: the students' IWB related confidence, IWB competence, computer literacy, attitudes towards ICT and the frequency of their computer use away from school. Among these, the frequency of computers use away from school showed a very small effect size. All these factors showed their influence on the deep learning approach through the classroom interactions using IWB, meaning that students with high IWB confidence and competence, and those who had positive attitudes towards ICT and use computers away from school more frequently, were also more likely to use a deep learning approach. Apart from all these student related factors, the frequency of IWB use by the teacher (as reported by the students) was also seen to have positive impact on students' deep learning approach, indicating that the students of those teachers who used IWB more frequently in their teaching were slightly more likely to adopt a deep learning approach.

In the HLM analysis, it was also found that a factor from the Teacher level, i.e. IWB support they get from the schools, was also directly influencing the deep learning approach of the students in a positive manner. This is an indication that the students of those teachers who had IWB related support were likely to adopt a deep learning approach when taught using IWB. The possible reason behind this could be that the teachers who have got IWB related support can obtain a better opportunity to explore IWB related pedagogies and use IWB related interactive resources or exchange ideas and tips with other teachers in order to learn effective integration of IWB (enhanced interactive) in their teaching which in turn may encourage the students to use deep approach in learning.

The HLM analysis further revealed that another predictor from school level, i.e. ICT integration in the classrooms, also showed a direct impact on the students' deep learning approach. It was likely that the higher the level of ICT integration in the classroom the deeper was the learning approach adopted by the students using IWB. Thus based on the factors from the teacher level and the school level, the ICT infrastructure of the school in the form of ICT integration and IWB related support available to the teachers can play an important role in encouraging the students to adopt deep approach of learning when taught using IWB.

12.9.2.2 Surface Learning Approach

The findings of the single level path analysis clearly showed that the gender of the students was the most prominent factor impacting their surface learning approach and was influencing it in a direct, medium and negative way, with more male students tending towards the surface learning approach. Secondly, the direct, small and negative relationship between computer literacy of the students and their surface learning approach showed that the students who were more computer literate were less likely to choose a surface approach of learning. This finding confirms the findings for the deep learning approach where the computer literacy of the students was found to be impacting positively. Along with this it was also found that the students who used computers away from school more frequently and who had more internet access at school were slightly less likely to use surface learning approach, because these factors showed a very small and negative effect on the surface approach to learning. These findings again confirmed the findings for the deep learning approach given in the above section.

The above findings revealed that there was no IWB related factor found in this study to influence the surface learning of the students in any way. So there was no connection found between any kind of IWB use in the classrooms (including both teachers and students) and the students' surface learning approach and hence it can be said based on these findings of the current study that any kind of IWB use in the classroom does not influence (promote) surface approach of learning among the students. This is a significant finding of this research study.

12.10 Student Learning Outcomes

This section deals with the discussion of the factors found in this study which impact the learning outcomes of the students. The findings related to both the teacher participants and the student participants are discussed.

12.10.1 Teachers

The second aspect of student learning addressed in this research was the learning outcomes. It is important to mention here that the theoretical underpinnings used for evaluating the learning outcomes of the students in this study were based on the Bloom’s revised taxonomy (Figure 2.7) which was considered useful for determining the impact of IWB use on the learning, if any (Bailey, 2001; Halawi, McCarthy, & Pires, 2009). But the teachers in this study were also asked to comment about the possible impact of their IWB use on student achievement as well. The findings from the interviews revealed that the teachers had noticed improvement in some aspects of learning, notably regarding the understanding aspect which could be connected to the improved cognitive ability of the students and hence better outcomes of learning (Blooms's Revised Taxonomy, Krathwohl, 2002). Most of the teachers mentioned that the use of IWB improves the understanding of the students regarding otherwise difficult to understand concepts, a few of them also mentioned about the development of abstract learning and construction of new knowledge by the students when the classroom activities included interactive use of IWB. According to Bloom's Revised Taxonomy (Krathwohl, 2002), understanding of the concepts comes under lower order thinking skills (LOTS) and abstract learning or construction of new knowledge falls under the category of higher order thinking skills (HOTS) (Krathwohl, 2002; Rao, Gu, Zhang, & Hu, 2007). However, there was little real evidence found regarding the increased student achievement due to use of IWB, with most of the teachers unable to comment about this issue due to lack of any evidence based on any comparative or longitudinal study.

So, these findings provide some indication of a positive impact of the IWB on the learning outcomes of the students when it is used effectively by the teachers, but this evidence is largely based on the perspectives of the teachers. There have been some studies done in the past which presented similar findings, but these studies only highlighted some aspects of student learning and none of these studies addressed the issue of learning outcomes exclusively based on any learning theory as was done in the present research. For example, Xu and Moloney (2011) reported on the visual advantage of IWB to help recall Chinese characters; White (2007) also documented the improvement in the recall ability of the students and also significant improvement in their learning achievements as a whole, especially students with learning difficulties; Lopez (2010) reported that the use of IWBs fostered performance parity and closed the achievement gap between ELL (English Language Learners) and regular students along with increasing the achievements of ELL students; Swan, Schenker, and Kratcoski (2008) reported a slight increase in reading and mathematics achievement of primary school students in a comparative study between IWB users and non-users. But further research is highly recommended to study the perceptions of the teachers regarding the impact of IWB use on the quality of the learning outcomes based on Bloom's Revised Taxonomy.

12.10.2 Students

In this study, clear evidence was found in the path analysis that students' attitudes towards IWB had a very strong (strongest among all the factors) and positive influence on their perceived learning outcomes. The students' IWB attitudes impacted their learning outcomes in both a direct and indirect manner. Indirectly the attitudes of students towards IWB impacted their classroom interactions using IWB which further impacted their deep learning approach and ultimately influenced their perceived learning outcomes. The findings of the HLM analysis also showed that the attitude of the students towards IWB was the strongest influencing factor among the other factors at level-1 (Student level). These findings are in-line with the findings of the single level path analysis. Thus students who had more positive attitudes towards IWB saw themselves as more likely to have better learning outcomes when taught using IWB.

This is a very significant finding and also a crucial contribution to the existing ICT research literature as a whole, and IWB research literature in particular, because there is a lack of studies which provide some kind of evidence that the attitudes towards a technological tool (IWB in this case) can influence the quality of learning outcomes among the students who use it. It also becomes a crucial finding because there is also serious lack of studies which use Bloom's Revised taxonomy (Figure 2.7) to examine students' learning outcomes in ICT/IWB integrated learning environments (Halawi et al., 2009). These findings provide an over-all picture and can serve as an initiating point for future more extensive studies (e.g. experimental research) to investigate the impact of attitudes on each and every category of Bloom's Revised Taxonomy (Figure 2.7)

The second most important factor found in this research was that the deep learning approach of the students showed a direct, positive and very strong impact on the perceived learning outcomes of the students. Although the findings of single level path analysis of student data also revealed that surface learning approach of the students also showed some impact the perceived learning outcomes of the students positively, but the impact of deep learning approach was seen to be much stronger than the surface approach of learning. This made it clear that when IWB is used, the students' who adopted a deeper learning approach tended to perceive themselves as having much better learning outcomes as compared to the students who adopted a surface approach of learning.

The findings from HLM analysis also portrayed the same picture that both a deep learning approach and a surface learning approach of the students directly impacted their learning outcomes, but the impact of deep learning approach was stronger. Also, it was interesting to see that the gender of the teachers (from level-2) had a moderating effect on the relationship between students' deep learning approach and their learning outcomes, with students taught by female teachers showing a stronger impact of their deep learning approach on their learning outcomes than the students who were taught by the male teachers. That is, when taught by a female teacher, the deep learning approach adopted by the students plays a more significant role in their learning outcomes.

The link between approaches to learning and quality of learning outcomes has been previously documented in the educational research literature (Dix, 2007) where the deep approach to learning is linked with high quality learning outcomes (higher order thinking skills, HOTS) and the surface approach to lower quality of learning outcomes (lower order thinking skills) (Biggs, Kember, & Leung, 2001; Dix, 2007; Rao et al., 2007). So along with confirming the previous findings regarding the positive association between the deep learning approach and the learning outcomes of the students, this study has highlighted another aspect of this relationship: the environment where learning is happening (i.e. classrooms integrated with IWB technology) which highlights the possible role played by the IWB technology on this relationship between the deep learning approach and the quality of learning outcomes. Nevertheless these findings need further exploration using more rigorous research studies focusing entirely on these two factors and investigate their association with each other in an IWB integrated learning environment.

A third important factor at the student level which was found to have impact on their perceived learning outcomes was the classroom interactions students experience using IWB. It was found that this factor had an indirect, positive but medium impact on the students' perceived learning outcomes, meaning that students who experienced their classroom interactions using IWB to be more interactive tended to perceive better learning outcomes. Further, the classroom interactions were found to be influencing the students' learning outcomes through their deep learning approach. That is students who experienced more and enhanced interactive classroom environments using IWB tended to adopt deeper approaches towards learning and ultimately were more likely to achieve better quality learning outcomes. This kind of relationship between classroom interactions, learning approaches and learning outcomes has been taken into account in '3-P model of learning process' by John Biggs (Figure 2.5) who explains that "learning outcomes are a result of the interactions of teaching and learning contexts with student approaches to learning" (Dix, 2007).

The findings from HLM analysis also confirmed the relationship between students' classroom interactions using IWB and their perceived learning outcomes. Further, it was found that this relationship was also moderated by a factor from the teacher level i.e. the computer literacy of the teachers. This means that if students were taught by a highly computer literate teacher, then the impact of their classroom interactions using IWB on their learning outcomes tended to be stronger as compared with a teacher who was less computer literate.

There are very few research studies done to evaluate the impact of classroom use of IWB on student learning and most of that available research literature is comprised of studies that focused on learning achievements in one or two subject areas (Lopez, 2010; Swan et al., 2008; White, 2007; Xu & Moloney, 2011). However, Hopson et al. (2001) conducted a study to investigate the impact of technology-enriched classrooms on the higher order thinking skills (HOTS) of the primary school students and found small positive impact on the analysis and synthesis skills and significant positive impact on the evaluation skills of the students. But no such kind of study has focussed particularly on IWB-integrated classrooms. So this finding, showing influence of students' classroom interactions using IWB on the quality of their learning outcomes, is a most valuable finding because it provides the initial evidence that there is a link between classroom IWB use and the quality of learning outcomes of the students. Hence these findings are significant contribution towards ICT and IWB research literature and also provide a direction for further research on the issue of impact of an IWB integrated classroom environment on students' learning outcomes (based on the Bloom's Revised Taxonomy).

It was also found in the path analysis that the attitudes of the students towards ICT also showed a positive but small and indirect influence on their perceived learning outcomes. So the students who had more positive attitudes towards ICT were also likely to perceive better learning outcomes when taught using IWB. The perceived learning outcomes of the students were also indirectly influenced by the frequency of IWB use by their teacher (small impact) i.e. the students whose teacher used IWB more frequently tended to have better learning outcomes. And, the frequency of IWB use by the teacher was further influenced by the availability of IWB in the classroom, so it was evident that availability of IWB in the classroom had a small positive influence on the perceived learning outcomes of the students. Further, the learning outcomes of those students who had higher computer literacy, higher IWB competence and higher IWB confidence were also found to be slightly better when taught using IWB, although the impact sizes of these factors were extremely small. All these findings have only provided some initial in-sights into the kind of relationships between students' ICT related attitudes, their ICT/computer literacy, the availability and frequency of IWB use, their IWB literacy and the quality of learning outcomes of the students but further research to explore the impact of these factors separately is recommended.

Apart from this, in the path analysis, the gender of the students was found to have a very small negative and indirect influence on the learning outcomes when taught using IWB; thus the male students tended to have slightly better learning outcomes than the female students but again the difference was extremely small. Moreover, the results of HLM further revealed that gender of the students also had direct, negative and medium range of influence on their learning outcomes using IWB, with male students having better perceived learning outcomes when IWB was used for teaching and learning. And this impact of gender on the learning outcomes was moderated by the availability of software and hardware (a predictor from the school or macro-level) to the students. These findings revealed that when the students had full access to the software and hardware, the difference between the perceived learning outcomes of female and male students decreased, but when the students did not have full access to the software and the hardware, the difference between the male and female students' perceived learning outcomes increased. So it can be proposed that the gender based differences among the students' perceived learning outcomes can be minimised by providing all of them full access to the software and hardware at schools. This is a crucial finding that indicates the importance of availability of ICT related resources to the students in the schools and how it can be used to develop better quality learning outcomes among the students when using IWB in the classroom.

The path analysis identified another factor with an extremely small, indirect but positive impact on students' perceived learning outcomes i.e. their frequency of computer use away from school. Lastly, the HLM analysis findings revealed that the age of the teachers (teacher-level factor) had a direct, negative and small impact on the learning outcomes of the students, with students taught by younger teachers more likely to show slightly better learning outcomes in an IWB integrated classroom. Further research is needed in this area to gain in-sights into the possible reasons for this kind of impact of the age of the teachers on the quality of learning outcomes of the students when taught using IWB.

So, based on the above findings, it can be said that the most important factors found to have impacted the perceived learning outcomes of the students were their attitudes towards IWB and their deep learning approach, both of which had the strong, positive and direct influence. The other important factors were the classroom interactions of students and their attitudes towards ICT which had positive but indirect impact influence on the perceived learning outcomes through the deep learning approach of the students. Surface learning approach was also found to be influencing perceived learning outcomes but the impact is much smaller as compared to deep learning approach.

12.11 Theoretical and Practical Implications

The significance of the present research to the educational research literature and practice is discussed in this section. The major contribution of this research is that it provides evidence regarding the impact of IWB use on student learning approaches and the quality of learning outcomes at the secondary school level. The scarcity of this kind of research evidence has been continuously pointed out by many researchers, practitioners, policy makers and investors in the field of education. This study is the first of its kind to investigate the influence of IWB use on two important aspects of learning i.e. student learning approaches and quality of learning outcomes, along with taking into consideration other essential school, teacher and student level factors which have been identified in the research literature.

Secondly, most of the IWB research to date has focused either on exploring the features of IWB or on the teachers' perspective towards IWB. There is a shortage of studies with the primary focus on the issues related to the students. This issue has also been addressed in this study by including the perspectives of both the teachers and the students with a primary focus on students' perspective regarding the crucial issues of classroom interactions using IWB and the impact of IWB use on their learning approaches and outcomes. So this is an important contribution towards existing IWB research literature.

This study is also important because it is the first large scale study of its kind at secondary school level using predominately quantitative methods of data collection along with qualitative methods. Earlier IWB research literature is comprised mainly of small scale qualitative (mostly case-studies) studies including only a small number of participants and focusing on only one or two subject-areas at one time. So the findings from these earlier studies are scattered and it is not possible to generate general conclusions, especially regarding the essential issue of the influence of IWB on student learning. But the present research made an attempt to deal with this problem by including 30 teachers and 269 students from 12 South Australian secondary schools. Moreover, this study included 13 subject-areas at secondary school level in South Australia unlike the majority of other IWB studies which focus only on IWB use in one or two subject areas at primary level.

The study has also provides some important insights into factors affecting the adoption and utilization of IWB by secondary schools teachers and their students, with the knowledge and understanding of the different factors influencing the classroom interactions when using IWB in the Australian educational context being a useful contribution. And because the relationship between different teaching approaches and the classroom interactions using IWB were also examined, the findings can be very helpful to provide suggestions to the teachers regarding the pedagogical methods that can be adopted to use IWB technology in an effective manner. These types of suggestions can also be used to improve teacher education or professional development courses by providing the idea of kind of support, facilities and training required to prepare teachers to use IWB successfully.

Apart from the specific findings, this study has also produced the models i.e. path analysis models for both teacher and student levels separately and hierarchical linear models including school, teacher and student levels. These models have incorporated all the relevant factors identified from the educational research literature and provide an understanding of the complex relationships among these factors, and how the inter-relationships among these factors influence the learning of students.

In summary, this study is the first time that all these issues (i.e. adoption, utilization and impact of IWB on secondary school students learning approaches and quality of learning outcomes) have been addressed in one study including both teacher and student participants and using a predominately quantitative approach along with supporting qualitative data. Thus the findings of this study provide valuable insights into a minimally explored area in the ICT educational research in general, and IWB educational research in particular.

12.12 Limitations and Further Research

Though the present study makes its contribution to the development of knowledge and understanding in the field of the impact of IWB use on student learning, it has several limitations. First of all, it is important to mention that this study used a cross-sectional procedure of data collection. This was due to the limited time availability for completing this research which did not allow the researcher to undertake a longitudinal kind of study which would be able to focus on changing attitudes, behaviour and outcomes. The second considerable limitation is related to the sampling procedure. Ideally, the researcher should have used random sampling, the most rigorous form of probability sampling, but in this research the non-probability convenience sampling was used in the main quantitative phase because of the limited number of South Australian secondary schools with IWB installed in their classrooms and difficulties in obtaining participants.

Thirdly, not all the teacher participants included their students in this study, so the student data does not reflect a complete picture. Another limitation of this research is that the qualitative phase (teacher interviews) was conducted simultaneously while collecting the quantitative data because of the lack of time, but ideally it should have been undertaken as a follow-up of the quantitative phase to get deeper understanding of the reasons behind teachers' responses in the quantitative phase. Further, the qualitative phase included only the teacher participants, because students' interviews could have provided deeper insights into their perceptions regarding the use of IWB and its importance or impact on their learning. The students were not included in qualitative data collection because of their unwillingness to participate in the interviews.

Although, this study presents evidence regarding the impact of IWB use on the learning of the students, there is need to further explore these issues and the findings of the current study can be used as the starting point for the future research. Future studies addressing the issues of students' learning approaches and the learning outcomes in an IWB integrated classroom environment are recommended to be done separately and exclusively focusing on each aspect of these issues and using longitudinal or other relevant research methods.

12.13 Summary

It is prevalent notion in the ICT and IWB research literature that investigating and isolating the impact of any technological tool, including IWB, on student learning and providing some rigorous evidence on this issue cannot be done because of complexities of number of factors which play role in an educational setting (Honey, Culp, & Spielvogel, 2005; Newhouse, 2002). The present research attempted to overcome these barriers by designing a study which included most of the possible factors which were identified in the literature to play role in such association. The inter-relationships among these factors were investigated using predominately quantitative and supporting qualitative data from secondary school teachers who used IWB, and their students, with the purpose of providing some research evidence of the impact of IWB on the student learning. In other words, this study was an effort to extend the currently very limited understanding on the influence of the use of IWB in a classroom setting on the learning of the students (learning approaches and learning outcomes), and the findings have provided some valuable evidence in this regard.

Some of the significant findings of this study which are depicted in the models obtained using single level path analysis for teachers and students and hierarchical linear modelling including school, teacher and student levels are as follows:

- The amount of classroom interactions experienced by students using IWB has a significant and positive impact on their deep learning approach and on the quality of their learning outcomes i.e. when the students experience an interactive and enhanced interactive classroom environment using IWB, they tend to adopt a deeper learning approach and the quality of their learning outcomes improves.
- The strength of the positive association between classroom interactions students experience using IWB, their deep learning approach, and the quality of their learning outcomes, increases when they are taught by more computer literate teachers i.e. the more computer literate the teacher is, the more the students tend to adopt deep approach to learning and achieve better learning outcomes when they are taught using IWB.
- The positive impact of students' experienced classroom interactions using IWB on their deep learning approach also increases when they have full access to software and hardware resources at their schools. When the quality of learning outcomes is concerned, full access to software and hardware resources at school

also decreases the gender differences in which male students tend to have better quality of learning outcomes.

- The students' attitudes towards IWB also showed direct and strong positive influence on the quality of their learning outcomes i.e. the students with more positive attitudes towards IWB are highly likely to have better quality learning outcomes. The students with more positive attitudes towards IWB and ICT are also likely to experience more interactive classroom learning using IWB which further tend to impact deep learning approach and quality of learning outcomes in positive way.
- The students also tend to be more inclined to use deep learning approach when the learning takes place in classrooms with a high level of ICT integration and where teachers receive more IWB related support from their schools.
- IWB competence and IWB confidence of the students, frequency of IWB used by teacher, computer literacy of the students, and availability of IWB are some other factors which have small positive impact on the deep learning approach and learning outcomes of the students.
- The most prominent factor at the teacher level to influence the classroom interactivity using IWB is their attitudes towards IWB i.e. the teachers with more favourable attitudes towards IWB tend to use IWB in an enhanced interactive way in their classrooms. Equally important is their age and IWB support i.e. the older teachers and those who receive better IWB related support from their schools also more likely to use IWB in an interactive or enhanced interactive way. The teachers' classroom interactions using IWB also depends upon their teaching approach i.e. the teachers who use student-centred teaching approach are likely to have more or enhanced interactive classroom teaching using IWB.
- The teachers with more positive attitude towards ICT, more computer and IWB literacy, and more teaching experience also tend to have more interactive classrooms using IWB.
- Male teachers and those who use computers more frequently have also shown to have slightly better classroom interactions using IWB.

The significant findings from the teacher interviews, which provided deeper insights into the issues related to the adoption and utilization of IWB by the teachers and their perceptions of its impact on student learning, were:

- Availability or easy access to IWB, proper support and training from the schools, and teachers' perceived advantages of IWB for better teaching and learning are the main factors which leads to adoption of IWB by the teachers.
- Being able to use multimodal style of teaching and cater for a variety of learning styles, record the lessons, provide instantaneous access to the internet and various interactive resources, the ability to write/annotate on the screen, students being motivated, interested, engaged in learning are advantages of IWB recognised by the teachers.
- Classroom management issues, the limited options of physical interaction with the board at any one time, and changed curriculum needs were factors responsible for some teachers being reluctant to allow the students to use the board during the lesson.
- The connection between the improvements in the students' approaches to learning was recognised in the form of their increased interest in learning, especially lower ability and disadvantaged students, and more engagement during the classroom learning in the form of discussions.
- Improvement in the quality of learning outcomes due to IWB use was recognised by some teachers in the form of improved understanding of difficult concepts, abstract learning and the construction of new knowledge by the students, together with a small increase in the learning achievement of some students.
- Lack of time to learn about effective use of IWB, lack of ready-made resources and technical difficulties are the main barriers in the use of IWB.
- Attending IWB training sessions or workshops, adopting a step by step approach to learn the effective use of IWB, and asking for help whenever needed are the recommendations suggested for teachers new to IWB use.

12.14 Final Conclusion

The main purpose of this study was to investigate the impact of IWB use on the learning approaches and quality of learning outcomes of the secondary school students in South Australia by exploring the inter-relationships among various factors related to the adoption and utilization of IWB in a classroom. So, the most noteworthy finding of this research was that when the students experienced an interactive and enhanced interactive classroom environment using IWB, they tended to adopt a deeper learning approach and the quality of their learning outcomes improved. Along with this, it was also evident that the students with more positive attitudes towards IWB were highly likely to have better quality perceived learning outcomes and were likely to adopt deeper approach of learning when using IWB. The association between these important factors provides clear evidence that the IWB technology, when used in an interactive or enhanced interactive way by the teachers and the students in the classroom setting, has the potential to play a significantly positive role in the learning (deeper approach and better quality outcomes) of the students.

Appendices

Appendix A

The Pilot Study Teacher Questionnaire

Teacher Questionnaire

Section 1:

<u>Personal factors:</u> In this section, general questions about your background and computer use will be asked. Please tick the appropriate box.

a) <u>Demographic factors:</u>

1. Name of the school where you teach *(Please print)*:

   ………………………………………………………………….

2. Your age:

   ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-45

   ☐ 46-Above

3. Your gender:

   ☐ Male ☐ Female

4. Your teaching experience:

   ☐ Less than 1 year ☐ 1-5 years ☐ 6-10 years

   ☐ 11-15 years ☐ 16-20 years ☐ 21-above

5. Your teaching qualifications:

   ☐ Bachelor of Teaching ☐ Graduate Diploma in Education

   ☐ Other, please specify……………………………………………….

6. Subject-Area you teach using IWB *(Please specify your one main subject area which you teach using IWB)*:

   ☐ English ☐ Science ☐ Mathematics

   ☐ Society and Environment ☐ Languages ☐ Arts

   ☐ Design and Technology ☐ Health and Physical Education

   ☐ Other, please specify……………………………………………..

7. Year level where you teach the above stated subject-area using an IWB *(Please choose only one main year level where you teach using IWB, even if you teach to more than one year level)*:

   ☐ Year 7 ☐ Year 8 ☐ Year 9 ☐ Year 10

   ☐ Year 11 ☐ Year 12

b) General Information about your computer use:

1. Do you have access to a computer at school?

☐ Yes ☐ No

2. Do you have access to a computer away from the school?

☐ Yes ☐ No

3. Do you have access to the Internet at school?

☐ Yes ☐ No

4. Do you have access to the Internet away from school?

☐ Yes ☐ No

5. Do you own your own computer?

☐ Yes ☐ No

6. How would you rate your experience level in using computers?

0 1 2 3 4 5 6 7 8 9 10

No Experience — Highly Experienced

7. How would you rate your competence at working with computers?

0 1 2 3 4 5 6 7 8 9 10

Novice — Highly Competent

8. How confident do you feel about working with computers?

0 1 2 3 4 5 6 7 8 9 10

No Confidence — Very Confident

9. How often do you use computers for teaching in the classroom?

☐ Daily ☐ Almost twice a week ☐ Once in a week

☐ Occasionally ☐ Never

10. If you do use computers, what type of training have you received?

☐ No training ☐ Basic Computer Operations (*on/off, how to run programs*)

☐ Computer Applications (*word processing, spreadsheets etc.)*

☐ Computer integration (*how to use in classroom curriculum*)

Section 2:

Attitudinal factors: In this section, questions will be asked to determine your attitudes towards the use of ICT in general and IWB in particular in the education. The two sub-headings in this section have a series of statements. There are no right or wrong responses to these statements. Please read each statement and circle the number that best describes how you feel about that statement.

1= Strongly Disagree (SD)

2= Disagree (D)

3=Undecided (U)

4= Agree (A)

5= Strongly Agree (SA)

Please give a response to all the statements. Do not spend a long time on each: your first reaction is probably the best one.

a) Attitudes towards the use of ICT as an educational tool in the classroom: ICT is an acronym for Information and Communication Technology. It includes the technologies, such as computer, computer related devices, Internet, digital devices, software and digital resources which are used to access, gather, manipulate and present information.

	(SD)	(D)	(U)	(A)	(SA)
1. Knowing how to use various ICT tools is a necessary skill for me	1	2	3	4	5
2. I get confused when using ICT	1	2	3	4	5
3. I like using ICT tools in my teaching	1	2	3	4	5
4. I feel confident in my ability to learn about ICT	1	2	3	4	5
5. Working with ICT makes me nervous	1	2	3	4	5
6. I now use my knowledge of ICT in many ways as a teacher	1	2	3	4	5
7. I wish I could use technology more frequently	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
8. ICT makes me feel stupid	1	2	3	4	5
9. A job using ICT would be very interesting	1	2	3	4	5
10. I don't expect to use ICT much at work	1	2	3	4	5
11. I am not the type to do well with ICT	1	2	3	4	5
12. I feel uncomfortable using most ICT tools	1	2	3	4	5
13. Working with ICT is boring	1	2	3	4	5
14. It is important to know how to use ICT in order to get a teaching position	1	2	3	4	5
15. I know that if I work hard to learn about ICT, I will do well	1	2	3	4	5
16. ICT makes me feel uneasy	1	2	3	4	5
17. I am able to do as well working with ICT as my fellow teachers	1	2	3	4	5

b) Attitudes towards the use of IWB as an educational tool in the classroom: Please respond to the questions in this sub-section by reflecting on your teaching using an IWB. Please keep in mind that the researcher wants your responses to be based on your teaching of that particular subject-area, and that particular year level, which you selected in the section 1 of this questionnaire. Please do not spend a long time on each: your first reaction is probably the best one.

	(SD)	(D)	(U)	(A)	(SA)
1. Using IWB-based resources reduces the time I spend on writing during the lessons	1	2	3	4	5
2. When using an IWB in my lessons, I spend more time in the preparation of the lesson	1	2	3	4	5
3. I think using an IWB makes it easier to include different subject-specific learning resources when preparing the lesson plan	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
4. I think using an IWB makes it easier to display the available learning resources to the whole class	1	2	3	4	5
5. It is beneficial to be able to save and print the materials generated during the lessons	1	2	3	4	5
6. I give more effective explanations in my lessons when using an IWB	1	2	3	4	5
7. IWB helps me to easily summarise the lesson	1	2	3	4	5
8. Using an IWB, I can more easily control/manage the whole class	1	2	3	4	5
9. I can immediately reach the extra learning resources during my lesson when using an IWB	1	2	3	4	5
10. I think an IWB can be a good supplement to support teaching	1	2	3	4	5
11. Using an IWB makes me a more efficient teacher	1	2	3	4	5
12. Using an IWB makes it easier for me to move back and forth in the lesson very conveniently	1	2	3	4	5
13. I like using IWB technology in my lessons	1	2	3	4	5
14. I feel uncomfortable in front of my students when using an IWB	1	2	3	4	5
15. I do not think my students are ready for this IWB technology	1	2	3	4	5
16. What I do in class with my usual methods is sufficient for teaching my subject	1	2	3	4	5
17. Reviewing the whole lesson towards the end is very easy if the lesson is taught using an IWB	1	2	3	4	5
18. I am not the type to do well with IWB-based applications	1	2	3	4	5
19. I think IWB makes learning this subject more enjoyable	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
20. I believe that training is required to teach with IWB technology	1	2	3	4	5
21. If I do not get sufficient training, I do not feel comfortable with using an IWB in classrooms	1	2	3	4	5
22. I can keep my student's attention in lessons longer with the help of IWB technology	1	2	3	4	5
23. I think IWB increases the interaction and participation of the students in the classes	1	2	3	4	5
24. I think my students are more motivated when I use an IWB in lessons	1	2	3	4	5

Section 3:

General Approach towards Teaching (ATI): The statements in this section are designed to explore the way that teachers go about teaching in a specific context or subject or course. While responding to these statements, please keep in mind the subject area and year level which you selected in section 1 (which forms the context of your teaching). There are no right or wrong responses. Please read all the statements carefully and circle the number that best describes how you feel about that statement.

1= this statement was only rarely true for me in this context (RT)

2= this statement was sometimes true for me in this context (ST)

3= this statement was true for me about half the time in this context (HT)

4= this statement was frequently true for me in this context (FT)

5= this statement was almost always true for me in this context (AT)

Please do not spend a long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I design my teaching in this subject with the assumption that most of the students have very little useful knowledge of the topics to be covered	1	2	3	4	5
2. I feel it is important that this subject should be completely described in terms of specific objectives relating to what students have to know for formal assessment items	1	2	3	4	5
3. In my interactions with students in this subject I try to develop a conversation with them about the topics we are studying	1	2	3	4	5
4. I feel it is important to present a lot of facts to students so that they know what they have to learn for this subject	1	2	3	4	5
5. I feel that the assessment in this subject should be an opportunity for students to reveal their changed conceptual understanding of the subject	1	2	3	4	5
6. I set aside some teaching time so that the students can discuss, among themselves, the difficulties that they encounter studying this subject	1	2	3	4	5
7. In this subject I concentrate on covering the information that might be available from a good textbook	1	2	3	4	5
8. I encourage students to restructure their existing knowledge in terms of developing new ways of thinking about the subject	1	2	3	4	5
9. In teaching sessions for this subject, I use difficult or undefined examples to provoke debate	1	2	3	4	5
10. I structure this subject to help students to pass the formal assessment items	1	2	3	4	5
11. I think an important reason for running teaching sessions in this subject is to give students a good set of notes	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
12. In this subject, I only provide the students with the information they will need to pass the formal assessments	1	2	3	4	5
13. I feel that I should know the answers to any questions that students may put to me during this subject	1	2	3	4	5
14. I make available opportunities for students in this subject to discuss their changing understanding of the subject	1	2	3	4	5
15. I feel that it is better for students in this subject to generate their own notes rather than always copy mine	1	2	3	4	5
16. I feel a lot of teaching time in this subject should be used to question students' ideas	1	2	3	4	5

Section 4:

Learning Environment:

This section is designed to explore the way with which you use IWB in your teaching. Please keep in mind the same context (subject area and year level) which forms the basis of your responses in previous sections.

a) General Information about IWB use: The questions in this sub-section are designed to gather general information about your IWB use in the classroom. Please tick the appropriate box.

1. Do you have access to IWB to use for teaching?

   ☐ Yes ☐ No

2. How often do you use IWB for teaching in the classroom?

   ☐ Daily ☐ Twice a week ☐ Once a week ☐ Fortnightly

   ☐ Occasionally

3. What type of training have you received to learn to use IWB?

   ☐ No training ☐ Basic training ☐ IWB applications/tools

   ☐ IWB integration into curriculum

4. Where did you receive your training?

   ☐ Self-taught ☐ Introductory training sessions by IWB companies

   ☐ IWB Professional development workshops ☐ Other, please specify...

5. Do you get IWB related technical support in the school whenever needed?

   ☐ Yes ☐ No ☐ Sometimes

6. Are there any IWB related training workshops run by your school?

   ☐ Yes ☐ No ☐ Sometimes

7. Do you get encouragement from your school authority to use IWB in your teaching?

   ☐ Yes ☐ No

8. Do you get help from your colleagues for using IWB?

   ☐ Yes ☐ No ☐ Sometimes

9. How would you rate your competence at working with IWBs? (Please circle the appropriate number)

   0 1 2 3 4 5 6 7 8 9 10

   |---|---|---|---|---|---|---|---|---|---|

   Novice ... Highly Competent

10. How confident do you feel about working with IWBs? (Please circle the appropriate number)

   0 1 2 3 4 5 6 7 8 9 10

   |---|---|---|---|---|---|---|---|---|---|

   No Confidence ... Very Confident

11. How would you rate your experience level in using IWBs? (Please circle the appropriate number)

   0 1 2 3 4 5 6 7 8 9 10

   |---|---|---|---|---|---|---|---|---|---|

   No Experience ... Highly Experienced

b) <u>Classroom interactions using IWB</u>: Below are series of statements designed to explore the way that you go about teaching in a specific context using IWB. Please keep in mind the same context which forms the basis of your responses in above sections. There are no right or wrong responses. Please circle the number that best describes how you feel about the statement.

1= this statement was only rarely true for me in this context (RT)

2= this statement was sometimes true for me in this context (ST)

3= this statement was true for me about half the time in this context (HT)

4= this statement was frequently true for me in this context (FT)

5= this statement was almost always true for me in this context (AT)

Please do not spend long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. In my teaching I use IWB to provide visual support to the lesson	1	2	3	4	5
2. When I deliver lessons using IWB, students get maximum chance to participate in the learning process	1	2	3	4	5
3. I prepare my lessons by using a number of IWB-based teaching/learning resources	1	2	3	4	5
4. In my teaching using IWB I do not allow the students to work on the IWB	1	2	3	4	5
5. I use all the features of IWB i.e., visual, verbal and kinaesthetic for the representation of a topic in multi-modal form	1	2	3	4	5
6. I use both simple whiteboard and IWB in my classroom simultaneously	1	2	3	4	5
7. I use IWB in my teaching in the way which encourage the students to participate in classroom discussions	1	2	3	4	5
8. I do not think there is any difference in my teaching with and without IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
9. In my classroom the use of IWB creates more interaction:					
a. between students in the class	1	2	3	4	5
b. between students and me	1	2	3	4	5
10. My use of IWB in my classroom helps my students initiate questioning related to the lesson	1	2	3	4	5
11. I use IWB in a way in my classroom so that the students get more involved in their learning	1	2	3	4	5

Section 5:

Student Learning: In this you will need to give responses to the statements developed to know about your perceptions of the impact of IWB use on student learning i.e., learning approaches and learning outcomes. Please reflect on your teaching using IWB in the same context as specified in the previous sections of this questionnaire. There are no right or wrong responses. Please circle the number that best describes how you feel about the statement.

1= this statement is never or only rarely true of my students (RT)

2= this statement is sometimes true of my students (ST)

3= this statement is true of my students about half the time (HT)

4= this statement is frequently true of my students (FT)

5= this statement is always or almost always true of my students (AT)

Please do not spend long time on each: your first reaction is probably the best one.

a) <u>Learning Approach</u>: This sub-section has a number of general questions developed to understand your perceptions of your students' approach towards learning the subject-area (specified in section 1) when you use IWB to teach.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I think that most of my students feel more satisfied with their learning when I teach using IWB instead of simple whiteboard	1	2	3	4	5
2. I think using IWB in my classroom helps most of my students to pass the subject by doing as little work as possible	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
3. I find that learning about a topic in the classroom using IWB gives my students the chance to obtain enough information to form their conclusions	1	2	3	4	5
4. I find that majority of my students only learn the information which I represented on the IWB	1	2	3	4	5
5. Once I help my students to get into a topic using IWB, mostly they find it highly interesting	1	2	3	4	5
6. I find that my students mostly tend to think that those sections of information which are elaborated by me on IWB during a lesson are important from the assessment point of view	1	2	3	4	5
7. I find my students engaging more in discussions when I teach using IWB	1	2	3	4	5
8. I think that most of my students do not look for more information other than which is represented on IWB in the classroom	1	2	3	4	5
9. I find my students working hard on topics which are taught using IWB	1	2	3	4	5
10. I feel that my students keep their learning to minimum when I use IWB	1	2	3	4	5
11. My use of various modes of representation to represent a topic on IWB helps my students to memorise the topic even if they don't understand it	1	2	3	4	5
12. My students prefer me to use IWB in classroom because it helps them to make connections between different topics	1	2	3	4	5
13. I find that IWB helps my students to remember the facts and details about a topic	1	2	3	4	5
14. When I use IWB to teach a topic, my students ask more questions to get more clarification about the topic	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
15. I find that my students get confused when I teach a topic using multi-modal representations on IWB	1	2	3	4	5
16. I have noticed that my students think that learning deeply about a topic using IWB is not useful	1	2	3	4	5
17. My students like to learn with IWB because it allows them to revisit the previous lessons	1	2	3	4	5
18. I feel that the students tend to learn only that information which is represented on IWB	1	2	3	4	5

b) <u>Learning Outcome</u>: This sub-section is designed to explore your perceptions of your students' learning outcomes in the subject-area (specified in section 1) when taught using IWB.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I think my students find it easier to recall a topic which is taught by me using IWB	1	2	3	4	5
2. My students do not understand the lessons when I use an IWB	1	2	3	4	5
3. When I teach a topic using IWB, my students can easily think of its use in their day to day life	1	2	3	4	5
4. When I introduce new topics using IWB, it helps my students to make connections with their previous learning	1	2	3	4	5
5. Learning a topic using IWB helps my students to make critical judgements	1	2	3	4	5
6. Learning on IWB does not help my students to improve their creative power	1	2	3	4	5
7. I think my students can remember a topic more easily when taught using IWB rather than the white-board	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
8. My students find it easier to compare two separate topics which are represented using IWB	1	2	3	4	5
9. I think my students find it hard to use their previous knowledge when a lesson is taught using IWB	1	2	3	4	5
10. My students can easily explore relationships between different aspects of a topic when I teach with IWB	1	2	3	4	5
11. My students usually demonstrate the understanding of the significance of a topic taught on IWB	1	2	3	4	5
12. I find that working on IWB in front of the class helps my students to express their creativity	1	2	3	4	5
13. My students find it hard to remember the information which is represented on IWB	1	2	3	4	5
14. Using audio and visual materials with IWB helps my students to understand lessons better	1	2	3	4	5
15. I feel that learning about a concept using IWB helps my students to think of ways of implementing that concept in various situations	1	2	3	4	5
16. Making comparisons between two different ideas learnt on IWB is always easier for my students	1	2	3	4	5
17. It is hard for my students to make judgements about the overall significance of a given idea when it is represented using IWB	1	2	3	4	5
18. I have noticed that learning on IWB helps my students to generate new knowledge out of their understanding	1	2	3	4	5
19. The learning material represented using verbal, visual and kinaesthetic features of IWB is easier for my students to remember	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
20. My students find it easier to summarize at the end of a lesson which has been taught with the use of IWB	1	2	3	4	5
21. I think learning using IWB helps my students to think how can they apply the knowledge of one subject to another subject area	1	2	3	4	5
22. My students always find it hard to organise the different concepts represented on IWB in their own way	1	2	3	4	5
23. My students could deeply evaluate any idea or concept when represented on IWB	1	2	3	4	5
24. I have noticed that when various facts and ideas are represented in a lesson using IWB it helps my students to synthesise new concepts out of it	1	2	3	4	5

Thank you very much for giving your precious time to complete the questionnaire!

Your Feedback regarding this Questionnaire: Please give your suggestions regarding this questionnaire by answering the following questions.

1. What do you think about the overall length of this questionnaire? Please suggest if the questionnaire is:

☐ Longer than it should be

☐ Of reasonable length

☐ Shorter than it should be

☐ Other, please specify...

2. What is your overall opinion regarding this questionnaire? (*Please give any suggestions which you think could help to improve this questionnaire*).

....

....

....

....

Your feedback is greatly appreciated!

Appendix B

The Pilot Study Student Questionnaire

Student Questionnaire

Section 1:

<u>Personal factors:</u> In this section, general questions about your background and computer use will be asked. Please tick the appropriate box.

a) Demographic factors:

1. Name of your school *(Please Print)*:

   ....

2. Your gender:

   ☐ Male ☐ Female

3. Your Year level:

   ☐ Year 7 ☐ Year 8 ☐ Year 9 ☐ Year 10

   ☐ Year 11 ☐ Year 12

4. Subject-Area in which your teacher uses IWB:

   ☐ English ☐ Science ☐ Mathematics

   ☐ Society and Environment ☐ Languages ☐ Arts

   ☐ Design and Technology ☐ Health and Physical Education

   ☐ Other, please specify..

b) General Information about your computer use:

1. Do you have access to a computer at school?

   ☐ Yes ☐ No

2. Do you access to a computer away from the school?

   ☐ Yes ☐ No

3. Do you have access to the Internet at school?

   ☐ Yes ☐ No

4. Do you have access to the Internet away from school?

   ☐ Yes ☐ No

5. Do you own your own computer?

   ☐ Yes ☐ No

6. How often do you use computers at school?

☐ Daily ☐ Almost twice a week ☐ Once in a week

☐ Occasionally ☐ Never

7. How often do you use computers away from school?

☐ Daily ☐ Almost twice a week ☐ Once a week

☐ Occasionally ☐ Never

8. How would you rate your experience level in using computers? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
No Experience										Highly Experienced

9. How would you rate your competence at working with computers? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
Novice										Highly Competent

10. How confident do you feel about working with computers? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
No Confidence										Very Confident

Section 2:

<u>Attitudinal factors:</u> In this section, questions will be asked to know about your attitudes towards the use of computers and other ICT tools in general and IWB in particular in the education. The two sub-sections in this section have series of statements. There are no right or wrong responses to these statements. Please read each statement and circle the number that best describes how you feel about that statement.

1= Strongly Disagree (SD)

2= Disagree (D)

3=Undecided (U)

4= Agree (A)

5= Strongly Agree (SA)

Please give response to all the statements. Do not spend a long time on each: your first reaction is probably the best one.

a) <u>Attitudes towards the use of ICT as educational tools in the classroom:</u> ICT is an acronym for Information and Communication Technology. It includes the technologies, such as computer, computer related devices, Internet, digital devices, software and digital resources, which are used to access, gather, manipulate and present information.

	(SD)	(D)	(U)	(A)	(SA)
1. I enjoy doing things using ICT	1	2	3	4	5
2. I am tired of using ICT	1	2	3	4	5
3. I will be able to get a good job if I learn how to use ICT	1	2	3	4	5
4. I get a sinking feeling when I think of trying to use an ICT tool	1	2	3	4	5
5. I would work harder if I could use ICT more often	1	2	3	4	5
6. I enjoy lessons in which I use ICT	1	2	3	4	5
7. I know that ICT give me opportunities to learn many new things	1	2	3	4	5
8. Working with ICT makes me nervous	1	2	3	4	5
9. I believe that it is very important for me to learn how to use ICT	1	2	3	4	5
10. I feel comfortable working with ICT	1	2	3	4	5
11. I think it takes a long time to finish when I use ICT	1	2	3	4	5
12. Using ICT tools is very frustrating	1	2	3	4	5
13. ICT do not scare me	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
14. I will do as little work with ICT as possible	1	2	3	4	5
15. ICTs is difficult to use	1	2	3	4	5

b) <u>Attitudes towards the use of IWB as an educational tool in the classroom:</u> The series of statements in this sub-section are designed to understand your attitudes towards the use of IWBs. Please give response to these statements by keeping in mind the use of IWB in the subject-area which you have mentioned in section 1 of this questionnaire. Please do not spend a long time on each: your first reaction is probably the best one.

	(SD)	(D)	(U)	(A)	(SA)
1. IWB makes learning more interesting and exciting	1	2	3	4	5
2. IWB makes the teachers' drawings and diagrams easier to see	1	2	3	4	5
3. It seems difficult for me to use the IWBs	1	2	3	4	5
4. I find opportunity to learn from different sources with the use of IWBs	1	2	3	4	5
5. I like going to the front of the class to use the IWB	1	2	3	4	5
6. I prefer lessons that are taught with an IWB	1	2	3	4	5
7. Using IWB saves time	1	2	3	4	5
8. Sometimes deficiencies of the IWB screen and sunlight in the classroom make it difficult to see the things on the IWB	1	2	3	4	5
9. I concentrate better when my teacher uses an IWB in lessons	1	2	3	4	5
10. I like to participate in lessons more when my teacher uses an IWB	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
11. I find it hard to keep up with the lesson in which my teacher uses IWB	1	2	3	4	5
12. I think I concentrate better when my teacher uses an IWB in lessons	1	2	3	4	5
13. I find the lesson to be more organised when my teacher uses IWB	1	2	3	4	5
14. It makes me uncomfortable when my work is shown to the whole class on the IWB	1	2	3	4	5
15. I find it easier to keep attention during the lesson when IWB is used	1	2	3	4	5
16. Use of IWB makes it easier for me to be motivated during lessons	1	2	3	4	5
17. The lessons become more enjoyable when taught using IWB	1	2	3	4	5

Section 3:

Learning Environment: This section is designed to explore your perceptions of the teaching and learning environment when IWB is used. To give responses to the statements in this section, you need to keep in mind the teaching and learning of the subject area which you selected in section 1.

a) General Information about IWB: The questions in this sub-section are designed to gather general information about the use of IWB in your classroom. Please tick the appropriate box.

1. Do you have IWB installed in your classroom?

   ☐ Yes ☐ No

2. How often does your teacher use IWB for instructions (of above stated subject-area) in the classroom?

   ☐ Daily ☐ Twice a week ☐ Once a week ☐ Fortnightly

   ☐ Occasionally

3. How would you rate your competence at working with IWBs? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

Novice ... Highly Competent

4. How confident do you feel about working with IWBs? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

No Confidence ... Very Confident

b) <u>Classroom interactions using IWB</u>: Below are series of statements designed to explore the way that your teacher go about teaching using IWB. Please keep in mind the same subject-area which forms the basis of your responses in above sections. There is no right or wrong responses. Please circle the number that best describes how you feel about the statement.

1= this statement is only rarely true (RT)

2= this statement is sometimes true (ST)

3= this statement is true for about half the time (HT)

4= this statement is frequently true (FT)

5= this statement is almost always true (AT)

Please do not spend long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. My teacher uses IWB to show us the visual material related to the lesson	1	2	3	4	5
2. When my teacher teaches using IWB, all the students get maximum chance to participate in the learning process	1	2	3	4	5
3. My teacher uses a number of IWB-based teaching/learning resources in lessons	1	2	3	4	5
4. My teacher does not allow students to work on the IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
5. My teacher represents the information related to a topic on the IWB in multi-modal form i.e., using visual, verbal and kinaesthetic forms together for a topic	1	2	3	4	5
6. My teacher uses both simple whiteboard and IWB in the classroom simultaneously	1	2	3	4	5
7. My teacher teaches using IWB, I participate in Classroom discussions more than usual	1	2	3	4	5
8. There is not much difference between my teachers' use of a traditional board and an IWB in terms of teaching techniques and methods	1	2	3	4	5
9. When my teacher uses IWB, overall there is more interaction:					
a. between students in the class	1	2	3	4	5
b. between students and teacher	1	2	3	4	5
10. I usually initiate questioning related to the lesson when my teacher teaches using IWB	1	2	3	4	5
11. When my teacher teaches using IWB, I often get the opportunity to go in front of the class to work on IWB	1	2	3	4	5

Section 4:

Student Learning: This section is designed to investigate the impact of particular kind of use of IWB on your learning. This section is further divided into two sub-sections. Please give your responses to the statements in these sections by reflecting on your learning of the subject (specified in section 1) using IWB in your present year level. If your teacher did not start using IWB in the beginning of current school year, please reflect only on the time period when s/he started using IWB for teaching this particular subject-area. In that case you do not need to think about your learning from the start of your current year level.

*(**For example:** Suppose you have specified science subject in the first section of this questionnaire because your science teacher uses IWB in classroom. Now if your teacher is using IWB since the start of this current year level (started 8 months back), then you have to think that how you go about learning science in this year level, but if your teacher has started using IWB within last 4 months, then you only need to reflect on your science learning within last 4 months.)*

There is no right or wrong answers. Please circle the number that best describes how you feel about the statement.

1= this statement is never or only rarely true of me (RT)

2= this statement is sometimes true of me (ST)

3= this statement is true of me about half the time (HT)

4= this statement is frequently true of me (FT)

5= this statement is always or almost always true of me (AT)

Please do not spend long time on each: your first reaction is probably the best one.

a) Learning Approach: This sub-section has a number of statements designed to understand that how you go about learning the subject-area (specified in section 1) when your teacher uses IWB to teach.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I find that at times learning gives me a feeling of deep satisfaction	1	2	3	4	5
2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied	1	2	3	4	5
3. My aim is to pass the course while doing as little work as possible	1	2	3	4	5
4. I only study seriously what's given out in class or in the course outlines	1	2	3	4	5
5. I feel that virtually any topic can be highly interesting once I get into it	1	2	3	4	5
6. I find most new topics interesting and often spend extra time trying to obtain more information about them	1	2	3	4	5
7. I do not find my course very interesting so I keep my work to the minimum	1	2	3	4	5
8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
9. I find that learning can at times be as exciting as a good novel or movie	1	2	3	4	5
10. I test myself on important topics until I understand them completely	1	2	3	4	5
11. I find I can get by in most assessments by memorising key sections rather than trying to understand them	1	2	3	4	5
12. I generally restrict my learning to what is specifically set as I think it is unnecessary to do anything extra	1	2	3	4	5
13. I work hard at my studies because I find the material interesting	1	2	3	4	5
14. I spend a lot of my free time finding out more about interesting topics which have been discussed in class	1	2	3	4	5
15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics	1	2	3	4	5
16. I believe the teachers should expect students to spend significant amounts of time learning topics everyone knows won't be examined	1	2	3	4	5
17. I come to most classes with questions in mind that I want answering	1	2	3	4	5
18. I make a point of looking at most of the suggested readings that go with the lessons	1	2	3	4	5
19. I see no point in learning material which is not likely to be in the examination	1	2	3	4	5
20. I find the best way to pass examinations is to try To remember answers to likely questions	1	2	3	4	5

b) <u>Learning Outcomes</u>: This sub-section is designed to explore your perceptions of your learning outcomes in the subject-area (specified in section 1) when taught using IWB.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I find it easier to recall a topic which is taught by my teacher using IWB	1	2	3	4	5
2. I do not understand the lessons when my teacher uses an IWB	1	2	3	4	5
3. When I learn about a new topic using IWB, I can think of its use in my day to day life very easily	1	2	3	4	5
4. When new topics are introduced by my teacher using IWB, it helps me to make connections with my previous learning	1	2	3	4	5
5. Learning a topic using IWB helps me to make critical judgements	1	2	3	4	5
6. Learning on IWB does not help me to improve my creative power	1	2	3	4	5
7. I think I can remember a topic more easily when taught using IWB rather than simple board	1	2	3	4	5
8. When two separate concepts or ideas are represented using IWB, I usually find myself comparing them to see the similarities or differences between them	1	2	3	4	5
9. When a lesson is taught using IWB, I find it very hard to use my previous knowledge in it	1	2	3	4	5
10. I can easily explore relationships between different concepts of a topic which I learn with IWB	1	2	3	4	5
11. It is easier to understand the significance of a topic taught on IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
12. I find that working on IWB in front of the class helps me to express my creativity	1	2	3	4	5
13. I find it hard to remember the information which is represented on IWB	1	2	3	4	5
14. Using audio and visual materials with IWB helps me understand lessons better	1	2	3	4	5
15. Learning about a concept using IWB helps me to think of ways of implementing that concept to various situations	1	2	3	4	5
16. Making comparisons between two different ideas learnt on IWB is always easier for me	1	2	3	4	5
17. It is hard to make judgements about the overall significance of a given idea when it is represented using IWB	1	2	3	4	5
18. I have noticed that learning on IWB helps me generate new knowledge out of my understanding	1	2	3	4	5
19. The learning material represented using verbal, visual and kinaesthetic features of IWB is easy to remember	1	2	3	4	5
20. I find it easier to summarize at the end of a lesson which is taught with the use of IWB	1	2	3	4	5
21. Learning using IWB helps me to think that how can I apply the knowledge of one subject to another subject area	1	2	3	4	5
22. I always find it hard to organise the different concepts represented on IWB in my own way	1	2	3	4	5
23. I could deeply evaluate any idea or concept when represented on IWB	1	2	3	4	5
24. When various facts and ideas are represented in a lesson using IWB it helps me to synthesise new concepts out of it	1	2	3	4	5

Thank you very much for giving your precious time to complete the questionnaire!

Appendix C

The Final Teacher Questionnaire

Teacher Questionnaire

Section 1:

<u>Personal factors:</u> In this section, general questions about your background and computer use will be asked. Please tick the appropriate box.

a) Demographic factors:

1. Name of the school where you teach *(Please print)*:

   ....

2. Your age:

   ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-45

   ☐ 46-Above

3. Your gender:

   ☐ Male ☐ Female

4. Your teaching experience:

   ☐ Less than 1 year ☐ 1-5 years ☐ 6-10 years

   ☐ 11-15 years ☐ 16-20 years ☐ 21-above

5. Your teaching qualifications:

   ☐ Bachelor of Teaching ☐ Graduate Diploma in Education

   ☐ Other, please specify..

6. Subject-Area you teach using IWB *(Please specify your one main subject area which you teach using IWB)*:

   ☐ English ☐ Science ☐ Mathematics

   ☐ Society and Environment ☐ Languages ☐ Arts

   ☐ Design and Technology ☐ Health and Physical Education

   ☐ Other, please specify..

7. Year level where you teach the above stated subject-area using an IWB *(Please choose only one main year level where you teach using IWB, even if you teach to more than one year level)*:

   ☐ Year 7 ☐ Year 8 ☐ Year 9 ☐ Year 10

   ☐ Year 11 ☐ Year 12

b) <u>General Information about your computer use:</u>

1. Do you have access to a computer at school?

   ☐ Yes ☐ No

2. Do you have access to a computer away from the school?

   ☐ Yes ☐ No

3. Do you have access to the Internet at school?

   ☐ Yes ☐ No

4. Do you have access to the Internet away from school?

   ☐ Yes ☐ No

5. Do you own your own computer?

   ☐ Yes ☐ No

6. How would you rate your experience level in using computers?

   0 1 2 3 4 5 6 7 8 9 10

   No Experience ... Highly Experienced

7. How would you rate your competence at working with computers?

   0 1 2 3 4 5 6 7 8 9 10

   Novice ... Highly Competent

8. How confident do you feel about working with computers?

   0 1 2 3 4 5 6 7 8 9 10

   No Confidence ... Very Confident

9. How often do you use computers for teaching in the classroom?

   ☐ Daily ☐ Almost twice a week ☐ Once in a week

   ☐ Occasionally ☐ Never

10. If you do use computers, what type of training have you received?

    ☐ No training ☐ Basic Computer Operations (*on/off, how to run programs*)

    ☐ Computer Applications (*word processing, spreadsheets etc.)*

    ☐ Computer integration (*how to use in classroom curriculum*)

Section 2:

Attitudinal factors: In this section, questions will be asked to determine your attitudes towards the use of ICT in general and IWB in particular in the education. The two sub-headings in this section have a series of statements. There are no right or wrong responses to these statements. Please read each statement and circle the number that best describes how you feel about that statement.

1= Strongly Disagree (SD)

2= Disagree (D)

3=Undecided (U)

4= Agree (A)

5= Strongly Agree (SA)

Please give a response to all the statements. Do not spend a long time on each: your first reaction is probably the best one.

a) Attitudes towards the use of ICT as an educational tool in the classroom: ICT is an acronym for Information and Communication Technology. It includes the technologies, such as computer, computer related devices, Internet, digital devices, software and digital resources which are used to access, gather, manipulate and present information.

	(SD)	(D)	(U)	(A)	(SA)
1. Knowing how to use various ICT tools is a necessary skill for me	1	2	3	4	5
2. I get confused when using ICT	1	2	3	4	5
3. I like using ICT tools in my teaching	1	2	3	4	5
4. I feel confident in my ability to learn about ICT	1	2	3	4	5
5. Working with ICT makes me nervous	1	2	3	4	5
6. I now use my knowledge of ICT in many ways as a teacher	1	2	3	4	5
7. I wish I could use technology more frequently	1	2	3	4	5
8. ICT makes me feel stupid	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
9. A job using ICT would be very interesting	1	2	3	4	5
10. I don't expect to use ICT much at work	1	2	3	4	5
11. I am not the type to do well with ICT	1	2	3	4	5
12. I feel uncomfortable using most ICT tools	1	2	3	4	5
13. Working with ICT is boring	1	2	3	4	5
14. It is important to know how to use ICT in order to get a teaching position	1	2	3	4	5
15. I know that if I work hard to learn about ICT, I will do well	1	2	3	4	5
16. ICT makes me feel uneasy	1	2	3	4	5
17. I am able to do as well working with ICT as my fellow teachers	1	2	3	4	5

b) Attitudes towards the use of IWB as an educational tool in the classroom: Please respond to the questions in this sub-section by reflecting on your teaching using an IWB. Please keep in mind that the researcher wants your responses to be based on your teaching of that particular subject-area, and that particular year level, which you selected in the section 1 of this questionnaire. Please do not spend a long time on each: your first reaction is probably the best one.

	(SD)	(D)	(U)	(A)	(SA)
1. Using IWB-based resources reduces the time I spend on writing during the lessons	1	2	3	4	5
2. When using an IWB in my lessons, I spend more time in the preparation of the lesson	1	2	3	4	5
3. I think using an IWB makes it easier to include different subject-specific learning resources when preparing the lesson plan	1	2	3	4	5
4. I think using an IWB makes it easier to display the available learning resources to the whole class	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
5. It is beneficial to be able to save and print the materials generated during the lessons	1	2	3	4	5
6. I give more effective explanations in my lessons when using an IWB	1	2	3	4	5
7. IWB helps me to easily summarise the lesson	1	2	3	4	5
8. Using an IWB, I can more easily control/manage the whole class	1	2	3	4	5
9. I can immediately reach the extra learning resources during my lesson when using an IWB	1	2	3	4	5
10. I think an IWB can be a good supplement to support teaching	1	2	3	4	5
11. Using an IWB makes me a more efficient teacher	1	2	3	4	5
12. Using an IWB makes it easier for me to move back and forth in the lesson very conveniently	1	2	3	4	5
13. I like using IWB technology in my lessons	1	2	3	4	5
14. I feel uncomfortable in front of my students when using an IWB	1	2	3	4	5
15. I do not think my students are ready for this IWB technology	1	2	3	4	5
16. What I do in class with my usual methods is sufficient for teaching my subject	1	2	3	4	5
17. Reviewing the whole lesson towards the end is very easy if the lesson is taught using an IWB	1	2	3	4	5
18. I am not the type to do well with IWB-based applications	1	2	3	4	5
19. I think IWB makes learning this subject more enjoyable	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
20. I believe that training is required to teach with IWB technology	1	2	3	4	5
21. If I do not get sufficient training, I do not feel comfortable with using an IWB in classrooms	1	2	3	4	5
22. I can keep my student's attention in lessons longer with the help of IWB technology	1	2	3	4	5
23. I think IWB increases the interaction and participation of the students in the classes	1	2	3	4	5
24. I think my students are more motivated when I use an IWB in lessons	1	2	3	4	5

Section 3:

General Approach towards Teaching (ATI): The statements in this section are designed to explore the way that teachers go about teaching in a specific context or subject or course. While responding to these statements, please keep in mind the subject area and year level which you selected in section 1 (which forms the context of your teaching). There are no right or wrong responses. Please read all the statements carefully and circle the number that best describes how you feel about that statement.

1= this statement was only rarely true for me in this context (RT)

2= this statement was sometimes true for me in this context (ST)

3= this statement was true for me about half the time in this context (HT)

4= this statement was frequently true for me in this context (FT)

5= this statement was almost always true for me in this context (AT)

Please do not spend a long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I design my teaching in this subject with the assumption that most of the students have very little useful knowledge of the topics to be covered	1	2	3	4	5
2. I feel it is important that this subject should be completely described in terms of specific objectives relating to what students have to know for formal assessment items	1	2	3	4	5
3. In my interactions with students in this subject I try to develop a conversation with them about the topics we are studying	1	2	3	4	5
4. I feel it is important to present a lot of facts to students so that they know what they have to learn for this subject	1	2	3	4	5
5. I feel that the assessment in this subject should be an opportunity for students to reveal their changed conceptual understanding of the subject	1	2	3	4	5
6. I set aside some teaching time so that the students can discuss, among themselves, the difficulties that they encounter studying this subject	1	2	3	4	5
7. In this subject I concentrate on covering the information that might be available from a good textbook	1	2	3	4	5
8. I encourage students to restructure their existing knowledge in terms of developing new ways of thinking about the subject	1	2	3	4	5
9. In teaching sessions for this subject, I use difficult or undefined examples to provoke debate	1	2	3	4	5
10. I structure this subject to help students to pass the formal assessment items	1	2	3	4	5
11. I think an important reason for running teaching sessions in this subject is to give students a good set of notes	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
12. In this subject, I only provide the students with the information they will need to pass the formal assessments	1	2	3	4	5
13. I feel that I should know the answers to any questions that students may put to me during this subject	1	2	3	4	5
14. I make available opportunities for students in this subject to discuss their changing understanding of the subject	1	2	3	4	5
15. I feel that it is better for students in this subject to generate their own notes rather than always copy mine	1	2	3	4	5
16. I feel a lot of teaching time in this subject should be used to question students' ideas	1	2	3	4	5

Section 4:

Learning Environment:

This section is designed to explore the way with which you use IWB in your teaching. Please keep in mind the same context (subject area and year level) which forms the basis of your responses in previous sections.

a) General Information about IWB use: The questions in this sub-section are designed to gather general information about your IWB use in the classroom. Please tick the appropriate box.

1. Do you have access to IWB to use for teaching?

   ☐ Yes ☐ No

2. How often do you use IWB for teaching in the classroom?

   ☐ Daily ☐ Twice a week ☐ Once a week ☐ Fortnightly

   ☐ Occasionally

3. What type of training have you received to learn to use IWB?

   ☐ No training ☐ Basic training ☐ IWB applications/tools

   ☐ IWB integration into curriculum

4. Where did you receive your training?

☐ Self-taught ☐ Introductory training sessions by IWB companies

☐ IWB Professional development workshops ☐ Other, please specify..

5. Do you get IWB related technical support in the school whenever needed?

☐ Yes ☐ No ☐ Sometimes

6. Are there any IWB related training workshops run by your school?

☐ Yes ☐ No ☐ Sometimes

7. Do you get encouragement from your school authority to use IWB in your teaching?

☐ Yes ☐ No

8. Do you get help from your colleagues for using IWB?

☐ Yes ☐ No ☐ Sometimes

9. How would you rate your competence at working with IWBs? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
Novice										Highly Competent

10. How confident do you feel about working with IWBs? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
No Confidence										Very Confident

11. How would you rate your experience level in using IWBs? (Please circle the appropriate number)

0	1	2	3	4	5	6	7	8	9	10
No Experience										Highly Experienced

b) <u>Classroom interactions using IWB</u>: Below are series of statements designed to explore the way that you go about teaching in a specific context using IWB. Please keep in mind the same context which forms the basis of your responses in above sections. There are no right or wrong responses. Please circle the number that best describes how you feel about the statement.

1= this statement was only rarely true for me in this context (RT)

2= this statement was sometimes true for me in this context (ST)

3= this statement was true for me about half the time in this context (HT)

4= this statement was frequently true for me in this context (FT)

5= this statement was almost always true for me in this context (AT)

Please do not spend long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. In my teaching I use IWB to provide visual support to the lesson	1	2	3	4	5
2. When I deliver lessons using IWB, students get maximum chance to participate in the learning process	1	2	3	4	5
3. I prepare my lessons by using a number of IWB-based teaching/learning resources	1	2	3	4	5
4. In my teaching using IWB I do not allow the students to work on the IWB	1	2	3	4	5
5. I use all the features of IWB i.e., visual, verbal and kinaesthetic for the representation of a topic in multi-modal form	1	2	3	4	5
6. I use both simple whiteboard and IWB in my classroom simultaneously	1	2	3	4	5
7. I use IWB in my teaching in the way which encourage the students to participate in classroom discussions	1	2	3	4	5
8. I do not think there is any difference in my teaching with and without IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
9. In my classroom the use of IWB creates more interaction:					
a. between students in the class	1	2	3	4	5
b. between students and me	1	2	3	4	5
10. My use of IWB in my classroom helps my students initiate questioning related to the lesson	1	2	3	4	5
11. I use IWB in a way in my classroom so that the students get more involved in their learning	1	2	3	4	5

Permission Request: I might wish to follow up your responses in this questionnaire by doing classroom observations or a face to face interview to gain a better, in-depth understanding of your views regarding IWB use. You will be contacted by the researcher to arrange for the time and place of the interview. The participation is entirely voluntary.

Would you be willing to participate in a short interview conducted by the researcher?

☐ Yes ☐ No

Would you be willing to allow the researcher to observe your teaching using IWB?

☐ Yes ☐ No

If your answer is yes to any of the above questions, how would you like to be contacted by the researcher?

☐ Via email, please provide your email address..

☐ Via phone, please provide your phone number

1. Landline number-... (Or),

2. Mobile number-..

Thank you very much for giving your precious time to complete the questionnaire!

Appendix D
The Final Student Questionnaire

Student Questionnaire

Section 1:

<u>Personal factors:</u> In this section, general questions about your background and computer use will be asked. Please tick the appropriate box.

a) Demographic factors:

1. Name of your school *(Please Print)*:

   ....

2. Your gender:

   ☐ Male ☐ Female

3. Your Year level:

   ☐ Year 7 ☐ Year 8 ☐ Year 9 ☐ Year 10

   ☐ Year 11 ☐ Year 12

4. Subject-Area in which your teacher uses IWB:

   ☐ English ☐ Science ☐ Mathematics

   ☐ Society and Environment ☐ Languages ☐ Arts

   ☐ Design and Technology ☐ Health and Physical Education

   ☐ Other, please specify..

b) General Information about your computer use:

1. Do you have access to a computer at school?

   ☐ Yes ☐ No

2. Do you have access to a computer away from the school?

   ☐ Yes ☐ No

3. Do you have access to the Internet at school?

   ☐ Yes ☐ No

4. Do you have access to the Internet away from school?

   ☐ Yes ☐ No

5. Do you own/lease your own computer or have a computer at home which you can use?

   ☐ Yes ☐ No

6. How often do you use computers at school?

   ☐ Daily ☐ Almost twice a week ☐ Once in a week

☐ Occasionally ☐ Never

7. How often do you use computers away from school?

☐ Daily ☐ Almost twice a week ☐ Once a week

☐ Occasionally ☐ Never

8. How would you rate your experience level in using computers? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

No Experience — Highly Experienced

9. How would you rate your competence at working with computers? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

Novice — Highly Competent

10. How confident do you feel about working with computers? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

No Confidence — Very Confident

Section 2:

<u>Attitudinal factors:</u> In this section, questions will be asked to know about your attitudes towards the use of computers and other ICT tools in general and IWB in particular in the education. The two sub-sections in this section have series of statements. There are no right or wrong responses to these statements. Please read each statement and circle the number that best describes how you feel about that statement.

1= Strongly Disagree (SD)

2= Disagree (D)

3=Undecided (U)

4= Agree (A)

5= Strongly Agree (SA)

Please give response to all the statements. Do not spend a long time on each: your first reaction is probably the best one.

a) Attitudes towards the use of ICT as educational tools in the classroom: ICT is an acronym for Information and Communication Technology. It includes the technologies, such as computer, computer related devices, Internet, digital devices, software and digital resources, which are used to access, gather, manipulate and present information.

	(SD)	(D)	(U)	(A)	(SA)
1. I enjoy doing things using ICT	1	2	3	4	5
2. I am tired of using ICT	1	2	3	4	5
3. I will be able to get a good job if I learn how to use ICT	1	2	3	4	5
4. I get a sinking feeling when I think of trying to use an ICT tool	1	2	3	4	5
5. I would work harder if I could use ICT more often	1	2	3	4	5
6. I enjoy lessons in which I use ICT	1	2	3	4	5
7. I know that ICT give me opportunities to learn many new things	1	2	3	4	5
8. Working with ICT makes me nervous	1	2	3	4	5
9. I believe that it is very important for me to learn how to use ICT	1	2	3	4	5
10. I feel comfortable working with ICT	1	2	3	4	5
11. I think it takes a long time to finish when I use ICT	1	2	3	4	5
12. Using ICT tools is very frustrating	1	2	3	4	5
13. ICTs do not scare me	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
14. I will do as little work with ICT as possible	1	2	3	4	5
15. ICT is difficult to use	1	2	3	4	5

b) Attitudes towards the use of IWB as an educational tool in the classroom: The series of statements in this sub-section are designed to understand your attitudes towards the use of IWBs. Please give response to these statements by keeping in mind the use of IWB in the subject-area which you have mentioned in section 1 of this questionnaire. Please do not spend a long time on each: your first reaction is probably the best one.

	(SD)	(D)	(U)	(A)	(SA)
1. IWB makes learning more interesting and exciting	1	2	3	4	5
2. IWB makes the teachers' drawings and diagrams easier to see	1	2	3	4	5
3. It seems difficult for me to use the IWBs	1	2	3	4	5
4. I find opportunity to learn from different sources with the use of IWBs	1	2	3	4	5
5. I like going to the front of the class to use the IWB	1	2	3	4	5
6. I prefer lessons that are taught with an IWB	1	2	3	4	5
7. Using IWB saves time	1	2	3	4	5
8. Sometimes deficiencies of the IWB screen and sunlight in the classroom make it difficult to see the things on the IWB	1	2	3	4	5
9. I concentrate better when my teacher uses an IWB in lessons	1	2	3	4	5
10. I like to participate in lessons more when my teacher uses an IWB	1	2	3	4	5

	(SD)	(D)	(U)	(A)	(SA)
11. I find it hard to keep up with the lesson in which my teacher uses IWB	1	2	3	4	5
12. I think I concentrate better when my teacher uses an IWB in lessons	1	2	3	4	5
13. I find the lesson to be more organised when my teacher uses IWB	1	2	3	4	5
14. It makes me uncomfortable when my work is shown to the whole class on the IWB	1	2	3	4	5
15. I find it easier to keep attention during the lesson when IWB is used	1	2	3	4	5
16. Use of IWB makes it easier for me to be motivated during lessons	1	2	3	4	5
17. The lessons become more enjoyable when taught using IWB	1	2	3	4	5

Section 3:

Learning Environment: This section is designed to explore your perceptions of the teaching and learning environment when IWB is used. To give responses to the statements in this section, you need to keep in mind the teaching and learning of the subject area which you selected in section 1.

a) General Information about IWB: The questions in this sub-section are designed to gather general information about the use of IWB in your classroom. Please tick the appropriate box.

1. Do you have IWB installed in your classroom?

   ☐ Yes ☐ No

2. How often does your teacher use IWB for instructions (of above stated subject-area) in the classroom?

   ☐ Daily ☐ Twice a week ☐ Once a week ☐ Fortnightly

   ☐ Occasionally

3. How would you rate your competence at working with IWBs? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

Novice — Highly Competent

4. How confident do you feel about working with IWBs? (Please circle the appropriate number)

0 1 2 3 4 5 6 7 8 9 10

No Confidence — Very Confident

b) Classroom interactions using IWB: Below are series of statements designed to explore the way that your teacher go about teaching using IWB. Please keep in mind the same subject-area which forms the basis of your responses in above sections. There is no right or wrong responses. Please circle the number that best describes how you feel about the statement.

1= this statement is only rarely true (RT)

2= this statement is sometimes true (ST)

3= this statement is true for about half the time (HT)

4= this statement is frequently true (FT)

5= this statement is almost always true (AT)

Please do not spend long time on each: your first reaction is probably the best one.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. My teacher uses IWB to show us the visual material related to the lesson	1	2	3	4	5
2. When my teacher teaches using IWB, all the students get maximum chance to participate in the learning process	1	2	3	4	5
3. My teacher uses a number of IWB-based teaching/learning resources in lessons	1	2	3	4	5
4. My teacher does not allow students to work on the IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
5. My teacher represents the information related to a topic on the IWB in multi-modal form i.e., using visual, verbal and kinaesthetic forms together for a topic	1	2	3	4	5
6. My teacher uses both simple whiteboard and IWB in the classroom simultaneously	1	2	3	4	5
7. My teacher teaches using IWB, I participate in Classroom discussions more than usual	1	2	3	4	5
8. There is not much difference between my teachers' use of a traditional board and an IWB in terms of teaching techniques and methods	1	2	3	4	5
9. When my teacher uses IWB, overall there is more interaction:					
a. between students in the class	1	2	3	4	5
b. between students and teacher	1	2	3	4	5
10. I usually initiate questioning related to the lesson when my teacher teaches using IWB	1	2	3	4	5
11. When my teacher teaches using IWB, I often get the opportunity to go in front of the class to work on IWB	1	2	3	4	5

Section 4:

Student Learning: This section is designed to investigate the impact of particular kind of use of IWB on your learning. This section is further divided into two sub-sections. Please give your responses to the statements in these sections by reflecting on your learning of the subject (specified in section 1) using IWB in your present year level. If your teacher did not start using IWB in the beginning of current school year, please reflect only on the time period when s/he started using IWB for teaching this particular subject-area. In that case you do not need to think about your learning from the start of your current year level.

*(**For example:** Suppose you have specified science subject in the first section of this questionnaire because your science teacher uses IWB in classroom. Now if your teacher is using IWB since the start of this current year level (started 8 months back), then you have to think that how you go about learning science in this year level, but if your teacher has started using IWB within last 4 months, then you only need to reflect on your science learning within last 4 months.)*

There is no right or wrong answers. Please circle the number that best describes how you feel about the statement.

1= this statement is never or only rarely true of me (RT)

2= this statement is sometimes true of me (ST)

3= this statement is true of me about half the time (HT)

4= this statement is frequently true of me (FT)

5= this statement is always or almost always true of me (AT)

Please do not spend long time on each: your first reaction is probably the best one.

b) Learning Approach: This sub-section has a number of statements designed to understand that how you go about learning the subject-area (specified in section 1) when your teacher uses IWB to teach.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I find that at times learning gives me a feeling of deep satisfaction	1	2	3	4	5
2. I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied	1	2	3	4	5
3. My aim is to pass the course while doing as little work as possible	1	2	3	4	5
4. I only study seriously what's given out in class or in the course outlines	1	2	3	4	5
5. I feel that virtually any topic can be highly interesting once I get into it	1	2	3	4	5
6. I find most new topics interesting and often spend extra time trying to obtain more information about them	1	2	3	4	5
7. I do not find my course very interesting so I keep my work to the minimum	1	2	3	4	5
8. I learn some things by rote, going over and over them until I know them by heart even if I do not understand them	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
9. I find that learning can at times be as exciting as a good novel or movie	1	2	3	4	5
10. I test myself on important topics until I understand them completely	1	2	3	4	5
11. I find I can get by in most assessments by memorising key sections rather than trying to understand them	1	2	3	4	5
12. I generally restrict my learning to what is specifically set as I think it is unnecessary to do anything extra	1	2	3	4	5
13. I work hard at my studies because I find the material interesting	1	2	3	4	5
14. I spend a lot of my free time finding out more about interesting topics which have been discussed in class	1	2	3	4	5
15. I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics	1	2	3	4	5
16. I believe the teachers should not expect students to spend significant amounts of time learning topics everyone knows won't be examined	1	2	3	4	5
17. I come to most classes with questions in mind that I want answering	1	2	3	4	5
18. I make a point of looking at most of the suggested readings that go with the lessons	1	2	3	4	5
19. I see no point in learning material which is not likely to be in the examination	1	2	3	4	5
20. I find the best way to pass examinations is to try to remember answers to likely questions	1	2	3	4	5

b) <u>Learning Outcomes</u>: This sub-section is designed to explore your perceptions of your learning outcomes in the subject-area (specified in section 1) when taught using IWB.

	(RT)	(ST)	(HT)	(FT)	(AT)
1. I find it easier to recall a topic which is taught by my teacher using IWB	1	2	3	4	5
2. I do not understand the lessons when my teacher uses an IWB	1	2	3	4	5
3. When I learn about a new topic using IWB, I can think of its use in my day to day life very easily	1	2	3	4	5
4. When new topics are introduced by my teacher using IWB, it helps me to make connections with my previous learning	1	2	3	4	5
5. Learning a topic using IWB helps me to make critical judgements	1	2	3	4	5
6. Learning on IWB does not help me to improve my creative power	1	2	3	4	5
7. I think I can remember a topic more easily when taught using IWB rather than simple board	1	2	3	4	5
8. When two separate concepts or ideas are represented using IWB, I usually find myself comparing them to see the similarities or differences between them	1	2	3	4	5
9. When a lesson is taught using IWB, I find it very hard to use my previous knowledge in it	1	2	3	4	5
10. I can easily explore relationships between different concepts of a topic which I learn with IWB	1	2	3	4	5
11. It is easier to understand the significance of a topic taught on IWB	1	2	3	4	5

	(RT)	(ST)	(HT)	(FT)	(AT)
12. I find that working on IWB in front of the class helps me to express my creativity	1	2	3	4	5
13. I find it hard to remember the information which is represented on IWB	1	2	3	4	5
14. Using audio and visual materials with IWB helps me understand lessons better	1	2	3	4	5
15. Learning about a concept using IWB helps me to think of ways of implementing that concept to various situations	1	2	3	4	5
16. Making comparisons between two different ideas learnt on IWB is always easier for me	1	2	3	4	5
17. It is hard to make judgements about the overall significance of a given idea when it is represented using IWB	1	2	3	4	5
18. I have noticed that learning on IWB helps me generate new knowledge out of my understanding	1	2	3	4	5
19. The learning material represented using verbal, visual and kinaesthetic features of IWB is easy to remember	1	2	3	4	5
20. I find it easier to summarize at the end of a lesson which is taught with the use of IWB	1	2	3	4	5
21. Learning using IWB helps me to think that how can I apply the knowledge of one subject to another subject area	1	2	3	4	5
22. I always find it hard to organise the different concepts represented on IWB in my own way	1	2	3	4	5
23. I could deeply evaluate any idea or concept when represented on IWB	1	2	3	4	5
24. When various facts and ideas are represented in a lesson using IWB it helps me to synthesise new concepts out of it	1	2	3	4	5

Permission Request: I might wish to follow up your responses in this questionnaire with a face to face interview to gain a better, in-depth understanding of your views regarding IWB use. You will be contacted by the researcher to arrange for the time and place of the interview. The participation is entirely voluntary. **You will get a chance to enter a 'Lucky Draw' to win an iPod Shuffle for showing interest in participating in the interview. There are three iPod Shuffles to be drawn.**

Would you be willing to participate in the interview?

☐ Yes ☐ No

If yes, how would you like to be contacted by the researcher?

☐ Via email, please provide your email address..

☐ Via phone, please provide your phone number

1. Landline number-... (Or),
2. Mobile number-...

Thank you very much for giving your precious time to complete the questionnaire!

Appendix E

The School Questionnaire

School Questionnaire

General Information regarding ICT resources at School: Some questions are asked in this questionnaire to gather general information regarding your school and ICT related facilities available at this school. To give response, the participant has to tick the appropriate box in the yes-no questions and circle the appropriate response on the rating-scale. In some questions, the participant will need to write one or two words answer.

Note: As this study is focused on secondary school level, so even if your school has both primary level and secondary level campus combined, you will only need to provide information regarding secondary school.

Thank you in advance for your time!

1. Name of the school (Please print)..

2. Total number of teachers in this school (Please print)...

3. Total number of students in this school (Please print)...

4. How would you rate the ICT integration level in the classrooms of this school?

1	2	3	4	5	6
Very Low	Below Average	Average	Above Average	High	Very High

5. All the classrooms in this school have IWBs installed in them

☐ Yes ☐ No

6. If the answer of question 5 is **No**, please specify how many classrooms in this school have IWB installed in them? ....

7. At any given time, the year levels that can have access to the IWBs

1	2	3	4	5
Only One	Less than Half	Half	More than Half	All of them

8. This school provides the on-site technical support to the teachers

☐ Yes ☐ No

9. This school provides the on-site technical support to the students

☐ Yes ☐ No

10. High speed broadband Internet connection is available at the school at all times

☐ Yes ☐ No

11. The number of teachers having access to Internet

0	1	2	3	4
None	Less than Half	Half	More than Half	All of them

12. The number of students having access to Internet

0	1	2	3	4
None	Less than Half	Half	More than Half	All of them

13. The school authority encourage the teachers to use more and more ICT tools in their teaching

☐ Yes ☐ No

14. The school encourage teachers to attend ICT related professional development courses or workshops

☐ Yes ☐ No

15. The school runs IWB related training sessions

0	1	2	3	4	5	6	7	8
Not at all	Yearly	Half Yearly	Quarterly	Monthly	Fortnightly	Weekly	Daily	Twice in a week

16. The teachers in this school have full access to software and hardware

0	1	2	3	4	5
Not at all	Rarely	Sometimes	Half of the time	Frequently	All the times

17. The students in this school have full access to software and hardware

0	1	2	3	4	5
Not at all	Rarely	Sometimes	Half of the time	Frequently	All the times

Appendix F

Information Sheet for the Schools

Information Sheet for the School

Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

My name is Amrit Pal Kaur. I am a research scholar at the School of Education, The University of Adelaide. I am undertaking a research study leading to the production of thesis on the topic of **the impact of the use of IWB on the learning of secondary students in South Australian schools**. Investigating the issue of adoption of IWB in the secondary school classrooms in South Australia is another focus of this research. This information will be collected by inviting the teachers and students of your school to complete two survey questionnaires respectively.

Before asking teachers and students to fill survey questionnaire, I want to gather general information regarding ICT related facilities present at you school. For that purpose, I would like to invite you to give responses to some general questions given in the school questionnaire. You will need only 3-5 minutes to complete this small questionnaire. Your responses will remain confidential. No individual school will be identified in any way to others, or in final report.

The participation in this study is entirely voluntary. Your school need not complete the questionnaire and you can withdraw from participating at any time.

Any questions or enquiries related to this study are welcome. Please feel free to contact me, Amrit Pal Kaur- 0425136272 or email- amrit.kaur@adelaide.edu.au (or) My Principal Supervisor- Dr Igusti Ngurah Darmawan, Lecturer, School of Education- (08) 83035788 or email- igusti.darmawan@adelaide.edu.au (or) My Co-Supervisor- Dr Christopher Dawson, Adjunct Associate Professor, School of Education- (08) 83034192 or email- christopher.dawson@adelaide.edu.au

Please see the attached independent complaints procedure form should you have any complaints about this project.

Thank you in advance for your contribution!

Appendix G

Information Sheet for the Teacher Participants

Information Sheet for the Teacher Participants

Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

My name is Amrit Pal Kaur. I am a research scholar at the School of Education, The University of Adelaide. I am undertaking a research study leading to the production of thesis on the topic of **the impact of the use of IWB on the learning of secondary students in South Australian schools**. Investigating the issue of adoption of IWB in the secondary school classrooms in South Australia is another focus of this research. This information will be collected by inviting you to complete a survey questionnaire.

The questionnaire will ask you the questions about your attitude towards the use of Information and Communication Technologies (ICTs) in education and particularly towards the use of IWB in your teaching. Some questions will be asked about your general approach towards teaching and most importantly about your teaching method using IWB. In the beginning sections of this questionnaire, general information will be collected about your computer and IWB use along with some demographic information about you. You will need 10-15 minutes to complete the questionnaire. You are requested to fill the questionnaire during your free time in the school. Your responses will remain confidential. No individual participant will be identified in any way to others, or in final report.

I might wish to follow up your responses in this questionnaire by doing a face to face interview or classroom observations to gain a better, in-depth understanding of your views regarding IWB use. You will be contacted by the researcher to arrange for the time and place of the interview if you will be willing to participate in interview or observations. The participation in this study is entirely voluntary. You need not complete the questionnaire and you can withdraw from participating in observations or interview and the study as a whole at any time.

Any questions or enquiries related to this study are welcome. Please feel free to contact me, Amrit Pal Kaur- 0425136272 or email- amrit.kaur@adelaide.edu.au (or) My Principal Supervisor- Dr Igusti Ngurah Darmawan, Lecturer, School of Education- (08) 83035788 or email- igusti.darmawan@adelaide.edu.au (or) My Co-Supervisor- Dr Christopher Dawson, Adjunct Associate Professor, School of Education- (08) 83034192 or email- christopher.dawson@adelaide.edu.au

Please see the attached independent complaints procedure form should you have any complaints about this project.

Thank you in advance for your contribution!

Appendix H

Information Sheet for the Student Participants

THE UNIVERSITY of ADELAIDE

Information Sheet for the Student Participants

Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

My name is Amrit Pal Kaur. I am a research scholar at the School of Education, The University of Adelaide. I am undertaking a research study leading to the production of thesis on the topic of **the impact of the use of IWB on the learning of secondary students in South Australian schools**. Investigating the issue of adoption of IWB in the secondary school classrooms in South Australia is another focus of this research. This information will be collected by inviting you to complete a survey questionnaire.

In the beginning section of this questionnaire, general information will be collected about your computer use along with some background information about you. Next you will be asked about your attitudes towards the use of Computers and other Information and Communication Technologies (ICTs) in education and particularly towards the use of IWB in your learning. Further, questions will be asked about your views of the teaching and learning atmosphere when IWB is used. The questions towards the end of the questionnaire are focused on your learning in that particular subject-area in which your teacher uses IWB. You will need 15-20 minutes to complete the questionnaire. You are requested to fill the questionnaire during your free time in the school. Your responses will remain confidential. No individual participant will be identified in any way to others, or in final report.

I might wish to follow up your responses in this questionnaire with a face to face interview to gain a better, in-depth understanding of your views regarding IWB use. **The participants will receive automatic entry into a lucky draw to win an 'iPod shuffle' (3 iPod shuffles to be drawn) by just showing their interest in participating in the interviews**, although it is not necessary that you will be called for the interview. If selected for the interview, you will be contacted by the researcher to arrange for the convenient time and place of the interview. The participation in this study is entirely voluntary. You need not complete the questionnaire and you can withdraw from participating in the interview and the study as a whole at any time.

Any questions or enquiries related to this study are welcome. Please feel free to contact me, Amrit Pal Kaur- 0425136272 or email- amrit.kaur@adelaide.edu.au (or) My Principal Supervisor- Dr Igusti Ngurah Darmawan, Lecturer, School of Education- (08) 83035788 or email- igusti.darmawan@adelaide.edu.au (or) My Co-Supervisor- Dr Christopher Dawson, Adjunct Associate Professor, School of Education- (08) 83034192 or email- christopher.dawson@adelaide.edu.au

Please see the attached independent complaints procedure form should you have any complaints about this project. **Thank you in advance for your contribution!**

Appendix I

Information Sheet for the Parents

Information Sheet for the Parents

Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

My name is Amrit Pal Kaur. I am a research scholar at the School of Education, The University of Adelaide. I am undertaking a research study leading to the production of thesis on the topic of **the impact of the use of IWB on the learning of secondary students in South Australian schools**. Investigating the issue of adoption of IWB in the secondary school classrooms in South Australia is another focus of this research. This information will be collected by inviting your child to complete a survey questionnaire.

In the beginning section of this questionnaire, general information will be collected about your child's computer use along with some background information. Next your child will be asked about his/her attitudes towards the use of Computers and other Information and Communication Technologies (ICTs) in education and particularly towards the use of IWB in his/her learning. Further, questions will be asked about your child's views of the teaching and learning atmosphere when IWB is used. The questions towards the end of the questionnaire are focused on your child's learning in that particular subject-area in which his/her teacher uses IWB. Your child will need 15-20 minutes to complete the questionnaire. Your child will be requested to fill the questionnaire during his/her free time in the school. His/her responses will remain confidential. No individual participant will be identified in any way to others, or in final report.

I might wish to follow up your child's responses in this questionnaire with a face to face interview to gain a better, in-depth understanding of your views regarding IWB use. **The participants will receive automatic entry into a lucky draw to win an 'iPod shuffle' (3 iPod shuffles to be drawn) by just showing their interest in participating in the interviews**, although it is not necessary that they will be called for the interview. If selected for the interview, the participants will be contacted by the researcher to arrange for the convenient time and place of the interview. The participation in this study is entirely voluntary. Your child need not complete the questionnaire and s/he can withdraw from participating in the interview and the study as a whole at any time.

Any questions or enquiries related to this study are welcome. Please feel free to contact me, Amrit Pal Kaur- 0425136272 or email- amrit.kaur@adelaide.edu.au (or) My Principal Supervisor- Dr Igusti Ngurah Darmawan, Lecturer, School of Education- (08) 83035788 or email- igusti.darmawan@adelaide.edu.au

Please see the attached independent complaints procedure form should you have any complaints about this project. **Thank you in advance for your contribution!**

Appendix J
Consent Form

CONSENT FORM

1. I, ...…………………………………………………………(*please print name)*
consent to take part in the research project entitled:

Interactive Whiteboard: adoption and the impact of its utilization on student learning in South Australian secondary schools

2. I acknowledge that I have read the attached Information Sheet entitled:
Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

4. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

5. I understand that I am free to withdraw from the project at any time.

6. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

………………………………………………………………………………………
………...
(signature) *(date)*

WITNESS

I have described to ……………………………………………….......... *(name of participant)* the nature of the research to be carried out. In my opinion she/he understood the explanation.

Status in Project**:** ……………………………………………………………………….

Name: …………………………………………………………………………….….

……………………………………………………………………………………...
(signature) *(date)*

Appendix K

Parent Consent Form

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

CONSENT FORM

To be Completed by Parent or Guardian

1. I, ………………………………………………………………………..…. *(please print name)*

   consent to allow …………………………………………………….... *(please print name)*

   to take part in the research project entitled:
   Interactive Whiteboard: adoption and the impact of its utilization on student learning in South Australian secondary schools

2. I acknowledge that I have read the attached Information Sheet entitled:
   Impact of Interactive Whiteboard (IWB) Use on Secondary Students Learning

   and have had the project, as far as it affects …………………………………… *(name)*
   fully explained to me by the research worker. My consent is given freely.

   IN ADDITION, I ACKNOWLEDGE THE FOLLOWING ON BEHALF OF
   ………………………………………………………………………………. *(name)*

3. Although I understand that the purpose of this research project is to improve the quality of education, it has also been explained to me that involvement may not be of any benefit to him/her.

4. I have been given the opportunity to have a member of his/her family or friend present while the project was explained to me.

5. I have been informed that the information he/she provides will be kept confidential.

6. I understand that he/she is free to withdraw from the project at any time.

7. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

   ……………………………………………Parent/Guardian ………………………………………
   (signature and please indicate relationship) *(date)*

WITNESS

I have described to ……………………………………………… *(name of parent/guardian)*

the nature of the research to be carried out. In my opinion she/he understood the explanation.

Status in Project: …………………………………………………………………………………….

Name:……………………………………………………………………………..………….……

…………………………………………………………………………………………………
(signature) *(date)*

Appendix L

Complaint Form

THE UNIVERSITY OF ADELAIDE
HUMAN RESEARCH ETHICS COMMITTEE

Document for people who are participants in a research project

CONTACTS FOR INFORMATION ON PROJECT AND INDEPENDENT COMPLAINTS PROCEDURE

The Human Research Ethics Committee is obliged to monitor approved research projects. In conjunction with other forms of monitoring it is necessary to provide an independent and confidential reporting mechanism to assure quality assurance of the institutional ethics committee system. This is done by providing research participants with an additional avenue for raising concerns regarding the conduct of any research in which they are involved.

The following study has been reviewed and approved by the University of Adelaide Human Research Ethics Committee:

Project title: **Interactive Whiteboards: adoption and the impact of its utilization on student learning in South Australian secondary schools**

1. If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the project co-ordinator:

Name: Dr Igusti Ngurah Darmawan, *Telephone*: (08) 83035788
Or
Name: Dr Christopher Dawson, *Telephone*: (08) 83034192
Or
Name: Amrit Pal Kaur*, Telephone:* 0425136272

2. If you wish to discuss with an independent person matters related to

- making a complaint, or
- raising concerns on the conduct of the project, or
- the University policy on research involving human participants, or
- your rights as a participant

contact the Human Research Ethics Committee's Secretary on phone (08) 8303 6028

Appendix M
Interview Questions for Teacher Participants

Interview Protocol for Teachers

Name of the School: ....

Name of the Teacher: ....

Subject area taught by the Teacher: ....

Position: ....

Date of Interview: ....

Time of Interview: ....

I want to thank you for taking the time to meet with me today. My name is Amrit Pal Kaur and I would like to talk to you about your experiences of using Interactive Whiteboard in your teaching. Specially, as one of the main aim of this research, I am studying the impact or link of IWB use on student learning.

The interview should take around 30-35 minutes. I will be taping the session because I don't want to miss any of your comments. Although I will be taking some notes during the session, I can't possibly write fast enough to get it all down. Because we're on tape, please be sure to speak up so that we don't miss your comments.

All responses will be kept confidential. This means that I will ensure that any information we include in our reports does not identify you as the respondent. Remember, you don't have to talk about anything you don't want to and you may end the interview at any time.

Are there any questions about what I have just explained?

Are you willing to participate in this interview?

Interview Questions

1. How long have you been using IWB in your teaching?

2. How did you start using IWB?

3. Why do you use IWB for teaching in your classroom?

4. What prompted their use (if education; teacher focus or student focus)? Who are you doing it for? Please explain.

5. What kind of support/training do you get from your school? Please give examples.

6. Where do you see yourself going in this regard?

7. With what age students did you start using IWB in the beginning?

8. How did the use of IWB gradually evolve?

9. How do you involve students in this process?

10. What kind of constraints do you face while using IWB in your teaching?

11. How do you overcome the barrier(s)?

12. How do you perceive other staff members?

13. How much is the school initiative/faculty versus individual initiative?

14. What are your perceptions of its value to students (e.g., teaching better, learning better, attitude better)?

15. What do you think are the negative aspects of using IWBs?

16. What recommendations do you have for other teachers who are in the beginning of using IWBs?

Is there anything more you would like to add?

I'll be analysing the information you and others gave me and submitting a draft report to the organization in one month. I'll be happy to send you a copy to review at that time, if you are interested.

Thank you very much for your time.

Appendix N
Interview Transcription Sample

Interview Transcript

Name of the School: School A

Name of the Teacher: Teacher X

Subject area taught by the Teacher: Arts-Media

Position: ICT Coordinator

Date of the Interview: 02-11-2011

Time of the Interview: 3.10pm

Researcher: Mr. X, how long have you been using this IWB in your teaching?

Participant: I have been using in my own classroom one for about two years now but prior to that I was training teach different use of IWB when I had the teacher-training role.

Researcher: So before you start using it yourself, you use to teach others.

Participant: Well, I did a research project myself when I was at Technology school of the Future and I discovered all the information I needed about IWBs, I then ran training courses for schools in things to watch out for and things to, you know, the positives and negatives of using IWB.

Researcher: Ok, so you did the training courses for other schools as well.

Participant: Yes.

Researcher: Alright, and then you gradually start using it yourself.

Participant: So I move from my role which was about teacher training to back into the classroom level. So I since that, I have been using from last two years.

Researcher: So, I think that you have already mentioned that how did you start of using it. You start by having some kind of research about IWB.

Participant: Yeah.

Researcher: And what age students did you start it with?

Participant: Mostly I start teaching at High School level from Year 9. So the age of the students is around about 14.

Researcher: And, so the main reason of you start using IWB was your personal interest in it or is their other kind of reason?

Participant: I think I started as being a skeptic about IWB. I learn a lot about it in my role as a teacher-training role and became more and more convinced, seeing good use of it by some very good teachers, that it was a worthwhile investment if the teachers are supported well and are motivated to use, it can be a very gagging technology. I started out believing that over priced and probably not worth the investment, but then I changed my mind.

Researcher: So the use of IWB, I mean your use or your attitude, change in your attitude towards it started with thinking that it is useful for teachers.

Participant: Certainly, the best use of it I have seen has been one for the teachers use it but also where the students are active users of the Board and it is a typical transition that all, almost all teachers go through. They start out using it as it is a play device to show videos or PowerPoint to start to use some other interactive tools and then the next step for the students to start using it. And it happens probably the best in junior primary schools where I have seen students use it all the time.

Researcher: So the teachers whom you train initially were from the primary level.

Participant: Certainly, the majority. I mean certainly in SA, the majority of IWBs first gone to primary schools then probably junior primary and finally secondary schools are getting involved.

Researcher: How long ago did you start giving this kind of training?

Participant: That would have been about, I have been here, it's my fourth year here. I was in that role probably 3 years, so about 7 years ago.

Researcher: Alright ok, so long time ago.

Participant: Nearly, when the schools started taking them on in SA, and there was initial interest in it, I was in the role where I had my opportunity to research how people are using it.

Researcher: Alright, ok.

Researcher: In this school, what kind of support and training, because you use to train others.

Participant: Certainly I have taken the role of training other staff and I have also have another staff member here, music teacher, who is very good at this technology and he has also taken some of the training sessions for us at the school. And also the company that supply the boards did some training initially and then some follow-up training, like train the trainers about the top model.

Researcher: So teachers do get good training in the school.

Participant: It varies, year to year, depending on what are the priorities in the school but certainly when we first got the IWB, we had quite a bit of training.

Researcher: Right.

Researcher: As being a teacher how your use of IWB has evolved gradually?

Participant: Like everyone, I guess so. I, probably at the starting point having done the research to know and also because I am the ICT coordinator at the school using the technology a lot, I didn't feel, held back, and so I able to get into the higher level use of it probably much quicker than some people would. I actually certainly use the IWB in every lesson every day.

Researcher: Ok.

Researcher: And how do you involve students in it?

Participant: They all present information from the board, they would show examples of how they are producing. Like in the area of Media production, students would get up to demonstrate how they can choose a something like a software and it will come up, and its certainly easier for the students to see, how it is happening when they are physically touching the board or the software to see what they taking on rather than just sitting in the projectors or data projector style. Mostly, it is to do with student sharing work, showcasing what they are doing.

Researcher: So they do get very good chance of coming up to the board?

Participant: I think it's one area where I would like to still improve myself. I think there still more scope for students to get up and to do more. There a lot to do with the confidence of individual students to feel ok by getting up and to come in the front of the class and certainly for the 13-14 year old, that's not always what they want to do, primary school, junior primary kids often quiet happy to. They are bit more self-conscious at a higher school level but those who have got confidence, get up quite regularly.

Researcher: Have you ever noticed any kind of change in their confidence or in their willingness in front of the class to use the IWB. Are they encouraged more to do that?

Participant: My students, they write journal of how their work is progressing. And most students who have shown work to the class, quite often would write in their journal, how they feel about that which is quite positive actually that they feel a bit special that they have been selected to come and show their work, yeah.

Researcher: Right, ok.

Researcher: So they do feel encouraged.

Participant: Yeah.

Researcher: And what are your perceptions of its value and if you can differentiate its advantages for teaching and for student learning.

Participant: I think, whenever you have a multimodal style of learning, where its visuals, auditory, text and now so much more like animations as well an interactive web technology, that definitely my perception is higher level of engagement, whenever that's used. There are many many teachers who stick with paper and pencil and pen and for particularly motivated class, they will not stay as engaged with traditional methods these days because technology is all around them, they use higher level of technology on their phones than some of the classrooms so, its inevitably going to be less engaging. Its bringing their world to their classrooms.

Researcher: Do you think it impacts on their learning attitude as well like attitudes towards learning a particular kind of topic?

Participant: Mostly, since they are less likely to be distracted, they are more involved in the class, in the lesson and the activity that is happening. So, yes I think with the higher level of interest and involvement. The students involve with any kind of technology but the IWB certainly helps in it. Only just today, I had a teacher from another learning area come and show me stop and stare animation film made by a wonderful artist and I straight away was able to show them because I had some students doing stop and play animations in the classroom. And it is very quick way to show how it is done and show examples to them. So it's very motivating, very quicker.

Researcher: Have you noticed any kind of change or improvement in their grades or learning outcomes?

Participant: It's very hard to gage that because you can't really do that with one group of students by comparing in contrast that how they would have gone otherwise. And all my teaching because I work in the lab with computers is very heavily focused on the use of technology. It's a subject you can't really imagine teaching without it, so it is hard to say. I have started out teaching in this room mainly with only a data projector and I have noticed an improvement, certainly an improvement in engagement and involvement and probably the level of the work from the students is high because they are actually, I think, getting better quality of instruction.

Researcher: Ok, so better quality learning.

Participant: Yeah, it is.

Researcher: What are the negative aspects of IWB use?

Participant: The biggest negative is cost, its still, it's still expensive technology. The other inevitable part of that is the staff readiness, teacher's readiness to take on technology as much as IWB. It is very very varied from people who are very involved and use it a lot to those who don't or absolutely minimum and this has always been a problem with education and this has not always related to the age, I am one of the oldest teachers here and I use it more than almost anyone. But sometimes it's associated with age, people who have not grown up with the technology and we are seeing now quite young teachers pretty adaptable to the technology not being held back. So we are going through that because of change of teacher profile to people who are more comfortable with using technology and therefore IWB would be just another technology that they can have access to.

Researcher: And if I would like you to comment on teachers who are not very technology savvy, apart from not very familiar with the technology, what else could be reason for the teachers to be reluctant to use it?

Participant: Well I think, teachers who have been doing teaching for a very long time in the same approach which they have find effective to work are reluctant to change. I have seen in the higher profile private schools as well as the government schools, there is probably even less motivation for teachers who are getting higher results with senior secondary students. So they are less motivated to change because they think they are getting the good results, everyone is happy with the work, why bother change if it's working and I don't really agree with that approach, but then what some will say.

Researcher: How the school can help or how the teacher, or how an individual teacher can help him/herself to overcome these kind of barriers?

Participant: Look, one of the first thing, after we had a three year strategic plan at the school, the very first thing that we did was to give laptops to teachers because no chance for the teacher for getting students actively using technology, if they don't, teacher doesn't know how to use it themselves and so that has been a big success at this school because now every teacher uses the laptop for marking attendance, they use it for marking, well assessing work. The last assessment was all done in the same way by using the laptops. And it's a way of getting teachers onboard because they had access to the technology, they are made to get comfortable to the point that they start to getting expand on that.

Researcher: They are more familiar with it.

Participant: Sure.

Researcher: And, so the school is really helpful in providing all the resources to the teachers?

Participant: I think, the central government 'Digital Revolution' has had a bigger impact on the school, on our school. We have a lot more technology, not just computers but certainly a lot of computers and a very good wireless network so you can get internet anywhere in the school. We are always looking up for new opportunities. So the school has done quite well out of the federal funding. We also have very good IT support staff who are open to new ideas and very helpful staff.

Researcher: And where do you feel yourself going in this direction in future?

Participant: Look I think, I just recently when I had a look at a thing called as Virtable, it's a table with IWB like camera that can rotate down to the table top and you can use it as a desk where the people are around the desk and interacting with the computer environment, much likely the Microsoft interactive desk. And I think we will see a lot those kinds of interactive technologies as the technology improves. We have already seen the tablet type technology, you know, with touch screen and only the news this morning that the Microsoft projects the future where there will be laptops will be interactive devices that you wear etc and I find with the iPhone, u can talk to the iPhone and it will do things, so changing our whole tradition of the way that we think of a computer. So I see, you know, with students coming with their iPhones, which they do and all sorts of different application, I have an application free one on my iPhone called 'Dragon Dictation' that I have been trying and show to the people. So you talking to it and it type the text with very good accuracy. So everything is changing, and the IWB is one component that is one of many for the future.

Researcher: What are your recommendations for the teachers who are just in the beginning of using IWB, what do they need the most to learn how to use it effectively in their teaching?

Participant: Look I think they have to understand that there is a typical process that they will go through and that they start out simply as a projection device and then they go to the stage of ok we can do all that and now I want to do more, I want to be able to interact with the board more and they will start to go down on that path and eventually they will see more and more classrooms where the students are using the Board, so I think, that's a normal progression and you can't really skip steps easily, you can't go from a beginner to end high user straight away.

Researcher: So they need to spend more time.

Participant: Teachers have, always have problems with time, they are always very very busy. They are working day and night, many of us and we always needing to learn new things but there are so many things we could be learning. I think in teaching, juggling a lot of competing demands and it is very difficult to do it all very well. So, most people complain, not much time. It is not easily fixed either. It is not just about training; you can supply training if they can find the time to attend it too.

Researcher: Yes, I think we have talked about all the other things. And that's it for this interview. Thank you very much Mr. X!

Appendix O

Ethics Approval from the University of Adelaide

Ethics Approval from the University of Adelaide

THE UNIVERSITY
OF ADELAIDE
AUSTRALIA

RESEARCH BRANCH
RESEARCH ETHICS AND COMPLIANCE UNIT

SABINE SCHREIBER
SECRETARY
HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA

TELEPHONE +61 8 8303 6028
FACSIMILE +61 8 8303 7325
email: sabine.schreiber@adelaide.edu.au
CRICOS Provider Number 00123M

Applicant: Dr IN Darmawan

Department: School of Education

Project Title: *Interactive whiteboard: adoption and the impact of its utilisation on student learning in South Australian secondary schools*

THE UNIVERSITY OF ADELAIDE HUMAN RESEARCH ETHICS COMMITTEE

Project No: **H-152-2010** RM No: 0000010637

APPROVED for the period until: 30 September 2011

subject to: (i) approval from the Department of Education and Children's Services, and (ii) receipt of the interview schedule prior to commencement of that phase of the study. It is noted that this study will be conducted by Amrit Pal Kaur, PhD candidate.

Refer also to the accompanying letter setting out requirements applying to approval.

Professor Garrett Cullity '
Convenor
Human Research Ethics Committee

Date: 15 SEP 2010

Appendix P
Ethics Approval from DECS

Government of South Australia
Department of Education and Children's Services

Policy Directorate
Education Centre
Level 8//31 Flinders Street
Adelaide 5000
South Australia

Tel: 8226 0119
Fax: 8226 7839

DECS CS/10/251-3.2

30 November 2010

Dear Principal/Director/Site Manager

The research project titled *"Interactive Whiteboard: Adoption and the impact of its utilization on student learning in South Australian secondary schools"* conducted by Mrs Amrit Pal Kaur from the University of Adelaide has been reviewed centrally and granted approval for access to DECS sites. However, the researcher will still need your agreement to proceed with this research at your site.

Once approval has been given at the local level, it is important to ensure that the researchers fulfil their responsibilities in obtaining informed consent as agreed, that individuals' confidentiality is preserved, and that safety precautions are in place.

Researchers are encouraged to provide feedback to sites used in their research, and you may want to make this as one of the conditions for accessing your site. To ensure maximum benefits to DECS, researchers are also asked to supply the department with a copy of their final report which will be circulated to interested staff, and then made available to DECS educators for future reference.

Please contact Jeffrey Stotter on (08) 8226 0119 for further clarification if required, or to obtain a copy of the final report.

Yours sincerely

Ben Temperly
EXECUTIVE DIRECTOR
POLICY DIRECTORATE

Appendix Q

Ethics Approval from Catholic Association

Catholic Education
SOUTH AUSTRALIA

Catholic Education Centre
116 George Street Thebarton SA 5031
PO Box 179 Torrensville Plaza South Australia 5031
Telephone: (08) 8301 6600
Facsimile: (08) 8301 6611
ISD: 61 8 8301 6600
Email: director@ceo.adl.catholic.edu.au
www.cesa.catholic.edu.au

COPY

Mrs Amrit Pal Kaur
PhD Candidate
The University of Adelaide
School of Education
Faculty of Professions
Level 8, 10 Pulteney Street
The University of Adelaide SA 5005

Dear Mrs Pal Kaur

Thank you for your recent letter in which you seek permission to conduct research in Catholic secondary schools in connection with the project *'Interactive whiteboard: adoption and the impact of its utilisation on student learning in South Australian secondary schools'*. I understand that data will be gathered through a survey of teachers and students and semi-structured interviews.

In the normal course, permission of the Principal of each school in which you wish to conduct research is required. Research in Catholic schools is granted on the basis that individual students, schools and the Catholic sector itself is not specifically identified in published research data and conclusions.

Approval is also contingent upon the following conditions, i.e. that:

- a copy of the surveys has been provided to the Principal
- the permission of parents has been obtained
- the research complies with the ethics proposal of the University
- the research complies with any provisions under the Privacy Act that may require adherence by you as researcher in gathering and reporting data
- no comparison between schooling sectors is made
- the researcher will be carrying out the research within view of the class teacher or school observer
- sector requirements relating to child protection and police checks are met by researchers:
    - where researchers obtain information in relation to a student which suggests or indicates abuse, this information must be immediately conveyed to the Director of Catholic Education SA
    - all researchers and assistants, who in the course of the research interact in any way with students, are required to undertake a police check through the Archdiocese of Adelaide Police Check Unit.

...../2.

Information with regard to obtaining police clearance can be accessed at the website address:
www.cesa.catholic.edu.au

Researchers should forward a certified copy of their National Police Certificate, which has been issued within the last three months, to the Catholic Archdiocese of Adelaide Police Check Unit at the Catholic Diocesan Centre, GPO Box 1364, Adelaide SA 5001. The Police Check Unit will then post a clearance letter to the researcher. This letter should be provided to the Principal of each school.

Please accept my very best wishes for the research process.

Yours sincerely

HELEN O'BRIEN
ASSISTANT DIRECTOR – CATHOLIC EDUCATION SA

17 November 2010

Catholic Archdiocese of Adelaide
POLICE CHECK UNIT

May 13, 2011

File Number:

Mrs Amrit Pal Kaur
15 Lorna Road
PARA HILLS SA 5096

Dear Mrs Kaur,

RE: Police Check Outcome

The application recently submitted by you to the Police Check Unit for a national police check has now been processed. As a result of this process, I am pleased to inform you that you have been granted a police check CLEARANCE. Please note that other screening processes such as referee checks may also be required and that this police check clearance is only one part of the screening process and does not guarantee automatic clearance for employment or acceptance as a volunteer.

This letter should be kept for your own records. You are also required to produce this as verification of your clearance.

Your next police clearance will be due on 2 May 2014 or earlier as may be requested at the discretion of the organisation for whom you work or volunteer.

For any further enquiries in relation to this, please contact Anne-Marie Hogan on 8301 6173 or receptionpcu@cesa.catholic.edu.au.

Yours sincerely,

Anne-Marie Hogan
Operations Supervisor, Police Check Unit
Catholic Archdiocese Of Adelaide

Appendix R

Descriptive analysis results for teacher data (Teacher Questionnaire)

Descriptive analysis results for teacher data (Teacher Questionnaire)

Scale: Attitudes towards ICT (AICT)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
AICT 1	30	4.87	.063	.346	.120
AICT 2R	30	4.30	.145	.794	.631
AICT 3	30	4.57	.104	.568	.323
AICT 4	30	4.50	.133	.731	.534
AICT 5R	30	4.30	.153	.837	.700
AICT 6	30	4.27	.159	.868	.754
AICT 7	30	3.97	.195	1.066	1.137
AICT 8R	30	4.57	.149	.817	.668
AICT 9	30	3.83	.215	1.177	1.385
AICT 10R	30	4.57	.104	.568	.323
AICT 11R	30	4.37	.162	.890	.792
AICT 12R	30	4.47	.104	.571	.326
AICT 13R	30	4.43	.114	.626	.392
AICT 14	30	4.17	.118	.648	.420
AICT 15R	30	4.23	.141	.774	.599
AICT 16R	30	4.33	.168	.922	.851
AICT 17	30	4.27	.159	.868	.754

Scale: Attitudes towards IWB (AIWB)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
AIWB 1	30	3.93	.185	1.015	1.030
AIWB 2R	30	2.53	.213	1.167	1.361
AIWB 3	30	4.27	.126	.691	.478
AIWB 4	30	4.43	.092	.504	.254
AIWB 5	30	4.17	.160	.874	.764
AIWB 6	30	3.93	.166	.907	.823
AIWB 7	30	3.93	.159	.868	.754
AIWB 8	30	3.70	.153	.837	.700
AIWB 9	30	4.17	.160	.874	.764
AIWB 10	30	4.47	.093	.507	.257
AIWB 11	30	4.07	.159	.868	.754
AIWB 12	30	4.27	.126	.691	.478
AIWB 13	30	4.43	.092	.504	.254
AIWB 14R	30	4.30	.174	.952	.907
AIWB 15R	30	4.77	.079	.430	.185

Scale: Attitudes towards IWB (AIWB) contd.

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
AIWB 16R	30	3.37	.182	.999	.999
AIWB 17	30	3.97	.155	.850	.723
AIWB 18R	30	4.33	.154	.844	.713
AIWB 19	30	4.27	.106	.583	.340
AIWB 20R	30	1.73	.172	.944	.892
AIWB 21R	30	3.07	.230	1.258	1.582
AIWB 22	30	3.90	.175	.960	.921
AIWB 23	30	4.17	.152	.834	.695
AIWB 24	30	4.03	.176	.964	.930

Scale: Approaches towards teaching Inventory (ATI)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
ATI 1	30	3.00	.198	1.083	1.172
ATI 2	29	3.48	.220	1.184	1.401
ATI 3	30	4.27	.135	.740	.547
ATI 4	30	3.23	.184	1.006	1.013
ATI 5	29	3.83	.179	.966	.933
ATI 6	30	2.83	.198	1.085	1.178
ATI 7	30	2.73	.209	1.143	1.306
ATI 8	30	3.70	.153	.837	.700
ATI 9	30	2.63	.206	1.129	1.275
ATI 10	30	3.77	.184	1.006	1.013
ATI 11	30	2.63	.206	1.129	1.275
ATI 12	30	1.83	.180	.986	.971
ATI 13	30	3.20	.242	1.324	1.752
ATI 14	30	3.57	.149	.817	.668
ATI 15	30	3.33	.211	1.155	1.333
ATI 16	30	2.90	.194	1.062	1.128

Scale: Classroom Interactions towards IWB (CIIWB)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
CIIWB 1	30	4.03	.176	.964	.930
CIIWB 2	30	3.43	.157	.858	.737
CIIWB 3	30	3.03	.237	1.299	1.689
CIIWB 4R	30	4.03	.232	1.273	1.620
CIIWB 5	30	2.60	.212	1.163	1.352
CIIWB 6	30	3.50	.248	1.358	1.845
CIIWB 7	30	3.40	.212	1.163	1.352
CIIWB 8R	30	4.20	.182	.997	.993
CIIWB 9a	30	3.43	.177	.971	.944
CIIWB 9b	30	3.93	.143	.785	.616
CIIWB 10	30	3.50	.164	.900	.810
CIIWB 11	30	3.87	.150	.819	.671

Appendix S

Descriptive analysis results for student data (Student Questionnaire)

Descriptive analysis results for student data (Student Questionnaire)

Scale: Attitudes towards ICT (AICT)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
AICT 1	269	4.15	.053	.874	.764
AICT2R	269	3.98	.061	.998	.996
AICT3	267	3.70	.061	.992	.984
AICT4R	269	4.16	.062	1.025	1.050
AICT5	268	3.13	.071	1.162	1.350
AICT 6	267	3.91	.056	.923	.852
AICT 7	269	4.03	.048	.779	.608
AICT8R	268	4.26	.059	.958	.918
AICT9	268	3.91	.061	.992	.984
AICT 10	265	4.22	.054	.881	.776
AICT11R	269	3.79	.059	.970	.942
AICT12R	267	3.76	.069	1.129	1.275
AICT13R	267	1.93	.066	1.075	1.157
AICT14R	268	3.85	.063	1.033	1.066
AICT15R	268	4.01	.068	1.108	1.228

Scale: Attitudes towards IWB (AIWB)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
AIWB 1	267	3.63	.068	1.108	1.227
AIWB 2	267	3.67	.068	1.113	1.238
AIWB 3R	267	3.57	.064	1.043	1.088
AIWB 4	265	3.34	.060	.969	.938
AIWB 5	266	3.02	.072	1.182	1.396
AIWB 6	267	3.51	.063	1.035	1.070
AIWB 7	266	3.35	.068	1.114	1.241
AIWB 8R	267	2.47	.067	1.098	1.205
AIWB 9	267	3.34	.057	.925	.856
AIWB 10	267	3.31	.060	.979	.958
AIWB 11R	266	3.70	.061	.997	.994
AIWB 12	267	3.37	.060	.985	.971
AIWB 13R	266	2.98	.070	1.149	1.321
AIWB 14	265	3.26	.058	.952	.905
AIWB 15	267	3.27	.062	1.006	1.011
AIWB 16	267	3.54	.067	1.094	1.197

Scale: Classroom Interactions using IWB (CIIWB)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
CIIWB 1	263	3.57	.071	1.147	1.315
CIIWB 2	264	3.02	.069	1.123	1.262
CIIWB 3	264	3.23	.068	1.100	1.211
CIIWB 4R	265	3.45	.085	1.389	1.930
CIIWB 5	259	3.29	.069	1.105	1.222
CIIWB 6	266	3.11	.077	1.263	1.596
CIIWB 7	262	2.76	.070	1.130	1.277
CIIWB 8R	265	3.19	.075	1.226	1.502
CIIWB 9	265	3.13	.072	1.170	1.370
CIIWB 9a	261	3.41	.065	1.044	1.089
CIIWB 10	265	2.85	.068	1.109	1.230
CIIWB 11	265	2.57	.075	1.223	1.496

Scale: Learning Approaches (LA)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
LA 1	264	3.21	.066	1.075	1.156
LA 2	264	3.31	.060	.976	.953
LA 3R	266	3.52	.076	1.241	1.541
LA 4R	265	2.94	.064	1.046	1.095
LA 5	267	3.31	.066	1.071	1.147
LA 6	264	2.92	.066	1.076	1.158
LA 7R	267	3.58	.067	1.092	1.192
LA 8	266	2.79	.069	1.117	1.248
LA 9	267	2.93	.069	1.122	1.259
LA 10	266	3.14	.065	1.065	1.134
LA 11	266	2.86	.070	1.141	1.302
LA 12R	265	3.22	.066	1.081	1.169
LA 13	266	3.35	.062	1.006	1.012
LA 14	266	2.27	.069	1.130	1.277
LA 15R	265	3.49	.067	1.094	1.198
LA 16	265	2.72	.069	1.123	1.261
LA 17	266	2.71	.062	1.014	1.027
LA 18	265	2.83	.065	1.059	1.121
LA 19R	266	3.11	.071	1.152	1.328
LA 20	265	3.16	.071	1.154	1.331

Scale: Learning Outcomes (LO)

	N	Mean		Std. Deviation	Variance
Variable Label	Statistic	Statistic	Std. Error	Statistic	Statistic
LO 1	266	2.90	.076	1.240	1.538
LO 2	265	4.17	.068	1.108	1.227
LO 3	265	2.77	.074	1.198	1.435
LO 4	264	2.84	.073	1.181	1.394
LO 5	264	2.57	.071	1.152	1.326
LO 6R	264	3.31	.081	1.312	1.722
LO 7	264	3.05	.077	1.244	1.549
LO 8	263	2.86	.075	1.222	1.493
LO 9R	263	3.90	.065	1.049	1.100
LO 10	264	2.95	.067	1.086	1.180
LO 11	261	2.93	.074	1.188	1.411
LO 12	263	2.68	.076	1.229	1.510
LO 13R	264	3.87	.068	1.109	1.230
LO 14	264	3.38	.073	1.186	1.406
LO 15	262	2.73	.071	1.147	1.315
LO 16	264	2.78	.073	1.189	1.414
LO 17R	264	3.60	.066	1.067	1.138
LO 18	264	2.85	.071	1.152	1.328
LO 19	264	3.28	.071	1.146	1.313
LO 20	263	3.17	.076	1.227	1.506
LO 21	264	2.55	.069	1.122	1.260
LO 22R	262	3.63	.068	1.105	1.222
LO 23	263	2.75	.072	1.169	1.366
LO 24	262	2.69	.071	1.151	1.324

Appendix T

Skewness and Kurtosis values for variables on Teacher Questionnaire

Skewness and Kurtosis values for variables on Teacher Questionnaire

Scale: Attitudes towards ICT (AICT)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
AICT 1	-2.273	.427	3.386	.833
AICT 2R	-1.495	.427	2.970	.833
AICT 3	-.882	.427	-.168	.833
AICT 4	-1.702	.427	3.475	.833
AICT 5R	-1.014	.427	.393	.833
AICT 6	-1.245	.427	1.292	.833
AICT 7	-.662	.427	-.781	.833
AICT 8R	-2.260	.427	5.058	.833
AICT 9	-1.151	.427	.652	.833
AICT 10R	-.882	.427	-.168	.833
AICT 11R	-1.454	.427	1.574	.833
AICT 12R	-.456	.427	-.748	.833
AICT 13R	-.635	.427	-.453	.833
AICT 14	-.166	.427	-.502	.833
AICT 15R	-.441	.427	-1.160	.833
AICT 16R	-1.591	.427	2.070	.833
AICT 17	-1.245	.427	1.292	.833

Scale: Attitudes towards IWB (AIWB)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
AIWB 1	-.920	.427	-.047	.833
AIWB 2R	.612	.427	-.449	.833
AIWB 3	-1.080	.427	2.644	.833
AIWB 4	.283	.427	-2.062	.833
AIWB 5	-.676	.427	-.474	.833
AIWB 6	-.456	.427	-.525	.833
AIWB 7	-.543	.427	-.140	.833
AIWB 8	-.500	.427	-.022	.833
AIWB 9	-1.007	.427	.687	.833
AIWB 10	.141	.427	-2.127	.833
AIWB 11	-.812	.427	.337	.833
AIWB 12	-.409	.427	-.770	.833
AIWB 13	.283	.427	-2.062	.833
AIWB 14R	-1.432	.427	1.342	.833

Scale: Attitudes towards IWB (AIWB) contd.

AIWB 15R	-1.328	.427	-.257	.833
AIWB 16R	-.161	.427	-1.149	.833
AIWB 17	-.295	.427	-.724	.833
AIWB 18R	-1.460	.427	2.138	.833
AIWB 19	-.086	.427	-.357	.833
AIWB 20R	1.371	.427	1.257	.833
AIWB 21R	.089	.427	-.972	.833
AIWB 22	-.793	.427	-.044	.833
AIWB 23	-1.097	.427	1.320	.833
AIWB 24	-.812	.427	-.127	.833

Scale: Approaches towards Teaching Inventory (ATI)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
ATI 1	.175	.427	-.436	.833
ATI 2	-.511	.434	-.461	.845
ATI 3	-1.028	.427	1.635	.833
ATI 4	.147	.427	-1.123	.833
ATI 5	-.907	.434	1.302	.845
ATI 6	.180	.427	-.482	.833
ATI 7	.269	.427	-.668	.833
ATI 8	-.878	.427	.393	.833
ATI 9	.029	.427	-.823	.833
ATI 10	-.582	.427	.399	.833
ATI 11	.029	.427	-.823	.833
ATI 12	1.282	.427	.909	.833
ATI 13	-.011	.427	-1.121	.833
ATI 14	-.229	.427	-.269	.833
ATI 15	-.139	.427	-.485	.833
ATI 16	-.529	.427	-.929	.833

Scale: Classroom Interactions using IWB (CIIWB)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
CIIWB 1	-.812	.427	-.127	.833
CIIWB 2	-.305	.427	-.609	.833
CIIWB 3	-.369	.427	-.963	.833
CIIWB 4R	-1.142	.427	.272	.833
CIIWB 5	.164	.427	-.999	.833
CIIWB 6	-.575	.427	-.983	.833
CIIWB 7	-.728	.427	-.107	.833
CIIWB 8R	-1.774	.427	3.418	.833
CIIWB 9a	-.041	.427	-.914	.833
CIIWB 9b	-.338	.427	-.170	.833
CIIWB 10	-.608	.427	-.632	.833
CIIWB 11	-.950	.427	1.028	.833

Appendix U

Skewness and Kurtosis values for variables on Student Questionnaire

Skewness and Kurtosis values for variables on Student Questionnaire

Scale: Attitudes towards ICT (AICT)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
AICT 1	-1.247	.149	2.179	.296
AICT2R	-.780	.149	-.036	.296
AICT3	-.729	.149	.381	.297
AICT4R	-1.072	.149	.393	.296
AICT5	-.026	.149	-.769	.297
AICT 6	-.622	.149	.020	.297
AICT 7	-.569	.149	.334	.296
AICT8R	-1.307	.149	1.209	.297
AICT9	-.809	.149	.454	.297
AICT 10	-1.306	.150	2.073	.298
AICT11R	-.510	.149	-.251	.296
AICT12R	-.583	.149	-.608	.297
AICT13R	1.257	.149	1.166	.297
AICT14R	-.779	.149	.212	.297
AICT15R	-1.028	.149	.352	.297

Scale: Attitudes towards IWB (AIWB)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
AIWB 1	-.799	.149	.155	.297
AIWB 2	-.764	.149	-.009	.297
AIWB 3R	-.466	.149	-.284	.297
AIWB 4	-.483	.150	.107	.298
AIWB 5	-.154	.149	-.797	.298
AIWB 6	-.518	.149	.085	.297
AIWB 7	-.452	.149	-.397	.298
AIWB 8R	.613	.149	-.105	.297
AIWB 9	-.404	.149	.164	.297
AIWB 10	-.382	.149	-.128	.297
AIWB 11R	-.710	.149	.140	.298
AIWB 12	-.586	.149	.083	.297
AIWB 13R	.015	.149	-.693	.298
AIWB 14	-.409	.150	.042	.298
AIWB 15	-.414	.149	-.191	.297
AIWB 16	-.570	.149	-.192	.297

Scale: Classroom Interactions using IWB (CIIWB)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
CIIWB 1	-.694	.150	-.182	.299
CIIWB 2	.035	.150	-.644	.299
CIIWB 3	-.254	.150	-.484	.299
CIIWB 4R	-.407	.150	-1.113	.298
CIIWB 5	-.402	.151	-.321	.302
CIIWB 6	-.267	.149	-.960	.298
CIIWB 7	.059	.150	-.689	.300
CIIWB 8R	-.067	.150	-.875	.298
CIIWB 9a	-.180	.150	-.711	.298
CIIWB 9b	-.454	.151	-.165	.300
CIIWB 10	-.093	.150	-.514	.298
CIIWB 11	.273	.150	-.917	.298

Scale: Learning Approaches (LA)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
LA 1	-.154	.150	-.452	.299
LA 2	-.286	.150	-.314	.299
LA 3R	-.467	.149	-.732	.298
LA 4R	.301	.150	-.456	.298
LA 5	-.276	.149	-.583	.297
LA 6	.115	.150	-.542	.299
LA 7R	-.452	.149	-.467	.297
LA 8	.121	.149	-.742	.298
LA 9	.021	.149	-.750	.297
LA 10	-.081	.149	-.491	.298
LA 11	.022	.149	-.730	.298
LA 12R	-.184	.150	-.521	.298
LA 13	-.132	.149	-.515	.298
LA 14	.526	.149	-.613	.298
LA 15R	-.377	.150	-.608	.298
LA 16	.091	.150	-.673	.298
LA 17	-.060	.149	-.592	.298
LA 18	.082	.150	-.729	.298
LA 19R	-.081	.149	-.731	.298
LA 20	-.284	.150	-.686	.298

Scale: Learning Outcomes (LO)

	Skewness		Kurtosis	
Variable Label	Statistic	Std. Error	Statistic	Std. Error
LO 1	.019	.149	-.908	.298
LO 2	-1.292	.150	.836	.298
LO 3	-.013	.150	-.977	.298
LO 4	.081	.150	-.766	.299
LO 5	.223	.150	-.760	.299
LO 6R	-.119	.150	-1.213	.299
LO 7	-.185	.150	-.892	.299
LO 8	-.090	.150	-.902	.299
LO 9R	-.773	.150	.055	.299
LO 10	-.171	.150	-.567	.299
LO 11	-.074	.151	-.802	.300
LO 12	.102	.150	-.965	.299
LO 13R	-.737	.150	-.248	.299
LO 14	-.485	.150	-.631	.299
LO 15	.185	.150	-.608	.300
LO 16	.126	.150	-.796	.299
LO 17R	-.250	.150	-.738	.299
LO 18	.022	.150	-.753	.299
LO 19	-.321	.150	-.689	.299
LO 20	-.286	.150	-.791	.299
LO 21	.242	.150	-.655	.299
LO 22R	-.351	.150	-.710	.300
LO 23	.233	.150	-.605	.299
LO 24	.177	.150	-.655	.300

Appendix V

Summary Statistics of Missing data for Teachers

Summary Statistics of Missing data for Teachers

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
School	30	5.57	3.491	0	.0
SchoolType	30	1.23	.430	0	.0
TEACHER	30	58.40	34.237	0	.0
Age	30	4.23	1.870	0	.0
Gender	30	.60	.498	0	.0
TeachingExp	30	3.93	1.617	0	.0
TeachingQuali	30	2.00	.743	0	.0
SubjectArea1	30	.13	.346	0	.0
SubjectArea2	30	.43	.504	0	.0
SubjectArea3	30	.23	.430	0	.0
SubjectArea4	30	.03	.183	0	.0
SubjectArea5	30	.10	.305	0	.0
SubjectArea6	30	.10	.305	0	.0
SubjectArea7	30	.03	.183	0	.0
SubjectArea8	30	.00	.000	0	.0
YearLevel	30	9.97	1.629	0	.0
GICU1	30	1.00	.000	0	.0
GICU2	30	1.00	.000	0	.0
GICU3	30	1.00	.000	0	.0
GICU4	30	1.00	.000	0	.0
GICU5	30	1.00	.000	0	.0
GICU6	30	8.17	1.289	0	.0
GICU7	30	7.97	1.299	0	.0
GICU8	30	8.30	1.393	0	.0
GICU9	30	3.63	.718	0	.0
GICU10	30	.20	.407	0	.0
GICU10A	30	.20	.407	0	.0
GICU10B	30	.50	.509	0	.0
GICU10C	30	.43	.504	0	.0
AICT1	30	4.87	.346	0	.0

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
AICT2	30	1.70	.794	0	.0
AICT2R	30	4.30	.794	0	.0
AICT3	30	4.57	.568	0	.0
AICT4	30	4.50	.731	0	.0
AICT5	30	1.70	.837	0	.0
AICT5R	30	4.30	.837	0	.0
AICT6	30	4.27	.868	0	.0
AICT7	30	3.97	1.066	0	.0
AICT8	30	1.43	.817	0	.0
AICT8R	30	4.57	.817	0	.0
AICT9	30	3.83	1.177	0	.0
AICT10	30	1.43	.568	0	.0
AICT10R	30	4.57	.568	0	.0
AICT11	30	1.63	.890	0	.0
AICT11R	30	4.37	.890	0	.0
AICT12	30	1.53	.571	0	.0
AICT12R	30	4.47	.571	0	.0
AICT13	30	1.57	.626	0	.0
AICT13R	30	4.43	.626	0	.0
AICT14	30	4.17	.648	0	.0
AICT15	30	4.23	.774	0	.0
AICT16	30	1.67	.922	0	.0
AICT16R	30	4.33	.922	0	.0
AICT17	30	4.27	.868	0	.0
AIWB1	30	3.93	1.015	0	.0
AIWB2	30	3.47	1.167	0	.0
AIWB2R	30	2.53	1.167	0	.0
AIWB3	30	4.27	.691	0	.0
AIWB4	30	4.43	.504	0	.0
AIWB5	30	4.17	.874	0	.0
AIWB6	30	3.93	.907	0	.0
AIWB7	30	3.93	.868	0	.0
AIWB8	30	3.70	.837	0	.0
AIWB9	30	4.17	.874	0	.0

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
AIWB10	30	4.47	.507	0	.0
AIWB11	30	4.07	.868	0	.0
AIWB12	30	4.27	.691	0	.0
AIWB13	30	4.43	.504	0	.0
AIWB14	30	1.70	.952	0	.0
AIWB14R	30	4.30	.952	0	.0
AIWB15	30	1.23	.430	0	.0
AIWB15R	30	4.77	.430	0	.0
AIWB16	30	2.63	.999	0	.0
AIWB16R	30	3.37	.999	0	.0
AIWB17	30	3.97	.850	0	.0
AIWB18	30	1.67	.844	0	.0
AIWB18R	30	4.33	.844	0	.0
AIWB19	30	4.27	.583	0	.0
AIWB20	30	4.27	.944	0	.0
AIWB20R	30	1.73	.944	0	.0
AIWB21	30	2.93	1.258	0	.0
AIWB21R	30	3.07	1.258	0	.0
AIWB22	30	3.90	.960	0	.0
AIWB23	30	4.17	.834	0	.0
AIWB24	30	4.03	.964	0	.0
ATI1	30	3.00	1.083	0	.0
ATI2	29	3.48	1.184	1	3.3
ATI3	30	4.27	.740	0	.0
ATI4	30	3.23	1.006	0	.0
ATI5	29	3.83	.966	1	3.3
ATI6	30	2.83	1.085	0	.0
ATI7	30	2.73	1.143	0	.0
ATI8	30	3.70	.837	0	.0
ATI9	30	2.63	1.129	0	.0
ATI10	30	3.77	1.006	0	.0
ATI11	30	2.63	1.129	0	.0
ATI12	30	1.83	.986	0	.0

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
ATI13	30	3.20	1.324	0	.0
ATI14	30	3.57	.817	0	.0
ATI15	30	3.33	1.155	0	.0
ATI16	30	2.90	1.062	0	.0
GIWBU1	30	.83	.379	0	.0
GIWBU2	30	4.00	1.438	0	.0
GIWBU3	30	.17	.379	0	.0
GIWBU3A	30	.57	.504	0	.0
GIWBU3B	30	.27	.450	0	.0
GIWBU3C	30	.17	.379	0	.0
GIWBU4A	30	.53	.507	0	.0
GIWBU4B	30	.67	.479	0	.0
GIWBU4C	30	.13	.346	0	.0
GIWBU5	30	1.10	.759	0	.0
GIWBU6	30	1.10	.712	0	.0
GIWBU7	30	.90	.305	0	.0
GIWBU8	30	1.27	.785	0	.0
GIWBU9	30	6.97	1.866	0	.0
GIWBU10	30	7.27	1.780	0	.0
GIWBU11	30	6.60	2.044	0	.0
CIIWB1	30	4.03	.964	0	.0
CIIWB2	30	3.43	.858	0	.0
CIIWB3	30	3.03	1.299	0	.0
CIIWB4	30	1.97	1.273	0	.0
CIIWB4R	30	4.03	1.273	0	.0
CIIWB5	30	2.60	1.163	0	.0
CIIWB6	30	3.50	1.358	0	.0
CIIWB7	30	3.40	1.163	0	.0
CIIWB8	30	1.80	.997	0	.0
CIIWB8R	30	4.20	.997	0	.0
CIIWB9a	30	3.43	.971	0	.0
CIIWB9b	30	3.93	.785	0	.0
CIIWB10	30	3.50	.900	0	.0
CIIWB11	30	3.87	.819	0	.0

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
SchoolName	30			0	.0
TeachingQualiOther	30			0	.0
SubjectAreaOther	30			0	.0
GIWBU4D	30			0	.0

b. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Appendix W

Summary Statistics for Missing Data for Students

Summary Statistics for Missing Data for Students

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
School	269	4.33	2.587	0	.0
SchoolType	269	1.47	.500	0	.0
TEACHER	269	44.89	25.581	0	.0
Gender	269	.41	.493	0	.0
YearLevel	269	9.61	1.435	0	.0
SubjectArea1	269	.35	.479	0	.0
SubjectArea2	269	.54	.500	0	.0
SubjectArea3	269	.33	.471	0	.0
SubjectArea4	269	.16	.364	0	.0
SubjectArea5	269	.30	.460	0	.0
SubjectArea6	269	.14	.353	0	.0
SubjectArea7	269	.16	.367	0	.0
SubjectArea8	269	.12	.329	0	.0
GICU1	269	1.00	.000	0	.0
GICU2	269	.99	.086	0	.0
GICU3	269	1.00	.061	0	.0
GICU4	269	.98	.148	0	.0
GICU5	268	.91	.281	1	.4
GICU6	268	3.60	.866	1	.4
GICU7	266	3.70	.851	3	1.1
GICU8	268	7.85	1.420	1	.4
GICU9	267	7.62	1.574	2	.7
GICU10	269	8.30	1.592	0	.0
AICT1	269	4.15	.874	0	.0
AICT2	269	2.02	.998	0	.0
AICT2R	269	3.98	.998	0	.0
AICT3	267	3.70	.992	2	.7
AICT4	269	1.84	1.025	0	.0
AICT4R	269	4.16	1.025	0	.0
AICT5	268	3.13	1.162	1	.4
AICT6	267	3.91	.923	2	.7
AICT7	269	4.03	.779	0	.0

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
AICT8	268	1.74	.958	1	.4
AICT8R	268	4.26	.958	1	.4
AICT9	268	3.91	.992	1	.4
AICT10	265	4.22	.881	4	1.5
AICT11	269	2.21	.970	0	.0
AICT11R	269	3.79	.970	0	.0
AICT12	267	2.24	1.129	2	.7
AICT12R	267	3.76	1.129	2	.7
AICT13	267	4.07	1.075	2	.7
AICT13R	267	1.93	1.075	2	.7
AICT14	268	2.15	1.033	1	.4
AICT14R	268	3.85	1.033	1	.4
AICT15	268	1.99	1.108	1	.4
AICT15R	268	4.01	1.108	1	.4
AIWB1	267	3.63	1.108	2	.7
AIWB2	267	3.67	1.113	2	.7
AIWB3	267	2.43	1.043	2	.7
AIWB3R	267	3.57	1.043	2	.7
AIWB4	265	3.34	.969	4	1.5
AIWB5	266	3.02	1.182	3	1.1
AIWB6	267	3.51	1.035	2	.7
AIWB7	266	3.35	1.114	3	1.1
AIWB8	267	3.53	1.098	2	.7
AIWB8R	267	2.47	1.098	2	.7
AIWB9	267	3.34	.925	2	.7
AIWB10	267	3.31	.979	2	.7
AIWB11	266	2.30	.997	3	1.1
AIWB11R	266	3.70	.997	3	1.1
AIWB12	267	3.37	.985	2	.7
AIWB13	266	3.02	1.149	3	1.1
AIWB13R	266	2.98	1.149	3	1.1
AIWB14	265	3.26	.952	4	1.5
AIWB15	267	3.27	1.006	2	.7
AIWB16	267	3.54	1.094	2	.7

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
GIWBU1	268	.85	.353	1	.4
GIWBU2	257	3.57	1.582	12	4.5
GIWBU3	263	5.94	2.326	6	2.2
GIWBU4	263	6.38	2.329	6	2.2
CIIWB1	263	3.57	1.147	6	2.2
CIIWB2	264	3.02	1.123	5	1.9
CIIWB3	264	3.23	1.100	5	1.9
CIIWB4	265	2.55	1.389	4	1.5
CIIWB4R	265	3.45	1.389	4	1.5
CIIWB5	259	3.29	1.105	10	3.7
CIIWB6	266	3.11	1.263	3	1.1
CIIWB7	262	2.76	1.130	7	2.6
CIIWB8	265	2.81	1.226	4	1.5
CIIWB8R	265	3.19	1.226	4	1.5
CIIWB9A	265	3.13	1.170	4	1.5
CIIWB9B	261	3.41	1.044	8	3.0
CIIWB10	265	2.85	1.109	4	1.5
CIIWB11	265	2.57	1.223	4	1.5
LA1	264	3.21	1.075	5	1.9
LA2	264	3.31	.976	5	1.9
LA3	266	2.48	1.241	3	1.1
LA3R	266	3.52	1.241	3	1.1
LA4	265	3.06	1.046	4	1.5
LA4R	265	2.94	1.046	4	1.5
LA5	267	3.31	1.071	2	.7
LA6	264	2.92	1.076	5	1.9
LA7	267	2.42	1.092	2	.7
LA7R	267	3.58	1.092	2	.7
LA8	266	2.79	1.117	3	1.1
LA9	267	2.93	1.122	2	.7
LA10	266	3.14	1.065	3	1.1
LA11	266	2.86	1.141	3	1.1
LA12	265	2.78	1.081	4	1.5
LA12R	265	3.22	1.081	4	1.5

Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
LA13	266	3.35	1.006	3	1.1
LA14	266	2.27	1.130	3	1.1
LA15	265	2.51	1.094	4	1.5
LA15R	265	3.49	1.094	4	1.5
LA16	265	3.28	1.123	4	1.5
LA16R	265	2.72	1.123	4	1.5
LA17	266	2.71	1.014	3	1.1
LA18	265	2.83	1.059	4	1.5
LA19	266	2.89	1.152	3	1.1
LA19R	266	3.11	1.152	3	1.1
LA20	265	3.16	1.154	4	1.5
LO1	266	2.90	1.240	3	1.1
LO2	265	1.83	1.108	4	1.5
LO2R	265	4.17	1.108	4	1.5
LO3	265	2.77	1.198	4	1.5
LO4	264	2.84	1.181	5	1.9
LO5	264	2.57	1.152	5	1.9
LO6	264	2.69	1.312	5	1.9
LO6R	264	3.31	1.312	5	1.9
LO7	264	3.05	1.244	5	1.9
LO8	263	2.86	1.222	6	2.2
LO9	263	2.10	1.049	6	2.2
LO9R	263	3.90	1.049	6	2.2
LO10	264	2.95	1.086	5	1.9
LO11	261	2.93	1.188	8	3.0
LO12	263	2.68	1.229	6	2.2
LO13	264	2.13	1.109	5	1.9
LO13R	264	3.87	1.109	5	1.9
LO14	264	3.38	1.186	5	1.9
LO15	262	2.73	1.147	7	2.6
LO16	264	2.78	1.189	5	1.9
LO17	264	2.40	1.067	5	1.9
LO17R	264	3.60	1.067	5	1.9
LO18	264	2.85	1.152	5	1.9

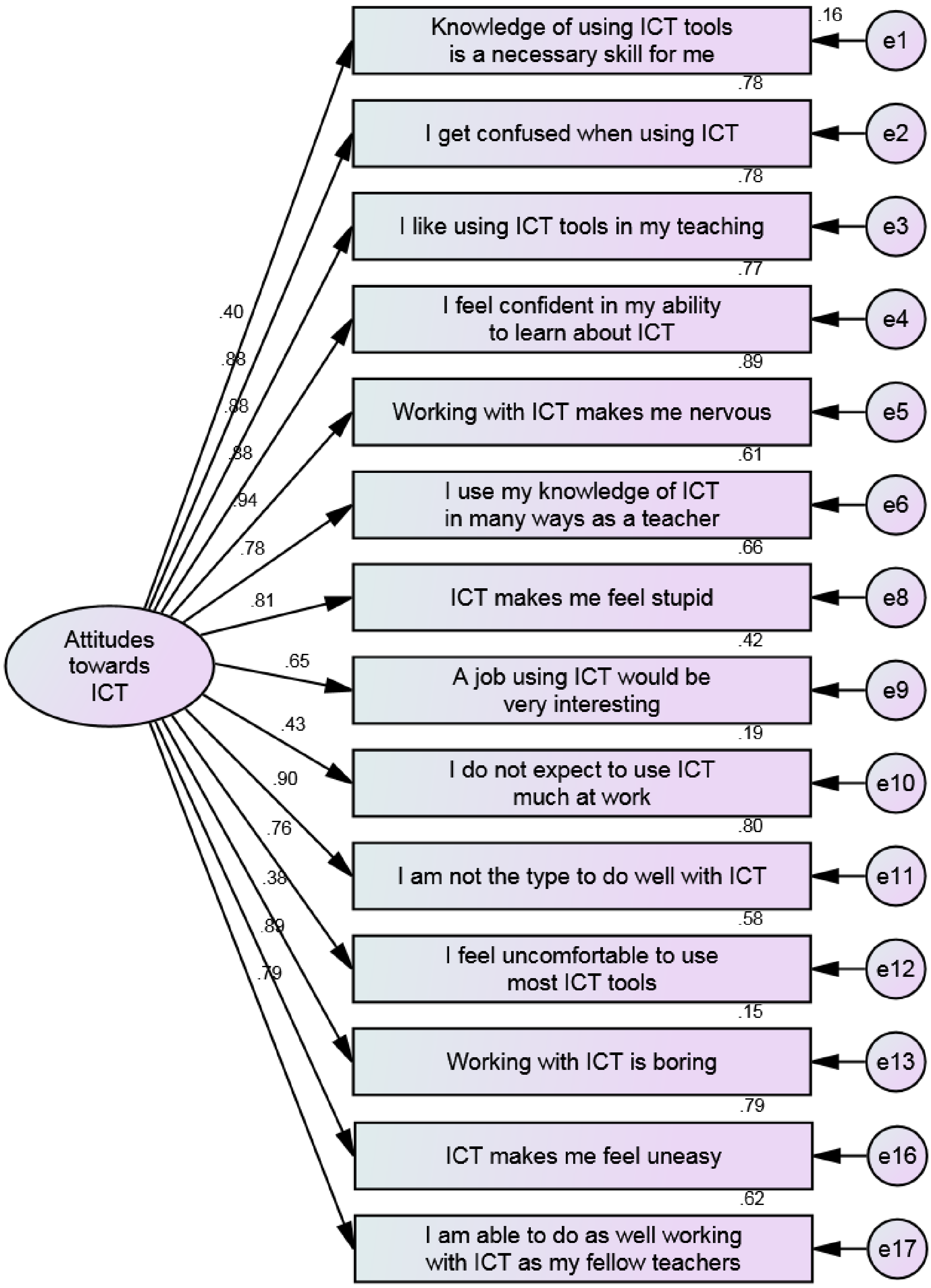
Variable	N	Mean	Std. Deviation	Missing	
				Count	Percent
LO19	264	3.28	1.146	5	1.9
LO20	263	3.17	1.227	6	2.2
LO21	264	2.55	1.122	5	1.9
LO22	262	2.37	1.105	7	2.6
LO22R	262	3.63	1.105	7	2.6
LO23	263	2.75	1.169	6	2.2
LO24	262	2.69	1.151	7	2.6

b. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

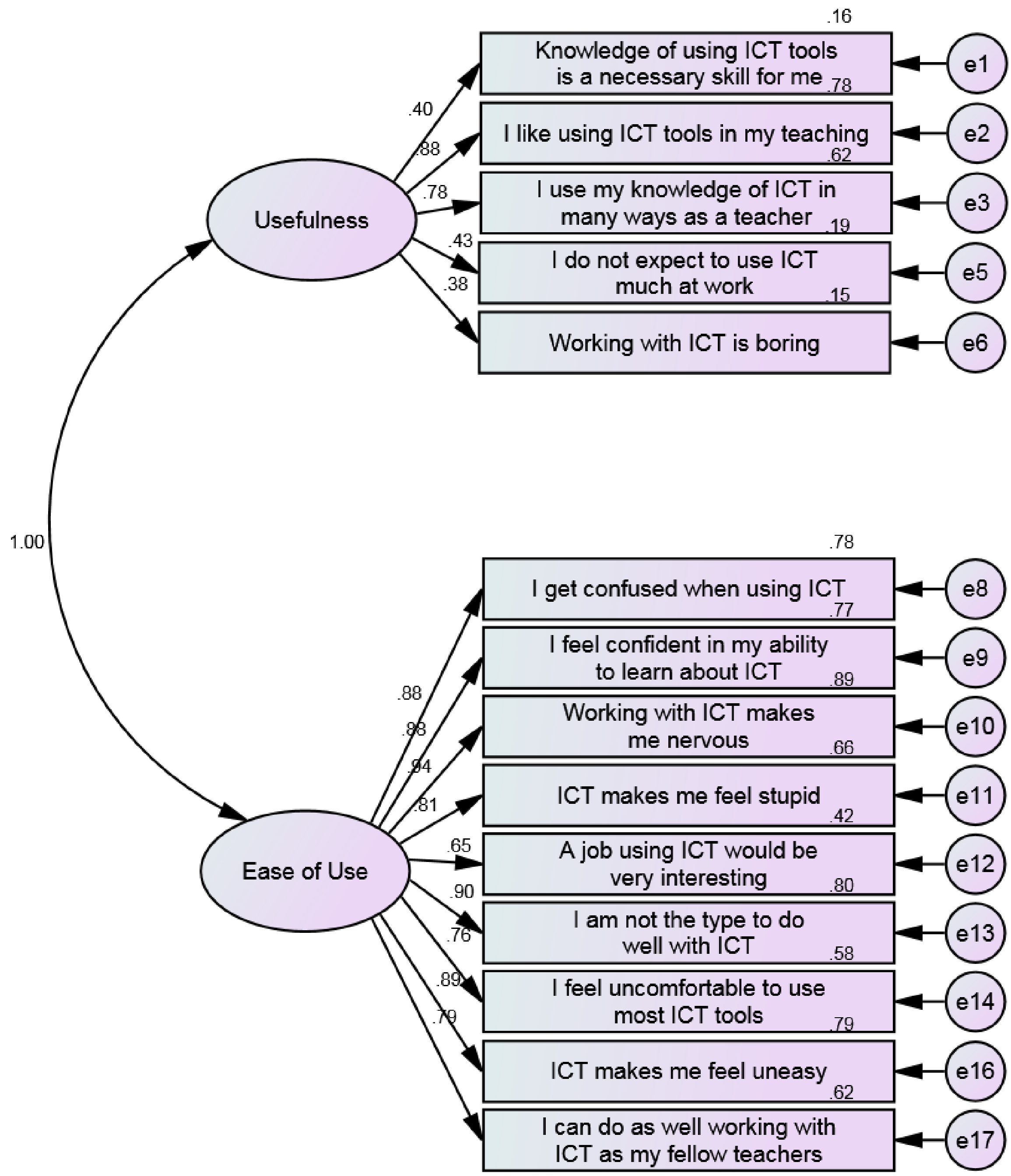
Appendix X

Standardised Results of Confirmatory Factor Analysis (CFA) (Teachers)

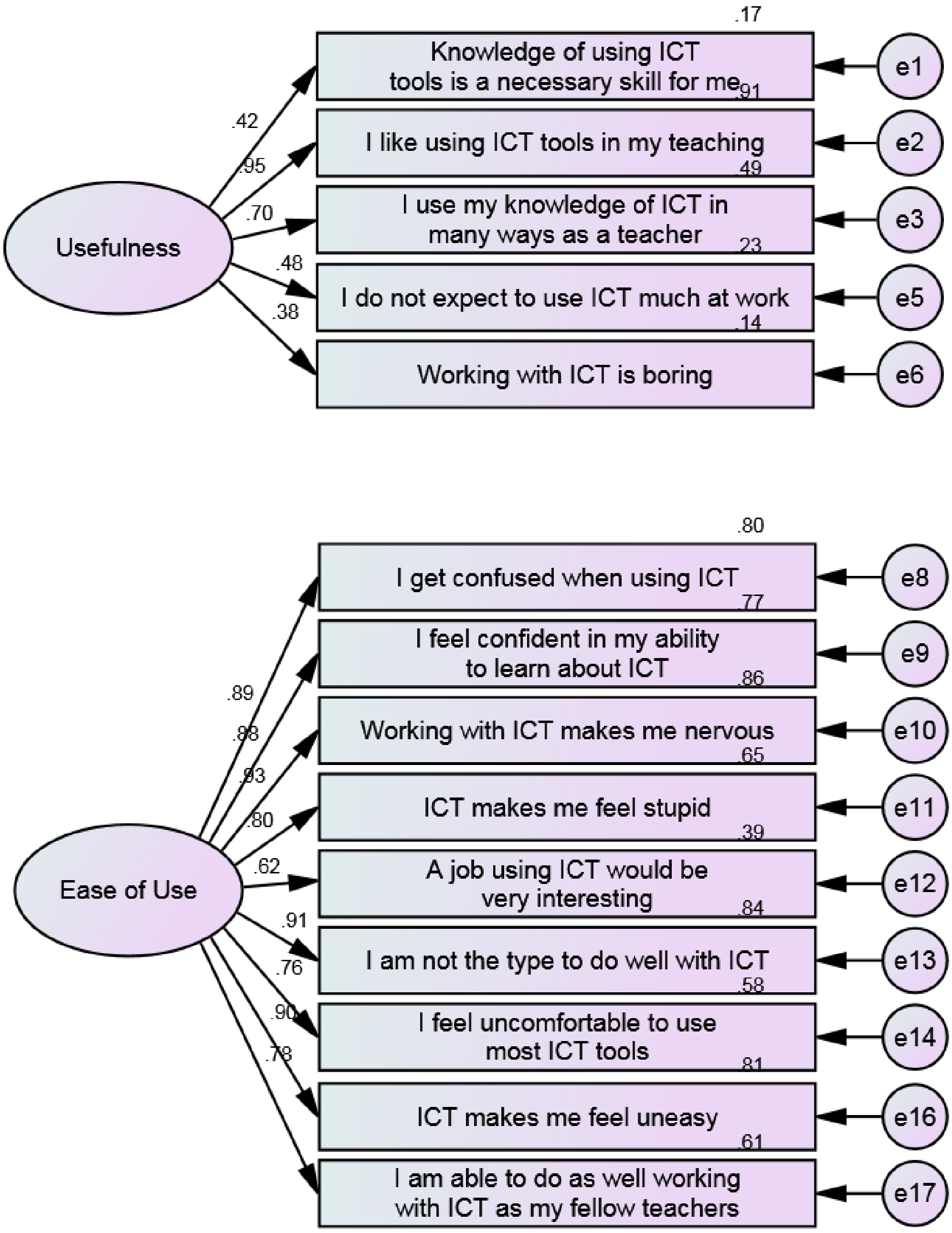
Scale: Attitudes towards ICT (AICT)



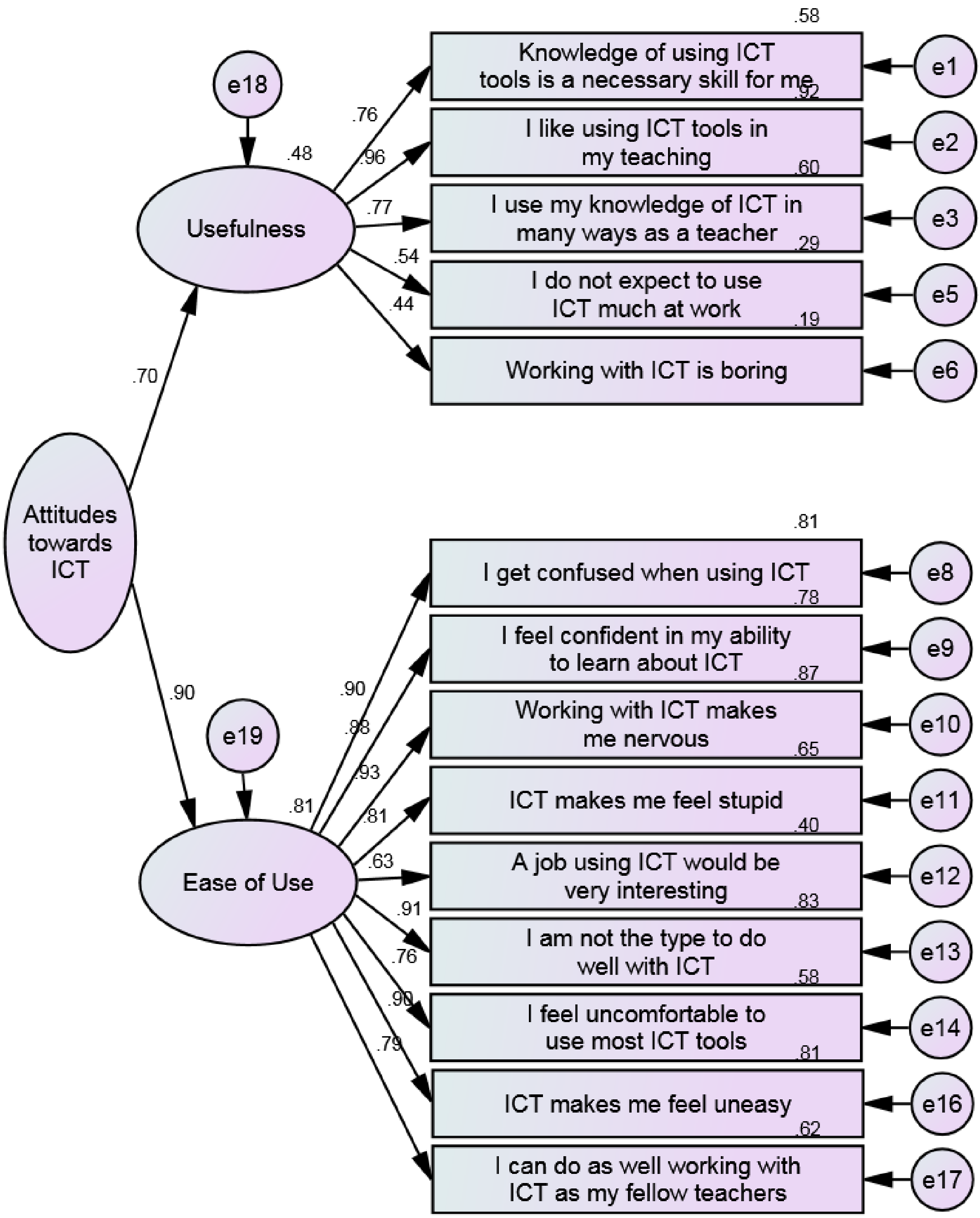
AICT_1 Factor Model



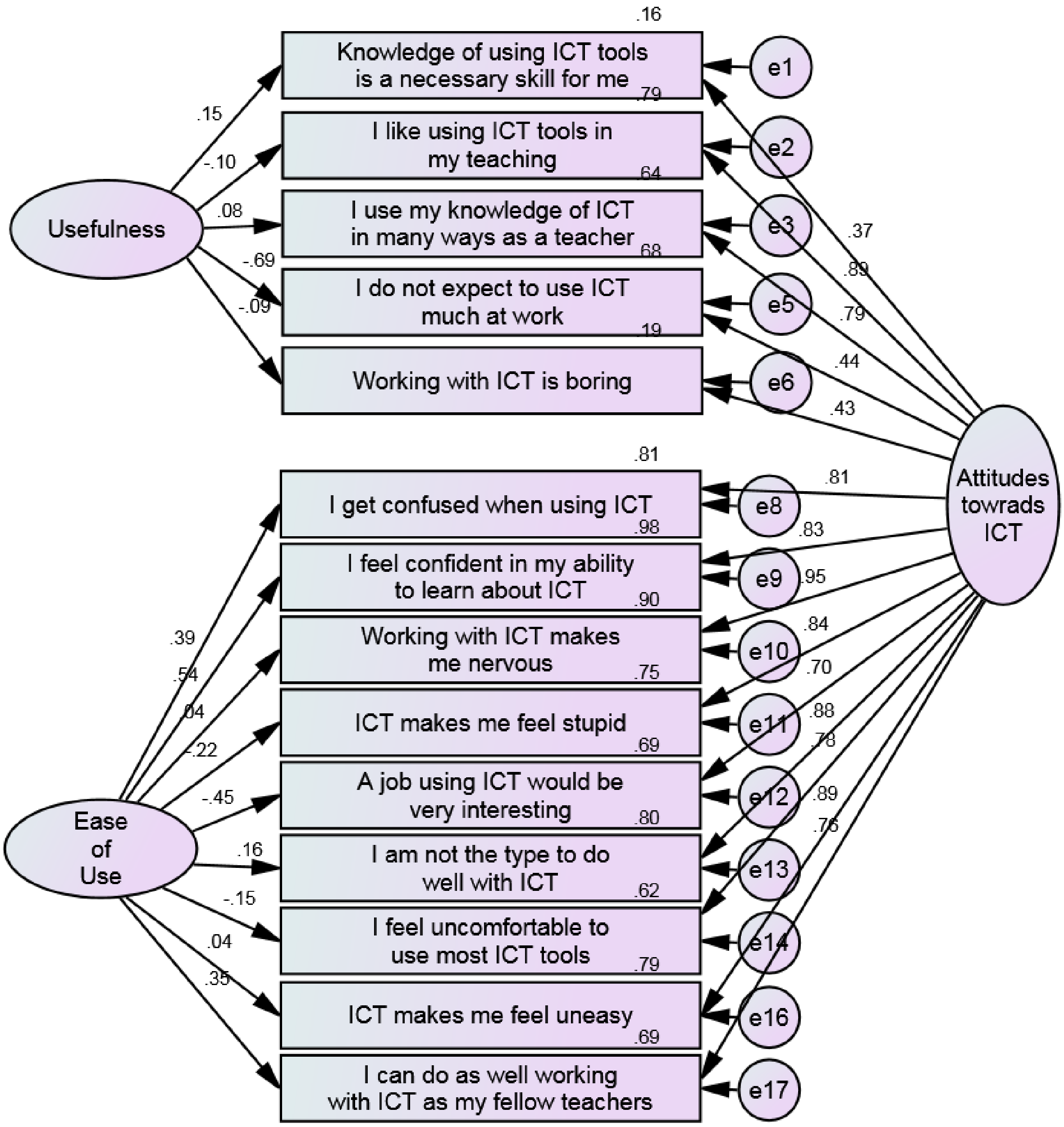
AICT_2 Correlated Factors Model



AICT_2 Orthogonal Factors Model

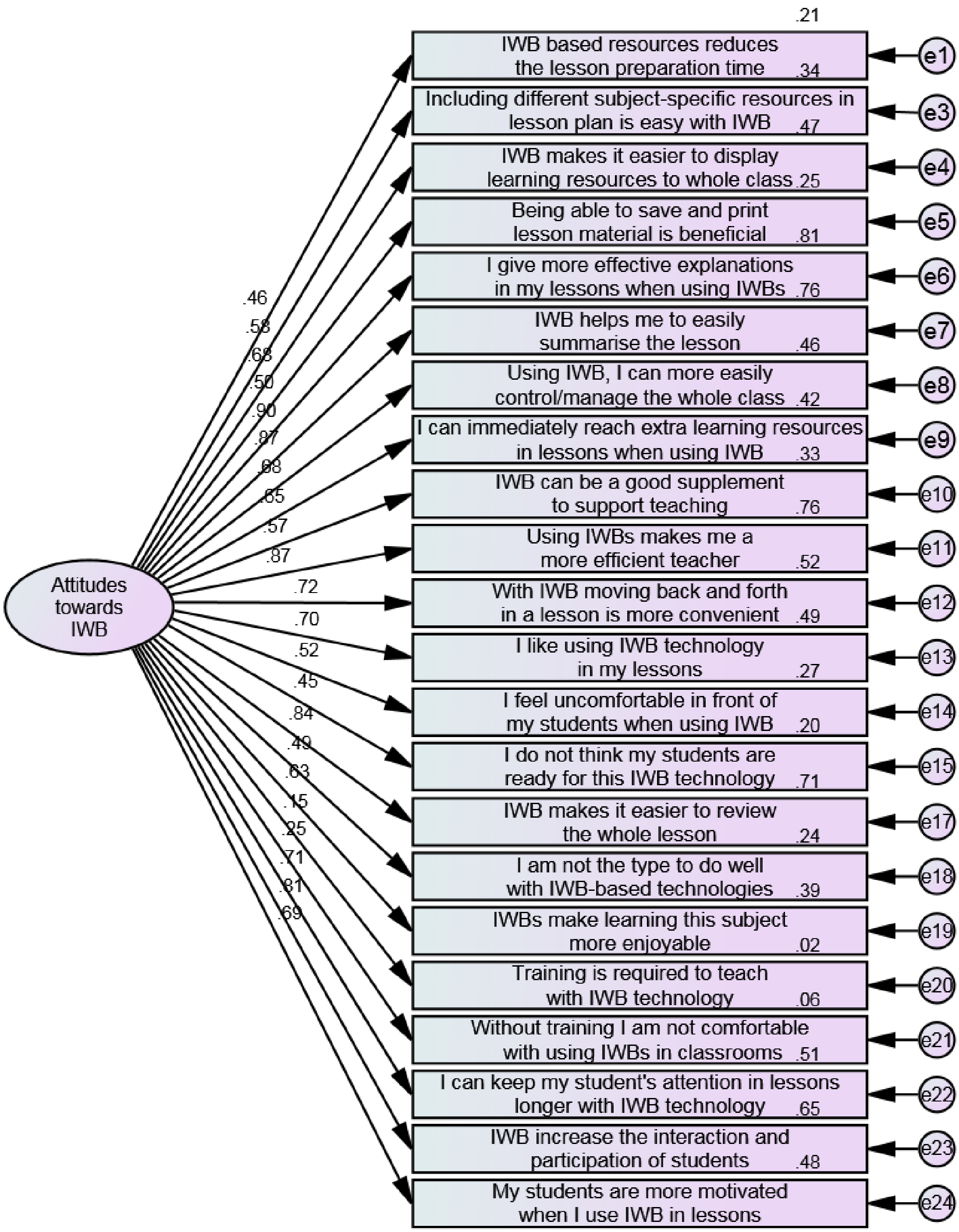


AICT_Hierarchical Model

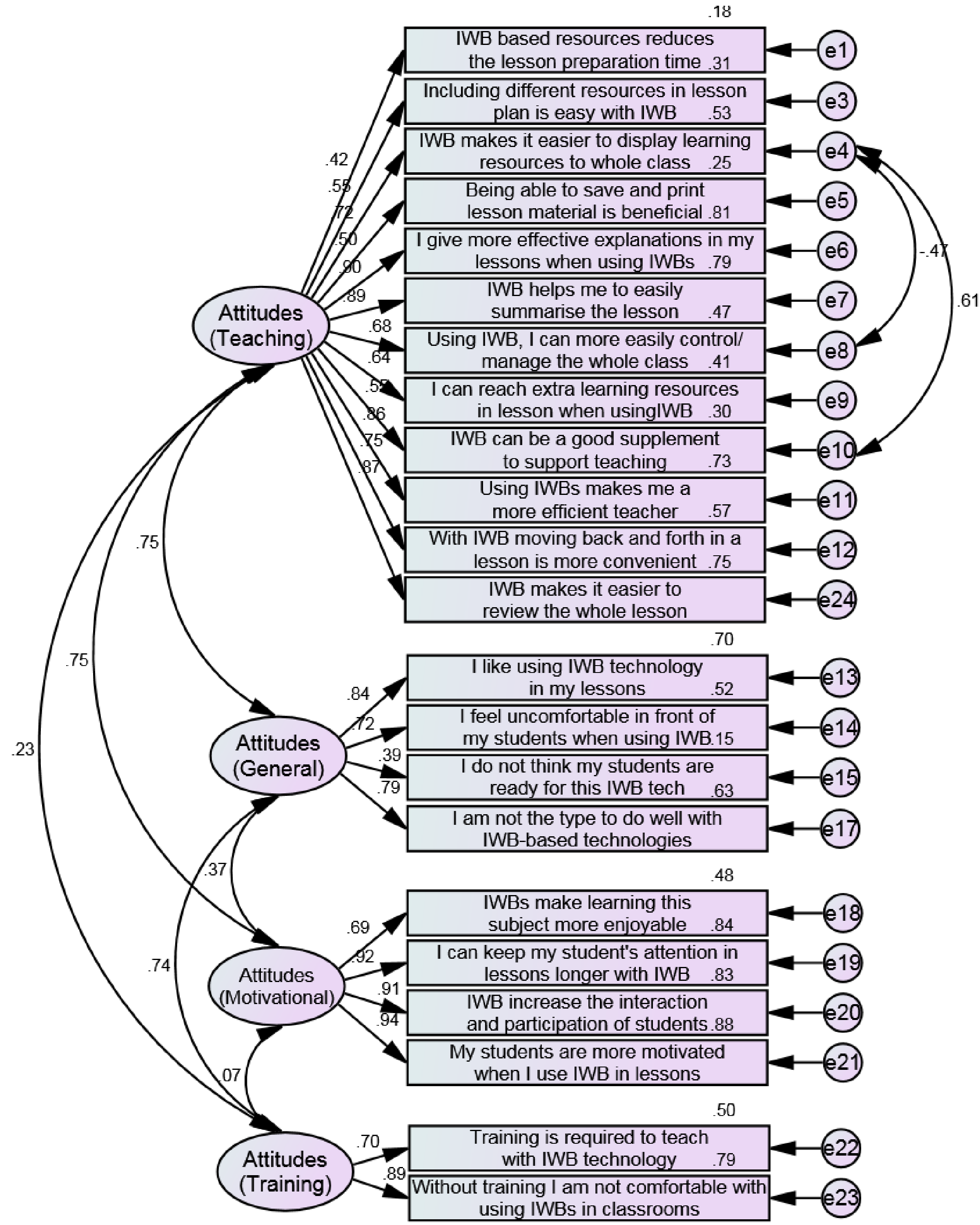


AICT_Nested Model

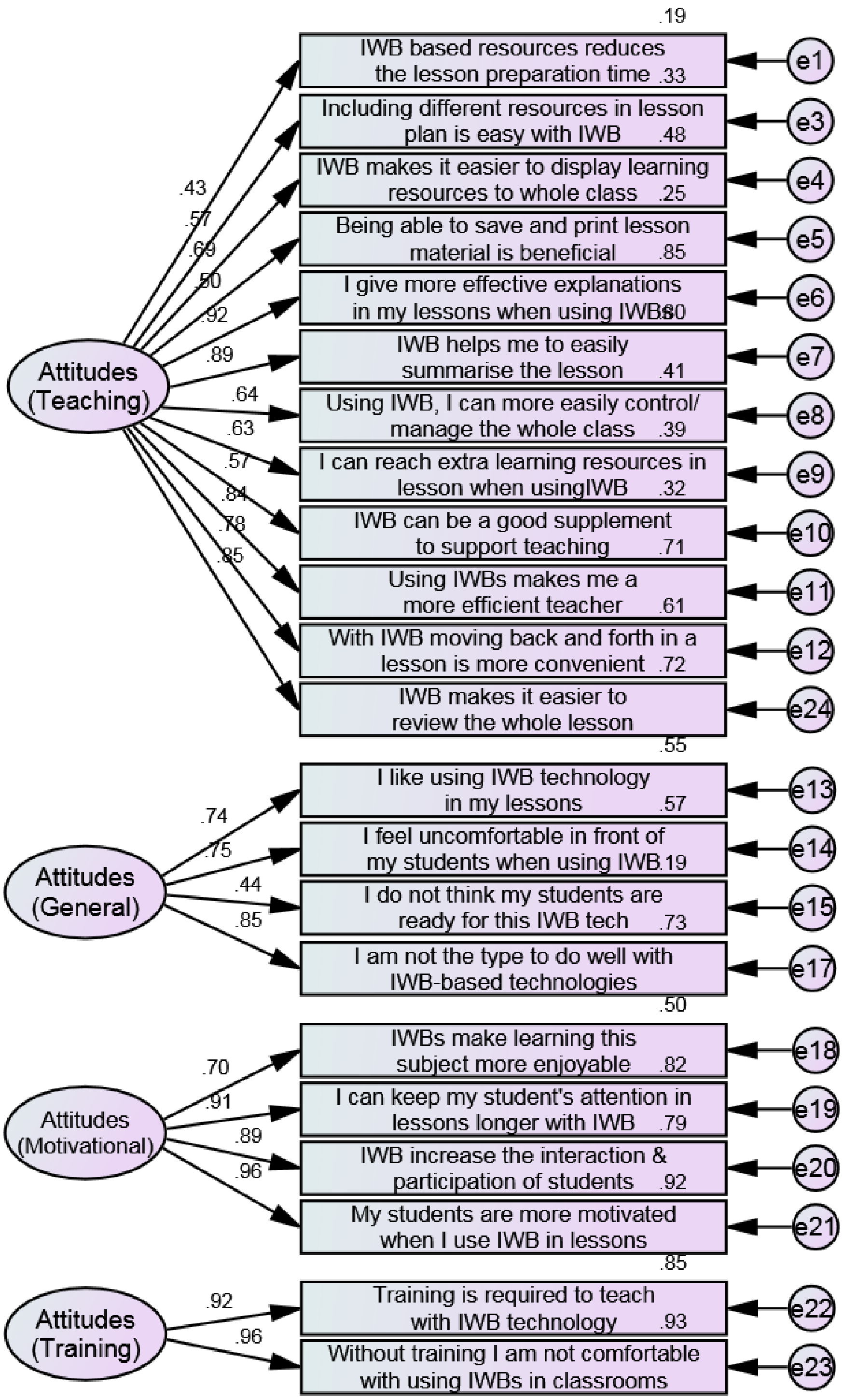
Scale: Attitudes towards IWB (AIWB)



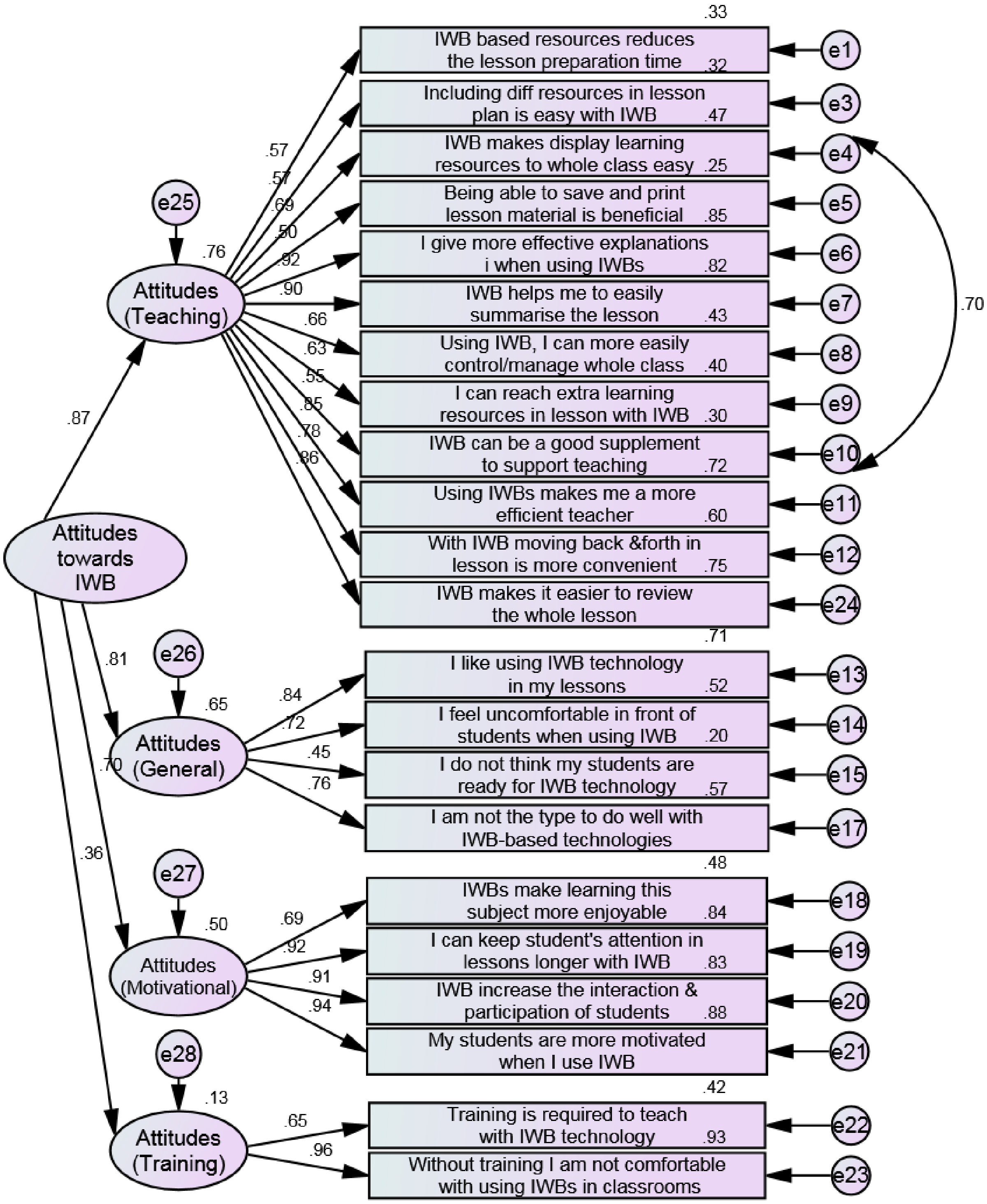
AIWB_1 Factor Model



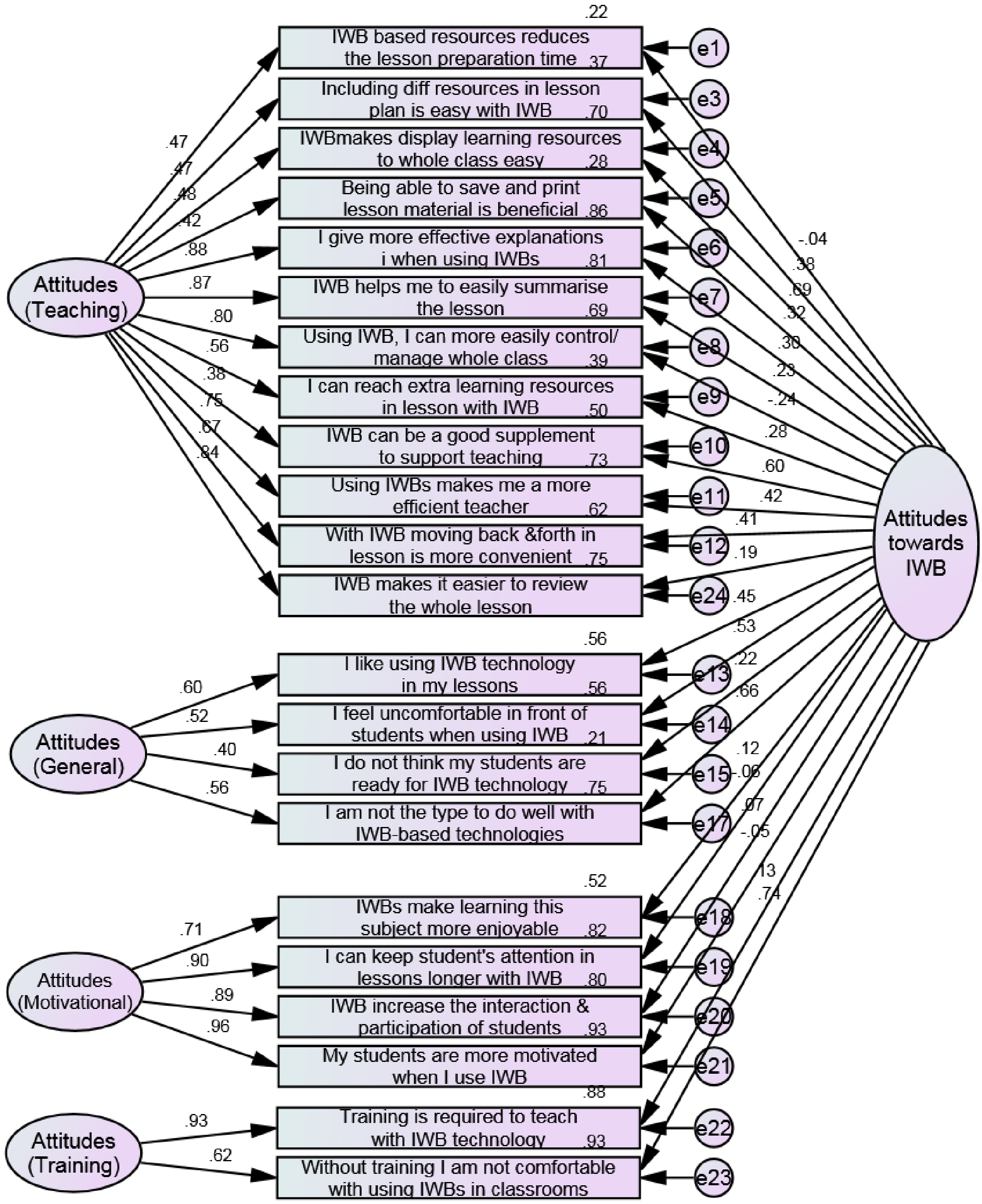
AIWB_4 Correlated Factor Model



AIWB_4 Orthogonal Factor Model

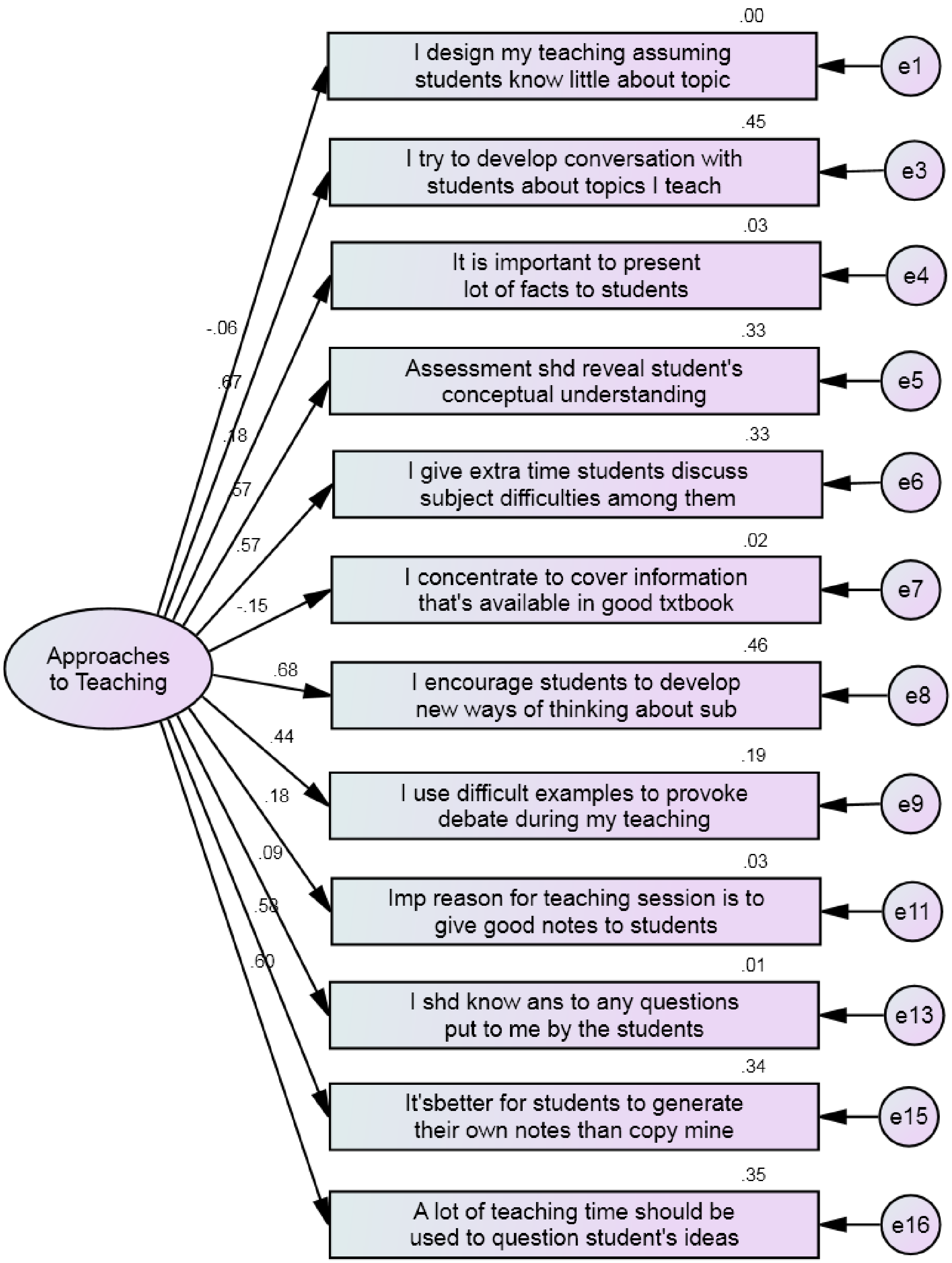


AIWB_Hierarchical Model

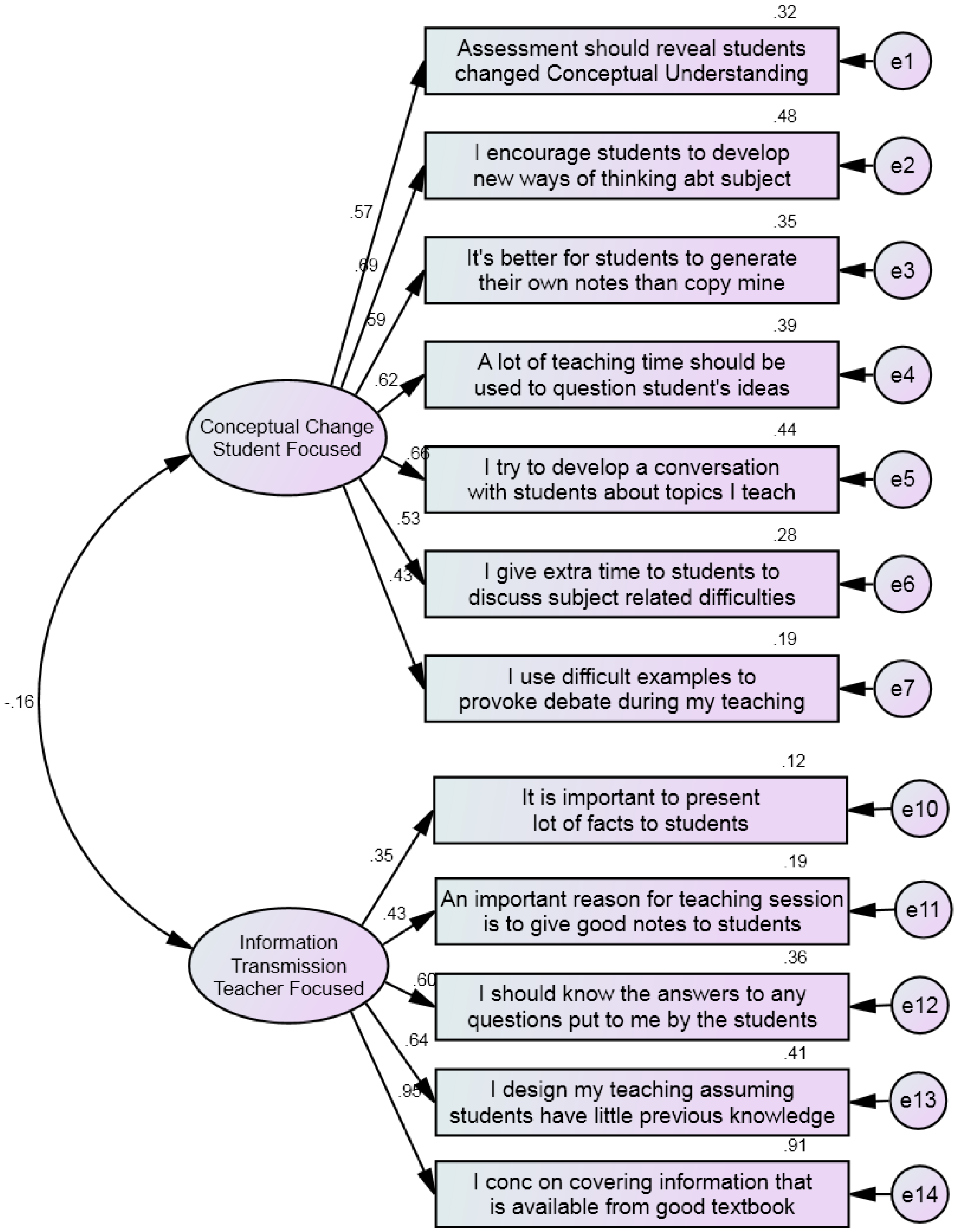


AIWB_Nested Model

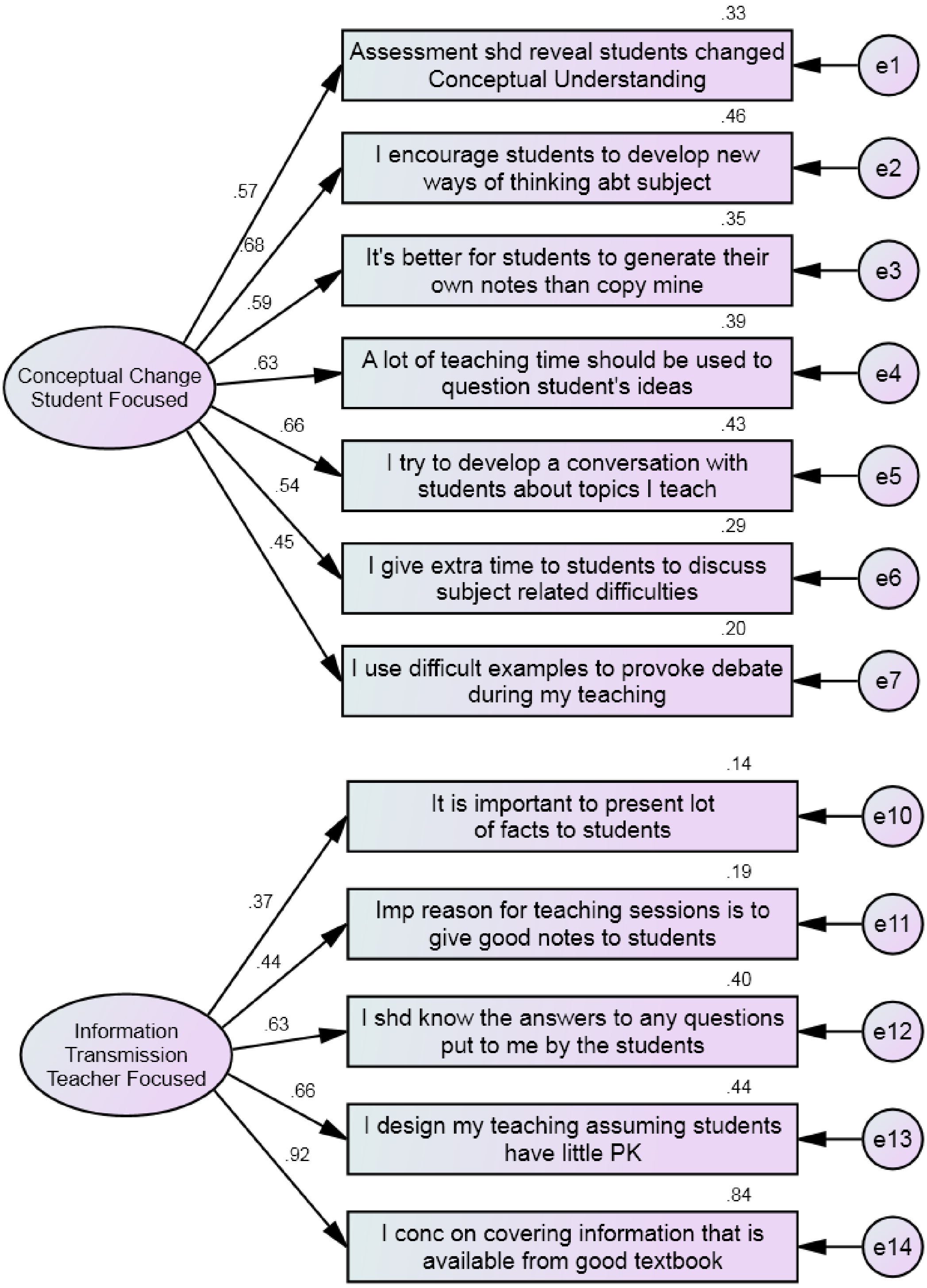
Scale: Attitudes towards Teaching Inventory (ATI)



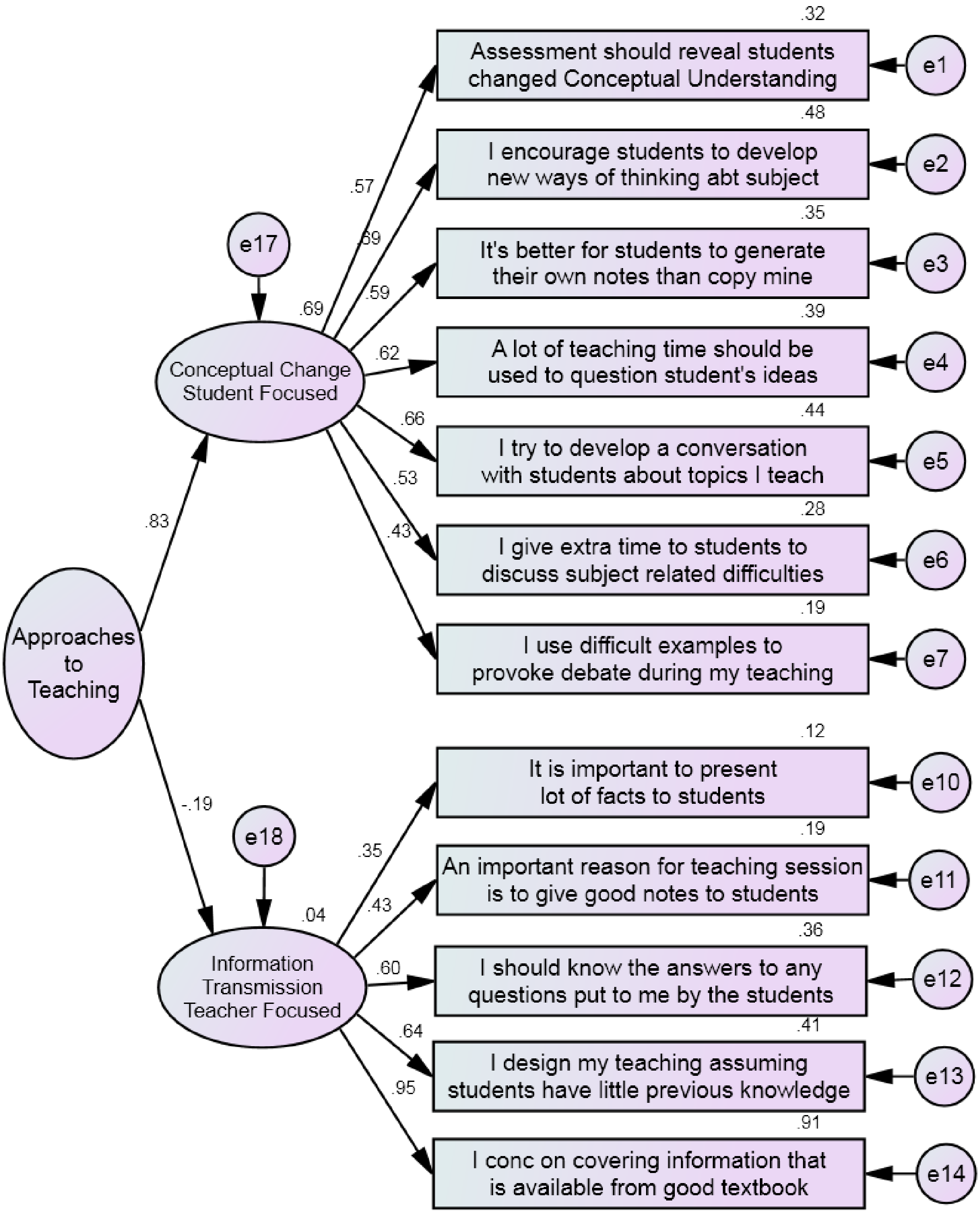
ATI_1 Factor Model



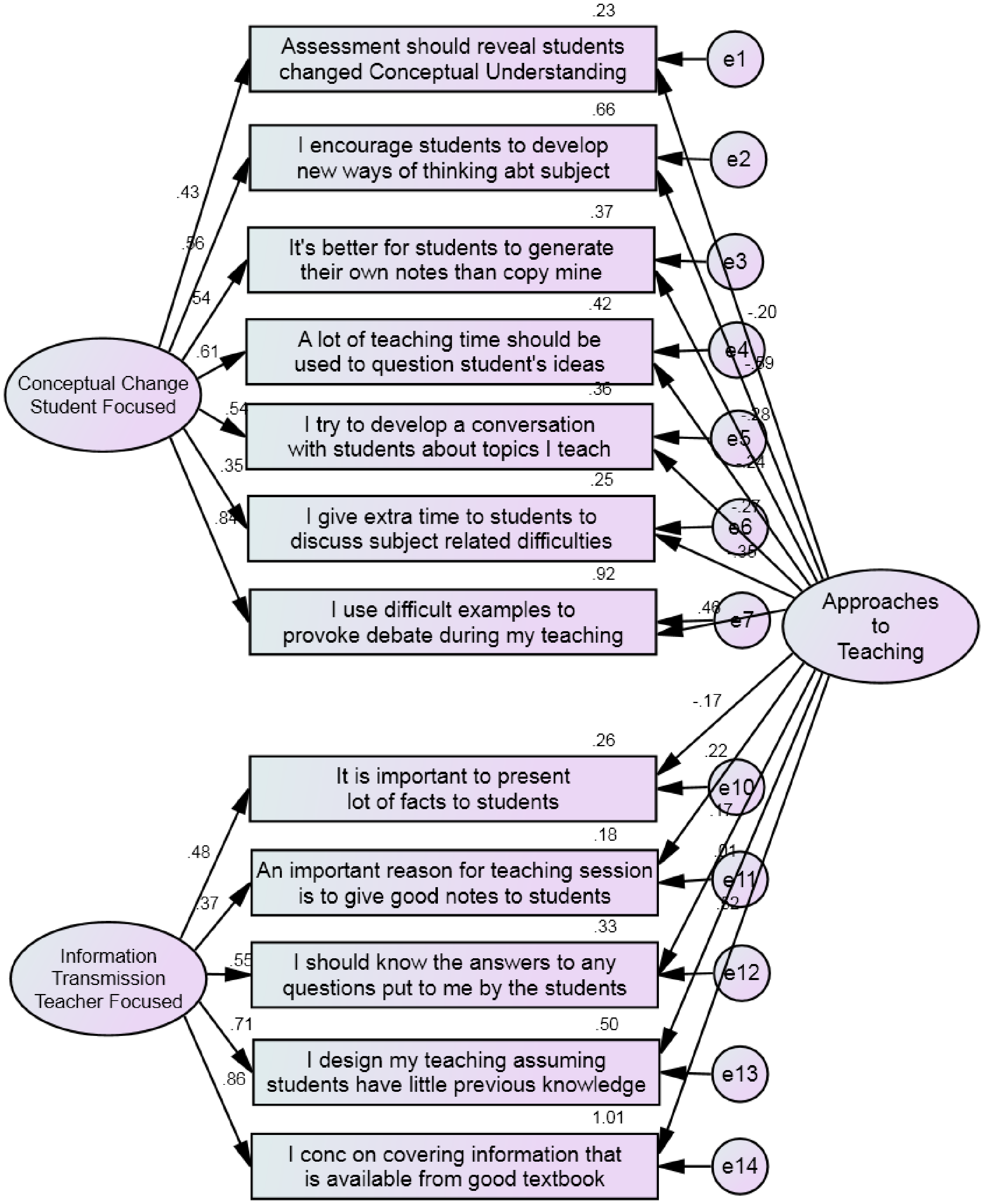
ATI_2 Correlated Factors Model



ATI_2 Orthogonal Factor Model

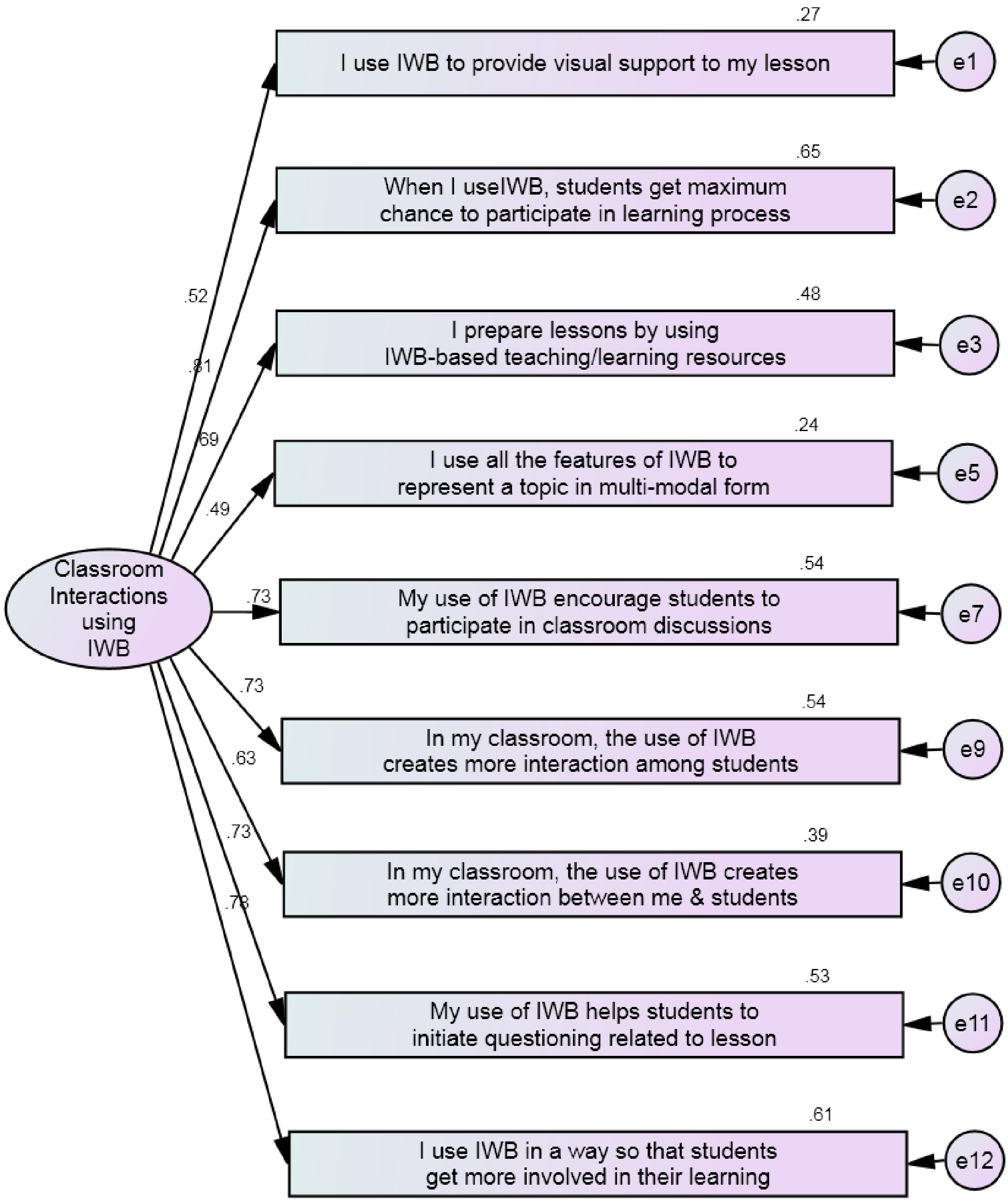


ATI_Hierarchical Model

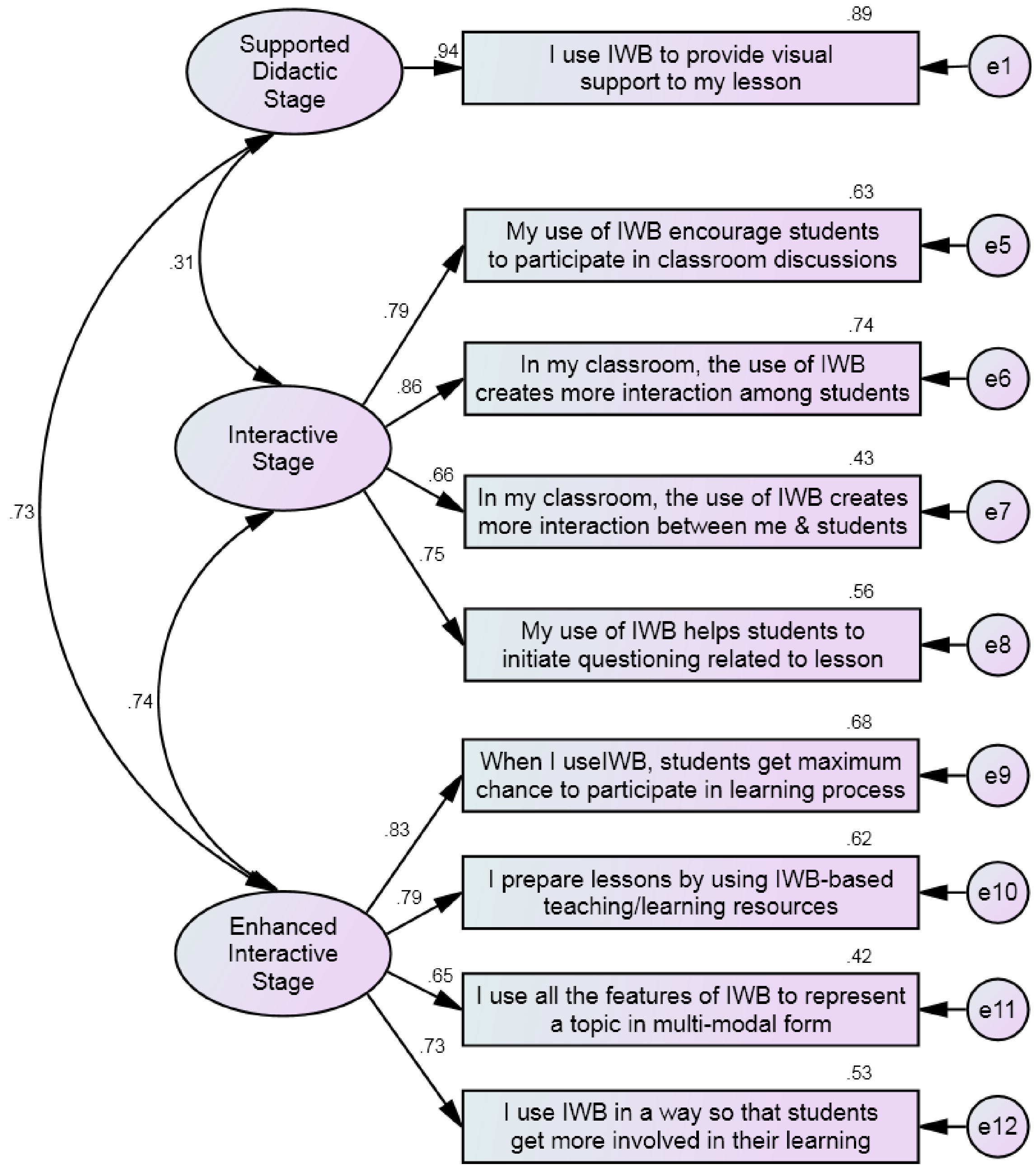


ATI_Nested Model

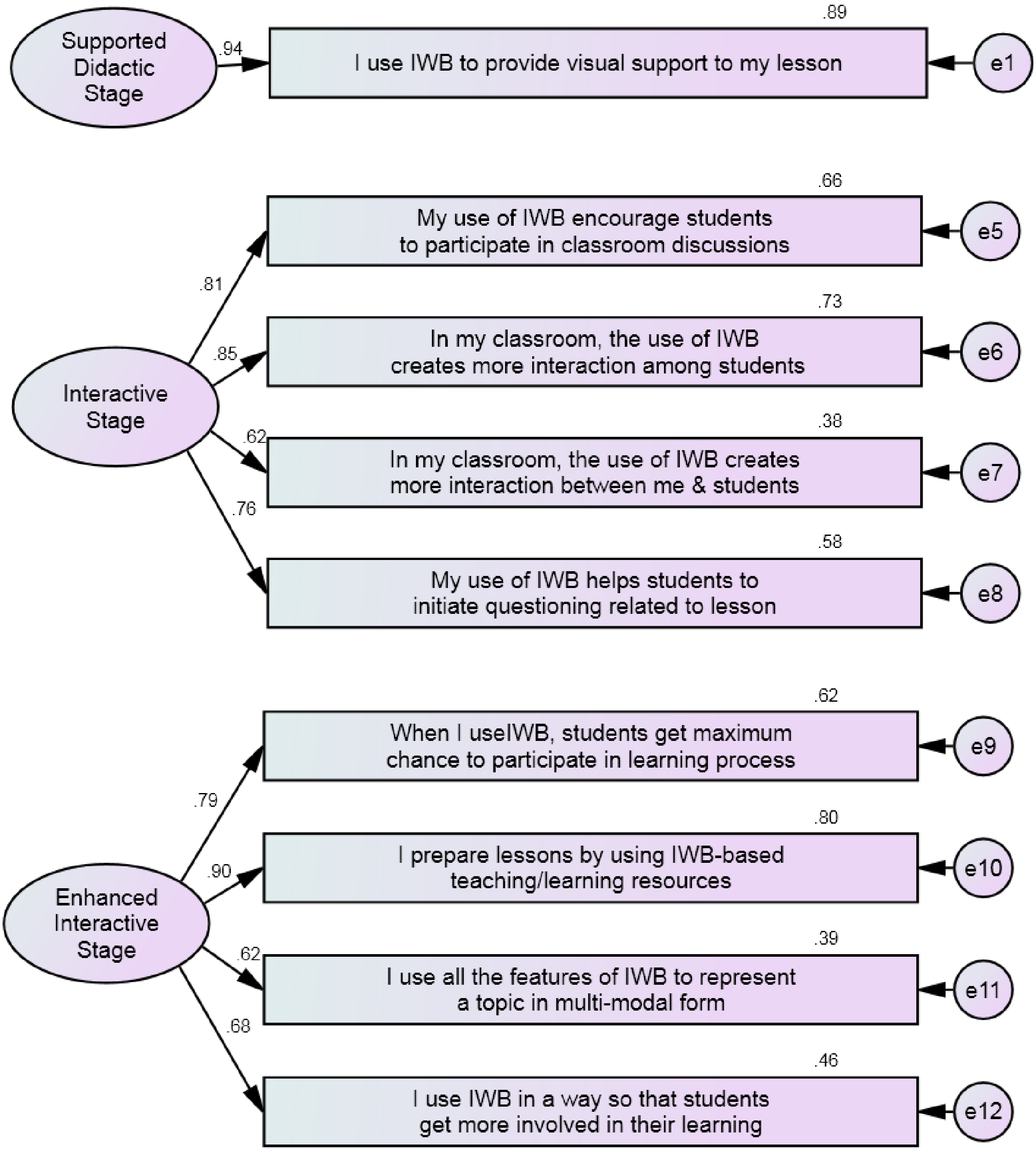
Scale: Classroom Interactions using IWB (CIIWB)



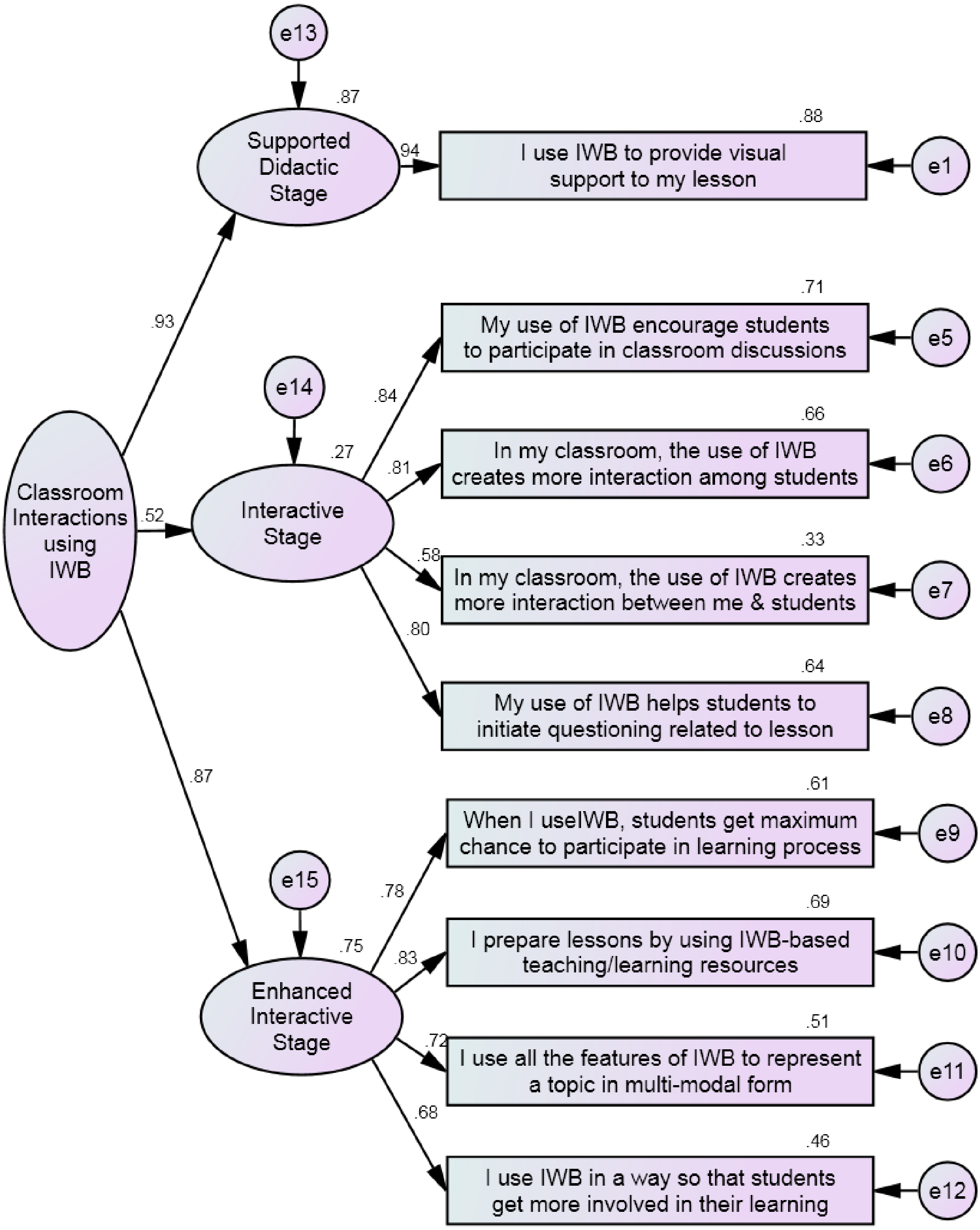
CIIWB_1 Factor Model



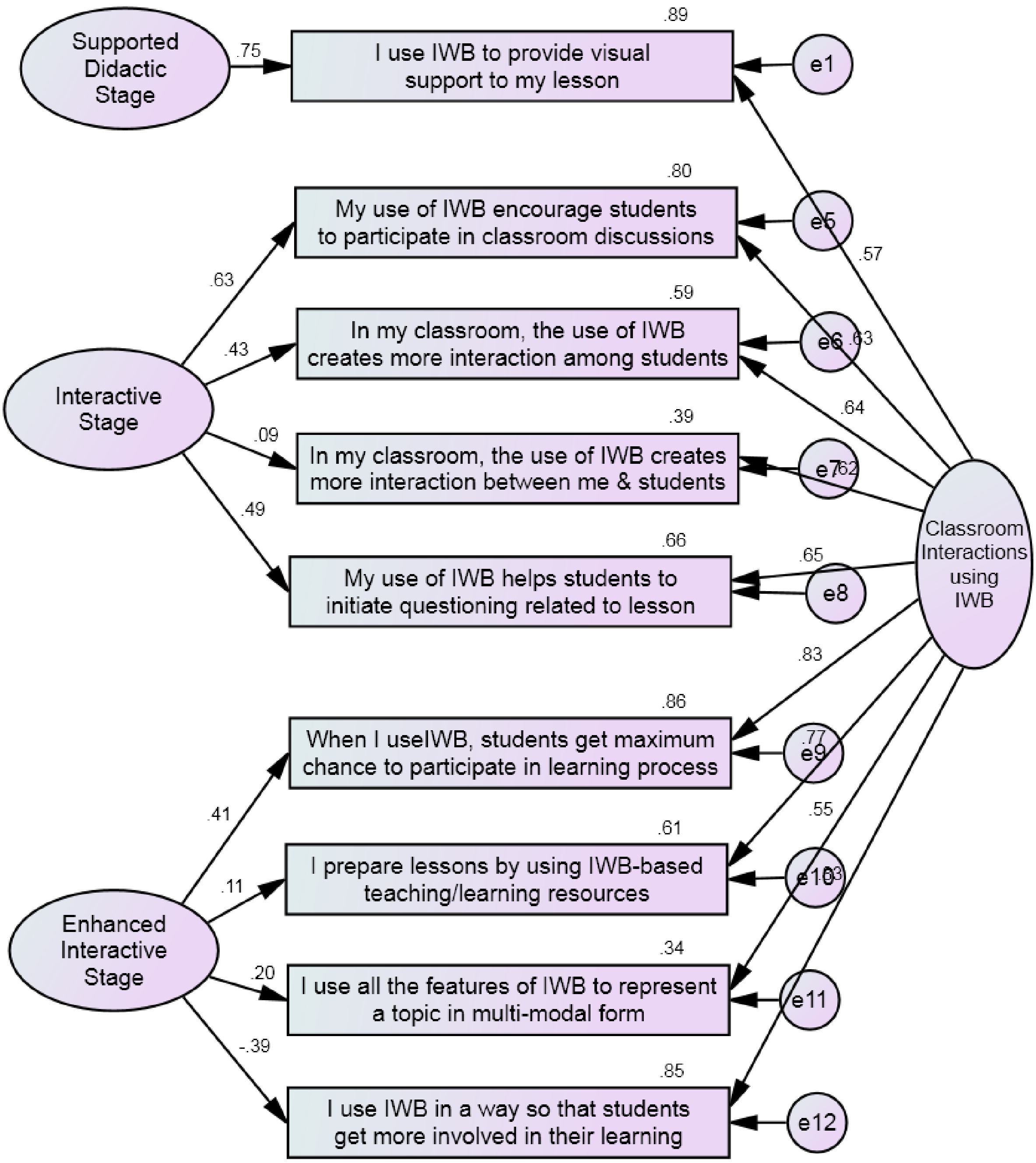
CIIWB_3 Correlated Factor Model



CIIWB_3 Orthogonal Factor Model



CIIWB_Hierarchical Model

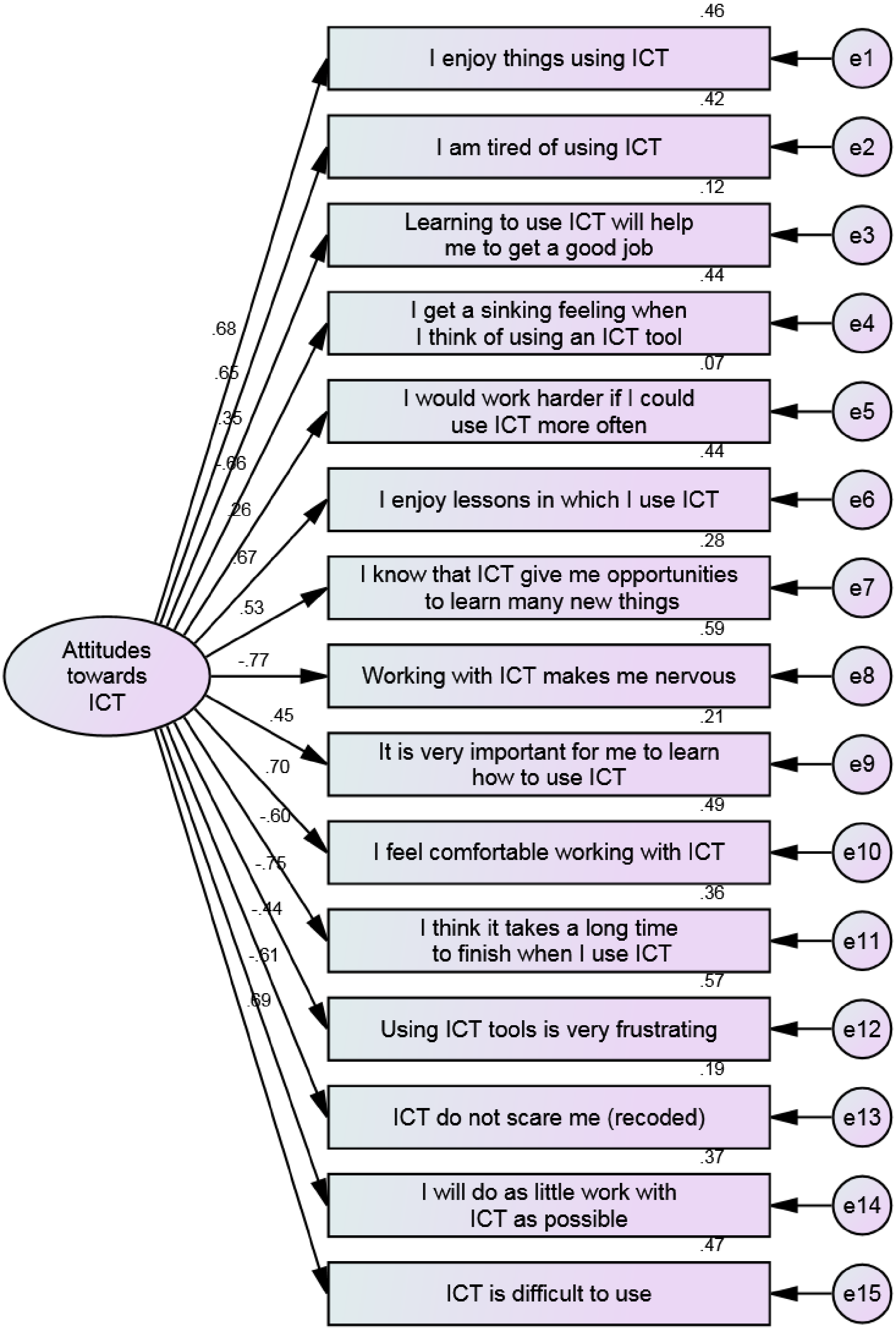


CIIWB_Nested Model

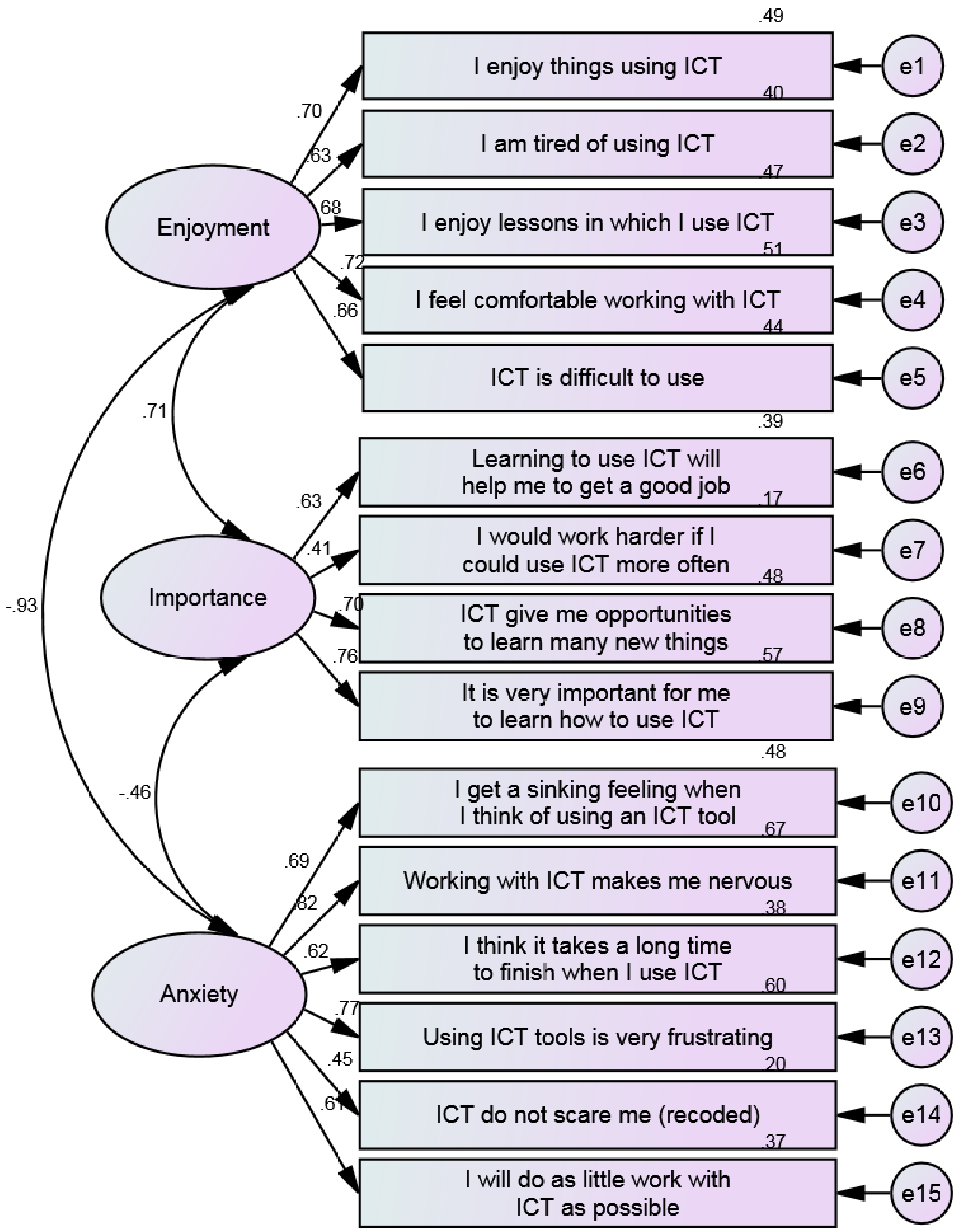
Appendix Y

Standardised Results of Confirmatory Factor Analysis (CFA) (Students)

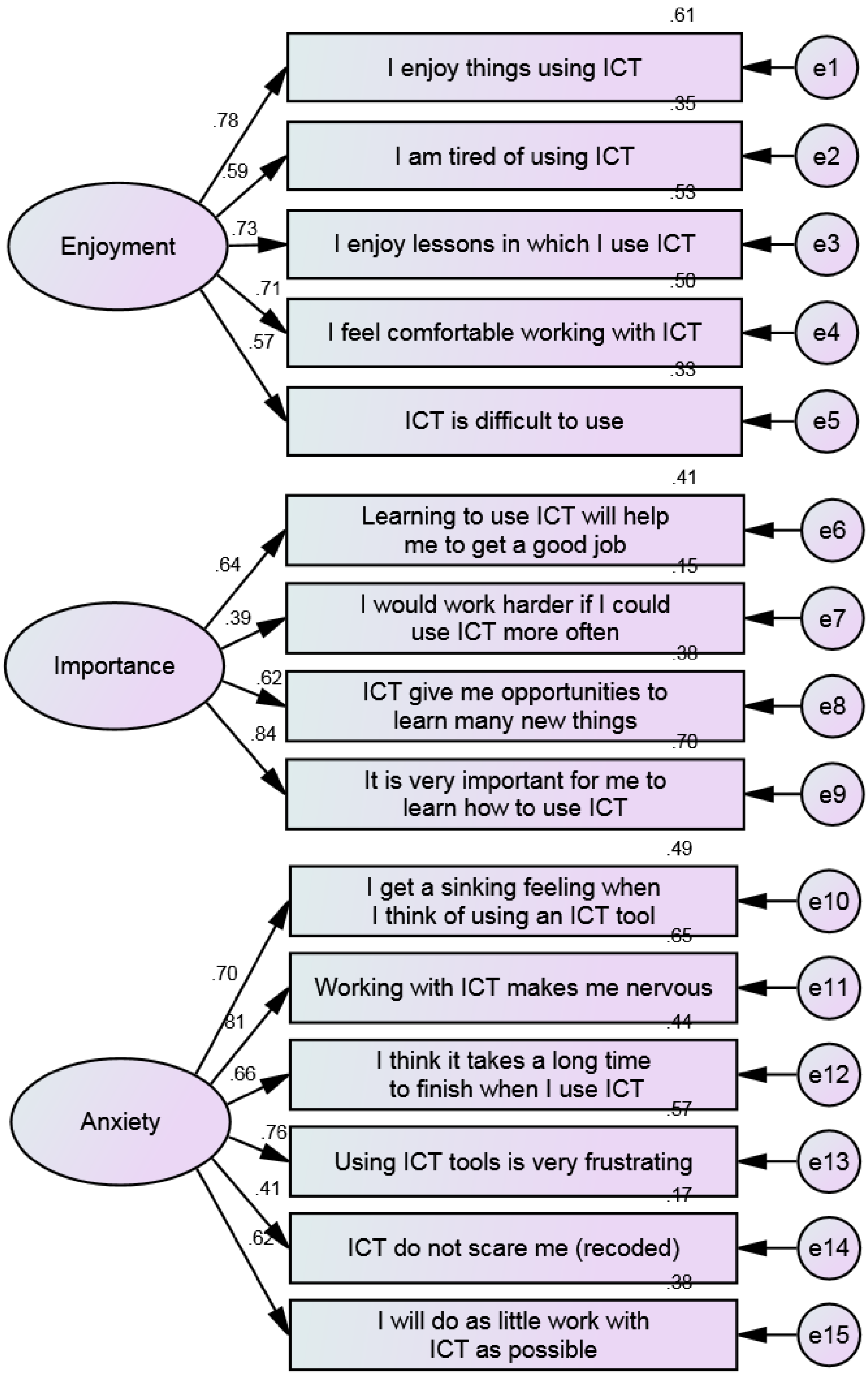
Scale: Attitudes towards ICT (AICT)



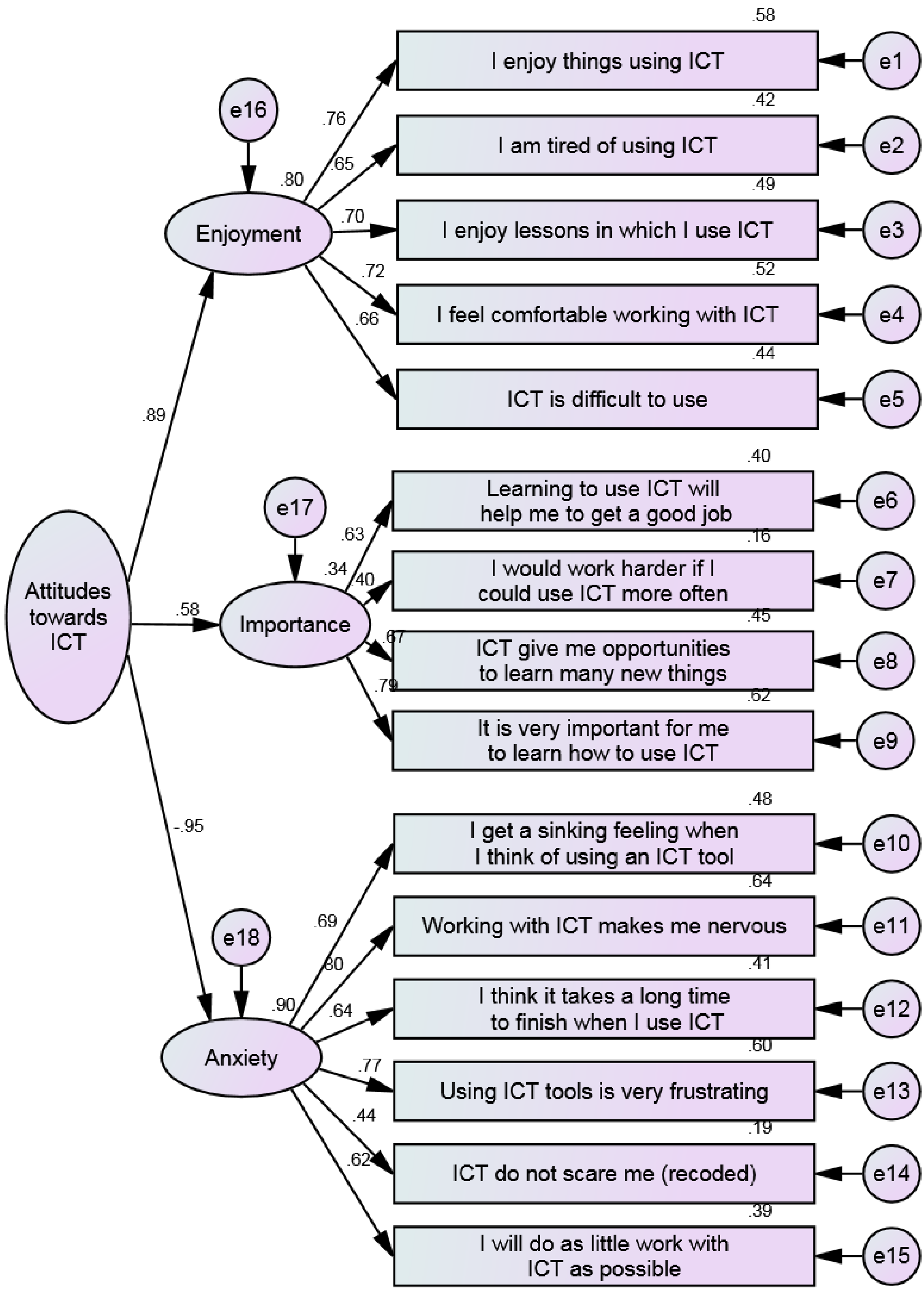
AICT_1 factor model



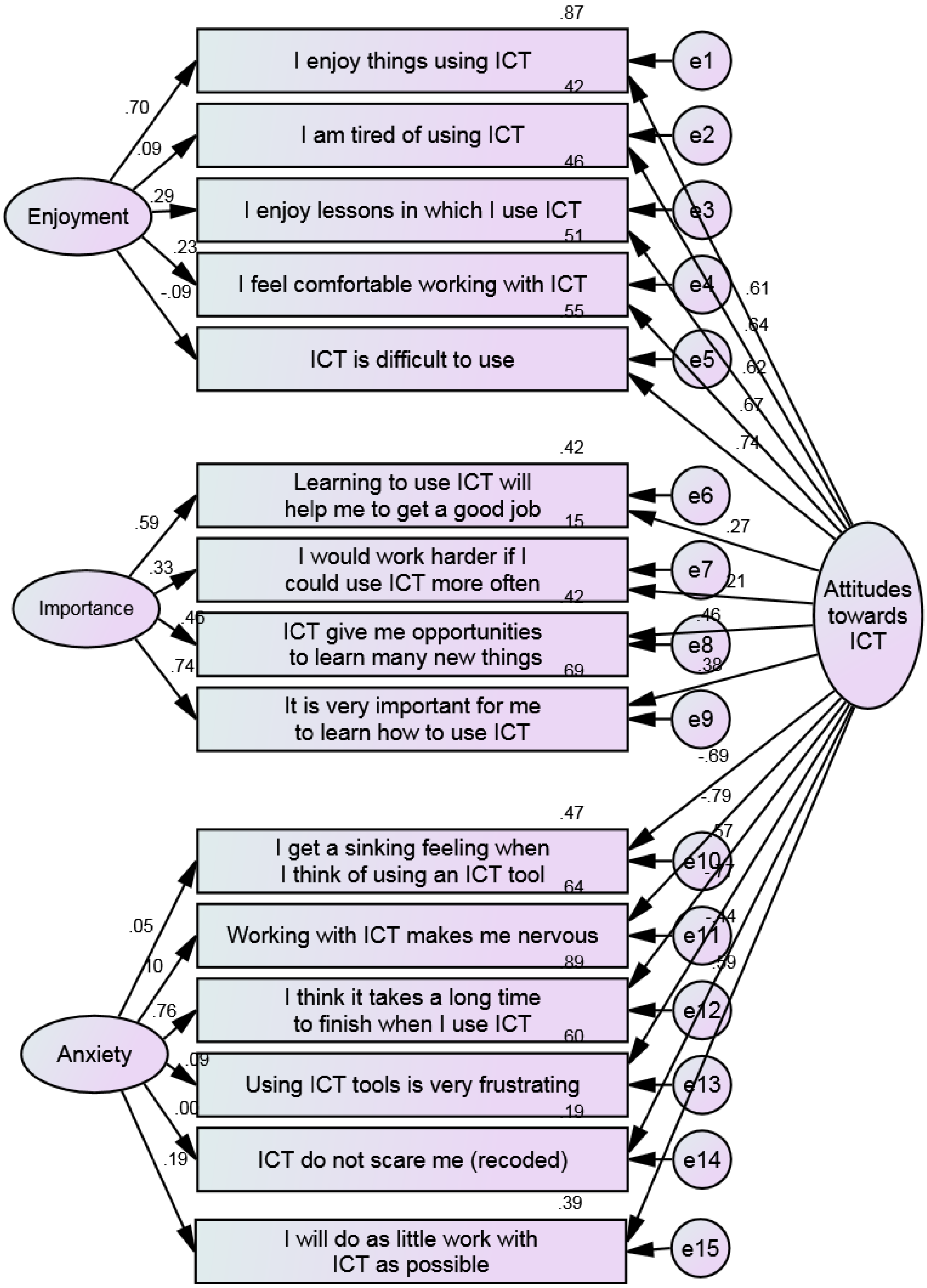
AICT_3 Correlated Factor Model



AICT_3 Orthogonal Factor Model

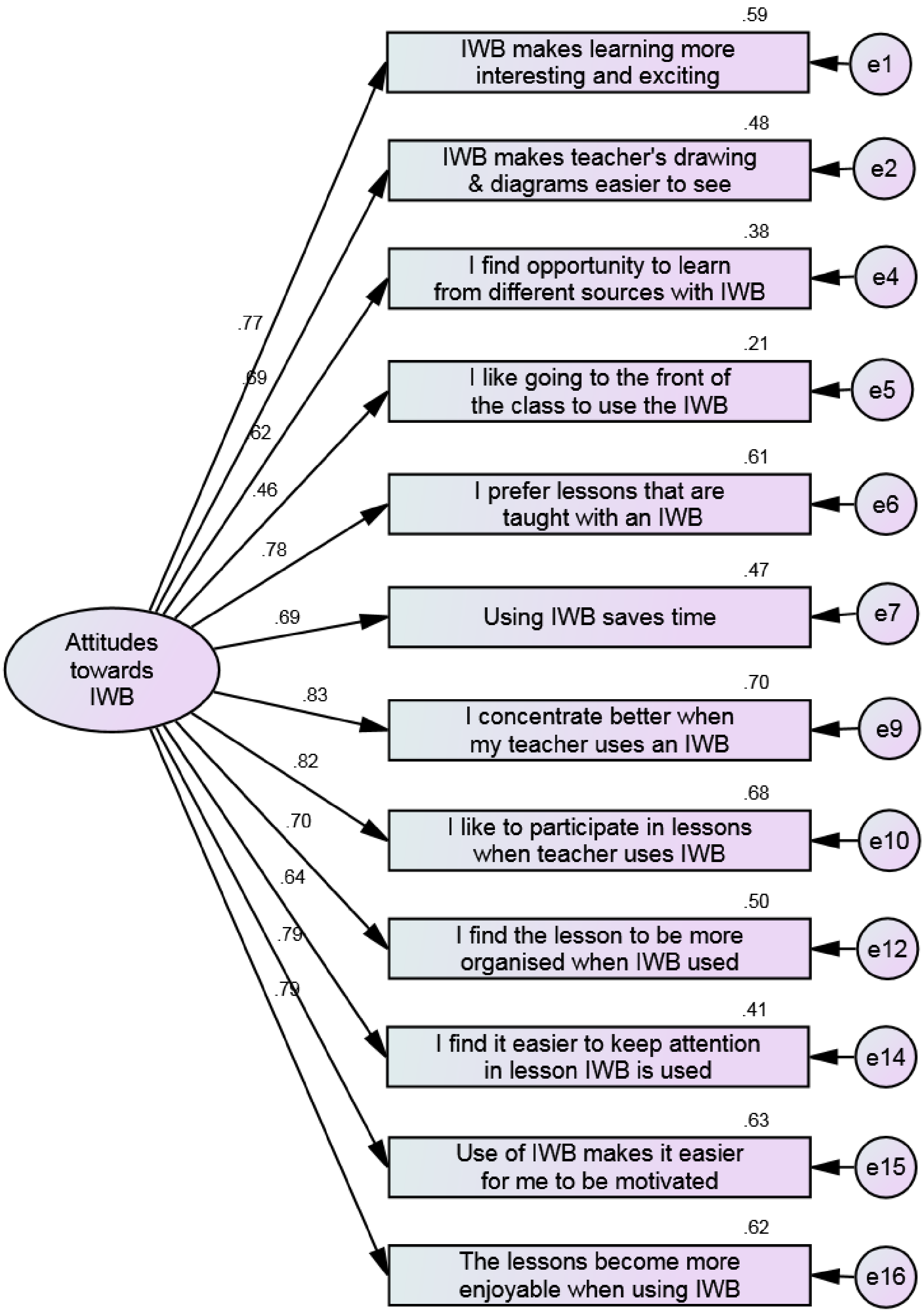


AICT_Hierarchical Model

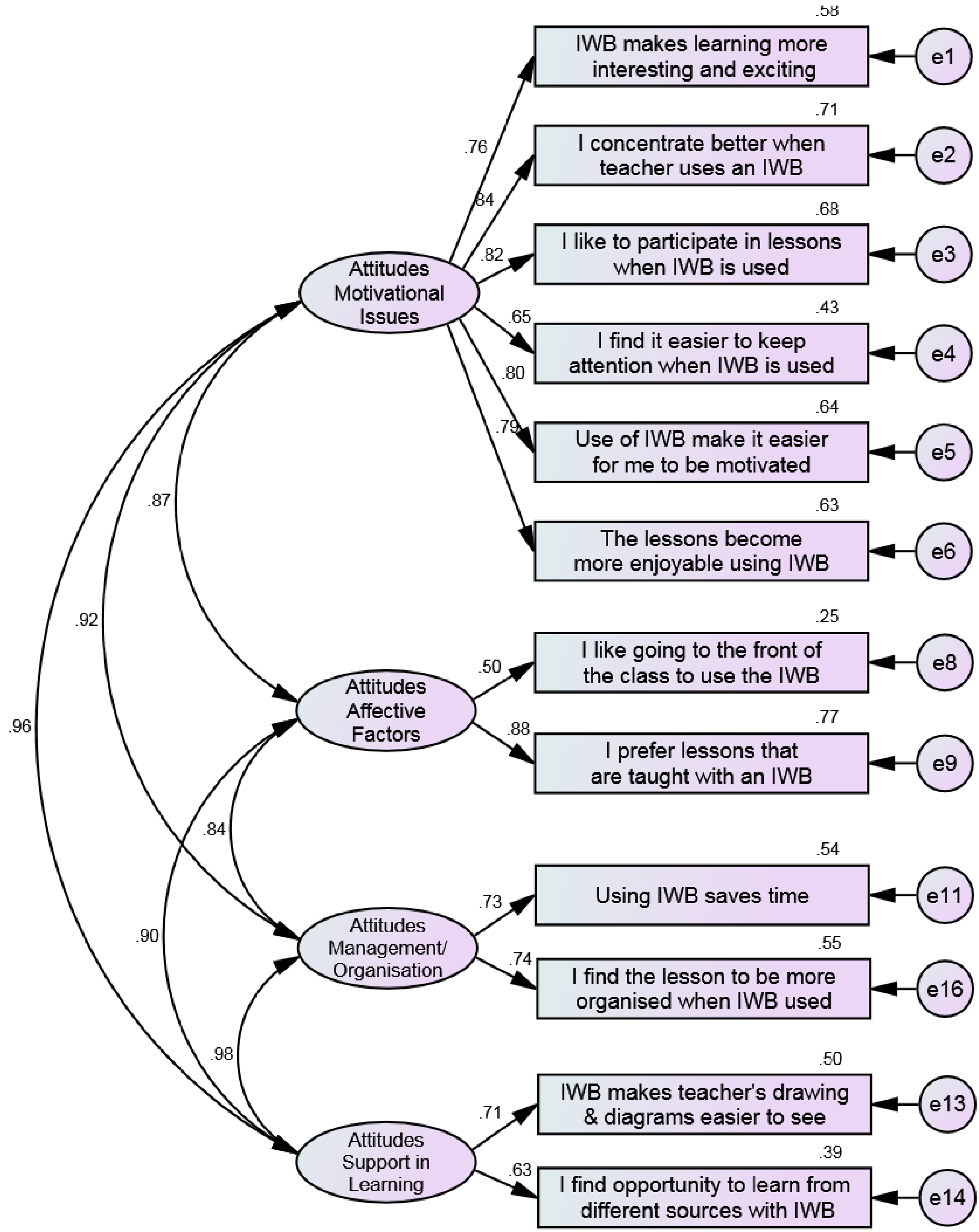


AICT_Nested Model

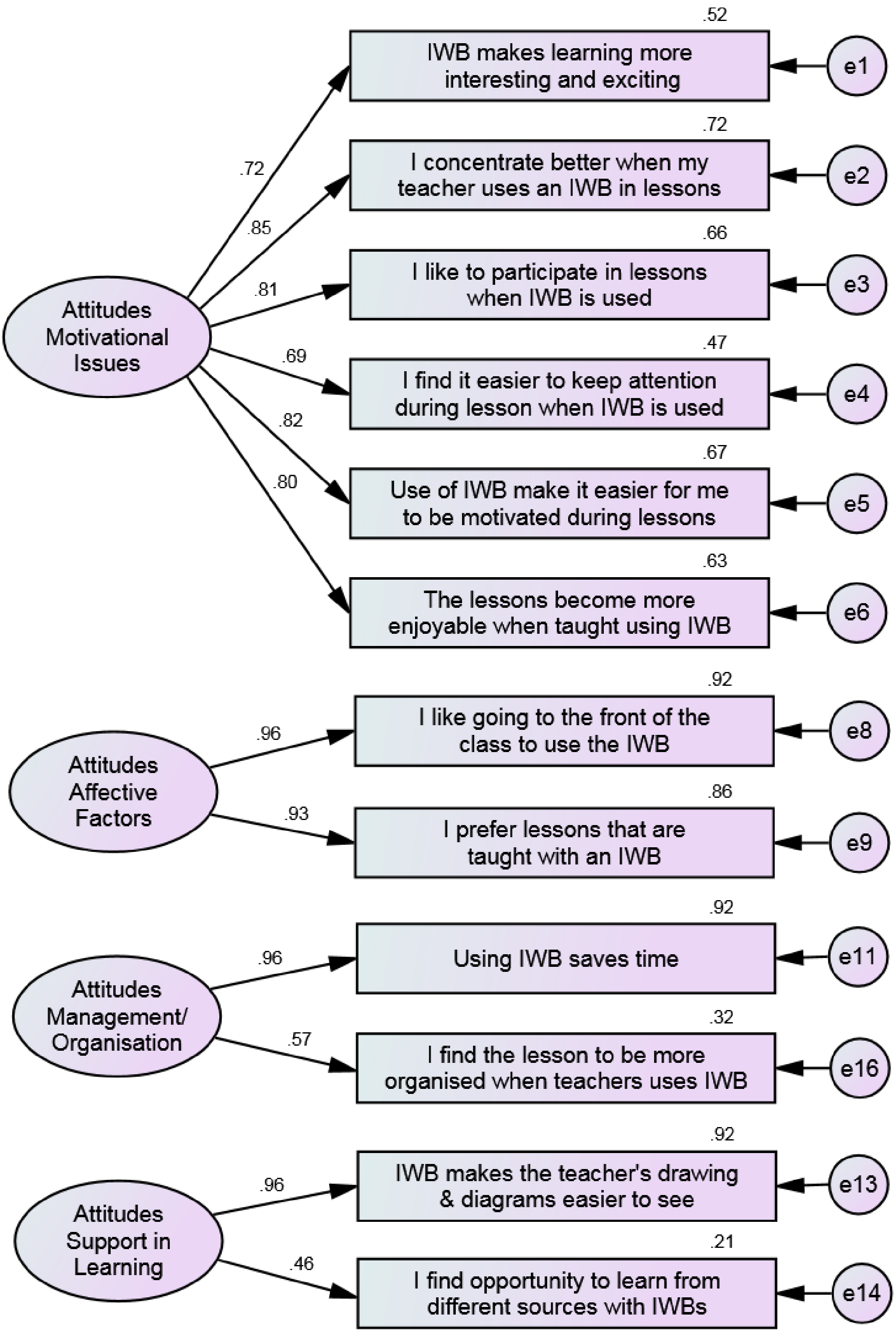
Scale: Attitudes towards IWB (AIWB)



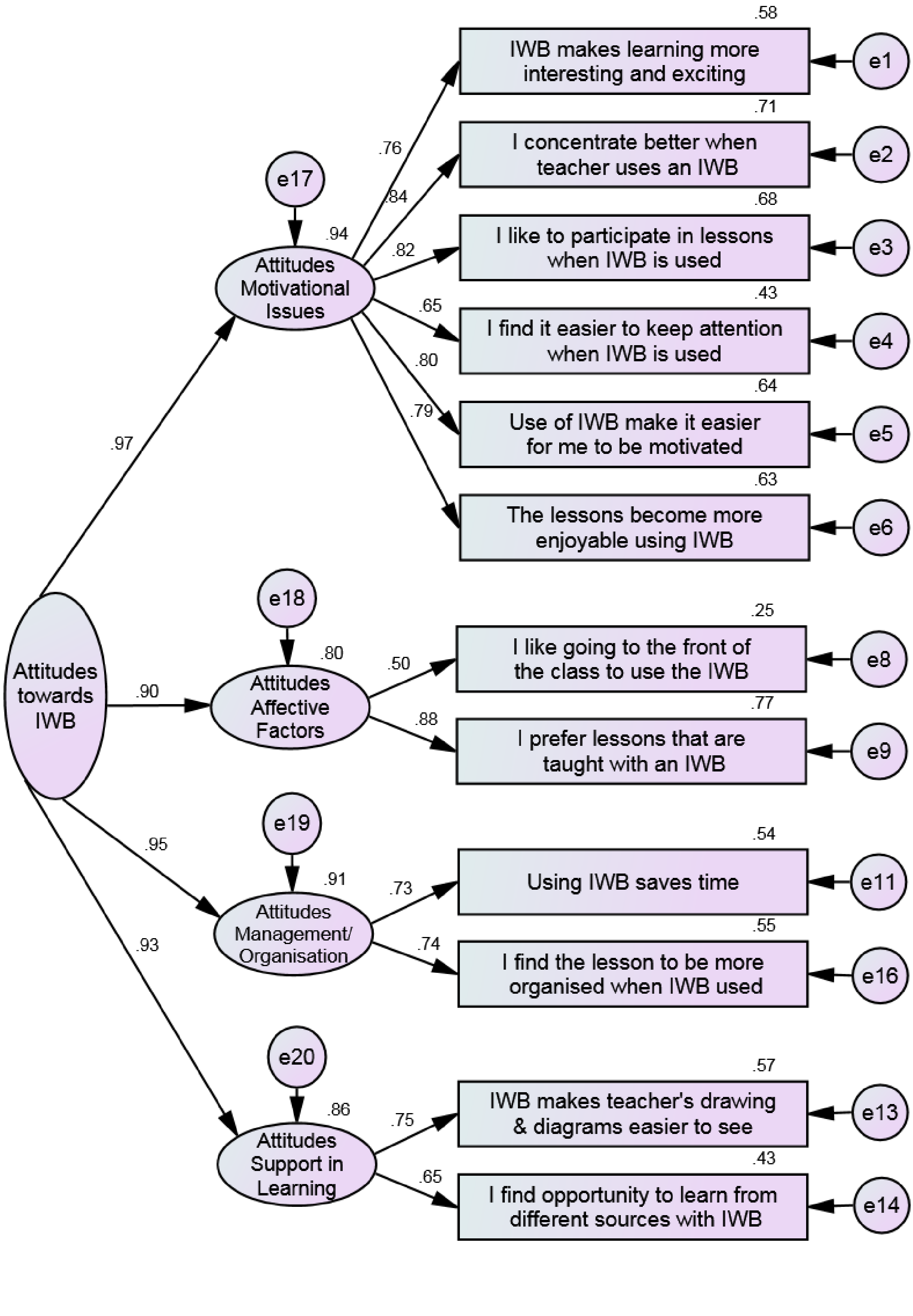
AIWB_1 factor model



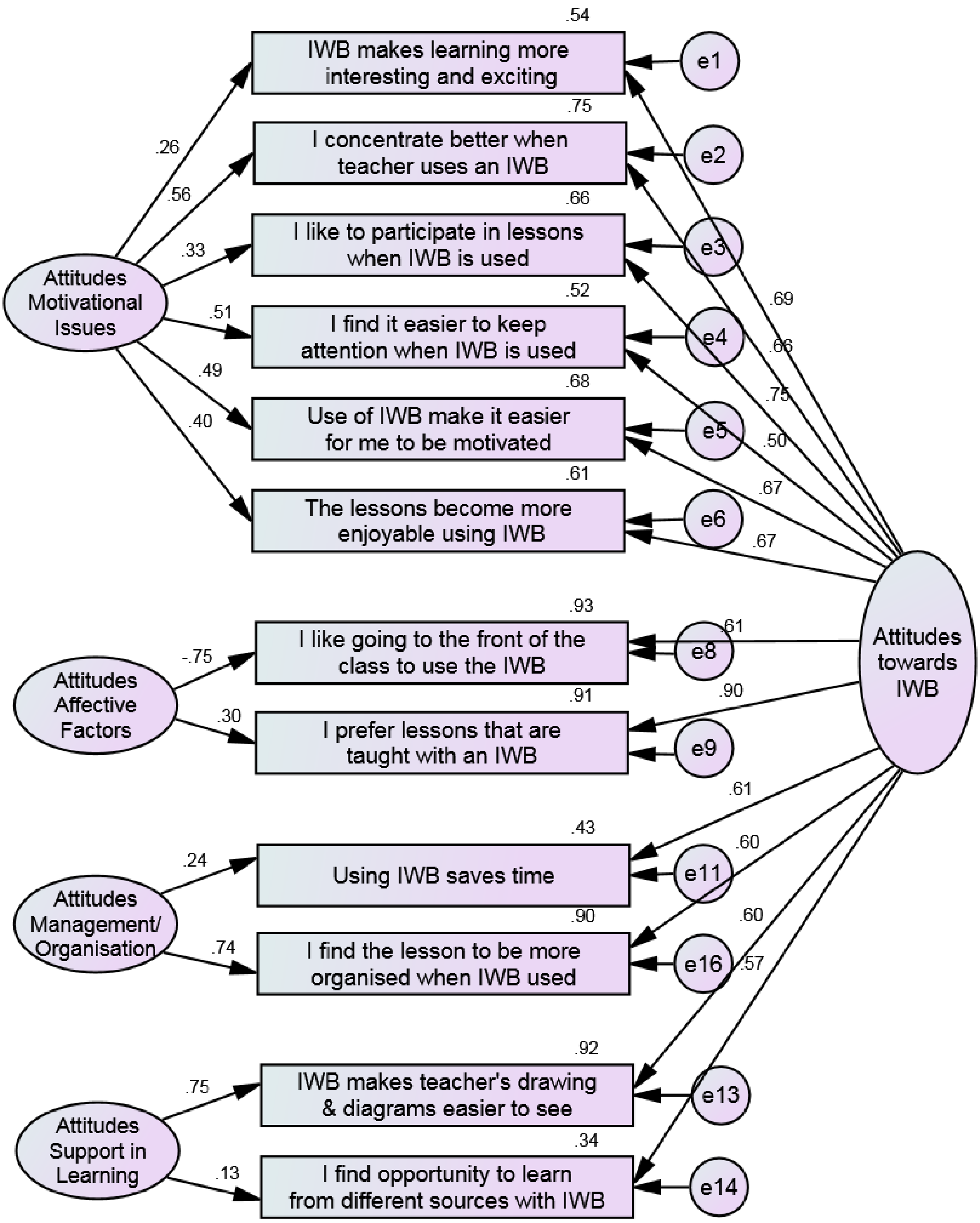
AIWB_4 Correlated Factor Model



AIWB_4 Orthogonal Factor Model

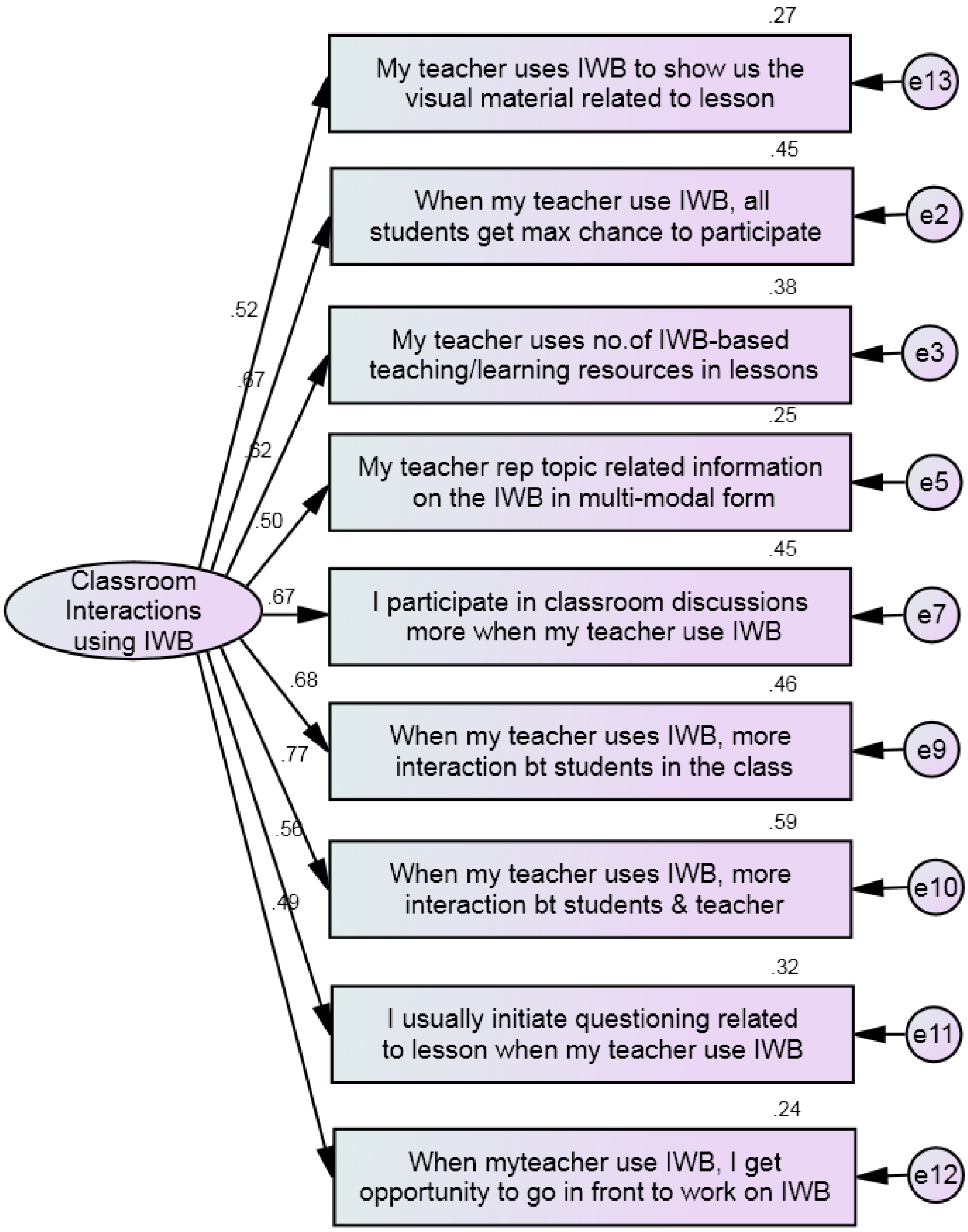


AIWB_Hierarchical Model

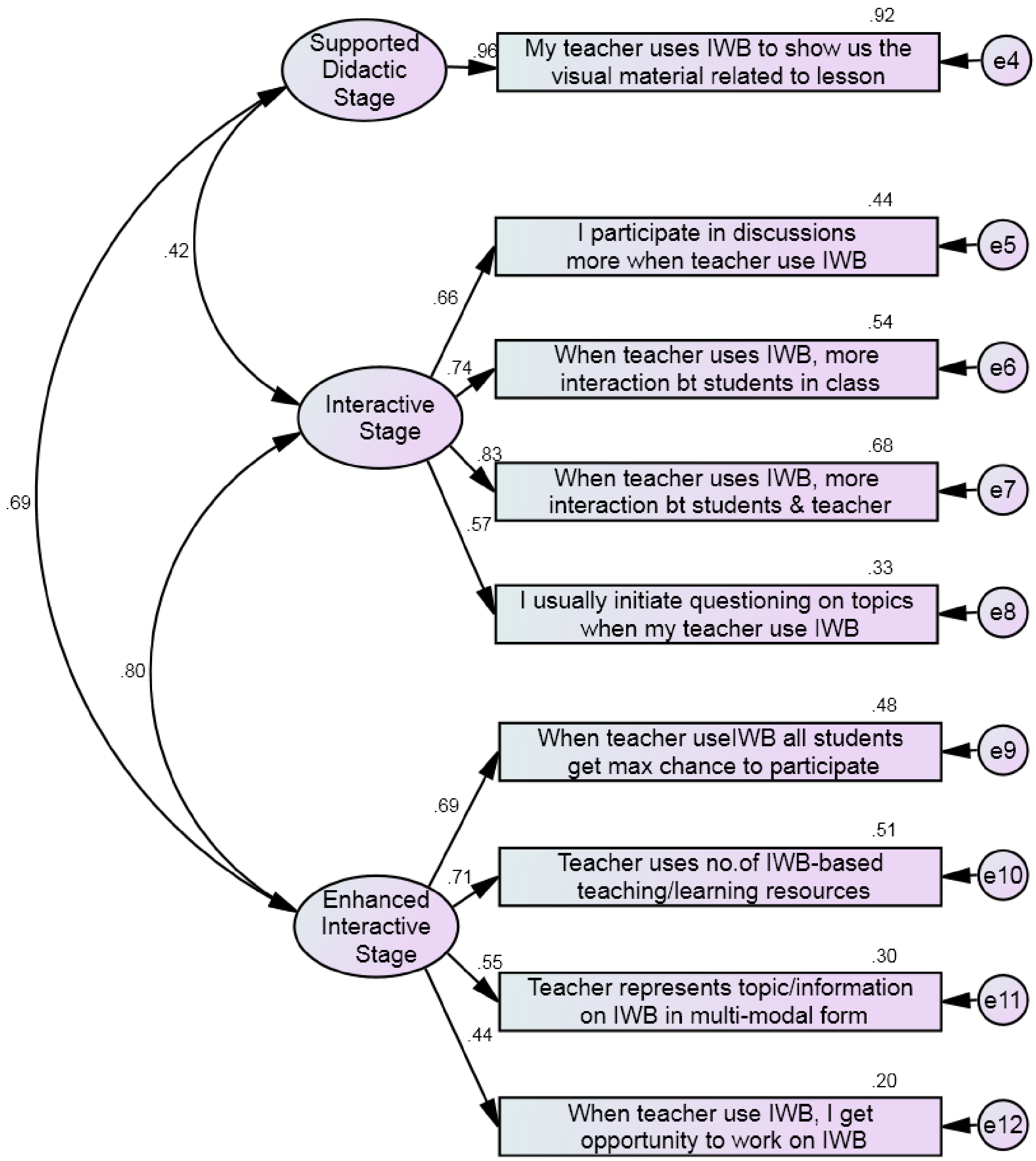


AIWB_Nested Model

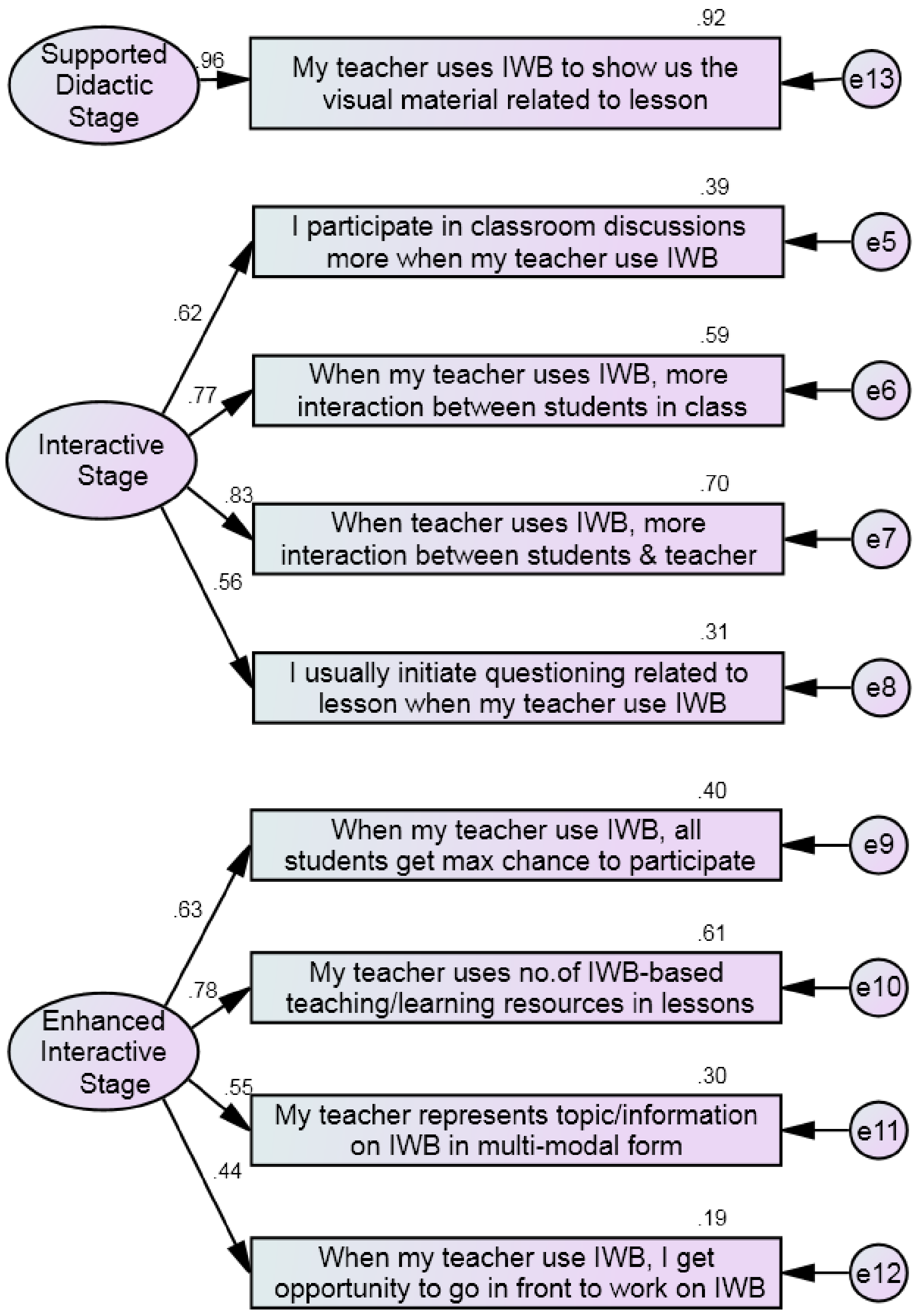
Scale: Classroom Interactions using IWB (CIIWB)



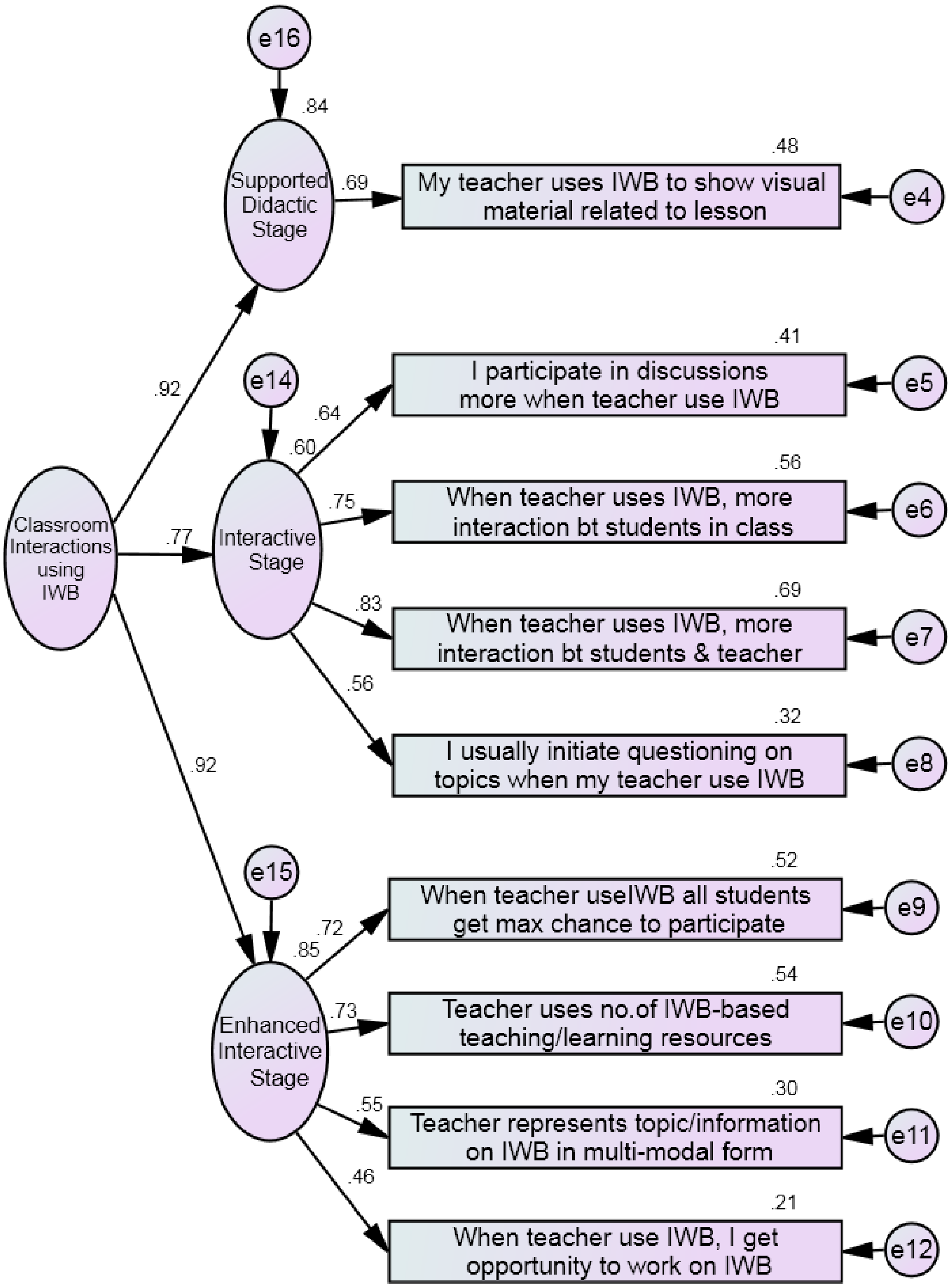
CIIWB_1 Factor Model (Input)



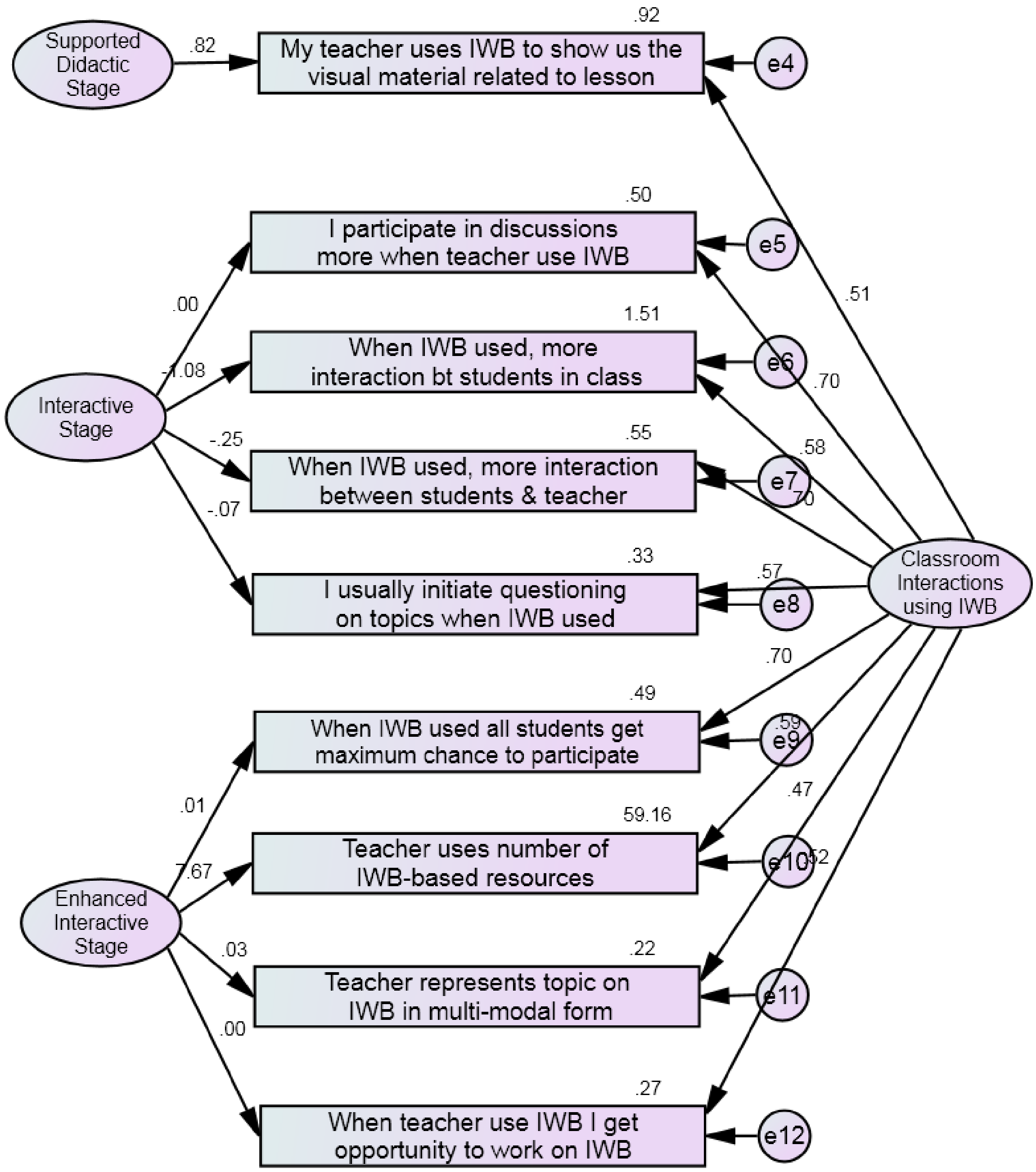
CIIWB_3 Correlated Factor Model



CIIWB_3 Orthogonal Factor Model

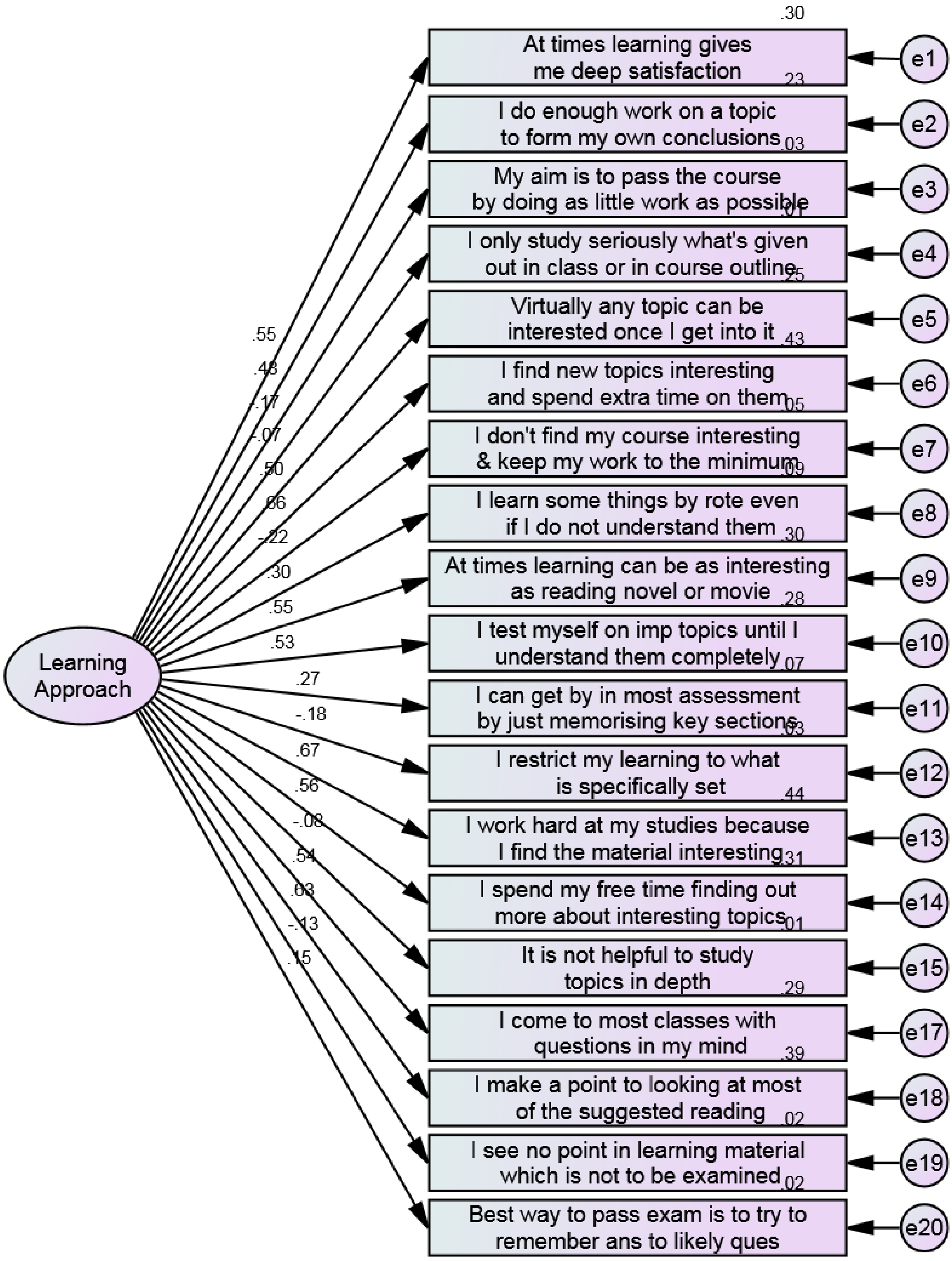


CIIWB_Hierarchical Model_Final

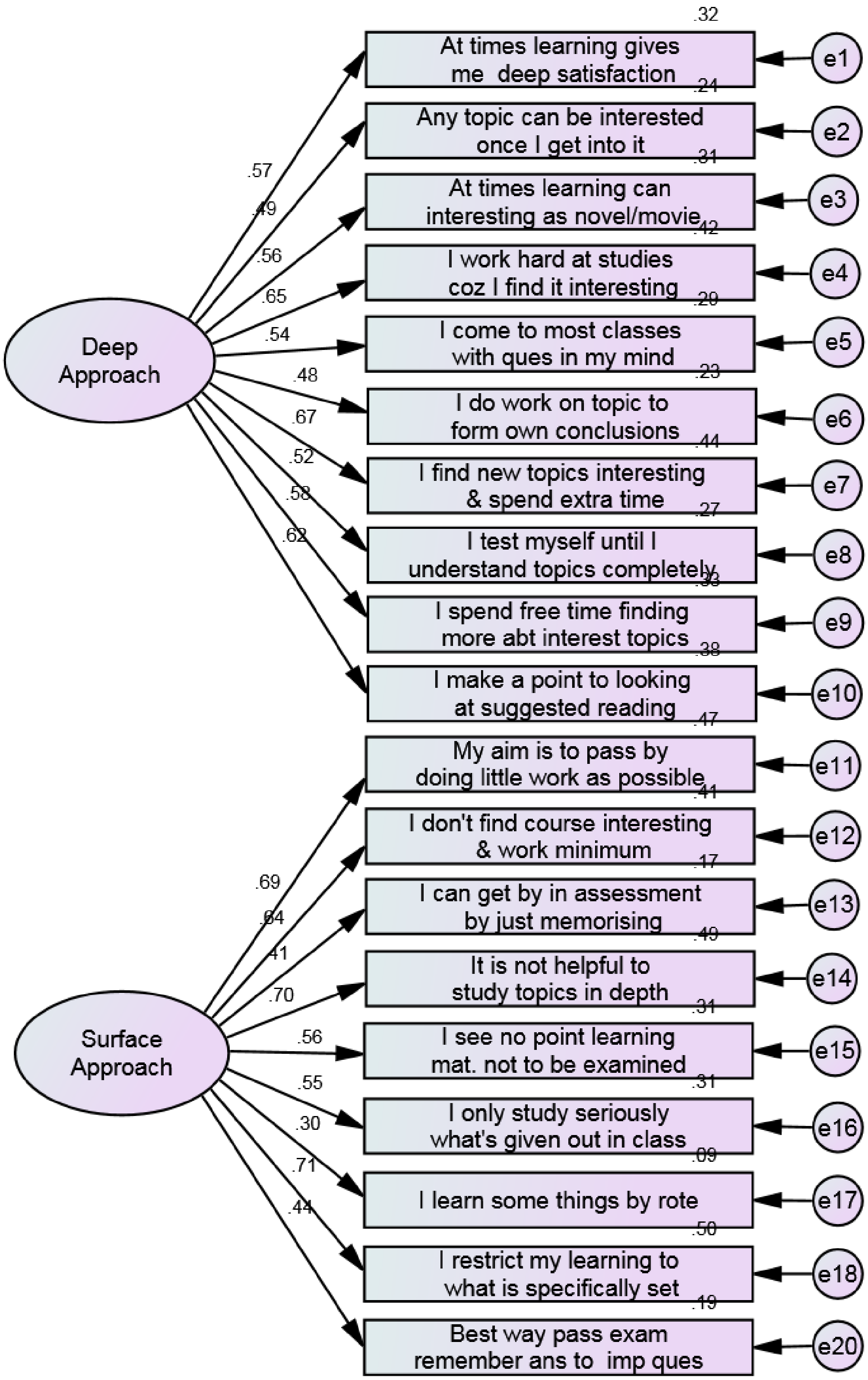


CIIWB_Nested Model

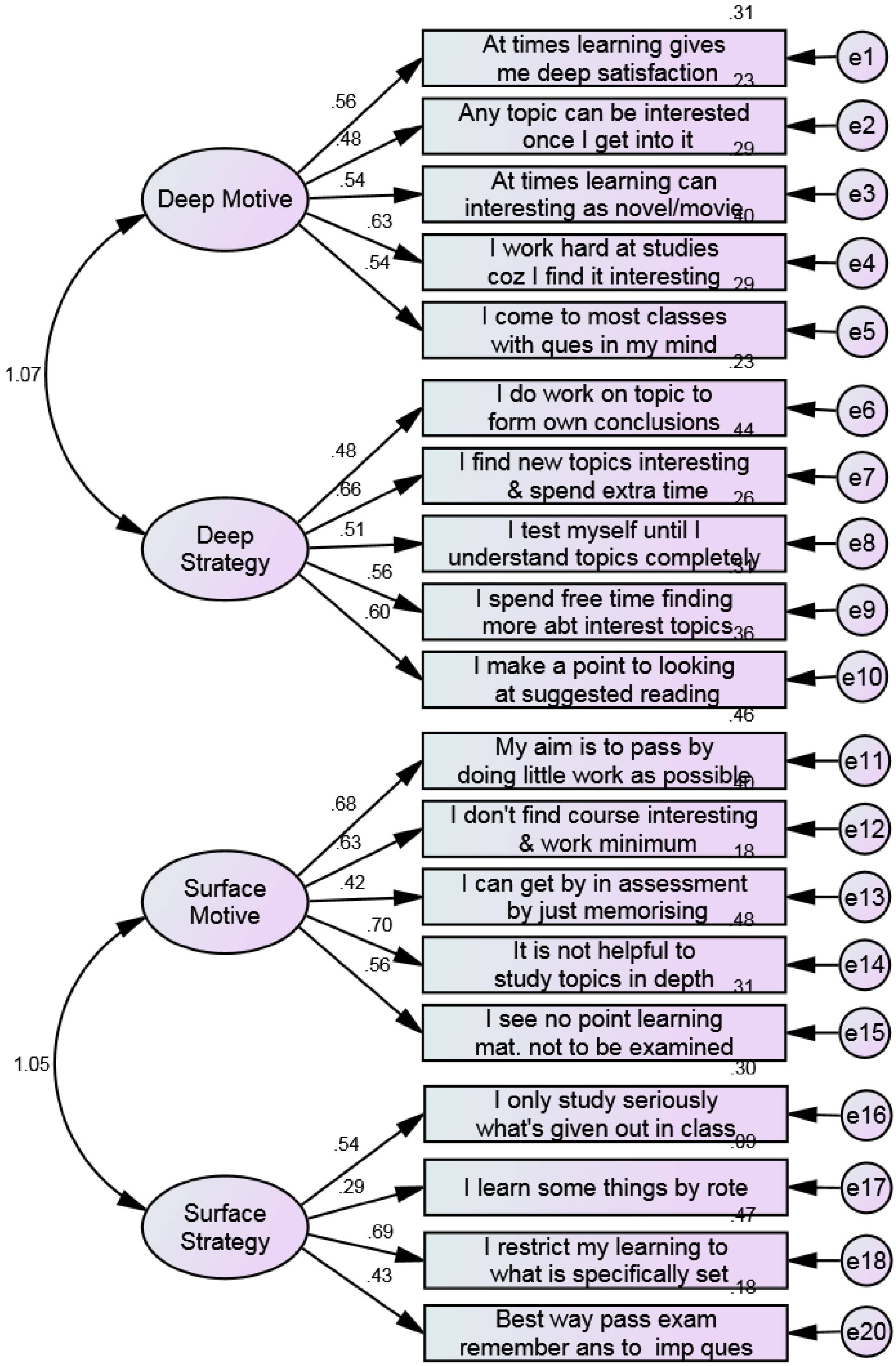
Scale: Learning Approaches using IWB (LA)



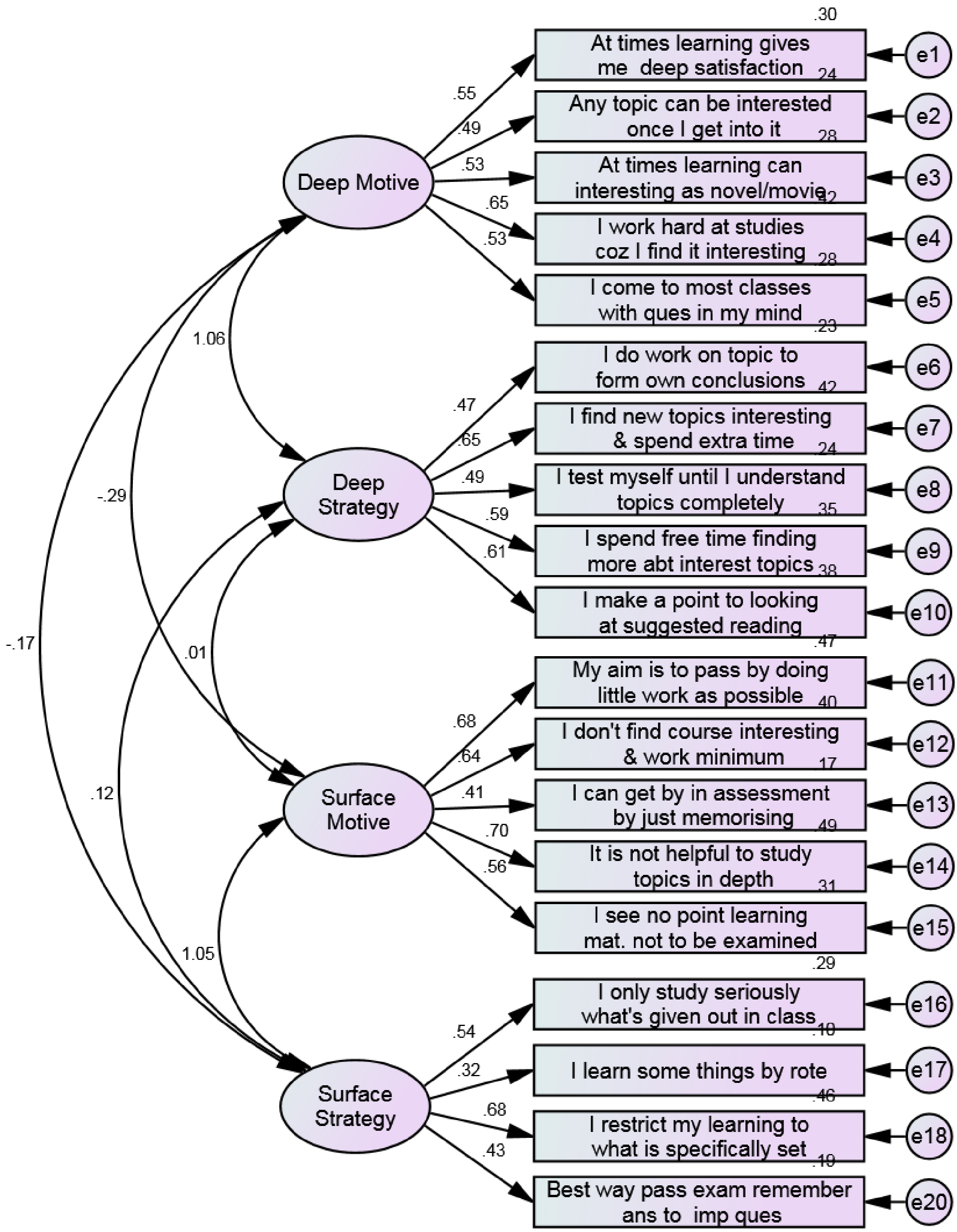
LA_1 factor model



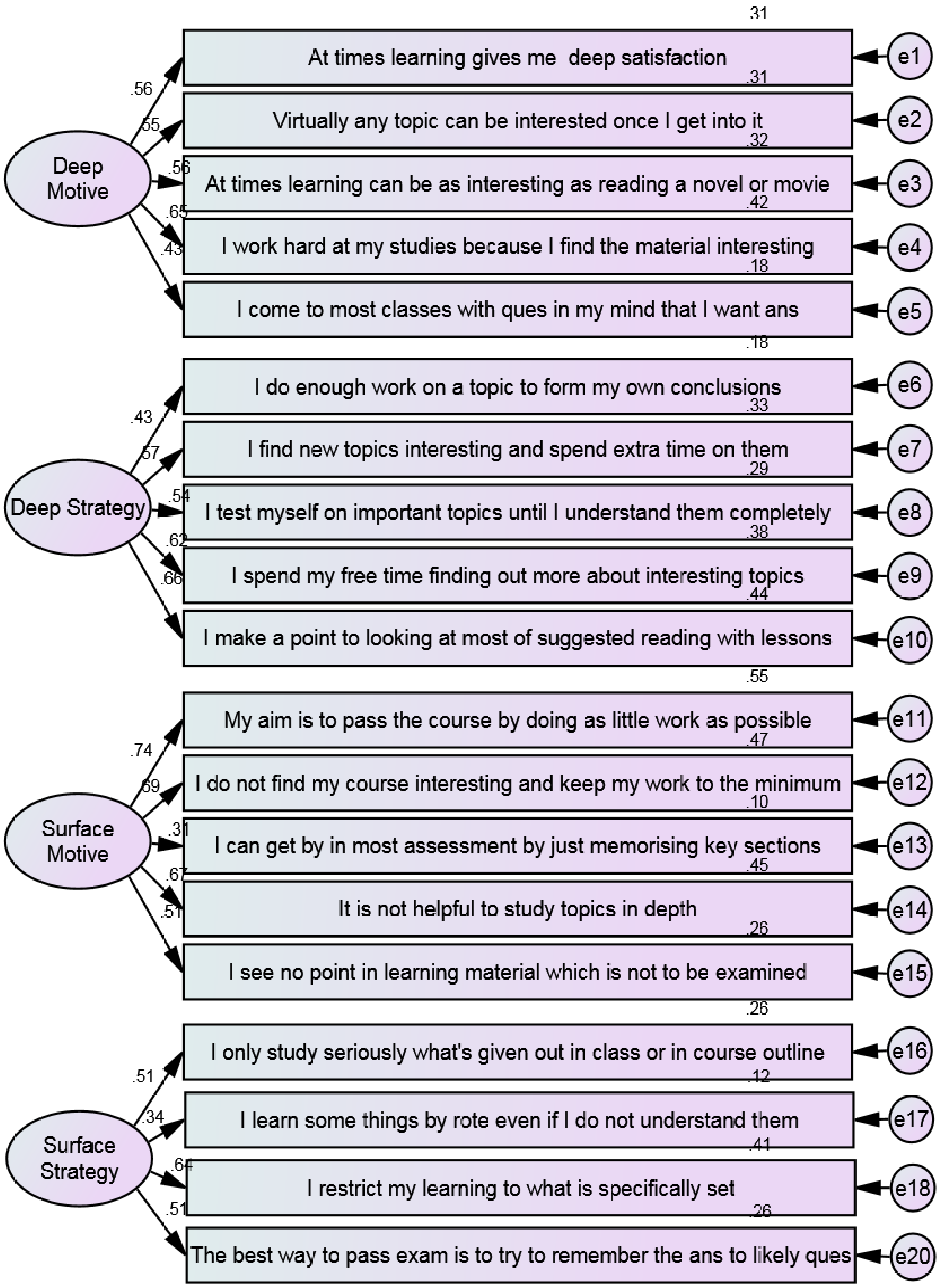
LA_2 Orthogonal Factor Model



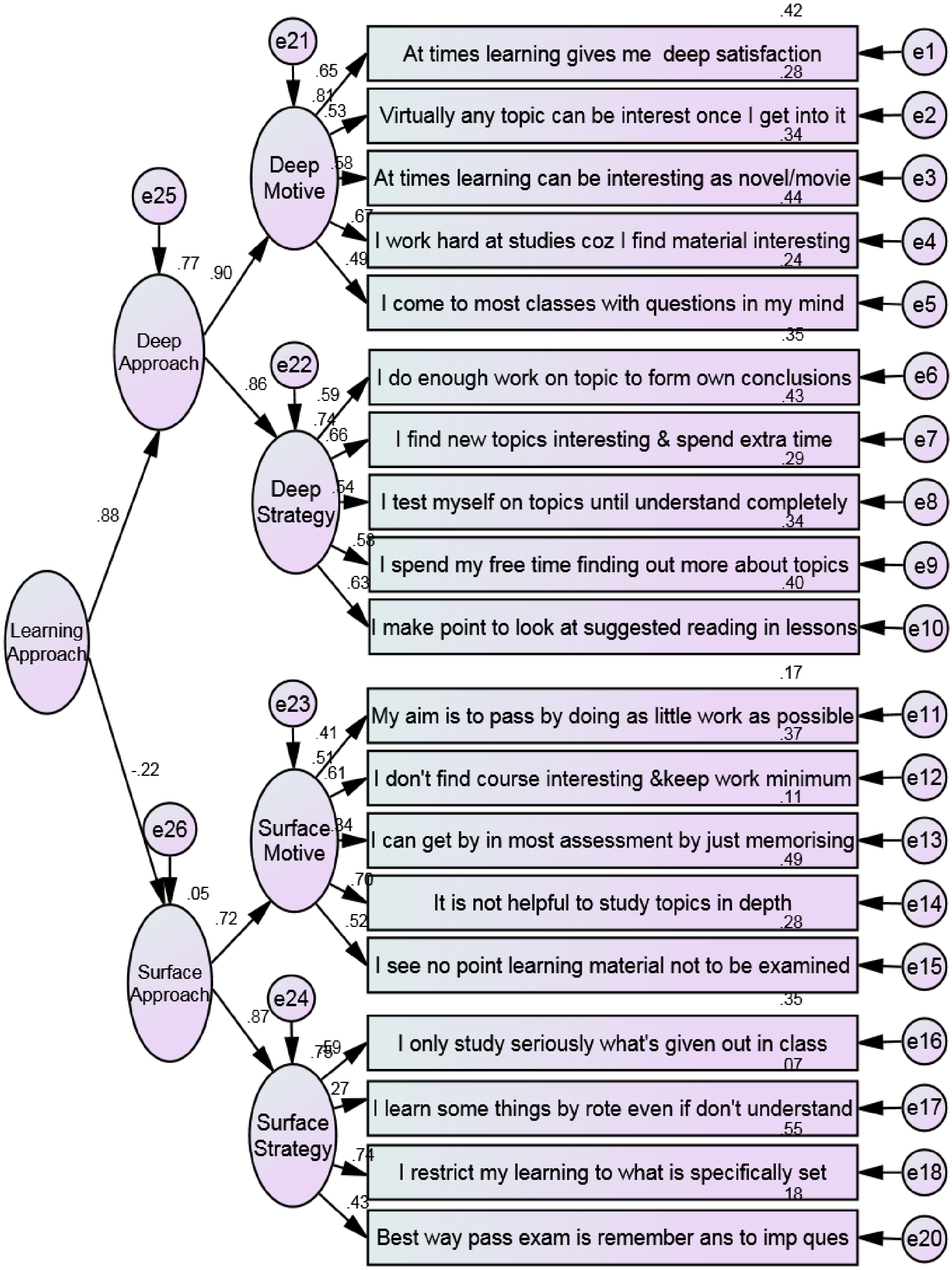
LA_4a Correlated Factor Model



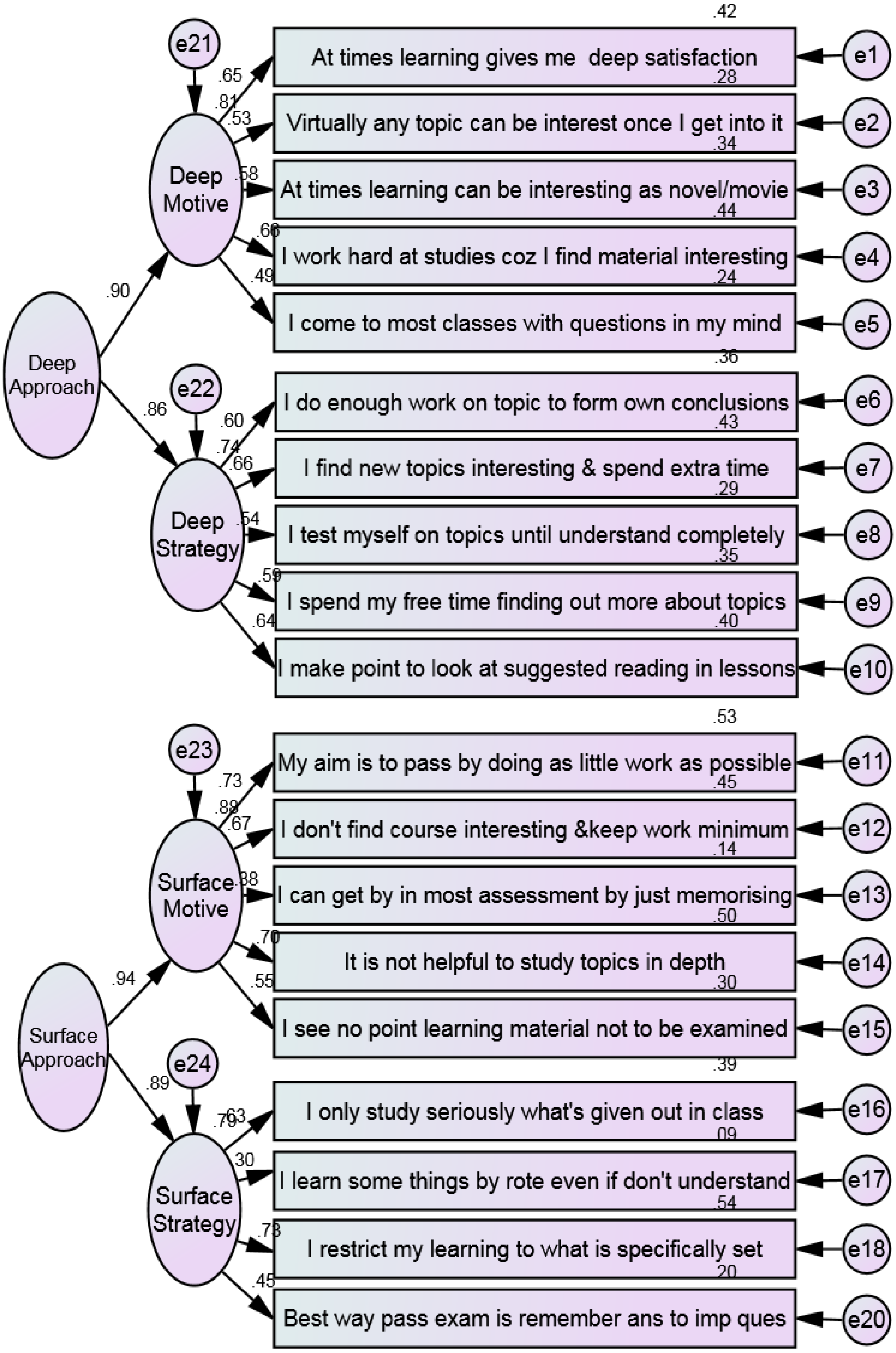
LA_4 Correlated Factor Model



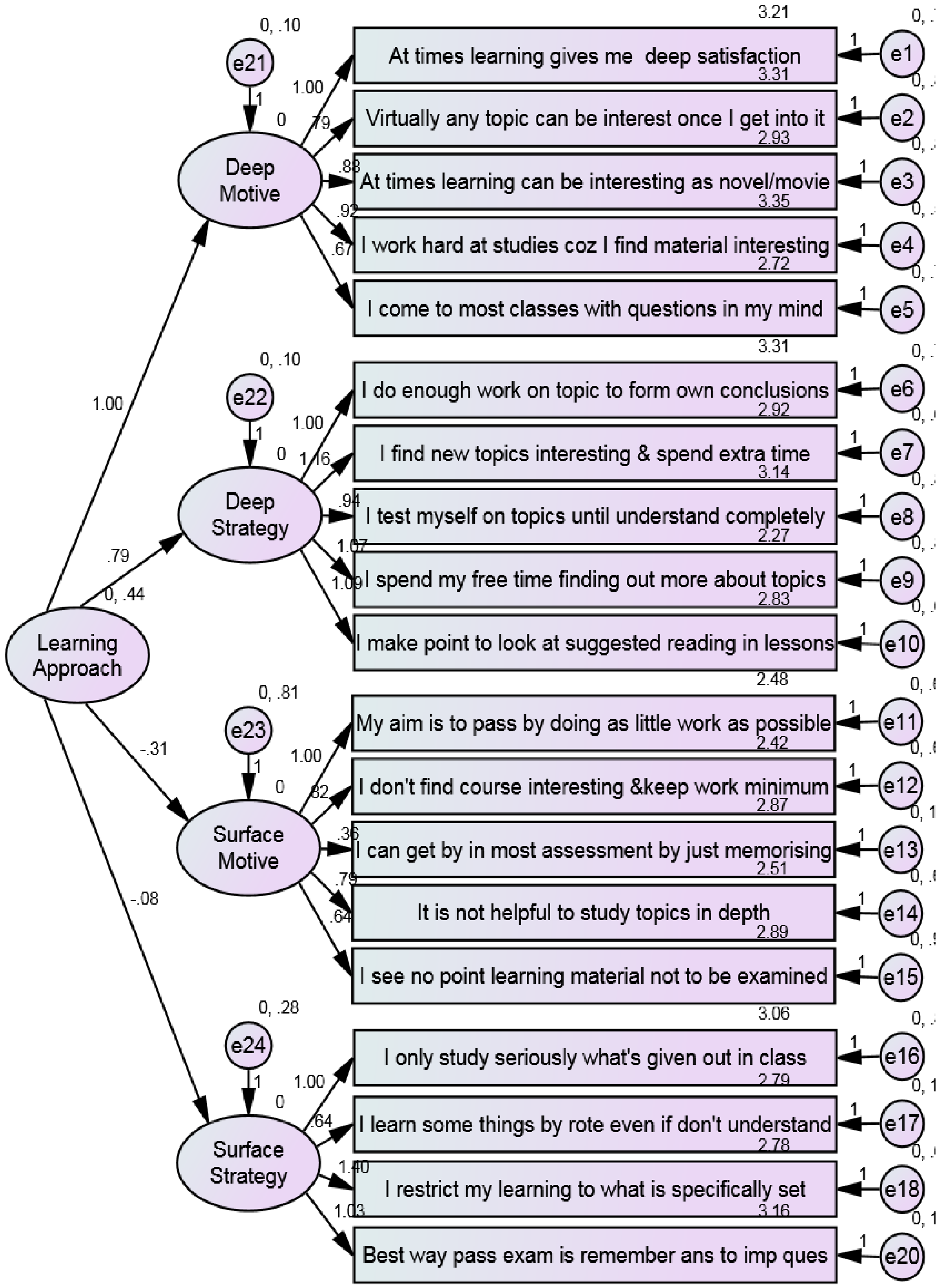
LA_4 Orthogonal factor model



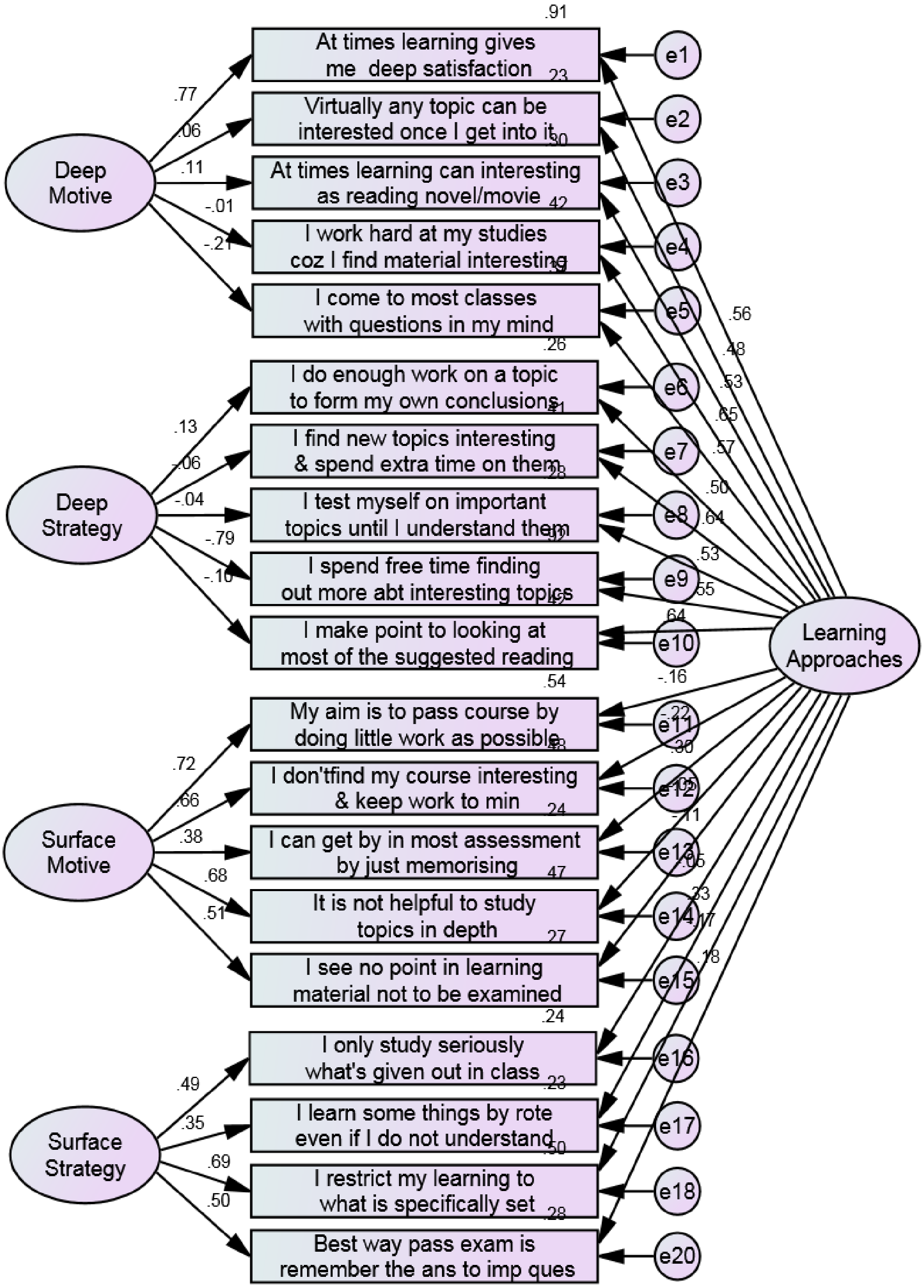
LA_Hierarchical Model 2



LA_Hierarchical Model 3

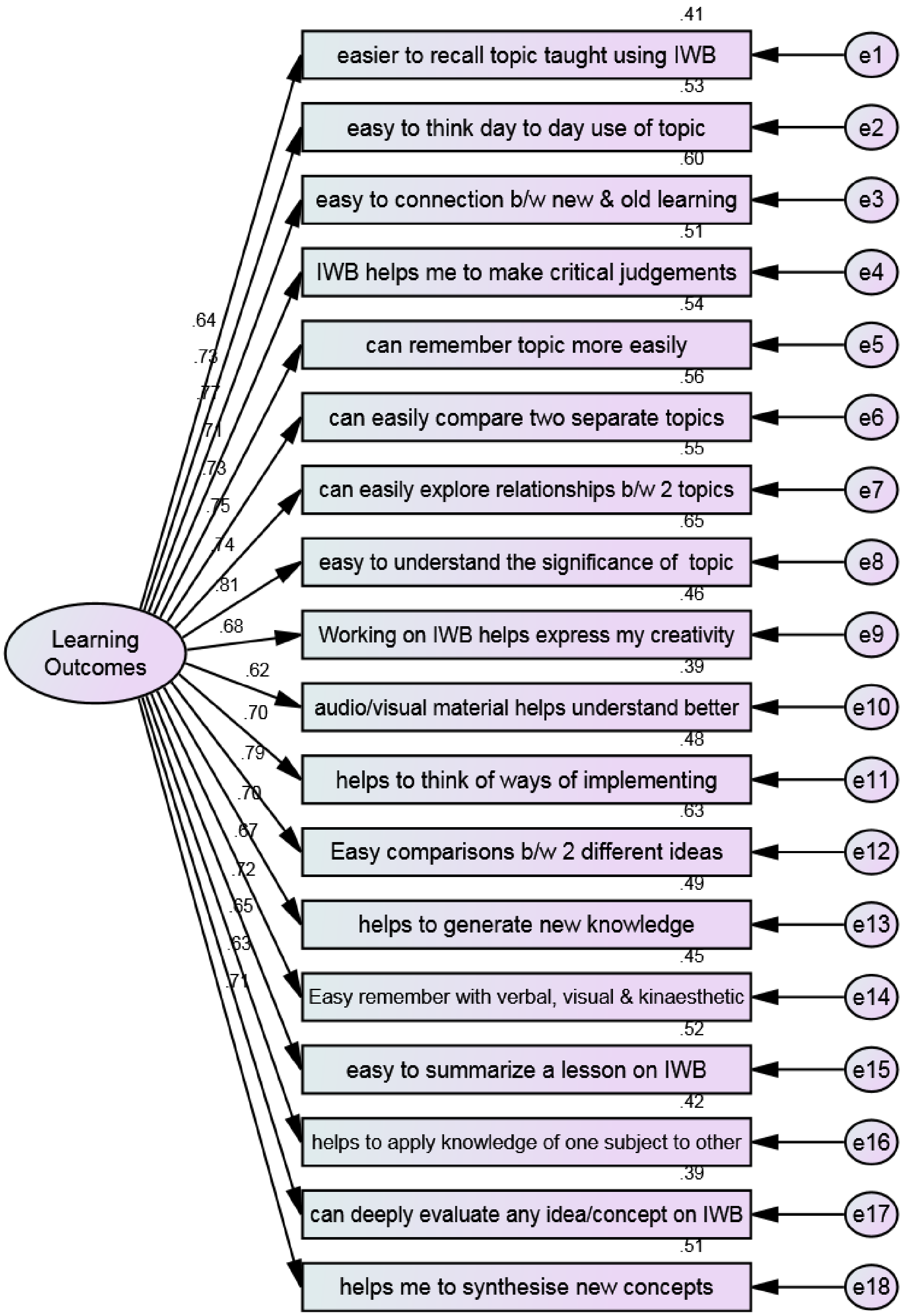


LA_Hierarchical Model

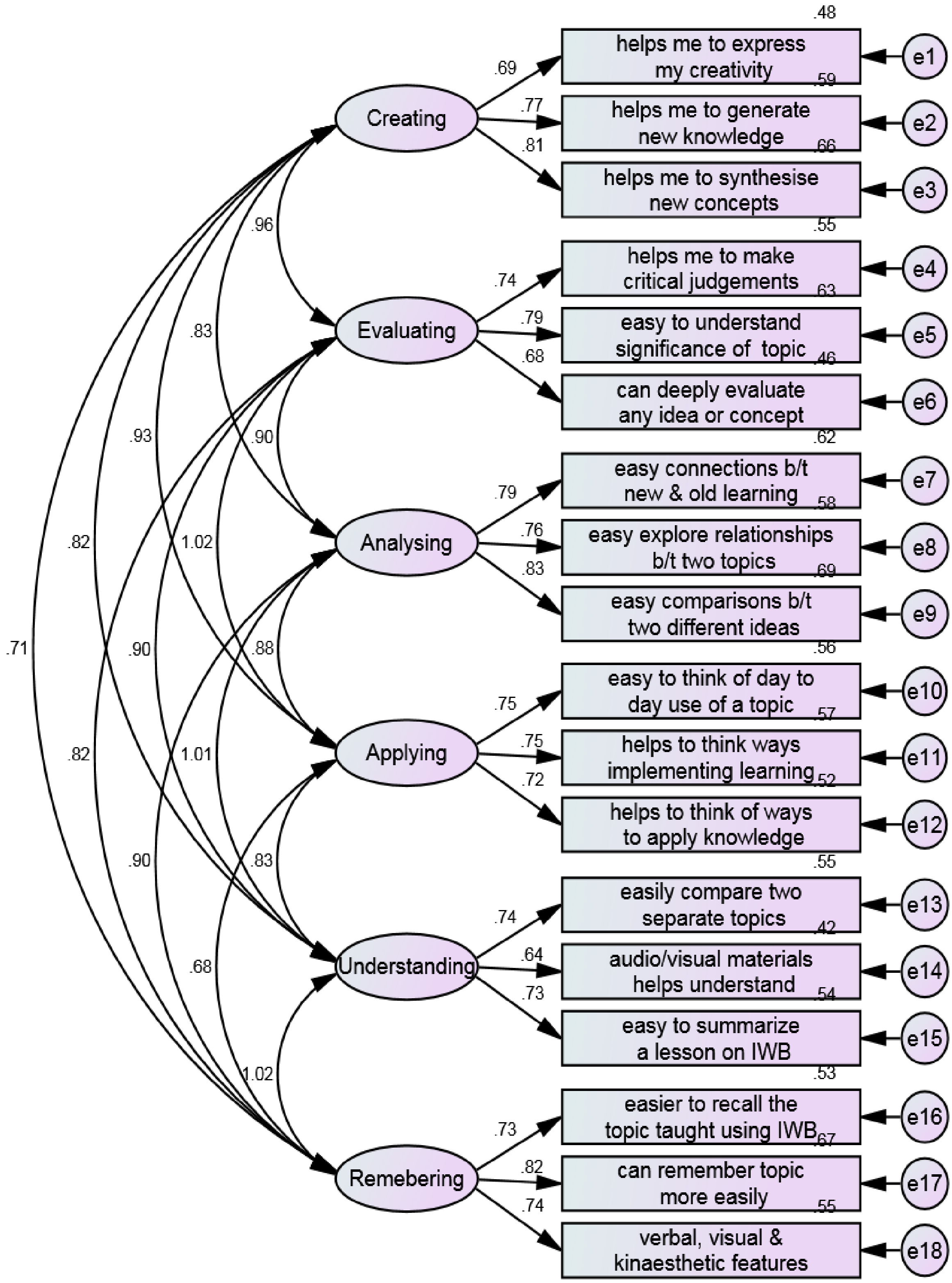


LA_Nested Model

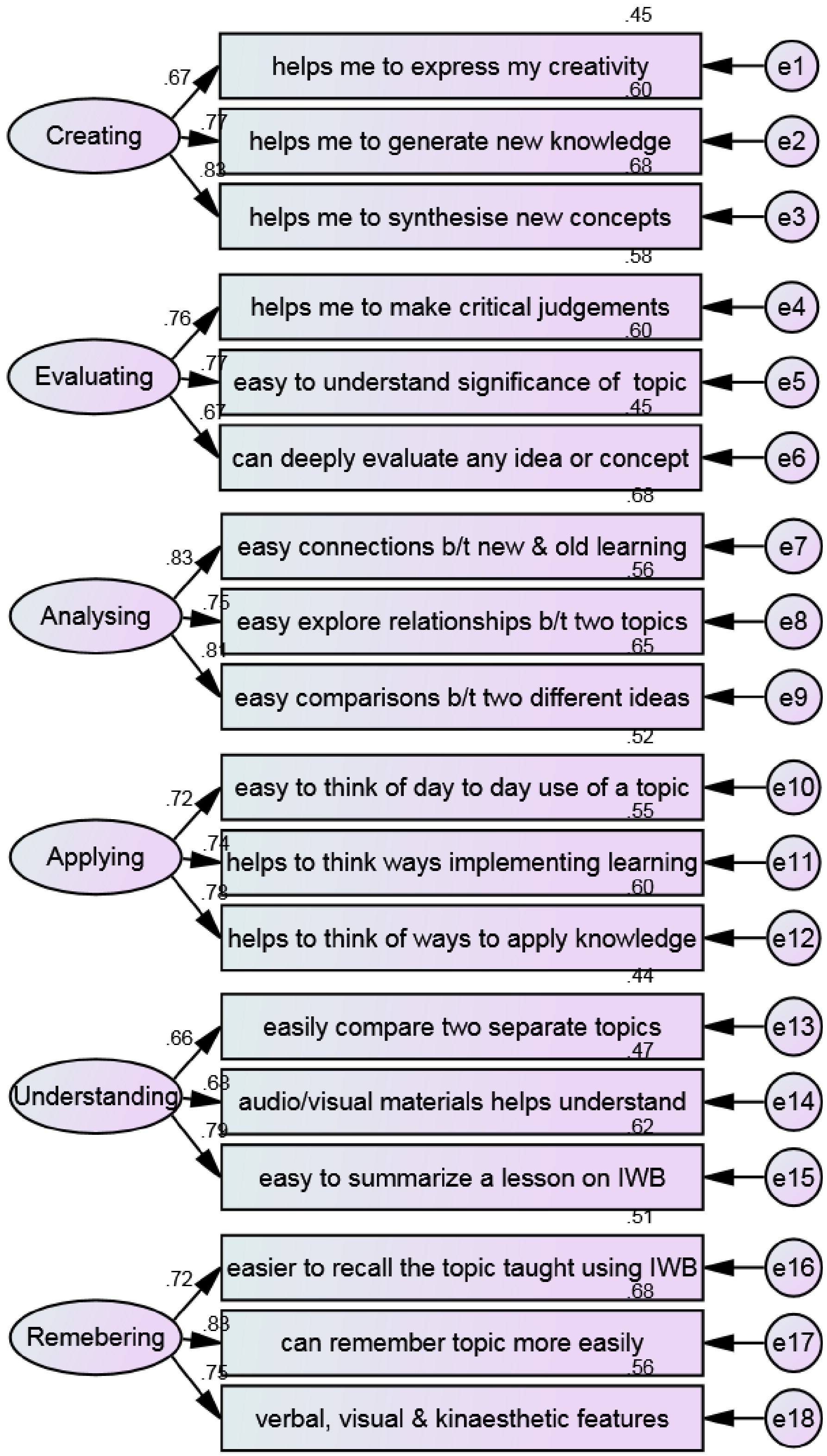
Scale: Learning Outcomes using IWB (LO)



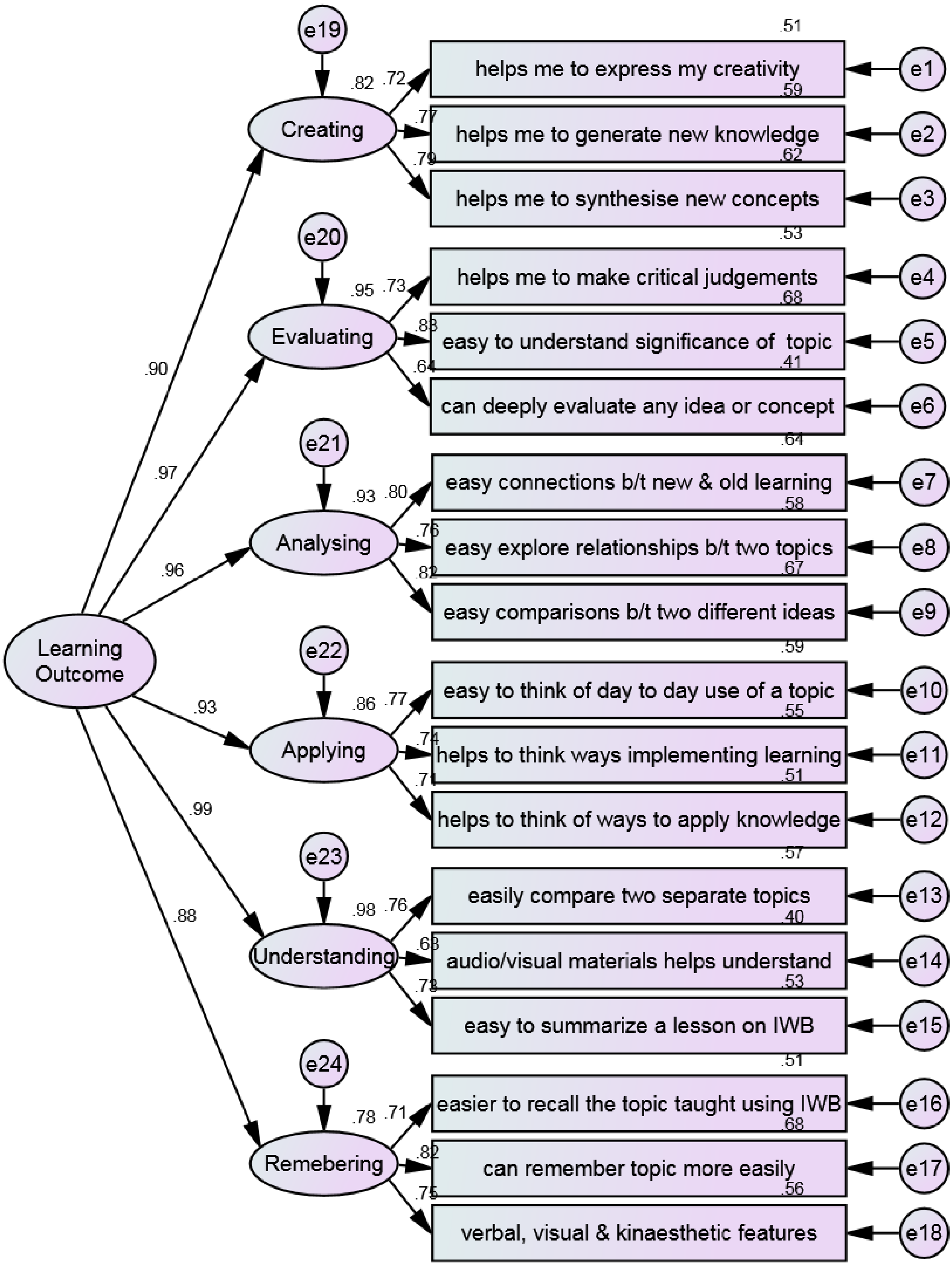
LO_1 factor model



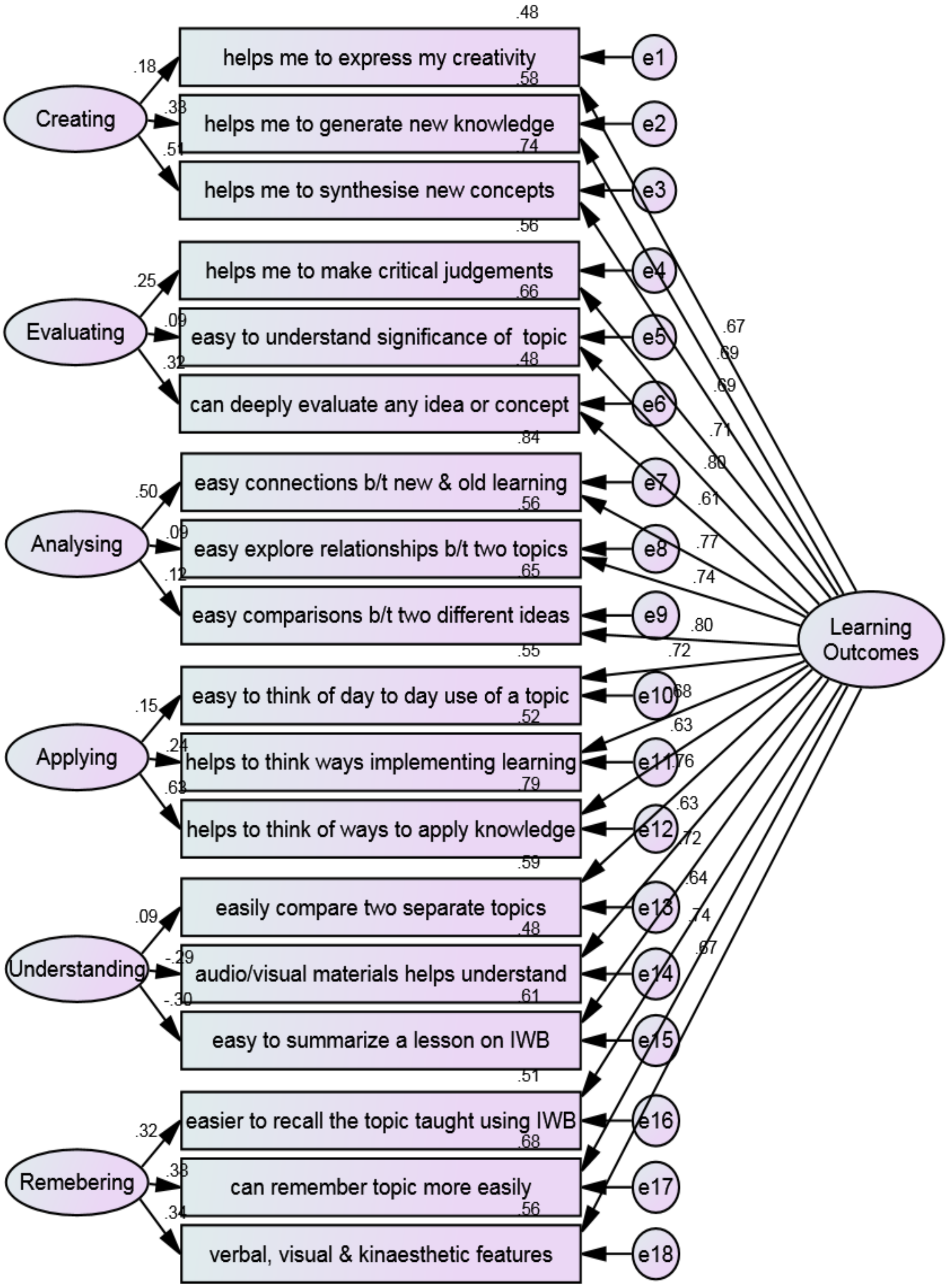
LO_6 Correlated factor model



LO_6 Factor Model



LO_Hierarchical Model



LO_Nested Model

Bibliography

ACS. (2005). Policy Statement on Computer Literacy. Retrieved from http://www.acs.org.au/acs_policies/docs/2005/ComputerLiteracy.pdf

Ainley, J. (2009). National policies and practices on ICT in education. In T. Plomp, R. Anderson, N. law & A. Quale (Eds.), *Cross-National Information and Communication Technology: Policies and Practices in Education* (Second ed., pp. 67-82). USA: Information Age Publishing.

Ainley, J., & Searle, D. (2005). Students in a digital age: some implications of ICT for teaching and learning. Retrieved May 12, 2010, from www.springerlink.com/index/u05t515n2r713nn4.pdf

Ajzen, I. (2005). Attitudes and personality traits *Attitudes, Personality and Behaviour (2nd Edition)* (pp. 20). England: Open University Press, McGraw-Hill House.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. New Jersey: Prentice-Hall.

Albion, P. R. (1999). *Self-Efficacy Beliefs as an indicator of Teachers' Preparedness for Teaching with Technology Association for the Advancement of Computing in Education (AACE)*. Paper presented at the 10th International Conference of the Society for Information Technology & Teacher Education (SITE 1999), San Antonio, TX, United States. http://eprints.usq.edu.au/6973/

Albirini, A. (2006). Teachers' attitudes toward information and communication technologies: the case of Syrian EFL teachers. *Computers & Education, 47*(4), 378-398.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., . . . Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing : a revision of Bloom's taxonomy of educational objectives* (Complete ed.). New York: Longman.

Arbuckle, J. L. (2009). *Amos 18 User's Guide*. USA: Amos Development Corporation.

Arbuckle, J. L. (2010). *IBM SPSS Amos 19 User's Guide*. USA: Amos Development Corporation.

Armstrong, V., Barnes, S., Sutherland, R., Curran, S., Mills, S., & Thompson, I. (2005).

Collaborative research methodology for investigating teaching and learning: the use of interactive whiteboard technology. *Educational Review, 57*, 455-467.

Arnold, S. (2004). Mathematics Education for the Third Millennium: Visions of a future for handheld classroom technology. Retrieved from http://www.dx.doi.org/10.1.1.132.6059

Aronson, J. (1994). A Pragmatic View of Thematic Analysis. *A Qualitative Report, 2*(1).

Bailey, K. D. (1987). *Methods of Social Research* (3rd ed.). New York: The Free Press.

Bailey, M. (2001). Reconceptulizing Teaching and Learning in a Technocracy: Bloom's Revised Taxonomy (2001). Retrieved May 1, 2010, from http://education.ed.pacificu.edu/aacu/workshop/reconcept2B.html

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing, 19*, 328-335.

Barrio, C. (1999). The Use of Semistructured Interviews and Qualitative Methods for the Study of Peer bullying. *Nature and Prevention of Bullying*. Retrieved November 27, 2008 from http://old.gold.ac.uk/tmr/reports/aim2_madrid1.html

Battaglia, M. P. (2008). Nonprobability Sampling *Encyclopedia of Survey Research Methods*: SAGE Publications.

Bayne, P. (2007). Interactive whiteboards: improving teaching *Teacher: Australian Council for Educational Research, 183*, 28-30.

Becta. (2003). What the research says about interactive whiteboards. *ICT Research*. Retrieved from http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/wtrs_whiteboards.pdf

Becta. (2004). Getting the most from your interactive whiteboard: A guide for secondary schools. *ICT Advice*. Retrieved from http://foi.becta.org.uk/display.cfm?resID=35754

Beeland, W. (2002). Student Engagement, Visual Learning and Technology: Can Interactive Whiteboards Help?. Retrieved from http://citeseerx.ist.psu.edu

Bennett, S., & Lockyer, L. (2008). A study of teachers' integration of interactive whiteboards into four Australian primary school classrooms. *Learning, Media, & Technology, 33*(4), 289-300.

Betcher, C., & Lee, M. (2009). *The Interactive Whiteboard Revolution: Teaching with IWBs*. Australia: Australian Council *for* Educational Research.

Biggs, J., Kember, D., & Leung, D. (2001). The Revised Two Factor Study Process Questionnaire: R-SPQ-2F. *British Journal of Educational Psychology, 71*, 133-149.

Bland, M. J., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *British Medical Journal, 314*, 572. doi: http://dx.doi.org/10.1136/bmj.314.7080.572

Boger, C., & Boger, D. (2000). Preservice Teachers' Explanations of Their Teaching Behavior. *Journal of Instructional Psychology*. Retrieved from http://findarticles.com/p/articles/mi_m0FCG/is_/ai_68998587

Borgatti, S. (1999). Elements of Research: Theoretical Framework. Retrieved April 28, 2010, from http://www.analytictech.com/mb313/element.htm

Bourbour, M., & Bjorklund, C. (2014). Preschool teachers' reasoning about interactive whiteboard embedded in mathematics education in Swedish preschools. *Journal of Nordic Early Childhood Education Research, 7*, 1-16.

Brown, J. D. (2000). Questions and answers about language testing statistics: What is construct validity?. *Shiken: JALT Testing & Evaluation SIG Newsletter, 4*(2), 8-12.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of Assessing Model Fit. In K. Bollen & J. Long (Eds.), *Testing Structural Equation Models* (pp. 136-162). Newbury Park, CA: Sage.

Bryk, A. S., & Raudenbush, S. W. (2002). *Hierarchical Linear Models: Applications and Data Analysis Methods* (2nd ed.): Sage Publications, Inc.

Burhanuddin. (2013). *Participative Management and its Relationships with Employee Performance Behaviour: A study in the University sector in Malang Indonesia.* (PhD), The University of Adelaide.

Burns, R. B. (2000). *Introduction to Research Methods* (4th ed.). Australia: Pearson Education Australia Pty Limited.

Byrne, B. M. (1989). *A primer of liseral: basic applications and programming for confirmatory factor analytic models*. New York: Springer-Verlag.

Byrne, B. M. (2010). *Structural Equation Modeling with AMOS: Basic Concepts, Applications and Programming*. USA: Routledge.

Cavanagh, R., Reynolds, P., & Romanoski, J. (2004). *Information and communication technology learning in the classroom: The influence of students, the class-group, teachers and the home*. Paper presented at the AARE Annual Conference, Melbourne. http://www.aare.edu.au/data/publications/2004/cav04445.pdf

Chandra, V., & Lloyd, M. (2008). The Methodological nettle: ICT and student achievement. *British Journal of Educational Technology, 39*(6), 1087-1098.

Chen, F., Curran, P. J., Bollen, K. A., Kirby, J., & Paxton, P. (2008). *An Empirical Evaluation of the Use of Fixed Cutoff Points in RMSEA Test Statistic in Structural Equation Models*. (PMC2743032, 36, 4). US National Library of Medicine.

Christensen, R. (2002). Effect of technology integration education on the attitudes of teachers and their students. *Journal of Research on Technology in Education*.

Churches, A. (2009). Bloom's Digital Taxonomy. Retrieved April 24, 2010, from http://edorigami.wikispaces.com/file/view/bloom%27s+Digital+taxonomy+v3.01.pdf

Cohen, Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). New York: RoutedgeFalmer.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Publishers.

Cook, D. (2010). Setting a new course for research on information technology in education. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, Practice and Future Directions (2nd Edition)* (pp. 39-45). Oxon: Routledge.

Cox, M. (2010). The changing nature of researching information technology in education. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, Practice and Future Directions* (pp. 11-24). Oxon:

Routledge.

Cox, M., Webb, M., Abbott, C., Blakeley, B., Beauchamp, T., & Rhodes, V. (2003). ICT and pedagogy: A review of the research literature *ICT in Schools Research and Evaluation Series- No. 18* Westminster, London: Department for Education and Skills.

Cramer, D. (2003). *Advanced Quantitative Data Analysis*. Philadelphia, USA: Open University Press.

Creswell, J. (2005). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (2nd ed.). New Jersey: Pearson Education, Inc. .

Creswell, J. (2008). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (3rd ed.). New Jersey: Pearson Education International.

CSHD. (2007). Qualitative Research Methods. *Information Bulletin, 1*, 1-3. Retrieved from http://chsd.uow.edu.au/Publications/2007_pubs/care_planning_info_bulletin_1.pdf

Cuban, L. (2001). *Oversold and underused: Computers in the classroom* USA: Cambridge: Harvard University Press.

Cuckle, P., & Clarke, S. (2002). Mentoring student-teachers in schools: views, practices and access to ICT. *Journal of Computer Assisted Learning, 18*(3), 330-340.

Curtis, D. D. (2005). Comparing classical and contemporary analyses and resch measurement. In S. Alagumalai, D. D. Curtis & N. Hungi (Eds.), *Applied Rasch measurement: A book of exemplars* (Vol. 4, pp. 179-195). Netherlands: Springer

Darmawan, I. G. N. (2003). *Implementation of Information Technology in Local Government in Bali, Indonesia*. South Australia: Flinders University Institute of International Education.

Darmawan, I. G. N., & Keeves, J. P. (2002). Two-level model of information technology adoption in local government of Bali. *International Education Journal, 3*(1), 47-60.

Darmawan, I. G. N., & Keeves, J. P. (2009). Using multilevel analysis. In C. R. Aldous,

I. G. N. Darmawan & J. P. Keeves (Eds.), *Change over time in learning numeracy and literacy in rural and remote schools* (Vol. 2, pp. 48-60). Adelaide, South Australia: Shannon Research Press.

DECD. (2012). *ICT Strategic Statement [Electronic version]*. Adelaide, South Australia: DECD Retrieved from http://www.decd.sa.gov.au/ictstrategy/files/pages/Homepage/ICT_Strategic_Statement_20.pdf.

DECS. (2006). *DECS Strategic Plan for Learning and Business technologies 2006-2010* Adelaide: Government of South Australia Retrieved from http://www.decs.sa.gov/policy/pages/OSPP/policy-index/?reFlag=1

DEEWR. (2007). *Computers in Australian Schools- Media Release*. Canberra: Australian Government. Retrieved from http://www.deewr.gov.au/Ministers/Gillard/Media/Releases/Pages/Article_080911_143951.aspx.

DEEWR. (March 2009). *Digital Education Revolution- Fact Sheet*. Canberra: Australian Government. Retrieved from www.deewr.gov.au/Schooling/DigitalEducationRevolution/Documents/Dig.Ed.Rev%2520A4%2520Fact%2520Sheet%2520(final).pdf.

Demircioglu, I. (2008). Learning How to Conduct Educational Research In Teacher Education: A Turkish Perspective. *Australian Journal of Teacher Education, 33*(1), 1-17.

DETE. (2001). *SACSA Framework: General Introduction* Adelaide: DETE Retrieved from http://sacsa.sa.edu/index_fsrc.asp?t=HOME.

Diamantopoulos, A. D., & Siguaw, J. A. (2000). *Introducing LISEREL: A guide for uninitiated*. London: Sage Publications.

Directory, A. S. (2011). The only guide to all Australian Primary and Secondary Schools. Retrieved March 10, 2011, from http://www.australianschoolsdirectory.com.au/

DiStefano, C., Zhu, M., & Mindrila, D. (2009). Understanding and Using Factors

Scores: Considerations for the Applied Researcher. *Practical Assessment, Research & Evaluation, 14*.

Dix, K. (2005). Are Learning Technologies making a Difference? A longitudinal Perspective of Attitudes [Electronic version]. *International Education Journal*, ERC2004 Special Issue, 5(5), 15-28. Retrieved Feb 4, 2010, from http://iej.cjb.net

Dix, K. (2007). DRIEF: A research paradigm for ICT adoption [Electronic version]. *International Education Journal*, 8(2), 113-124. Retrieved June 10, 2010, from http://iej.cjb.net/

Dix, K. L. (2001). Learning Technologies Project: 2000 Student Data (D. o. E. T. a. Employment, Trans.). Adelaide.

Dix, K. L. (2007). *A longitudinal study examining the impact of ICT adoption on students and teachers*. (Doctor of Philosophy), Flinders University of South Australia. Retrieved from http://www.flinders.edu.au/ehl/fms/education_files/staff/pdf/DixPhd.pdf

Dobbyn, A. (Producer). (2010, May 14, 2010). Why use an Interactive Whiteboard?. [PowerPoint Presentation] Retrieved from http:www.box.net/shared/mdqf6rxave

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education, 57*(2), 1469-1483. doi: 10.1016/j.compedu.2011.02.014

Education, S. o. (2008). *Academic Program Handbook*: The University of Adelaide.

Eiser, J. (1987). *The expression of attitude*. New York: Springer-Verlag.

Elliot, A. (2004). When the learners know more than the teachers. Retrieved from http://www.infoage.idg.com.au/index.php?id=667259628

Fall (Producer). (1997, April 6, 2010). Theoretical Framework Defined: Theoretical Framework or Logical Structure. [PowerPoint Presentation] Retrieved from http://www.education.astate.edu/cee/dcline/Slides/Theoretical_Framework.ppt

Finger, G., Baker, N., Nagel, D., & Rarere, K. (2002). Improving Students' ICT Use: The LDCT at Burleigh Heads State School. *Learning in Technology Education: Challenges for the 21st Century, 1*, 112-119.

Forgasz, H., & Kaur, B. (1997). The Role Of The Pilot Study In Mathematics Education Research. *The Mathematics Educator, 2*(2), 187-196.

Galanouli, D., & McNair, V. (2001). Students' perceptions of ICT-related support in teaching placements. *Journal of Computer Assisted Learning, 17*(4), 396-408.

Garbin, C. (n.d.). Introduction to Path Analysis. *Fundamentals of Research Design and Data Analysis 2*. Retrieved from http://psych.unl.edu/psycrs/942/q2/path.pdf

Gibson, W. (2006). Thematic analysis. Retrieved from http://www.ilit.org/air/files/thematic_analysis.doc

Glesne, C. (2006). *Becoming Qualitative Researchers: An Introduction* New Jersey: Pearson Education, Inc.

Glover, D., & Miller, D. (2003). Players in the Management of Change: introducing interactive whiteboards into schools. *Management in Education, 17*(1), 20-23.

Glover, D., & Miller, D. (n.d.). Missioners, Tentatives and Luddites: leadership challenges for school and classroom posed by the introduction of interactive whiteboards into schools in the United Kingdom. *New Technologies and Educational Leadership*. Retrieved April 13, 2010, from http://www.keele.ac.uk/education/research/interactivewhiteboard/

Glover, D., Miller, D., Averis, D., & Door, V. (2007). The evolution of an effective pedagogy for teachers using the interactive whiteboard in mathematics and modern languages: an empirical analysis from the secondary sector. *Learning, Media and Technology, 32*(1), 5-20.

Goodwin, K. (2008). The Impact of Interactive Multimedia on Kidergarten Students' Representations of Fractions. *Issues in Educational Research, 18*(2), 103-117.

Hair, J. F. J., Black, W. C., Babin, B. J., & Anderson, R. E. (2013). *Multivariate Data Analysis* (7 ed.). England: Pearson Education Limited.

Halawi, L., McCarthy, R., & Pires, S. (2009). An Evaluation of E-Learning on the Basis of Bloom;s Taxonomy: An Exploratory Study. *Journal of Education for Business, 84*(6), 374-380.

Haldane, M. (2007). Interactivity and the digital whiteboard: weaving the fabric of learning. *Learning, Media and Technology, 32*(3), 257-270.

Hall, I., & Higgins, S. (2005). Primary school students' perceptions of interactive whiteboards. *Journal of Computer Assisted Learning, 21*(2), 102-117. doi: 10.1111/j.1365-2729.2005.00118.x

Ham, V. (2010). Technology as Trojan horse: a 'generation' of information technology practice, policy and research in schools. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, Practice and Future Directions* (pp. 25-38). Oxon: Routledge.

Hansen, R. (Cartographer). (1995). Teacher Socialization in Technological Education. Retrieved from http://scholar.lib.vt.edu/ejournals/JTE/v6n2/rhansen.jte-v6n2.html

Hennessy, S., Deaney, R., Ruthven, K., & Winterbottom, M. (2007). Pedagogical strategies for using the interactive whiteboard to foster learner participation in school science *Learning, Media and Technology, 32*(3), 283-301.

Hennessy, S., & London, L. (2013). *Learning from International Experiences with Interactive Whiteboards: The Role of Professional Development in Integrating the Technology*. OECD Publishing. Retrieved from http://www.oecd-ilibrary.org/docserver/download/5k49chbsnmls.pdf?expires=1406261033&id=id&accname=guest&checksum=F31AFE39707A0396D03F21B2C39B880F.

Higgins, S., Beauchamp, G., & Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media and Technology, 32*(3), 213-225.

Higgins, S., & Moseley, D. (2001). Teachers' thinking about information and communications technology and learning: beliefs and outcomes. *An international journal of teachers' professional development, 5*(2), 191-210.

Hockly, N. (2013). Interactive Whiteboads. *ELT Journal: English Language Teachers Journal, 67*(3), 354-358. doi: 10.1093/elt/cct021

Hodge, S., & Anderson, B. (2007). Teaching and learning with an interactive whiteboard: a teacher's journey. *Learning, Media and Technology, 32*(3), 271-282.

Hoepfl, M. (2002). A Strategic Framework for Research in Technology Education. *International Conference on Technology Education Research Learning in technology education: challenges for the 21st Century, 1*, 191- 211.

Holmes, K. (2009). Planning to Teach with Digital Tools: Introducing the Interactive Whiteboard to Pre-Service Secondary Mathematics Teachers *Australasian Journal of Educational Technology, 25*(3), 351-365.

Holmes, K. (2009). Planning to teach with digital tools: Introducing the interactive whiteboards to pre-service secondary mathematics teachers. *Australasian Journal of Educational Technology, 25*(3), 351-365.

Honey, M., Culp, K. M., & Spielvogel, R. (2005). Critical Issue: Using Technology to Improve Student Achievement. Retrieved May 27, 2010, from http://www.ncrel.org/sdrs/areas/issues/methods/technlgy/te800.htm

Hopkins, W. (2000). Quantitative Research Design. *Perspectives/Research Resources, 4*(1). Retrieved from Sportscience website: http://www.sportsci.org/jour/0001/wghdesign.html

Hopson, M. H., Simms, R. L., & Knezek, G. A. (2001). Using a Technology-Enriched Environment to Improve Higher-Order Thinking Skills. *Journal of Research on Technology in Education, 34*(2). doi: 10.1080/15391523.2001.10782338

HREC. (2010). Research Ethics and Compliance Retrieved July 29, 2010, from http://www.adelaide.edu.au/research/ethics/human/guidelines/

Hu, L., & Bentler, P. M. (1999). Cutoff Criteria in Fit Indexes in Covariance Structural Analysis: Conventional Criteria Versus New Alternatives. *Structural Equation Modeling, 6*, 1-55.

Hunt, C. (2007). Psychology 5202: Attitudes and Social Behaviour. Retrieved June 25, 2010, from http://www.psych.umn.edu/courses/spring07/borgidae/psy5202/images/tripartitemodel.jpg

Hunter, J. (2006). The Ultimate Collaboration. *Teaching and Learning exchange*. Retrieved June 2, 2010, from http://www.tale.edu.au/tale/live/global/announcements/SBS_Issue10_Jun07.pdf

Jamieson-Proctor, R., Burnett, P., Finger, G., & Watson, G. (2006). ICTintegration and teachers' confidence in using ICT for teaching and learning in Queensland state schools. *Australasian Journal of Educational Technology, 22*(4), 511-530.

Jamieson-Proctor, R., & Finger, G. (2008). Measuring Student Use of ICT: A summary of findings of ICT use in Queensland catholic schools. Retrieved from http://www.eprints.usq.edu.au/3663/

Jamieson-Proctor, R., & Finger, G. (2009). Measuring and evaluating ICT use: developing an instrument for measuring student ICT use. In W. Hin, L. T. Wee & R. Subramaniam (Eds.), *Handbook of research on new media literacy at the K-12 level: issues and challenges* (Vol. 1, pp. 326-339). Hershey PA, USA: Information Science Reference (IGI Global).

Jenkins, J. (1999). *Teaching for Tomorrow: The changing role of teachers in the connected classroom*. Paper presented at the EDEN 1999 Open Classroom Conference, Balatonfured. http://www.eden-online.org/papers/jenkins.pdf

Jewitt, C., Moss, G., & Cardini, A. (2007). Pace, interactivity and multimodality in teachers' design of texts for interactive whiteboards in the secondary school classroom *Learning, Media and Technology, 32*(3), 303-317.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: a research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Johnston, H. (2002). Shaping Beliefs and Attitudes: A Handbook of Attitude Change Strategies. Retrieved from http://www.principalspartnership.com/AttitudeHandbookforUPWebs.htm

Jones, A. (2002). Integration of ICT in an Initial Teacher Training Course: Participants' Views. *Seventh World Conference on Computers in Education*, 26, from http://www.citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.19.6921

Jones, A., & Vincent, J. (2006). Introducing interactive whiteboards into school practice: one school's model of teachers mentoring colleagues. Retrieved from http://www.aare.edu.au/06pap/jon06333.pdf

Jones, T., & Clarke, V. (1994). A Computer Attitude Scale for Secondary Students. *Computers Educ., 22*(4), 315-318.

Kaplan, D. (2009). *Structural equation Modeling: Foundation and extensions* (2nd ed.). Los Angeles: Sage.

Kelley, P., Underwood, G., Potter, F., Hunter, J., & Beveridge, S. (2007). Viewpoints. *Learning, Media and Technology, 32*(3), 333-347.

Kennewell, S. (2003). *CRPIT '03 Proceedings of the 3.1 and 3.3 working groups conference on International federation for information processing: ICT and the teacher of the future*, Darlinghurst, Australia.

Kennewell, S. (2010). Analysing the impact of information technology on activity and learning. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, practice and future directions* (2nd ed., pp. 112-119). Oxon: Routledge.

Kennewell, S., & Beauchamp, G. (2007). The features of interactive whiteboards and their influence on learning. *Learning, Media and Technology, 32*(3), 227-241.

Kennewell, S., H.Tanner, S.Jones, & Beauchamp, G. (2007). Analysing the use of interactive technology to implement interactive teaching. *Journal of Computer Assisted Learning, 28*, 61-73.

Kennewell, S., & Higgins, S. (2007). Introduction. *Learning, Media and Technology, 32*(3), 207-212.

Kennewell, S., & Morgan, A. (2003). *Student teachers' experiences and attitudes towards using interactive whiteboards in the teaching and learning of young children*. Paper presented at the ACM International Conference. http://portal.acm.org/citation.cfm?id=1082070

Kenny, D. A. (2014). Measuring Model Fit. *SEM: Fit*. Retrieved from http://davidakenny.net/cm/fit.htm

Kent, N., & Facer, K. (2004). Different worlds? A comparison of young people's home and school ICT use. *Journal of Computer Assisted Learning, 20*(6), 440-455. doi: 10.1111/j.1365-2729.2004.00102.x

Kent, P. (2006). Using Interactive Whiteboards to enhance Mathematics Teaching. *Australian Primary Mathematics Classroom, 11*(2), 23-26.

Key, J. (1997). Qualitative Research *Research Design in Occupational Education*. Retrieved fromhttp://www.okstate.edu/ag/agedcm4h/academic/aged5980a/5980/newpage21.htm

Kitson, L., Fletcher, M., & Kearney, J. (2007). Continuity and change in literacy practices: a move toward multiliteracies. *Journal of Classroom Interaction, 41*(2), 29-41.

Kline, R. B. (1998). *Principles and Practice of Structural Equation Modeling*. New York: The Guilford Press.

Knezek, G., & Christensen, R. (1995). A Comparison of Two Computer Curricular Programs at a Texas Jr. High School Using the Computer Attitude Questionnaire (CAQ). Texas: Texas Center for Educational Technology.

Knezek, G., & Christensen, R. (2002). Impact of New Technologies on Teachers and Students. *Education and Information Technologies, 7*(4), 369-376.

Knight, P., Pennant, J., & Piggott, J. (2005). The power of the Interactive Whiteboard. *Micromath Summer, 21*(2), 11-15.

Krathwohl, D. (2002). A Revision of Bloom's Taxonomy: An Overview. *Theory into Practice, 41*(4), 212-218.

Kusano, K., Frederiksen, S., Jones, L., Kobayashi, M., Mukoyama, Y., Yamagishi, T., . . . Ishizuka, H. (2013). The Effects of ICT Environment on Teachers' Attitudes and Technology Integration in Japan and the U.S. *Journal of Information Technology Education: Innovations in Practice, 12*.

Labuschagne, A. (2003). Qualitative research - Airy fairy or fundamental?. *The Qualitative Report, 8*(1).

Lai, H.-J. (2010). Secondary school teachers' perceptions of interactive whiteboard training workshops: A case study from Taiwan. *Australasian Journal of Educational Technology, 26* (Special issue, 4), 511-522.

LaMarca, N. (2011). The Likert Scale: Advantages and Disadvantages. *Field Research in Organizational Psychology*. Retrieved from http://psyc450.wordpress.com/2011/12/05/the-likert-scale-advantages-and-disadvantages/

Lee, C., Teo, T., Chai, C., Choy, D., Tan, A., & Seah, J. (2007). Closing the gap: Pre-service teachers' perceptions of an ICT based, student centered learning curriculum. Retrieved from http://www.ascilite.org.au/conferences/singapore07/procs/lee-cb.pdf

Lee, M., & Boyle, M. (2003). The educational effects and implications of the interactive whiteboard strategy of Richardson Primary School-A Brief Review. Retrieved from http://web.archieve.org/web/20070829011419

Levine, T., & Donitsa-Schmidt, S. (1998). Computer Use, Confidence, Attitudes, and Knowledge: A Causal Analysis. *Computers in Human Behavior, 14*(1), 125-146.

Littleton, K. (2010). Research into teaching with whole-class interactive technologies: emergent themes. *Technology, Pedagogy and Education, 19*(2), 285-292. doi: 10.1080/1475939X.2010.491240

Liu, C., & Mathews, R. (2005). Vygotsky's philosophy: Constructivism and its criticisms examined. *International Education Journal, 6*(3), 386-399.

Lopez, O. S. (2010). The Digital Learning Classroom: Improving English Language Learners' academic success in mathematics and reading using interactive whiteboard technology. *Computers & Education, 54*(4), 901-915. doi: 10.1016/j.compedu.2009.09.019

Lu, C.-H. (2006). Assessing construct validity: The utility of factor analysis. *Journal of Educational Measurement and Statistics*, 79-94.

Mathews-Aydinli, J., & Elaziz, F. (2010). Turkish students' and teachers' attitudes toward the use of interactive whiteboards in EFL classrooms. *Computer Assisted Language Learning, 23*(3), 235-252.

McDougall, A., & Jones, A. (2010). Theory and history, questions and methodology: issues in research into information technology in education. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, practice and future directions* (pp. 1-7). Oxon: Routledge.

MCEETYA. (2000). Information and Communication Technology: Development of Key Performance Measures. *National Report on Schooling in Australia 2000*: Ministerial Council on Education, Employment, Training and Youth Affairs.

MCEETYA. (2008). *Melbourne Declaration for Educational Goals for Young Australians.* Ministerial Council on Education, Employment, Training and Youth Affairs. Retrieved from http://www.curriculum.edu.au/verve/_resources/National_Declaration_on_the_Educational_Goals_for_Young_Australians.pdf.

McFarlane, T., Hoffman, E., & Green, K. (1997). Teachers' Attitudes toward Technology: Psychometric Evaluation of the Technology Attitude Survey (Vol. 2010). Chicago: American Educational Research Association, Department of Education, Washigton, DC.

Mercer, N., Hennessy, S., & Warwick, P. (2010). Using interactive whiteboards to orchestrate classroom dialogue. *Technology, Pedagogy and Education, 19*(2), 195-209. doi: 10.1080/1475939X.2010.491230

Miles, M., & Huberman, A. (1994). *Qualitative Data Analysis* (2nd ed.). Thousand Oaks, California, USA: Sage Publications.

Miller, D., Averis, D., Door, V., & Glover, D. (2005). How can the use of an interactive whiteboard enhance the nature of teaching and learning in secondary mathematics and modern foreign languauges? *ICT Research Bursary 2003-04- Final Report.* United Kingdom: Becta.

Miller, D., & Glover, D. (2006). Developing the use of Interactive Whiteboards in Mathematics *Interactive Whiteboard evaluation for the Secondary National Strategy*. United Kingdom: Keele University.

Miller, D., & Glover, D. (2010). Presentation or mediation: is there a need for 'interactive whiteboard technology-proficient' teachers in secondary mathematics? *Technology, Pedagogy and Education, 19*(2), 253-259. doi: 10.1080/1475939X.2010.491236

Mohon, E. (2008). SMART moves? A case study of one teacher's pedagogical change through use of the interactive whiteboard. *Learning, Media and Technology, 33*(4), 301-312.

Mumtaz, S. (2000). Factors Affecting Teachers' Use of Information and Communications Technology: a review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319-342.

Munro, R. (2010). Setting a new course for research on information Technology in education. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education* (pp. 46-53). Oxon: Routledge.

Murcia, K. (2008). Teaching for scientific literacy with an interactive whiteboard. *Teaching Science: The journal of the Australian Science Teachers Association, 54*(4), 17-21.

Murcia, K. (2010). Multi-modal representations in primary science: What's offered by interactive whiteboard technology. *Teaching Science: The journal of the Australian Science Teachers Association, 56*(1), 23-29.

Murcia, K., & Sheffield, R. (2010). Talking about science in interactive whiteboard classrooms. *Australasian Journal of Educational Technology, 26*(4), 417-431.

Myers, D. (1993). *Social Psychology* (4th ed.). United States of America: McGraw-Hill.

Myers, M. (2000). Qualitative Research and the Generalizability Question: Standing Firm with Proteus. *The Qualitative Report [On-line serial], 4*(3/4). Retrieved from http://www.nova.edu/ssss/QR/QR4-1/myers.html

Neill, J. (2006). Analysis of Professional Literature Class 6: Quantitative Research 1. *Qualitative Research Methods.* Retrieved November 26, 2008, from http://wilderdom.com/OEcourses/PROFLIT/Class6Qualitative1.htm

Neuman, W. L. (2006). *Social research methods: Qualitative and quantitative approaches*. USA: Pearson Education, Inc.

Newhouse, P. (2002). *Literature Review: The IMPACT of ICT on LEARNING and TEACHING*. Perth: Specialist Educational Services.

Newson, J. (2005). Some Clarifications and Recommendations on Fit Indices. *USP 655 SEM*. Retrieved from www.upa.pdx.edu/IOA/newsom/semclass/ho_fit.doc

Newton, N. (2010). The use of semi-structured interviews. *Exploring Qualitative Methods*. Retrieved from http://www.academia.edu/1561689/The_use_of_semi-structured_interviews_in_qualitative_research_strengths_and_weaknesses

Noiwan, J., Piyawat, T., & Norcio, A. (2004). Computer Attitude and Computer Self-Efficacy: A Case Study of Thai Undergraduate Students. Retrieved from http://www.thaiscience.info/Article%20for%20ThaiScience/Article/6/Ts-6%20computer%20attitude%20&%20computer%20self-efficacy%20-%20a%20case%20study%20of%20thai%20undergraduate%20students.pdf

Odhabi, H. (2007). Investigating the impact of laptops on students' learning using Bloom's learning taxonomy *British Journal of Educational Technology, 38*(6), 1126-1131.

OECD. (2006). Are Students Ready for a Technology-Rich World? What PISA Studies Tell Us: Organisation for Economic Co-operation and Development.

Paas, L., & Creech, H. (2008). How Information and Communications Technologies Can Support Education for Sustainable Development: Current uses and trends. Retrieved from http://www.iisd.org/pdf/2008/ict_education_sd_trends.pdf

Parslow, G. (2008). Multimedia in Biochemistry and Molecular Biology Education: Commentary: Interactive Whiteboards. *Biochemistry & Molecular Biology Education, 36*(1), 76-76.

Patton, M. (2002). *Qualitative Research and Evaluation Methods* (3rd ed.). California: SAGE Publications.

Peters, M. (2004). Educational research: 'games of truth' and the ethics of subjectivity. *Journal of Educational Enquiry, 5*(2), 50-63.

Phan, H., & Deo, B. (2007). The revised learning process questionnaire: A validation of a western model of students' study approaches to the South Pacific context using confirmatory factor analysis. *British Journal of Educational Psychology, 77*, 719-739.

Popham, W. J., & Sirotnik, K. A. (1992). *Understanding Statistics in Education*. USA: F. E. Peacock Publishers, Inc.

Rao, Z., Gu, P., Zhang, L., & Hu, G. (2007). Reading Strategies and Approaches to Learning of Bilingual Primary School Pupils. *Languauge Awareness, 16*(4), 243-262.

Raudenbush, S., Bryk, A., & Congdon, R. (2009). HLM 6: Hierarchical Linear and Nonlinear Modelling (Version 6.08). Skokie, IL: Scientific Software International.

Raudenbush, S., & Bryk, A. S. (1986). A hierarchical model for studying school effects. *Sociology of Education, 59*, 1-17.

Reading, C. (2006). Focusing on ICT in Rural and Regional Education in Australia. *ACEC, Australian Educational Computing, 21*(2).

Reynolds, D., Treharne, D., & Tripp, H. (2003). ICT-the hopes and the reality. *British Journal of Educational Technology, 34*(2), 151-167.

Richardson, S. A., Dohrenwend, B. S., & Klein, D. (1965). *Interviewing*. New York: Basic Books.

Romeo, G., & Russell, G. (2010). Why 'what works' is not enough for information technology in education research. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education* (pp. 54-61). Oxon: Routledge.

Santos, J. R. A. (1999). Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. *The Journal of Extension, 37*(2).

Schmid, E. C. (2010). Developing competencies for using the interactive whiteboard to implement communicative language teaching in the English as a Foreign Language classroom. *Technology, Pedagogy and Education, 19*(2), 159-172. doi: 10.1080/1475939X.2010.491218

Schrum, L., & Hong, S. (2002). From the field: characteristics of successful tertiary online students and strategies of experienced online educators. *Education and Information, 7*(1), 5-16.

Schuck, S., & Kearney, M. (2007). Exploring Pedagogy with Interactive Whiteboards. Retrieved from http://www.ed-dev.uts.edu.au/teachered/research/iwbproject/home.html

Scrimshaw, P. (2004). Enabling Teachers to make successful use of ICT. Retrieved from http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/enablers.pdf

Sekaran, U. (1992). *Research Methods for Business: A Skill-Building Approach* (2nd ed.). New York: John Wiley and Sons, Inc.

Selwyn, N. (1997). Students' Attitudes toward Computers: Validation of a Computer Attitude Scale for 16-19 Education. *Computers Educ., 28*(1), 35-41.

Sendecka, L. (2006). *Adoption of mobile services: Moderating effects of service's information intensity.* (Master of Science in Economics and Business Administration), Norges Handelshoyskole, Bergen.

Serife, A. (2008). A Conceptual Analysis on the Approaches to Learning. *Educational Sciences: Theory & Practice, 8*(3), 707-720.

Shi, Y., Yang, Z., Yang, H. H., & Liu, S. (2012). *The impact of interactive whiteboards on education.* Paper presented at the International Conference on Internet Multimedia Computing and Service, New York, USA. http://dl.acm.org.proxy.library.adelaide.edu.au/citation.cfm?id=2382397

Sime, D., & Priestley, M. (2005). Student teachers' first reflections on information and communications technology and classroom learning: implications for initial teacher education. *Journal of Computer Assisted learning, 21*, 130-142.

Skrodal, S. (2010). *Virtual Classroom Simulation: Design and Trial in a Preservice Teacher Education Program.* (Doctor of Philosophy), The University of Adelaide, Adelaide.

Slay, H., Sieborger, I., & Hodgkinson-Williams, C. (2008). Interactive whiteboards: Real beauty or just "lipstick"? *Computers & Education, 51*(3), 1321-1341.

Slay, H., Siebörger, I., & Hodgkinson-Williams, C. (2008). Interactive whiteboards: Real beauty or just "lipstick"? *Computers & Education, 51*(3), 1321-1341. doi: 10.1016/j.compedu.2007.12.006

SMART. (2006). Interactive Whiteboards and Learning: Improving student learning outcomes and streamlining lesson planning [White Paper]: SMART Technologies.

Smith, H., Higgins, S., Wale, K., & Miller, J. (2005). Interactive whiteboards: boon or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning, 21*(2), 91-101.

Smith, H. W. (1975). *Strategies of Social Research: methodological imagination*. London: Prentice Hall International.

Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT International Handbook of Information Technology in Primary and Secondary Education (Vol. 20, pp. 449-460). Retrieved from http://www.springerlink.com/content/n418n07r47835860/

Somekh, B. (2010). The practical power of theoretically informed research into innovation. In A. McDougall, J. Murnane, A. Jones & N. Reynolds (Eds.), *Researching IT in Education: Theory, Practice and Future Directions* (pp. 129-141). Oxon: Routledge.

Somyürek, S., Atasoy, B., & Özdemir, S. (2009). Board's IQ: What makes a board smart? *Computers & Education, 53*(2), 368-374.

Steketee, C. (2005). Integrating ICT as an integral teaching and learning tool into pre-service teacher training courses [Online]. *Issues in Educational Research (IIER), 15*, 101-113.

Sun, C.-S., Chao, Y.-H., & Shih, R.-C. (2005). An analysis of senior high school students' perceptions of computers, and their attitudes and behavioural intentions towards computer use. *World Transactions on Engineering and Technology Education, 4*(2), 277-280.

Swan, K., Schenker, J., & Kratcoski, A. (2008). *The Effects of the Use of Interactive*

Whiteboards on Student Achievement. Paper presented at the World Conference on Educational Multimedia, Hypermedia and Telecommunications, Vienna, Austria.

Sweeney, T. (2010). Transforming pedagogy through interactive whiteboards: Using activity theory to understand tensions in practice. *Australian Educational Computing, 24*(3), 28-34.

Tarlinton, D. (2003). Bloom's Revised Taxonomy. Retrieved from www.kurwongbss.eq.edu.au/thinking/Bloom/bloomspres.ppt

Taylor, L. (2004). How student teachers develop their understanding of teaching using ICT. *Journal of Education for Teaching, 30*(1), 43-56.

Teijlingen, E., & Hundley, V. (2001). The importance of Pilot Studies. *Social Research Update*. Retrieved from http://sru.soc.surrey.ac.uk/SRU35.html

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education, 52*, 302-312.

Tere, R. (2006). Qualitative Data Analysis. Retrieved from http://e-articles.info/e/a/title/QUALITATIVE-DATA-ANALYSIS/

Thurmond, V. A. (2001). The point of triangulation. *Journal of nursing Scholarship, 33*(3), 253-258.

Tinio, L. (2003). *ICT in Education.* New York: Retrieved from http://www.apdip.net/publications/iespprimers/eprimer-edu.pdf.

Trigwell, K., & Prosser, M. (2004). Development and Use of the Approaches to Teaching Inventory. *Educational Psychology Review, 16*(4), 409-424.

Trochim, W. (2006). Nonprobability Sampling. *Research Methods Knowledge Base*. Retrieved from http://www.socialresearchmethods.net/kb/sampnon.php

Trucano, M. (2005). Knowledge Maps. *ICTs in Education*. Retrieved from http://www.infodev.org/en/Publication.157.html

Tuijnman, A. C., & Keeves, J. P. (1994). Path Analysis and Linear Structural Relationship Analysis. *International Encyclopedia of Education* (pp. 4339-4352).

New York: Pergamon.

Twiner, A., Coffin, C., Littleton, K., & Whitelock, D. (2010). Multimodality, orchestration and participation in the context of classroom use of the interactive whiteboard: a discussion. *Technology, Pedagogy and Education, 19*(2), 211-223. doi: 10.1080/1475939X.2010.491232

UNESCO. (1994). UNESCO/IFIP Curriculum- Information and Communication Technology in Secondary Education. *International Federation for Information Processing.* Retrieved May 24, 2010, from http://wwwedu.ge.ch/cptic/prospective/projets/unesco/en/teacher.html

UNESCO. (2009). Guide to measuring Information and Communication Technologies (ICT) in Education. Retrieved June 21, 2010, from http://www.unescobkk.org/fileadmin/user_upload/aims/...ICT_Guide_EN.pdf

Vallis, K., & Williamson, P. (2009). Build Your Own Board: Brightboards Offer a Cost-Effective Alternative to Interactive Whiteboards. *Learning & Leading with Technology, 37*(1), 18-20.

Vincent, J. (2007). The Interactive Whiteboard in an Early Years Classroom: A Case study in the Impact of a New technology on Pedagogy. *Australian Educational Computing, 22*(1), 20-25.

Vita, M. D., Verschaffel, L., & Elen, J. (2014). Interactive Whiteboards in Mathematics Teachings: A Literature Review. [Review Article]. *Education Research International, 2014*.

Voogt, J. (2010). Teacher factors associated with innovative curriculum goals and pedagogical practices: differences between extensive and non-extensive ICT-using science teachers. *Journal of Computer Assisted Learning, 26*(6), 453-464. doi: 10.1111/j.1365-2729.2010.00373.x

Wall, K., Higgins, S., & Smith, H. (2005). 'The visual helps me understand the complicated things': pupil views of teaching and learning with interactive whiteboards. *British Journal of Educational Technology, 36*(5), 851-867.

Webb, I., & Downes, T. (2003). *Raising the standards: ICT and the teacher of the future* ACT, Australia: Retrieved from http://delivery.acm.org.proxy.library.adelaide.edu.au/10.1145/860000/857137/p131-webb.pdf?key1=857137&key2=4613762221&coll=GUIDE&dl=GUIDE&CFID=68593816&CFTOKEN=70034406

White, Barnes, D. A., & Lawson, E. P. M. (2012). *Student Views on the Value and Use of Interactive Whiteboards in a Secondary School.* Paper presented at the ACEC2012: ITs Time Conference October, Perth, Australia. http://acec2012.acce.edu.au/sites/acec2012.acce.edu.au/files/proposal/254/ACEC2012-IWB%20paper%20edited%20final.pdf

White, K. (2007). Interactive Whiteboard Trial, South Western Sydney Region: A report (N. S. W. D. o. E. a. Training, Trans.): Centre for Learning Innovation.

Williamson, J., & Gardner, C. (2007). The use of Information Communication Technology to strengthen practicum experiences. In V. G. J. Sigafoos (Ed.), *Technology and Teaching* (pp. 75-88). Australia: Nova Science Publishers, Inc.

Xu, H. L., & Moloney, R. (2011). Perceptions of interactive whiteboard pedagogy in the teaching of Chinese language. *Australasian Journal of Educational Technology, 27*(2), 307-325.

Yanez, L., & Coyle, Y. (2011). Children's perceptions of learning with an interactive whiteboard. *ELT Journal: English Language Teachers Journal, 65*(4), 446-457.

Yushau, B. (2006). Computer attitude, use, experience, software familiarity and perceived pedagogical usefulness: the case of mathematics professors. *Eurasia Journal of Mathematics, Science and Technology Education, 2*(3), 1-17.

Zikmund, W. G. (1997). *Business Research Methods* (5th ed.). Florida: Dryden Press.

Zimitat, C. (2004). Changing student use and perceptions of learning technologies, 2002-2004. *Beyond the Comfort Zone: 21st ASCILITE Conference, 2010*(Feb 9), 984-993. Retrieved from http://www.ascilite.org.au/conferences/perth04/procs/zimitat.html