Classroom Practices in Mathematics: Effects on Elementary and Secondary School Students' Achievement in Mathematics in Region XII, Philippines

Michelle Rivera-Lacia

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

in the

School of Education

Faculty of the Arts

The University of Adelaide

September 2019

[PAGE INTENTIONALLY LEFT BLANK]

Table of Contents

Table of Contents .... **i**

List of Tables .... **v**

List of Figures .... **viii**

Abstract .... **x**

Declaration .... **xii**

Acknowledgments .... **xiii**

Chapter 1 Introduction **1**

1.1 Introduction 1

1.2 Aims/Objectives of the study 11

1.3 Research Questions 12

1.4 Context of the Study 13

1.5 Significance and Contribution to the discipline – Mathematics Teacher Education 18

1.6 Summary 20

Chapter 2 Literature Review **22**

2.1 Introduction 22

2.2 The Mathematics Classroom 22

2.3 Teacher - related Factors and Students Achievement 39

2.4 School-related Factors 49

2.5 Student-related factors 59

Chapter 3 Conceptualisation and Operationalisation **71**

3.1 Introduction 71

3.2 Theoretical Framework 71

3.3 Operationalisation and Instrumentation 77

3.4 Summary 99

Chapter 4 Methods of Research **101**

4.1 Introduction 101

4.2 Research Design 101

4.3 Ethics Approval 102

4.4 Methods 103

4.5 The pilot study 109

4.6 Analysis of Data ... 110
4.7 Delimitation of the study ... 124
4.8 Summary ... 125
Chapter 5 Validation of the Scales of Teacher- School- and Student-level Factors: Confirmatory Factor Analysis ... 127
5.1 Introduction ... 127
5.2 Validity ... 129
5.3 Validation of the Measures of Teacher-level Factors ... 131
5.4 Validation of the Measures of School-level factors ... 146
5.5 Validation of the Measures of the Student-level factors ... 156
5.6 Summary ... 166
Chapter 6 Validation of the Measures of Teacher-, School- and Student-level factors: Rasch Model analysis ... 168
6.1 Introduction ... 168
6.2 Case Fit ... 171
6.3 Rasch Analysis of Teacher-level factors ... 173
6.4 Rasch Analysis of School-level factors ... 186
6.5 Rasch Analysis of Student-level factors ... 192
6.6 Reliability Indices ... 197
6.7 Summary ... 200
Chapter 7 Examining the sample's demographic and general characteristics: Descriptive Statistics ... 202
7.1 Introduction ... 202
7.2 Teacher Level ... 202
7.3 School Level ... 209
7.4 Student Level ... 212
7.5 Summary ... 217
Chapter 8 Impact of Teacher factors on Classroom Practices: Teacher-level SEM Analysis ... 218
8.1 Introduction ... 218
8.2 Variables employed in Teacher-level Structural ... 220
8.3 Assumptions ... 221
8.4 The Hypothesised Model ... 224
8.5 Results of Teacher-level Path Analysis ... 226

8.6 Summary 242

Chapter 9 School-level factors SEM Analysis 245

9.1 Introduction 245

9.2 Variables employed in the School-level Structural 246

9.3 Test for Multicollinearity of Independent Variables 247

9.4 The Hypothesised Model..248

9.5 Results of School-level SEM Analysis 249

9.6 Summary 257

Chapter 10 Factors affecting Mathematics Achievement: Student-level SEM Analysis…… 259

10.1 Introduction 259

10.2 Variables employed in the Teacher-level Structural 259

10.3 Test for multicollinearity of Independent Variables 261

10.4 The Hypothesised Model..262

10.5 Results of Student-level Path Analysis 264

10.6 Summary 274

Chapter 11 Influence of Teacher-, School- and Student-factors on Students' achievement: Hierarchical Linear Modelling..276

11.1 Introduction 276

11.2 Examining Assumptions..277

11.3 Variables Used 278

11.4 Three-Level Model of Mathematics Achievement for students...............280

11.5 Summary 294

Chapter 12 Discussion..296

12.1 Introduction 296

12.2 Teacher-level factors 297

12.3 School-level factors..303

12.4 Student-level factors..307

12.5 Three-level hierarchical linear model..315

12.6 Summary 320

Chapter 13 Conclusion, Implications and Recommendations for Further Research…………………………………………………………………..322

13.1 Introduction 322

13.2 The design of the study 323

13.3 Summary of Findings ... 324
13.4 Implications of the study ... 334
13.5 Limitations ... 338
13.6 Recommendations for Future Research ... 340
13.7 Contribution / Unique aspect of the study ... 342
13.8 Conclusion ... 343
References ... 346
Appendices ... 384
Appendix A. Teacher Questionnaire ... 384
Appendix B. Principal Questionnaire ... 394
Appendix C. Student Questionnaire ... 406
Appendix D. Ethics Approval ... 412
Appendix E. Approval Region XII ... 414
Appendix F. SDS Kidapawan City ... 415
Appendix G. SDS Koronadal City ... 418
Appendix H. SDS South Cotabato ... 421
Appendix I. SDS Sultan Kudarat ... 423
Appendix J. Request Letter - NETRC ... 425

List of Tables

Table 3.3.1 Teaching Practices Scale..81
Table 3.3.2 Classroom Assessment Process Scale...82
Table 3.3.3 Preferred Classroom Assessment Practice..85
Table 3.3.4 Teachers Attitudes towards Mathematics and Mathematics Teaching..86
Table 3.3.5 Mathematics Teaching Efficacy Beliefs 87
Table 3.3.6 Instructional Leadership Style 90
Table 3.3.7 Administrative Leadership Style...91
Table 3.3.8 Teacher Appraisal Criteria 92
Table 3.3.9 School Climate for Learning..93
Table 3.3.10 Beliefs about the Nature of Teaching and Learning 93
Table 3.3.11 Confidence in Learning Mathematics..96
Table 3.3.12 Perception of Teachers Attitude...97
Table 3.3.13 Usefulness of Mathematics 97
Table 3.3.14 Mathematics Anxiety Scale 98
Table 3.3.15 Beliefs about Mathematics..99
Table 5.2.1 Fit indices used in the validation of the scales....................................131
Table 5.3.1 Comparison of the Confirmatory Factor Analysis (CFA) model-data fit for all Teacher-level factors/scales..133
Table 5.4.1 Comparison of model-data fit for all School-level factors/scales........147
Table 5.5.1 Comparison of model-data fit for all Student-level factors/scales.......158
Table 6.2.1 Number of Underfitting Cases temporarily deleted from each Scale ..172
Table 6.3.1 Estimates and Mean Square Fit of the items of TPS...........................176
Table 6.3.2 Estimates and Mean Square Fit of PCAP 177
Table 6.3.3 Estimates and Mean Square Fit of CAPS 180
Table 6.3.4 Estimates and Mean Square Fit of TATMT..182
Table 6.3.5 Estimates and Mean Square Fit of MTEBS 184
Table 6.3.6 Estimates and Mean Square Fit of PDP..186
Table 6.4.1 Estimates and Mean Square Fit of MLSI..187
Table 6.4.2 Estimates and Mean Square Fit of MLSA 188
Table 6.4.3 Estimates and Mean Square Fit of SCFL..189
Table 6.4.4 Estimates and Mean Square Fit of BANTL 190

Table 6.4.5 Estimates and Mean Square Fit of TACrit..191
Table 6.5.1 Estimates and Mean Square Fit of CLM 193
Table 6.5.2 Estimates and Mean Square Fit of PTA..194
Table 6.5.3 Estimates and Mean Square Fit of UOM..195
Table 6.5.4 Estimates and Mean Square Fit of MAS 196
Table 6.5.5 Estimates and Mean Square Fit of BAM..197
Table 6.6.1 Item and Person Reliability Indices of Teacher-level Factors............198
Table 6.6.2 Item and Person Reliability Indices of School-level Factors..............199
Table 6.6.3 Item and Person Reliability Indices of Student-level Factors.............200
Table 7.2.1 Distribution of teacher-respondents according to School level, School type and Gender 203
Table 7.2.2 Distribution of teacher-respondents according to Level of education and Frequency of attendance to PD sessions..205
Table 7.2.3 Mean and standard deviation of teachers' age and years of teaching experience 207
Table 7.2.4 Means, standard deviation, skewness and kurtosis of teacher-level factors..208
Table 7.3.1 Demographic Profile of the School Principal 210
Table 7.3.2 Means, standard deviation, skewness and kurtosis of school Principals' age, years as teacher and as principal 210
Table 7.3.3 Means, standard deviations, skewness and kurtosis of school Principal-level factors..211
Table 7.4.1 Demographic Profile of the students 213
Table 7.4.2 Mean and standard deviation of students' age, years as teacher and as principal 216
Table 7.4.3 Means, standard deviations, skewness and kurtosis of school Student-level factors..216
Table 8.2.1 Variables used in the Teacher-level path Analysis..220
Table 8.3.1 Collinearity Statistics of the Teacher-level Variables 223
Table 8.5.1 Summary of direct, indirect and total effects for structural models (N = 326) 229
Table 9.2.1 Variables used in the School-level Structural Equation Modelling.....246
Table 9.3.1 Collinearity Statistics of the School-level Variables 247
Table 9.5.1 Summary of direct, indirect and total effects for structural models 252

Table 10.2.1 Variables used in the Student-level path Analysis....260
Table 10.3.1 Collinearity Statistics of the Teacher-level Variables....261
Table 10.5.1 Summary of direct, indirect and total effects for inner models 267
Table 11.3.1 List of variables used in the Three-level HLM Models....279
Table 11.4.1 Null Model Results: Three-level Model of Students' mathematics achievement....285
Table 11.4.2 Final Model Results: Three-level Model of Students' mathematics achievement....289
Table 11.4.4 Estimation of Variance Components 294

List of Figures

Figure 1.4.1 Map of Region XII (Source: DepEd Region XII). 14
Figure 1.4.2 Comparison of the BEC 2002 and K-12 Curriculum. 16
Figure 3.2.1 Theoretical Framework. 74
Figure 3.3.1 Conceptual Framework and Instrumentation. 78
Figure 5.3.1 One-factor Model 132
Figure 5.3.2 Two-factor Orthogonal Model 132
Figure 5.3.3 Two-factor Correlated Model. 132
Figure 5.3.4 Hierarchical Model. 133
Figure 5.3.5 Hierarchical model of the Teaching Practices Scale. 135
Figure 5.3.6 Hierarchical Model for Preferred Classroom Assessment Practice. ... 137
Figure 5.3.7 Hierarchical Model for Classroom Assessment Process Scale. 139
Figure 5.3.8 Two-factor orthogonal model of Teachers' Attitudes towards Mathematics. 141
Figure 5.3.9 Hierarchical model of PMTE. 143
Figure 5.3.10 Hierarchical model of MTOE. 144
Figure 5.3.11 Hierarchical model of Professional Development Programs. 145
Figure 5.4.1 Hierarchical model of MLSI. 149
Figure 5.4.2 Hierarchical model of MLSA. 150
Figure 5.4.3 Hierarchical model of SCFL. 152
Figure 5.4.4 Hierarchical model of School Principal's BANTL. 154
Figure 5.4.5 Hierarchical model of TAC. 156
Figure 5.5.1 Hierarchical model of Students' Confidence in Learning Mathematics. 159
Figure 5.5.2 Hierarchical model of Students' Perception of Teacher's Attitudes. ... 160
Figure 5.5.3 Hierarchical model of UOM. 161
Figure 5.5.4 Hierarchical model of Mathematics Anxiety Scale (MAS). 163
Figure 5.5.5 Hierarchical model of BAM. 165
Figure 7.2.1 Mathematics teacher School level. 203
Figure 7.2.2 Mathematics teachers School type. 203
Figure 7.2.3 Gender of Mathematics teachers. 204
Figure 7.2.4 Mathematics teachers' level of education. 205

Figure 7.2.5 Distribution of teachers according to frequency of PD sessions. 206
Figure 7.2.6 Error bars of Teacher-level factors. 209
Figure 7.3.1 Error bars of school Principal-level factors 212
Figure 7.4.1 Error bars of Student-level factors. 217
Figure 8.4.1 Hypothesised Teacher-Level Path Model. 225
Figure 8.5.1 Final Structural equation Model: Teacher Single-level Model. 228
Figure 9.4.1 Hypothesised Principal Single-level Structural Equation Model. 248
Figure 9.5.1 Final Model of School Single-Level Path. 251
Figure 10.4.1 Hypothesised Student-Level Path Model. 263
Figure 10.5.1 Final Structural equation Model: Student Single-level Model. 266
Figure 11.4.1 Three-Level Model of Students' Mathematics Achievement. 281
Figure 11.4.2 Three-level Model of students' mathematics Achievement. 291

Abstract

Students from all levels (elementary to tertiary levels) regard mathematics as a difficult subject. This has been evident in their performances not only in the classroom but also in the local, national and international achievement tests. Students' difficulty in mathematics can be attributed to several factors, one of which is the teacher. The teacher has direct contact with students on a daily basis and therefore been considered to have a direct impact on students' achievement. Studies, such as that of Brophy and Good (1986), Hiebert (1999) and the National Research Council (1999) have found that teacher-level factors are the main contributing factors that influence students' performance. Hence, this study investigated whether teaching and assessment practices (collectively called classroom practices) have influenced students' achievement. Other teacher-level factors, such as teachers' attitudes towards teaching mathematics and efficacy beliefs in mathematics were also examined. School-level and student-level factors were also deemed to have a direct or indirect effect on teachers' classroom practices and students' achievement.

This study employed a cross-sectional design. Since this study basically identified and investigated the factors that influence outcomes (e.g. students’ achievement), a quantitative research approach was therefore employed. Survey questionnaires used were first validated. Confirmatory Factor Analysis (CFA) was used in examining the scale structures, while item response theory (IRT) using Rasch model analysis was utilised to examine the scales at the item level. Structural equation modelling (SEM) was employed to ascertain the causal relationship between the variables in each level. Since this study involves three levels of data, school-, teacher- and student-level, a multi-level analysis, particularly, Hierarchical Linear Modeling (HLM) was employed.

Findings show that only teachers’ level of education and participation in professional development activities have significant effects on students’ achievement in mathematics. Surprisingly, both teachers' teaching practices and assessment practices did not appear to be significant predictors of students’ achievement. Results at the school-level show that school principals' management or leadership style has a direct positive influence on school climate for learning. School climate, in turn, provides a learning environment that enhances students learning, thus, increasing their performance. Moreover, students’ achievement in mathematics could also be affected by their attitudes towards mathematics, which are measured in this study in terms of their confidence in learning mathematics and usefulness of mathematics. Likewise, students’ beliefs about mathematics appeared to have a positive effect on mathematics achievement. It is interesting to note that students’ mathematics anxiety has no significant effect on their achievement.

The findings of the study suggest that students' achievement in mathematics are significantly influenced by multi-level factors, either directly or indirectly. This likewise indicates that school principals, teachers, and students must all be engaged in maintaining a healthy learning environment. It would be beneficial for future research to investigate more deeply on the specific measures of teaching and assessment practices. Implications for educational policies, practice, theory and research are discussed.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, 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 in my name, 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 permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

Signed

Date 12 Dec. 2018

Acknowledgments

This journey has never been easy but, it is all worth it. The completion of this study could not have been possible without the direct or indirect support, encouragement, and guidance of the many people around me. And I would like to express my sincere appreciation and gratitude to the following:

Special appreciation is due to my principal supervisor, Dr. I Gusti Ngurah Darmawan, for his untiring support and guidance and for the knowledge shared. I am also deeply thankful to him for constantly reminding me not to give up when everything else seemed to fall out of place. Special gratitude is likewise given to my external supervisor, Dr. Francis Ben, for his invaluable time and patience in providing me with substantial feedbacks. It was an honour for me to be your supervisee.

I am also grateful to all my friends and colleagues at the School of Education, especially to Dr. Fizza Sabir, Dr. Che Yee Lye and Dr. Elizar for their constant support, encouragements, and for the great and happy memories. Likewise, big thanks to my Filipino friends in the university, Ate Rosalina, for the inspiration; Dr. Rio Maligalig and Dr. Christian Genova for the motivation and great support (moral and logistics).

I also would like to acknowledge the support afforded me by the Department of Education, national office administrators and personnel for the timely release of the documents requested. The same appreciation is extended to the Director of the

Department of Education, Region XII for the approval of the conduct of my study in the different schools division. Special thanks are likewise given to the Schools Division Superintendents of the seven schools division for allowing me to carry out my study and to the school principals for giving me the time to distribute my survey questionnaires to the mathematics teachers and students. I also am very thankful to all the teachers who unselfishly offered their time in participating in the study and in assisting the students in answering the survey questionnaire. And to the thousands of students for willingly participating in my study.

Words are not enough to express how grateful I am to the Australia Awards for the generous support through their scholarship program. It would not have been possible for me to reach my dream if not for this scholarship grant.

My deepest gratitude goes to my family, as well. To my mother who has given me moral and emotional support and for taking good care of my children while I was away. If not for her, this endeavour would not have been possible. To my children Dave, Kevin, Paulo, Keith and Angel for serving as my inspiration and my strength. To Tony, for the love, encouragement, and appreciation.

Above all, my greatest gratitude is offered to the Almighty God for making everything to happen. I am forever grateful for your goodness.

Chapter 1
Introduction

1.1 Introduction

Standards in teaching and assessment practices in the classroom are established so as to have objective measures for students' progress and achievement. This is particularly vital in key subjects such as Mathematics. Aside from being one of the key areas where achievement is gauged, students generally classify Mathematics as an arduous and challenging subject in school. It is one, if not the most, feared subject areas by most students from basic education up to the tertiary level. This has been a long-standing observation from numerous research studies around the world (e.g.Wenglinsky, 2002; Bietenbeck, 2011; Freeman, O'Malley & Eveleigh, 2014; Chen, 2013, 2014; TIMSS 2003, 2007).

Accordingly, the Mathematics subject is often seen as very taxing due to the perceived level of difficulty especially at the secondary and tertiary levels. This raised a concern among educators because the widespread belief about mathematics can lead to students' abhorrence of the subject and increased anxiety levels (Baykul, 1990) which may impede learning and deter students' progress. If left unaddressed, learning mathematics becomes even more difficult, whereby positive attitude toward the subject is unlikely to develop, achievement as well is hampered.

Consequentially, educators around the world are aware of this concern, leading into thinking that a number of factors, or combinations of factors, must have caused perplexity among students during classroom instruction. It is along this interest that this study is conducted, to investigate the effects of teachers' teaching and assessment practices on students' classroom achievement in Mathematics.

Schools in most countries adopt a mathematics curriculum that is outcome-based where achievement is assessed following certain guidelines and standards set by the education sector. In effect, students' learning, teacher effectiveness and quality of education are mirrored through the average grade or score students obtain in the subject. The Trends in Mathematics and Science Study (TIMSS) is a typical example. TIMSS is a global project that evaluates the achievement in Mathematics of fourth and eighth grade students in Mathematics and Science. The Philippines participated in TIMSS from 1995 to 2003. A probable violation in the guidelines on sample participation caused Philippine's exclusion in the final analysis. The 1999 results for mathematics showed that Grade 8 students in Singapore, Korea and China outperformed others including the United States and Australia. Meanwhile, Philippines ranked third from the bottom (36^{th}), outperforming only Morocco and South Africa. In 2003, Singapore again surpassed all participating countries in both 4^{th} and 8^{th} grades, while Philippines ranked 4^{th} from the bottom in the 8^{th} grade level.

TIMSS examined several factors associated with students' achievement in mathematics. Student-to-teacher ratio and instructional materials were considered a major factor in 1997; while in 1999, the study highlighted the teacher factor, particularly teachers' familiarity with the policy and their classroom practices. In 2007, however, TIMSS classified categories of factors: (a) student-level such as home resources, self-concept and attitudes towards mathematics; (b) teacher-level such as preparation and experience in teaching mathematics, and; (c) school-level or the emphasis on mathematics curriculum and availability of instructional materials for mathematics.

Other countries have likewise used the results of TIMSS to investigate other factors that influence students' achievement that are specific to their context. For instance, Ker (2013) compared students' achievement in mathematics overtime among Chinese Taipei, Singapore and USA. In addition, Isac and her colleagues (2015) used 2011 TIMSS data to examine teaching practices in primary schools in Europe and explored the relationship between teaching practices and students' achievement. The foregoing studies show that standardised tests, such as that of TIMSS, do not merely imply difficulty in learning the subject. The test results could also implicate curriculum evaluation and development, as well as the quality of teachers and educational services rendered.

In the Philippines, schools use large scale assessments as benchmark measures for students' achievement in mathematics. In 1992, the education department instituted a national standard examination which is known today as the National Achievement Test (NAT). It started in 1992 as a national examination for public (government) elementary schools only. In 1993, the National Elementary Achievement Test (NEAT) was administered to all sixth graders both in public and private elementary schools. The intention was to improve the quality of elementary education in the country (DECS Order no. 30, 1993). In 2003, NEAT was changed to the National Achievement Test (NAT), and was administered to public school students in third and fourth grade levels (elementary) and first year high school level. In 2010 however, the NAT is administered to third graders in public elementary schools; and to sixth graders and second year high school students in both public and private schools. Later, NAT included the fourth year high school students in both public and private schools.

The National Education Testing and Research Center of the Department of Education (DepEd-NETRC) is tasked with implementing the NAT. Its multi-grade level administration serves different purposes. In particular, NAT for the sixth grade and fourth year high school level serves as an exit assessment. As such, it measures students' readiness for secondary and tertiary education. It covers five subject areas namely English, Mathematics, Science, Filipino and Araling Panlipunan/Makabayan (secondary level) or HeKaSi (Heograpiya, Kasaysayan at Sibika) in the elementary level.

The main objectives of the NAT are to determine what students know, understand and can do in the subject areas covered, and to monitor the performance of schools over time (DepEd-NETRC, 2010). NAT uses the Mean Percentage Scores (MPS) which indicates not the students' grades but the percentage of correctly answered items in the test. For instance, a 50 MPS is interpreted as a general average correct answer of 20 out of a 40-item subject area test. In a way, NAT results do not pertain to the achievement of a specific pupil or student. Instead, it reflects the performance of the school with respect to their instruction in the covered subject areas, as reflected in the number of correctly answered items in the test.

NETRC used seven Learning Competencies set for each subject area. The national target has been set at 75 percent which is at the median of the range (66 - 85) interpreted as “Moving Towards Mastery” level. Unfortunately, the national target remains generally elusive particularly in Mathematics. For instance, in school year 2005-2006, Mathematics generated the second lowest score of 53.66 MPS for the elementary level. While, more than half (59.09%) of the fourth year high school students obtained Low Mastery (15-34% MPS) in all subject areas. In 2012, high school students obtained an MPS of 46.37 in mathematics, which was lower than in 2006 (47.82%) and in 2005 (50.70%). Also, during this period, Region XII’s (a region in the southern Philippines) performance in all subject areas was poor placing it second from the bottom position.

Meanwhile, private schools in the southern part of the Philippines, particularly in the SOCCSKSARGEN (South Cotabato, Cotabato, Sultan Kudarat, Sarangani and Genral Santos City) region, adopt a local standardized achievement test, called NDEA Test. The test is administered to elementary and secondary level students in schools run by the Notre Dame Educational Association (NDEA). In 2012, NDEA reported that the overall results from School Year 2006-2007 to 2010-2011 provided a view that students performed the poorest in mathematics obtaining only an average of 23 points, which is less than 50% of the highest possible score of 50. Both the NAT and NDEA test results suggest a problem on student performance in mathematics in the Philippines as it is in the other parts of the globe.

Quite a number of studies were conducted to investigate the reasons for poor performance in mathematics. Brahier (2005) asserts that this could be ascribed to students’ lack of understanding of the mathematical concepts, which has been a major problem in mathematics education. This was apparent in schools in the United

States as indicated in the 1996 TIMSS report. The TIMSS report show that 27 out of 40 nations outperformed the United States' Eighth Grade test takers. TIMSS has recorded that schools in the U.S. dealt greatly on "content at the surface level that does not promote understanding of the underlying mathematics" (Brahier, 2005, p. 7). Thus, reform agenda had centred on the goals of new mathematics education (Silver, 1992). The National Council of Teachers of Mathematics (NCTM) has always been at the forefront of looking at the kind of mathematics that the students were getting from schools. It exemplified in its Principles and Standards for School Mathematics (2000) that "students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" (Brahier, 2005, p. 160).

In the Philippines, the downtrend in the TIMMS, NAT and NDEA test results prompted the education sector especially the policy makers to examine its probable determinants. Problem areas that surfaced were the lack of expertise among teachers which adversely affects the quality of teaching; insufficient instructional materials; and a crowded curriculum particularly in the basic education. The government and policy makers opine that among these problems, teacher quality is considered the weakest (Earnest &Treagust, 2006). Hence, most of the mechanisms developed to enhance learning outcomes pointed at improving the quality of instruction by upgrading the capabilities and professional qualification of teachers.

In pursuit of such a goal, the Department of Education (DepEd) collaborates with other agencies and sectors. There were programs that focused on the improvement of both the pre-service education and in-service professional development of teachers (SEAMEO-INNOTECH, 2003). Other government agencies, higher education institutions (HEIs), and non-government organisations (NGOs) have taken part as education partners of DepEd in the implementation of education improvement programs. Extensive in-service teacher trainings were conducted with science and mathematics teachers through the Department of Science and Technology (DOST). While the Centre for Educational Measurement, Inc. (CEM) conducted National Workshops on International Trends in Mathematics Teaching and Assessment, which aimed to develop awareness of new trends in teaching mathematics as well as approaches to developing test questions (DepEd, 2009). This workshop was facilitated by Dr. Yeap Ban Har, an Assistant Professor at the National Institute of Education in Singapore. In addition, The University of the Philippines - National Institute for Science and Mathematics Education Development (UP-NISMED) hosted an International Conference on Science and Mathematics, to provide teachers, researchers, educators and administrators an opportunity to share innovative and effective assessment practices which could develop and deepen students' understanding and sharpen their scientific and mathematical thinking skills (DepEd, 2010).

It was found however, that mere attendance at conferences and seminars generated only superficial results. The Philippine Commission on Higher Education (CHED) responded to these issues confronting not only mathematics education, but all basic education programs. CHED promulgated the CMO 30 Series of 2004, otherwise known as the New Teacher Education Curriculum (NTEC), which requires future mathematics teachers to complete more mathematics subjects than what have been required in the previous curriculum. The goal was to equip future teachers with greater and advanced knowledge and skills that they could effectively transfer to the learners. With this, it was hoped that students' learning and performance in mathematics would improve. But that was not always the case. Institutional weaknesses might have obstructed the program to its fruition. It appeared that curriculum revision and attempts to improve the quality of teachers cannot be an assurance because of inevitable failures in cascading the program into the classroom setting. Therefore, there is greater sense in examining the real issues inside the classroom in order that more appropriate and practical solutions can be recommended.

Classrooms are places where students acquire new knowledge and understandings, develop new competencies and skills, and discover ways to apply their acquired learning. Moreover, the teacher is the most significant figure in the classroom, and the student, the most vulnerable in the teaching–learning process. Generally, students' performance and achievement in the classroom somehow reflects the practices of the teacher in terms of teaching and assessment. In this study, the teachers' teaching and assessment practices are taken as important pedagogical elements that define the learning environment in the classroom. Specifically, teaching and assessment practices refer to the strategies employed by the teacher in teaching mathematics and in assessing students' performance in class. These practices are hypothesized to have impact on students' achievement.

It is therefore assumed that teachers themselves as well as the practices they employ in teaching and assessment play a significant role in the students' progress. In this relation, a number of authors assert that teaching practices make a difference in students' learning (Brophy & Good, 1986; Hiebert, 1999; National Research Council, 1999 in Hollingsworth, Lokan & McCrae, 2003; Brahier, 2005). Prior studies have examined teacher level factors such as teaching strategies and teaching quality (e.g. UNESCO-IBE, 2010/11) as the main contributing factors that posed influence on students' performance. How the teacher delivers lessons is a crucial factor on learning and understanding. Undeniably, teachers and the teaching strategies applied in the classroom are indispensable in fostering students' understanding (Webster & Fisher, 2003).

Hollingsworth, McCrae, Lokan, and the Australian Council for Educational (2003), however, argued that teaching was not the sole motivator for enhancing learning. Accordingly, a lot more factors within and outside of the school system could influence the students' levels of achievement (e.g., National Research Council, 1999; Floden, 2001; Wittrock, 1986 in Hollingsworth et al., 2003). According to Adams and Hsu (1998), the assessment process is the most important aspect in ascertaining what and how students are learning (p. 174) and what the students needed to learn. In concurrence, the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) says that assessment was a fundamental part of teaching, further specifying that the main purpose of assessment is to help teachers better understand what students know and make meaningful instructional decisions (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997, p. 189). Panizzon and Pegg (2008) also subscribed to this in propagating the idea that assessments must be embedded in instruction so that learning could take place. A common adage advocated by educational experts is that "assessment drives learning". Despite this opinion, few studies exploring the effect of classroom assessment practices on students' achievement have been conducted especially in the Philippines.

Anchoring on the NCTM's Standards (1989) and Panizzon's and Pegg's (2008) assertion that assessment must be embedded in teaching, it is fundamental to probe the link (which are presumed to be seamless) between teaching and assessment, especially that there is a dearth of data in the existing literature about the link of these two elements and their effects on student outcomes. Moreover, prior studies about Mathematics Education mostly dealt with the characteristics, traits or qualities of a teacher. Only a few studies reviewed what the teacher really does (referring to teachers' activities, i.e. instruction and assessment) inside the classroom. This is the gap that this study intended to dwell on as it investigated the effects of classroom teaching and assessment practices on students' achievement in Mathematics. In addition, the study sought to examine the effects of the school-level factors including principals being the head of the school and student-level factors. For the analysis, it adopted a three-level model showing the interrelationships of factors at different levels, the first of its kind in the realm of mathematics education in the Philippines. Hence, various factors both at the school and student levels that directly or indirectly influence students' achievement are all scrutinized. In like manner, the interaction between and among the attributes of principals, teachers and students and how they influence student achievement is assayed. To do this, survey data were obtained from sampled Principals, Mathematics teachers and students in both public and private schools in SOCCSKSARGEN (formerly Region XII), Philippines.

1.2 Aims/Objectives of the study

The study investigated the usual assessment practices of mathematics teachers in SOCCSKSARGEN, Philippines, and how these practices are aligned with teaching practices. Factors that may influence the classroom practices are grouped into: (a) teacher-level factors; (b) school-level factors and, (c) student-level factors. Teacher-level factors include demographic profiles; personal attributes in terms of attitudes, efficacy and beliefs; and assessment preferences in mathematics. Whereas the school-level factors consisted of demographic profile, leadership style, beliefs about the nature of mathematics and school climate for learning. Finally, attributes in terms of attitudes and beliefs about mathematics and on mathematics achievement comprise the Student-level factors. Likewise, the influence of teaching and assessment practices on students' achievement in mathematics, as indicated in the National Achievement Test, is likewise examined. A three-level model was designed in the attempt to clearly illustrate the relationships between and among the factors, as well as how they influence student outcomes.

To deepen analysis, classroom practices among the different schools in Region XII were investigated. This verified whether differences in classroom practices can be attributed to the type of school and profile characteristics of the teacher such as gender, grade/year level handled, qualification, teaching experience, professional development, class size, and personal attributes.

In addition, the study presents the profiles of schools, teachers and students highlighting implications for professional development, curriculum improvement and educational policy review.

1.3 Research Questions

The goal was to examine the factors influencing the classroom teaching and assessment of mathematics teachers, as well as the effect of these practices on students' outcomes. To achieve this, the following questions were to be answered:

1. Classroom or Teacher-level factors

a. What individual-level characteristics (gender, age, years of teaching mathematics, level of education, school level, school type) influence teachers' attributes (professional development, teachers' attitudes and beliefs)?
b. Do individual-level characteristics influence classroom practices (teaching and assessment practices)?
c. How do teacher attributes affect classroom practices?
d. How do assessment practices affect teaching practices?

2. School-level factors

a. What profile characteristics of a school principal (age, gender, level of education, years of teaching experience and years as principal) and school characteristics (school level, school type, instruction time and class size) influence the school principal attributes (beliefs about the nature of teaching and learning and management/leadership style) and school attributes (school climate and criteria for teacher appraisal)?
b. How do school principal attributes (management or leadership style, beliefs about the nature of mathematics and teaching) influence school attributes (school climate and criteria for teacher appraisal)?

3. Student-level factors

a. What student-level factors (gender, age, school level, parents' educational level, employment status, ethnic group, and home possessions) influence students' attributes (beliefs about and attitudes toward mathematics)?

b. How do student-level factors and attributes influence mathematics achievement?

4. Which school-, teacher- and student-level factors and attributes have significant influence on students' mathematics achievement?

1.4 Context of the Study

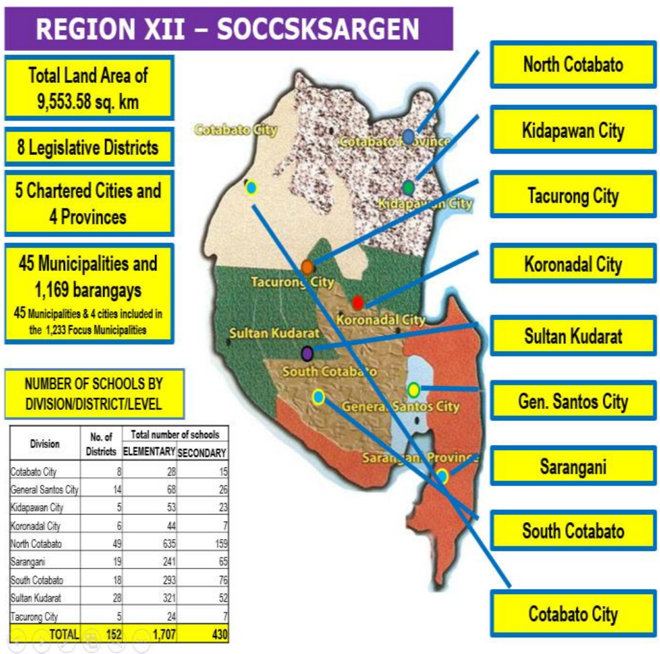
1.4.1 The Philippines

The Philippines is an archipelago of 7,107 islands in the South-eastern coast of Asia with an area of 300,000 square kilometres. The Philippines is divided into three large groups of islands. These groups of islands are further subdivided into regions, the regions into provinces, the provinces into cities and municipalities, and the cities and municipalities are further subdivided into *barangays* (villages). The country has 17 regions, one of which is Region XII or the SOCCSKSARGEN region, which is the area of the study and as of September 30, 2014, it has 81 provinces, 144 cities, 1,490 municipalities, and 42,029 barangays (PSA, 2015).

1.4.2 Region XII (SOCCSKSARGEN)

Region XII is also called the SOCCSKSARGEN Region, which stands as the acronym for the region's four provinces and one of its cities: South Cotabato, Cotabato, Sultan Kudarat, Sarangani and General Santos City. The regional centre is Koronadal City, located in the province of South Cotabato. Cotabato City is geographically located in Maguindanao province of the Autonomous Region of Muslim Mindanao, but it stands as a lone district and politically belongs to SOCCSKSARGEN. The region lies at the South Central part of the Philippines. As of 2010, regional population is marked at 4.11 million with an annual growth rate of 2.72 percent, which is 1.9 percent higher than the national annual growth rate.

Region XII consists of nine school divisions across the four provinces and five cities therein. Each school division is clustered into school districts, then into schools (both government and private). Figure 1.4.1 shows a map of Region XII:



Division	No. of Districts	Total number of schools	
		ELEMENTARY	SECONDARY
Cotabato City	8	28	15
General Santos City	14	68	26
Kidapawan City	5	53	23
Koronadal City	6	44	7
North Cotabato	49	635	159
Sarangani	19	241	65
South Cotabato	18	293	76
Sultan Kudarat	28	321	52
Tacurong City	5	24	7
TOTAL	152	1,707	430

Figure 1.4.1 Map of Region XII (Source: DepEd Region XII).

In school year 2013-2014, there were about 17 million students in the elementary schools and 7.1 million students in the secondary school programs (DepEd). The increasing population has placed too much pressure on the education sector in meeting the needs of the growing school populace. Government schools in particular are challenged by a great need of classrooms, increasing influx of pupils and students and large class size. Far above the ideal class of 30-40 students, most public schools have 70 or more students in a single class. Consider the report of the Organisation for Economic Cooperation and Development (OECD), the average number of students is 21.4 in the primary schools, and 23.9 in the lower secondary schools in all OECD countries.

1.4.3 The Philippine Education System

The 1987 Philippine Constitution specifies that "the State shall protect and promote the right of all citizens to quality education at all levels and shall take appropriate steps to make such education accessible to all." This constitutional mandate was, however, not fully implemented in the past. Until 2002, when the government's education department institutionalized the Basic Education Curriculum (BEC). Basic education then became compulsory, with six years elementary education starting at the age of 6, and four years of high school education starting at the age of 12. This defines a 10-year basic education applicable to both public and private schools. Further education was provided by technical or vocational schools, or in higher education institutions such as universities and colleges. This curriculum program remained in force until a major structural change in the country's educational framework with the promulgation of Republic Act No. 10533 or the Enhanced Basic Education Act of 2013 instituting the K-to-12 Enhanced Basic Education Curriculum.

By virtue of R.A. No. 10533 the country shifted from its old 10-year basic educational system to a K-to-12 educational system. The new 12-year basic education remains compulsory, along with the adoption of new curriculum for all public and private schools. K-to-12 was coined to mean Kindergarten and the 12 years of elementary and secondary education. Kindergarten points to a 5-year old child who undertakes the standardized curriculum for pre-schoolers. Elementary education refers to 6 years of primary school (Grades 1-6) while secondary education means four years of junior high school (Grades 7-10 or HS Year 1-4). In addition to this, two years are now allotted for senior high school (Grades 11-12 or HS Year 5-6). In support, Calingasan (2011), explains that K-to-12 is extending basic education by two years, so instead of having a high school graduate at age 16, high school students will graduate at age 18.

The extension of basic education aims "to raise the quality of basic education through the enhancement of the curriculum." (DepEd, 2010, p. 5). This likewise addresses the issue of an overcrowded curriculum. Figure 1.4.3.1 below shows the comparison of the 2002 BEC and the K to 12 Curriculum.

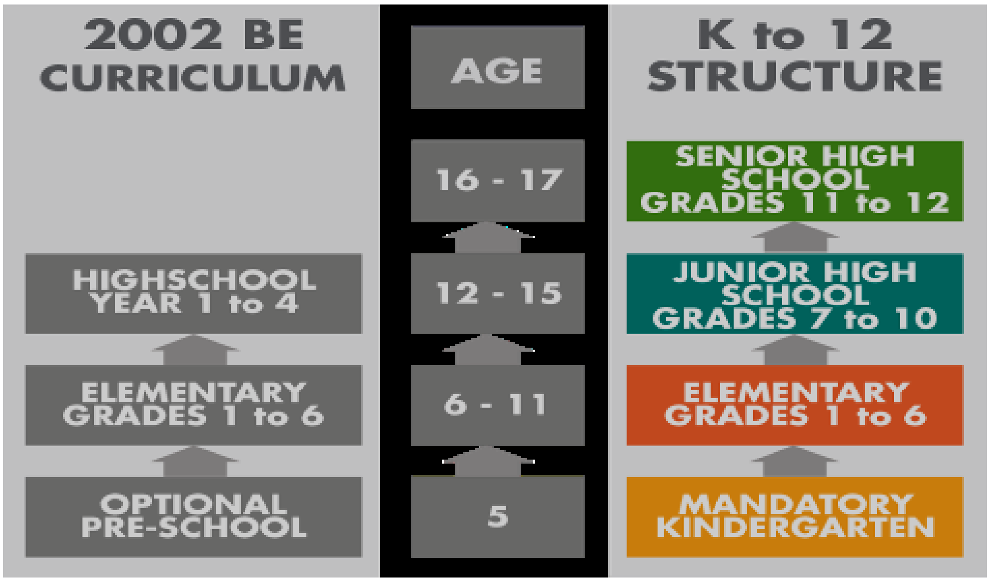


Figure 1.4.2 Comparison of the BEC 2002 and K-12 Curriculum.
(Source: Department of Education, Philippines)

The Department of Education (DepEd) is the principal government agency responsible for education and manpower development. Its mission is to provide quality basic education that is equitably accessible to all and lays the foundations for lifelong learning and service for the common good. The Department is tasked to formulate, plan, implement and coordinate policies, standards, regulations, plans, programs and project areas both for formal and non-formal education. It also supervises all basic education institutions, both public and private, and provides for the establishment and maintenance of a complete and integrated system of education relevant to the goals of national development. DepEd also specifies that the main function of regional offices is quality assurance. The regional offices are mandated to monitor and evaluate the performance of all schools within their jurisdiction; as well provide technical support to divisions and selected schools which are lagging behind the key outcome indicators.

DepEd mandates schools to implement the minimum curriculum standards (core/major and minor subjects). Allowing, however, the private schools to liberalise the content of the values education subject and to add more subjects such as Religion or Christian Living for Catholic/Christian schools, Arabic in Islamic schools and Language and Culture for International schools.

The guidelines on the implementation of the basic education curriculum are stipulated in DepEd Order No. 43, s. 2002. It mandates all mathematics teachers to encourage students to learn using interactive and collaborative teaching approaches. In addition, teachers shall design classroom activities that provide opportunities for students to “learn on their own, explore, discover and apply what they learned in their daily lives" (DO 43, 2002). In order to achieve these goals, teachers shall use appropriate teaching approaches and strategies together with the use of various instructional materials. Moreover, evidence of students' learning of desired outcomes shall be assessed through authentic performances.

In general, the DepEd mandates clearly specify that teachers are to use appropriate teaching approaches and assessment processes. Yet, the implementation of these approaches is subjective and varied as it greatly depends on an individual teacher's interpretation. This raises the need to look into the actual classroom settings to examine what teachers are doing on the ground. Hence, the objective of this study.

1.5 Significance and Contribution to the discipline – Mathematics Teacher Education

The results of the study provide baseline information the Philippine Government can use for timely educational reforms; particularly in promoting learning of mathematics by improving the mathematics curriculum, and in formulating appropriate policies with respect to the use of classroom assessments and teaching practices. The findings provide educators with an understanding of teachers' pedagogical knowledge, a valid basis for school officials in developing degree and non-degree programs that provide opportunities for teachers to improve their teaching and assessment practices eventually raising the standards of the schools.

The findings further create the need to update teacher education programs geared at equipping pre-service teachers with the necessary teaching skills for them to be at par with quality education service that promptly meets the needs of the 21st century learners, especially in the field of mathematics. In addition, the study benefits teachers, especially mathematics teachers, as positive attitudes and perceptions toward the use of alternative or other forms of assessments and teaching strategies are developed thus reducing, if not eliminating, their dilemmas in the practice. Most importantly, the results of this study help teachers reflect on their ways of interpreting students' performance. The researcher, a teacher herself, gains benefit from the study, by utilizing the results as a basis for designing in-service seminars and trainings for the Re-entry Action Plan (REAP). The REAP is an integral part of the research scholarship which made the conduct of this study possible.

Teachers and the teaching practice are a vital focus in policy-making not only due to the Education for All (EFA) mandate (DepEd, 2002) but also because quality education is a basic human right. All around the world, reforms to promote high-quality teaching in classrooms are pushed and professional collaboration at the school level are advanced. If the intention is to improve the learning conditions of students in mathematics, it is crucial to know and understand well what is truly happening in the classrooms in different settings and nature of school. The findings of this study provide such understanding needed to substantiate interventions in support of policy recommendations aimed at meeting the varied needs of all the stakeholders.

The results will enlighten policymakers and key stakeholders about professional practices and provide relevant information for the monitoring of the school system. Analysing relationships between the profiles of teacher-, school-and student-level background variables and processes will provide literature for comparative research on teachers and teaching practices. In effect, a more comprehensive understanding of professional teaching practices, especially in mathematics and related subjects is achieved. Overall, the study findings will respond to the knowledge and theoretical gaps in mathematics educational research.

1.6 Summary

Student achievement is frequently used as an indicator of several education outcomes including curriculum benchmarking and service quality. This chapter highlights the factors affecting student achievement, with particular emphasis on teachers and teaching practices. Central to the study are multi-level factors within the characters of the teachers, school heads and the student themselves.

The general aim with the specific research questions are also presented herein. The significance and limitations are likewise discussed. It is also pointed out that the analysis of the factors from three different data levels is the study's primary contribution to mathematics educational research in the Philippines.

The succeeding chapters present information relevant to the study. Chapter 2 is a review of the variables considered and their effects on students' outcomes. Chapter 3 presents the conceptual model and the operationalisation of the variables taken in the study. Chapter 4 discusses the methods of research, which includes the design of the study, description of the sample, instruments employed and methods of analysis. Validation of the scales using CFA and Rasch analysis are discussed in Chapters 5 and 6, respectively. Chapter 7 provides the general description of the three sets of samples, while Chapters 8, 9 and 10 present the results of the structural equation modelling. The results of the hierarchical linear modelling are reported in Chapter 11 and discussed in Chapter 12. Finally, Chapter 13 presents the conclusion and implication of the study.

Chapter 2
Literature Review

2.1 Introduction

The purpose of this study is to examine a range of factors including the attitudes, beliefs, assessment preference and practices of teachers of mathematics and their qualifications, professional development and relevant personal and professional experiences, and how these impact on student-level factors and achievement in mathematics in the elementary and secondary levels. This section reviews published works on the different factors examined in this study. This chapter begins with a discussion of the mathematics classroom, then classroom- or teacher-level factors influencing students' achievement in mathematics are also taken into account. The school-level factors' influence on teachers and students' achievement are discussed next and finally student-related factors are likewise discussed.

2.2 The Mathematics Classroom

The National Council of Teachers of Mathematics (NCTM), a US-based non-government organization, in its effort to provide guidelines to help improve mathematics education, recommended through the Principles and Standards for School Mathematics as to how students should learn mathematics. The NCTM Principle on learning states that "students must learn mathematics with understanding, actively building new knowledge from experience and previous knowledge" (NCTM, 2000, p. 2). This standard is provided to call for teachers to let go of the traditional way of teaching mathematics and embrace alternative strategies.

As observed, some teachers, however, may still resort to the traditional lecture style or structured teaching methods.

It is imperative that teachers' actual classroom instructional practices are examined since a number of studies have accounted students' poor achievement in mathematics to teachers' instructional practices (Ogwuche & Kurumeh, 2010). In the United States of America (USA) and other Western nations, the enhancement of instructional strategies has been considered as the prevailing method in decreasing the disparity in students' achievement (Chen, Crockett, Namikawa, Zilimu, & Lee, 2011). Teachers have varied approaches to teaching, which could be caused by their different views about mathematics and teaching mathematics. The following section highlights the details of the broad teaching approaches in mathematics education.

2.2.1 Approaches to Teaching Mathematics

2.2.1.1 Traditional approach

The traditional method of teaching mathematics refers to the lecture or direct instruction method. It is also considered as teacher-centred instruction as teachers normally discuss or explain the lessons according to his/her own pace leaving the students as simply the receiver of information. According to Ali, Hukamdad, Akhter, and Khan (2010) the teacher in a traditional mathematics classroom serves as "the focal point of discussion and the dispenser of knowledge" (p. 67). Thus, the direction of the communication is one-way, from the teacher to the students (Ali et al., 2010). Rickard (2009) also expounded that in a traditional mathematics classroom, teachers hardly considered the understanding of mathematical concepts. Most often students are taught and learn to memorise definitions and procedures. Thus, learning becomes superficial.

Additionally, in a traditional mathematics classroom, teachers greatly depend on textbooks. However, when Flanders (1987) scrutinized some textbook series he found that grades two to eight textbooks contained less than 50% of the new materials for students. Kulm, Morris, and Grier (1999) have the same observation when they examine a few middle-grade mathematics textbook series. They discovered that many of these textbook series are deficient of the content standards and the variety of instruction suggested by NCTM (Griffin & Jitendra, 2009). Webb (1989), on the other hand, claims that one of the factors of students' poor performance in mathematics in South Africa is the poor standard of textbooks.

Teachers should not rely heavily on textbooks. According to Grouws and Cebulla (2000) textbooks must be used only as one of the instructional tools. Teachers should not be obliged to make use of the textbook page-by-page. Instead, teachers should employ various teaching strategies to suit with the different learning styles and needs of the students so that learning will be enhanced (Kyriacou, 1997). There are several alternative teaching practices that appeared in the literature, some of them will be discussed below. Alternative approaches, according to McKinney and Frazier (2008), are student-centred that offers opportunities for students to make use of their previous knowledge and experiences. Evidence on the success of using alternative strategies in teaching mathematics has been found in the literature. For instance, Wenglinsky (2002) put forward that when teachers use inquiry-driven strategies, hands-on opportunities and development of higher order thinking skills students would obtain higher scores on achievement test.

2.2.1.2 Constructivist Approach

Students construct their own learning as they engaged themselves in the activities provided by the teachers. Teachers, on the other hand, simply guide the students during the process of construction and provide more avenues for students to exhibit their knowledge and achieve their desired goals. Thus, students take ownership of the learning (Brooks & Brooks, 1999) This is the common scenario in a constructivist classroom. Brooks and Brooks emphasized that constructivism normally engages students to hypothesise, explore, observe, discover, reflect and make inferences on the concept being examined. Hence, a constructivist approach is crucial in constructing an intensive understanding of the mathematical concepts as promoted by the NCTM Standards (Brooks & Brooks, 1999; NCTM, 2000).

The Australian Education Council (AEC), likewise, advocates for the use of the constructivist approach (Draper, 2002) to teaching and learning mathematics. Learning mathematics involves a dynamic process, hence it should be engaging and students construct their own learning (Nisbet & Warren, 2000) using their prior knowledge and experiences and through their interaction with the physical and social milieu. Applying the constructivist point of view, therefore, is a challenging task. Teachers need to take extra effort to understand their learners so that appropriate learning experiences will be designed and provided for the students (Cooney & Shealy, 1997). Nisbet and Warren added that in a constructivist classroom, teachers serve considerably as "facilitators of learning" and less likely as "transmitters of facts". Hence, Van Zoest (1998) argued that in a constructivist classroom it must be significantly emphasised that students do their "mathematical thinking" (p. 601). Furthermore, Taylor, Fraser, and Fisher (1997) deemed that a constructivist classroom is student-centred in which, students are given the opportunities to design their own learning that is relevant to their styles; to work independently according to their own phase; and link their new knowledge with the existing one.

2.2.2 Classroom Practices in Teaching Mathematics

Whether teachers view mathematics teaching as traditional or constructivist, the following strategies in teaching mathematics could still be deemed as necessary in teachers' repertoire of classroom practices.

2.2.2.1 Problem Solving

Problem solving is not new in mathematics education. It was popularised by a Hungarian Mathematician George Polya (1945 in Rickard, 2005) in his book *How to Solve It*. He introduced in this book the heuristics or strategies (understanding the problem, devising a plan, carrying out the plan, and looking back) in solving word problems. These heuristics are still prevailing in most mathematics classrooms today. Although Polya introduced problem solving in the 1940's, it was in 1977 that the National Council of Supervisors of Mathematics (NCSM) circulated the first major encouragement to include problem solving in mathematics education (Schoenfeld, 1992). In view of that, several researchers have subsequently endeavoured to look at the issues relating to problem solving (Fan & Zhu, 2007). In 1980, problem solving became the focus of mathematics education reform when the NCTM 1980 Yearbook, *Problem Solving in School Mathematics*, was published.

And in 2003, PISA and TIMSS have given special attention to problem solving (Peker, 2009).

However, the attempt to problem solving reform during the 1980s had slowed down because problem solving itself was not clearly defined and what it should constitute was also not delineated. Thus, researchers have offered their definition of problem solving. For example, Szetela and Nicol (1992) presented a definition of problem solving as “a process of confronting a new situation, formulating connections between given facts, identifying the goal, and exploring possible strategies for attaining the goal” (p. 97 in Peker, 2009). Likewise, the National Council of Supervisors of Mathematics (NCSM) propounded commonly acknowledged definition of problem solving:

> Problem solving is the process of applying previous acquired knowledge to new and unfamiliar situations...problem solving strategies involve posing questions, analysing situations, translating results, illustrating results, drawing diagrams, and using trial and error (NCSM, 1989, p. 471 in Rickard, 2005).

The NCSM’s definition has obviously encompassed a simple yet profound definition of problem solving and the logical procedure involved in dealing with problem solving. This definition will be adapted in the study.

Problem solving has been since become important in teaching mathematics. Polya (1957 in Peker, 2009) contended that problem solving should be a legitimate topic in teaching and learning mathematics. Halmos (1980), on the other hand, claimed that problem solving must be placed at the “heart of mathematics”. Other researchers, such as Akinsola (2008) and Altun and Sezgin-Memnun (2008), have likewise maintained that problem solving is largely an important subject in mathematics teaching.

Individuals are confronted with many problems in life and they solve these problems using their prior knowledge and acquired skills. Akinsola (2008) claimed that students’ common daily experiences or mathematical context can be used to introduce several mathematical concepts. It is therefore the ultimate objective of mathematics teaching and learning to improve students’ aptitude to solve mathematical problems (MEB, 2004 in Peker, 2009), which will eventually make them an effective and competent problem solver in real life (Schoenfeld, 1992; Walker & Lofton, 2003). Similarly, Ogwuche and Kurumeh (2011) asserted that the daily problems encountered by individuals can best be solved by using mathematics, either directly or indirectly.

It has been expounded in some studies that problem solving improves students’ performance in the mathematics classroom. For instance, Ogwuche and Kurumeh (2011) put forward that students’ achievement in Algebra was notably enhanced when teachers engaged themselves in problem solving models. The same result was revealed in the study carried out by Perveen (2010) involving 10^{th} grade female students from a Government high school in Pakistan. The study proved that students in the experimental group who were exposed to a problem solving approach displayed an improved achievement compared to those in the control group who were taught using the expository strategy. This is also consistent with the study performed by Ali and his colleagues (2010).

2.2.2.2 Cooperative Learning

Cooperative learning has long been discussed in the mathematics teaching literature. In a cooperative learning classroom, students are working with their classmates as a team. They work on activities (e.g. assignments, projects, problem solving) provided by their teacher with particular criteria to follow (Felder & Brent, 2007). Albeit, they work as a team, each student is held responsible for their individual contribution (Felder & Brent, 2007). The teacher, on the other hand, simply acts as the facilitator. Teachers also are responsible for deciding on the lesson, controlling the size of the group, supplying the materials needed for the activity, explaining the activity and monitoring the groups (Duff, 2012) ensuring that each member will take part of the activity.

According to Duff (2012), the fundamental goal of cooperative learning is for students to stay away from the conventions of using the lecture method and textbooks. He further put forward that cooperative learning must be used when conceptual understanding will be required, higher order and critical thinking skills will be needed from the students. Students will also have increased involvement in the activities making them more responsible in organising and running the lesson (Stevens & Slavin, 1995).

Based on Vygotsky’s theory (1982) of Zone of Proximal Development (ZPD), students learn more when they work in groups. It indicates further that students will learn to solve problems by themselves after solving the problem cooperatively with the members of the group (Leikin & Zaslavsky, 1997). Some research studies likewise confirmed that students learn far better when they work collaboratively with others (Duff, 2012). In this case, students learn to recognize the value of their contribution in the attainment of the group's goal. This, according to Stevens and Slavin (1995), results in increased student achievement.

Cooperative learning does not only impact students' achievement. It also has a positive influence on intergroup relations, self-esteem, attitudes toward class and school and the ability to work cooperatively with others (Johnson & Johnson, 1989). In addition, the action research carried out by Duff (2012) revealed that students were more concomitant to the real world in a cooperative learning environment. Furthermore, Johnson and Johnson (2009) specified positive impact of cooperative learning on students. They put forward that students exposed to cooperative learning have developed positive attitudes towards school, subject areas, teachers and peers; students also interact more effectively and learn more than when they work individually.

2.2.3 Teaching Practices

Thus, teachers, together with their experiences related to teaching and assessment practices, play significant role in the students' learning process. A number of studies have argued that teaching practices make a difference in students' learning (Brophy & Good, 1986; Hiebert, 1999; National Research Council, 1999 in Hollingsworth, Lokan & McCrae, 2003; Brahier, 2005). Most of these studies have examined teacher level factors such as teaching strategies and teaching quality (e.g. UNESCO-

IBE, 2010) as the main contributing factors that have had some influence on students' performance. The study conducted by Dyer, Lacey, and Osborne (1996) on Agricultural Education students disclosed that students displayed higher mean scores on achievement tests when problem-solving approach was employed. While Sullivan and Mousley (1994) put forward the idea that discussion between pupils has been found to be associated with students' success in learning. Moreover, a report on the study conducted in the United Kingdom which included 80 schools and 170 teachers maintained that teacher quality and effectiveness greatly impacted on pupil progress (Lamb & Fullarton, 2002). Teachers, considering their teaching approaches, were also identified as having the key impact on student achievement in a number of Australian studies (Lamb & Fullarton, 2002).

How the teacher delivers lessons is a crucial factor on students' learning and understanding. Undeniably, teachers and the teaching strategies applied in the classroom are indispensable in fostering students' understanding (Webster & Fisher, 2003). Cogan and Schmidt (1999) likewise presented a similar view, noting that teachers who chose, organised and exhibited a range of teaching activities, played an important role in enriching students' "learning experiences".

According to Goldhaber (2002) good teaching was obviously essential in raising students' achievement. Studies related to instructional practices and students' achievement put forward that students' learning in Mathematics was influenced by the "quality of teachers' instructional practices" (Butty, 2001; Cornell, 1999). A similar analysis was reported in some studies which put forward that the most significant factor for students' mathematics achievement was the teachers' classroom practice (Sutton & Krueger, 2002). Moreover, Webster and Fisher (2003) stated that the teaching strategies employed by the teachers in the classroom were important in developing students' understanding. Thus, this study looks into the common teaching practices in the Mathematics classroom. And how these practices influence students' learning and achievement was investigated.

Teachers play a very important role in preparing young individuals for a successful and productive life. Hence, the National Professional Standards for Teachers:

> reflect and build on national and international evidence that a teacher's effectiveness has a powerful impact on students, with broad consensus that teacher quality is the single most important in-school factor influencing student achievement. Effective teachers can be a source of inspiration and, equally importantly, provide a dependable and consistent influence on young people as they make choices about further education, work and life (AITSL, 2011).

Teachers' role inside the classroom is indeed complex. They need to consider how effectively they can deliver their lessons, appropriately assess their students and ensure that students have gained understanding of the lesson. To become effective, teachers must first know and understand their learners, their learning styles (Duff, 2012), and their strengths and weaknesses. Learning becomes meaningful when students are given the opportunity to learn the necessary content and skills that will be useful in real life (Grouws & Cebulla, 2000).

2.2.4 Assessment Practices in Mathematics

Hollingsworth, McCrae, Lokan, and Australian Council for Educational (2003) argued that teaching was not the mere motivation of students' learning. Many factors, both inside and outside of school, could influence students' levels of achievement (e.g., National Research Council, 1999; Floden, 2001; Wittrock, 1986 in Hollingsworth, Lokan & McCrae, 2003). According to Adams and Hsu (1998), the most important aspect in ascertaining "what and how students are learning" (p. 174) and what the students needed to learn was assessment. The Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) indicated that assessment was a fundamental part of teaching and specified that the main purpose of assessment was "to help teachers better understand what students know and make meaningful instructional decisions" (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997, p. 189). Pegg and Panizzon (2007) also subscribed to this as they asserted that assessments are needed to be embedded in instruction so that learning could take place. A common adage advocated by educational experts is that "assessment drives learning".

Assessment is the process of collecting evidence of students' performance on a daily, periodic or summative basis. It is used to determine what the students have learnt and need to learn. Assessment serves different purposes for different agencies of the society. For the employment sector, for example, they may need assessment for 'ranking and selection criteria for future placement of career' (Pfannkuch 2001, p. 185), whereas for teachers, it aims, not only to enhance students' learning (Pegg & Panizzon, 2007; Pfannkuch, 2001), but also to improve instruction (De Luca & Klinger 2010; Schulman 1996) and curriculum (Carnell 2010; Schulman 1996) and inform parents (DeLuca & Klinger 2010) and other stakeholders of the quality of teaching. Suurtamm, Koch and Arden (2010) put forward that the fundamental purpose of assessment must be 'to aid and improve students' learning' (p. 400).

Several researchers also subscribe to this idea (De Luca & Klinger 2010; Pegg & Panizzon 2007). However, the National Council of Teachers of Mathematics (NCTM) Assessment Standards confers the purposes of assessment which are broadly categorised as the following: ’monitoring students’ progress’, ’ making instructional decisions’, ‘evaluating students’ achievement’, and ‘evaluating programs’ (NCTM, 1995, p. 20). Suurtamm et al.'s, emphasis on the purpose of assessment is clearly integrated in the first category. Suurtamm et al. suggest, therefore that the main goal of assessment is towards the enhancement of students’ learning.

- Find the sum of *356* and *712*
- Evaluate $3x^2-5x+7$
- Find the area of the rectangle if the length is 4cm and the width is 2cm’

The examples above are the common questions that teachers ask in a mathematics classroom or what students encounter in a paper-and-pen test. In the traditional way of testing and assessing students’ performance, these questions are used to measure how much knowledge the students have acquired in their mathematics. These, however, require only familiarisation and memorisation of the algorithm (e.g. Schulman 1996). They do not delve into the conceptual and mathematical understanding of the students. Thus, Suurtamm et al., likewise suggest that assessment in mathematics must ‘not only require students to solve problems but also to understand what they are doing, to explain their methods and to follow the explanation of others’ (p. 401). In addition, the NCTM also advocates that mathematics should include ‘methods of investigating and reasoning’ (Watt 2005, p. 22). On the other hand, Pegg and Panizzon (2007) assert that assessment must be embedded in instruction so that learning will be improved (p. 66). They further infer that this may require teachers to take a significant move from the traditional view of assessment to one that gears toward students' understanding and learning (Pegg & Panizzon). This may be, to some teachers, a big leap forward which needs to be addressed in the curriculum document.

The call for reform also implies that teachers need to consider different assessment techniques (DeLuca & Klinger 2010; Pfannkuch 2001; Schulman 1996; Watt 2005, p. 23) so as to engender students' critical thinking (Suurtamm, Koch & Arden 2010). Suurtamm, Koch and Arden point out that the theoretical basis for this view of assessment is anchored in the 'cognitive, constructivist and socio-cultural views of learning' (p. 400) which other authors may have unwittingly failed to consider. Suurtamm, Koch and Arden (2010) further stress that students' different learning styles must be addressed by employing a wide range of assessment methods. By providing students with plenty of learning experiences and opportunities, they (students) would be able to maximise their capacities to learn.

Classroom assessment in Mathematics has been a growing concern in schools and maybe the whole education system as they had been confronted, alarmingly, by the kind of Mathematics the students were getting from school. Several countries like, Australia (Pegg & Panizzon 2007; Watt 2005), the US (Watt 2005) and Canada (Suurtamm, Koch, & Arden, 2010) had already responded to the call for reforms to improve, not only in the instruction and curriculum aspects, but also the assessment strategies employed by teachers in the classroom. One of the strategies that surfaced in the literature, was the use of alternative assessment. Several studies had shown that alternative assessments greatly contributed to the understanding of the mathematical concepts (Carnell 2010). Stiggins (1988), however, put forward that "low-quality assessment" (p. 366) could have a negative impact on students. Yet, despite this, only limited research has been conducted on the effect of classroom assessment practices on students' achievement, especially in the Philippines.

There have been several research studies conducted that compared Mathematics achievement among international students to a number of factors. However, missing in these factors was the seamless connection of teaching approaches to assessment practices and the attribution of these classroom practices to student achievement. For example, the first Mathematics study by the International Association for the Evaluation of Educational Achievement (IEA) (Husén, 1965) conducted in the early 1960s was a comparative international survey of students of the participating countries based on a number of factors. However, assessment practices were not one of the variables examined. It reported that course content and opportunity to learn were contributing factors for the differences in achievement (Husén, 1965). In addition, the Second International Mathematics Study (SIMS), conducted by the IEA in the early 1980s, also considered the content of the curriculum and teaching practices in the analysis of the students' achievement (Robitaille & Travers, 1992). Harnisch and his colleagues (Harnisch, Steinkamp, Tsai, & Walberg, 1986), in addition, investigated the samples of Mathematics achievement and their relationship with age and courses completed (Robitaille & Travers, 1992). Moreover, studies conducted by the Trends in International Mathematics and Science Study (TIMSS) on students' achievement showed that assessment practices were also not considered as a possible contributing factor to students' achievement.

2.2.4.1 Formative Assessment

Formative assessment has been receiving much attention in the UK and in the USA and perhaps in other countries. In this study, formative assessment is referred to as assessment for learning in the same way as other researchers use this term (see (Torrance & Pryor, 1998) which is based on its purpose, that is to improve students' learning (Torrance & Pryor). Heritage, Kim, Vendlinski, and Herman (2009), also defined formative assessment as assessment for the purpose of instruction. This brings in the idea that formative assessment will be used to obtain information and feedback from the students which will guide teachers improve their teaching (Ginsburg, 2009). In a more detailed view, Gao (2012) put forward that teachers will be able to observe and provide feedback on how students are progressing and enhance their teaching strategies to improve teaching and learning through formative assessments.

As Stenmark (1992) put it, assessment is an integral part of teaching. De Jong et al., (2004) and Kyriakides (2008) added that formative assessment, in particular, has shown its strong relationship with teaching effectiveness. It is therefore necessary that teachers constantly collect information about students' needs and performance through assessment so that results can be used to evaluate their practice.

Formative assessment is designed to inform teachers on how they can best improve their teaching practice, so that in the end, teachers can help students improve their performance. However, teacher efficacy beliefs may also come in the way as a mediator between assessment and teaching practices. In the research study carried out by Eufemia (2012), for example, she examined the relationship between teachers' use of formative assessment and their self-efficacy beliefs. This study involved 79 teachers from third, fourth and fifth grade levels in Florida public school districts. The teachers were requested to assess their knowledge and beliefs about formative assessment and how these might relate with their perceived self-efficacy. The results indicate that teachers use formative assessment to improve their classroom instruction, which in turn, help students achieve better in mathematics. In addition, teacher' use of formative assessment is positively related with their self-efficacy in terms of assessment type, assessment knowledge, and effectiveness of assessments.

2.2.4.2 Summative Assessment

The Association for Supervision and Curriculum Development (1996 cited in McIntosh, 1997) defined summative assessment as “a culminating assessment, which gives information on student's mastery of content" (p. 60). As OECD (2005) put it, summative assessment mainly reveals what the students have learned (Gao, 2012). Consistent with these definitions, Wiliam (2001) purported that summative assessment is a way of showing “what the individual has learned, knows, understands or can do” (p. 178). Harlen and James (1997), on the other hand, described that summative assessment is concerned not with the small, specific details of classroom learning but with the bigger picture and general progress that students are making.

Several research studies (e.g. Crooks, 1988; Harlen, 2004; Stiggins, 1999) have been carried out to investigate the influence of summative assessment not only on students’ achievement but on teaching and curriculum as well.

2.2.4.3 Alternative/Authentic Assessment

Students' achievement will be enhanced if assessment strategies employed by mathematics teachers are in line with their intended goals of instruction and learning (Reynolds, York, & Buffalo, 1996), relevant to their (students) real life experiences (Gulikers, Bastiaens, Kirschner, & Kester, 2008) and provide students equal opportunities to exhibit their mathematical capabilities (Gao, 2012).

2.3 Teacher - related Factors and Students Achievement

Teachers' preference for traditional or alternative teaching and assessment strategies depends on their preconceived notions about mathematics, previous experiences and their attitudes and beliefs about the subject.

Exploring on the extent of influence teachers have on students' achievement is one objective of this study. Specifically, this deals with more closely on certain teacher attributes that will lead to improved student achievement.

2.3.1 Attitudes

2.3.1.1 Attitudes towards mathematics

The concept "attitude" has been paid much attention in mathematics education. It has been a consistent feature in the literature for more than eight decades. However, due to the varying degree of understanding and perspectives of different researchers, "attitude" has been given several definitions (Akinsola & Olowojaiye, 2008; Utsumi & Mendes, 2000). Thurstone (1928), for example, defined attitude as "the total sum of inclinations and human feelings, prejudices or distortions and preconceived notions, ideas, fears and convictions regarding a certain matter" (p. 531). Aiken

(1979), on the other hand, referred to attitude as “a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person” (p. 551). Similarly, Ajzen (1988) maintained that “attitude is a disposition to respond favourably or unfavourably to an object, person, institution or event” (p. 34). Owing to its relevance to this study, Ajzen’s (1988) definition will be considered. Consistent with Ajzen’s definition of attitude, Neale (1969) claimed that attitudes toward mathematics is “an aggregate measure of a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless” (p. 632). This implies that attitude towards mathematics is simply looking at mathematics in a ‘positive’ and ‘negative’ view (Zan & Di Martino, 2007).

Attitude has been considered to have an influence on students’ learning. Attitudes are linked to Bandura’s (1977) social cognitive learning theory as one of the typical factors that impinge on learning (Newbill, 2005). According to Farrant (1994) learning is a means of obtaining and maintaining attitudes, knowledge, understanding, skills and capabilities. Therefore, attitude cannot be simply detached from learning. Zan & Di Martino (2007) put forward that attitude holds a critical part in learning mathematics. Correspondingly, Enemark and Wise (1981) expounded that attitude-related variables are critical indicators of "mathematics achievement” (p. 22). A later analysis of Steinkamp (1982) arrived at the same conclusion that attitudes toward mathematics determine achievement in mathematics. In the light of all these, Zan and Di Martino (2007) posited that the link between positive attitude and achievement in mathematics has not been convincingly established. On the contrary, Aiken (1976) documented that there is typically a positive association between attitudes toward mathematics and mathematics achievement at the elementary and secondary levels. This relationship, however, may not always be statistically significant. Neale (1969) noted down that “positive or negative attitudes toward mathematics appear to have only a slight causal influence on how much mathematics is learned, remembered and used” (p. 636)

Ignacio, Nieto, and Barona (2006) argued that students’ attitude toward mathematics learning is dependent upon their “academic self-image” and “motivation for achievement”. It is a known fact, nonetheless, that many pupils/students abhor mathematics. They found mathematics as a source of frustration rather than satisfaction, a cause of discouragement and anxiety. Even some of those who can do mathematics well find the subject a tedious and boring task (Ignacio, Nieto & Barona, 2006). Attitudes are manifested in a number of facets. For instance, in Guerrero, Blanco and Vicente’s (2002 cited in Ignacio, Nieto & Barona, 2006) view, students display several attitudinal and behavioural signs such as ‘denial’, ‘negation’, ‘frustration’, ‘pessimism’ and ‘avoidance’ when they are confronted with school activities or learning tasks. One commonly used learning activity in mathematics is problem solving which many students found difficult. Marshall (1989) construed students’ negative comments about problem solving in mathematics as an indication of anxiety and negative attitude toward mathematics. In cognizance of this, some researchers (Leikin & Zaslavsky, 1997) have proposed that working collaboratively in groups could help students enhance their performance and attitude to mathematics. It seems highly likely that in group activities students develop positive attitudes toward mathematics (Leikin & Zaslavsky, 1997) since students support each other.

Other studies have also shown that student involvement and positive attitudes increased when exposed to small collaborative group activities (Utsumi & Mendes, 2000). It is therefore necessary for the teachers to design his/her classroom that provides opportunities for students to develop positive attitude towards the subject. It is assumed that when teaching strategy and classroom activities are not aptly planned, students learning and achievement will be hampered (Akinsola & Olowojaiye, 2008). Akinsola and Olowojaiye highlighted further that students' learning will be greatly affected if they are not persuaded and supported to take in things they're learning in mathematics positively. Hence, teachers are held completely responsible for students' development of positive attitude towards mathematics learning (Akinsola & Olowojaiye, 2008).

2.3.1.2 Attitudes towards teaching mathematics

Teachers play important roles in the teaching and learning process, thus, the significance of attitude towards teaching mathematics has also been acknowledged by some researchers (Relich & Way, 1992). It is interesting to note that a number of studies (Ernest, 1989; Ball, 1990; Fennema & Franke, 1992; Wilkins, 2008) have widely regarded the imperative role that attitude towards mathematics play in teachers' efficacy and their preference for instructional practices. In a similar vein, Carpenter and Lubinski (1990) stressed that teacher attitudes impact the teaching strategies used in the classroom, which consequently affect student attitudes and achievement. This is likewise consistent with the results shown in other studies (e.g. Ball, 1990; Ernest, 1989; Wilkins, 2008). It has been further suggested that positive teacher attitude greatly influence the development of students' positive attitude (Relich, Way, & Martin, 1994).

As a further suggestion of a professed interaction between attitude and teaching mathematics, quite a few studies (e.g. Sullivan, 1987) have conveyed that an enormous number of pre-service students develop negative attitudes about mathematics when they go into teacher education courses. Several researchers (e.g. Ball, 1990; Rech, Hartzell, & Stephens, 1993) contended that an improved mathematics anxiety, dwindled self-concept and negative attitudes to mathematics have been evident on elementary school teachers. Other researchers (Quinn, 1997; Ball, 1990) expressed qualified agreement to this and added that elementary teachers have been predisposed to display negative attitudes toward mathematics than secondary teachers. This would have a substantial implication on teachers' instruction. Ogden (1987) argued that teachers with heightened mathematics anxiety could reasonably be expected to avoid if feasible and engage aversely in teaching mathematics.

2.3.2 Beliefs

The term "beliefs" is used tantamount to "attitude, disposition, opinion, perception, philosophy, and value" (Leder & Forgasz, 2002, p. 96). For this reason, it is rationally not simple to give an accurate definition of belief. Eventually, literature reveals various definitions of beliefs which presents general presumptions, differing importance and a slightly improved intricacy of the definition (Leder & Forgasz, 2002). In this study, Rokeach (1972) definition and Ajzen and Fishbein (1980) description of belief will be adapted. Rokeach purported that "a belief is any simple proposition, conscious or unconscious, inferred from what a person says or does, capable of being preceded by the phrase 'I believe that …'" (p. 113). While Ajzen and Fishbein (1980) indicated that belief is something considered as true by any person.

2.3.2.1 Beliefs about mathematics, mathematics teaching and learning

Belief is another affective construct that is assumed to have influence not only on students' learning but also on teachers' teaching practice. Ernest (1989) has reported the importance of beliefs to mathematics teachers relative to the nature of mathematics, mathematics teaching and learning. It has been accounted in several research papers (e.g. Ajzen & Fishbein, 1980; Pajares, 1992) that a person's belief stimulates his/her actions. Consequently, this creates an unwarranted effort to transform teachers' practice without transforming their beliefs first (Beswick, 2005). Other researchers, however, have seen the link between belief and practice differently. Sullivan and Mousley (2001), for instance, contended that the relationship is two-way, that is, beliefs influence practice and at the same time practice affects beliefs. Cobb, Wood, and Yackel (1990) study contain similar conclusion. They maintained that there is no linear causation in either way, instead, both beliefs and practice are dialectically associated and that they develop simultaneously.

2.3.2.2 Self-efficacy beliefs

Another much-researched concept related to belief is self-efficacy. Teachers' teaching efficacy is drawing attention to teacher education research (Philippou & Christou, 2002, in Leder, Pehkonen & Törner, 2002, p. 216). The notion of "teacher efficacy" has sprung from the two psychological elements: the first is anchored on Rotter's "expectancy theory for internal versus external control of reinforcement", and the second is derived from Bandura's "social cognitive theory" (Tschannen-Moran, Hoy, & Hoy, 1998). Bandura (1997) described perceived self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). In agreement with this description, teaching efficacy can be explained as "teachers' beliefs in their capabilities to design and apply effective teaching activities" (Philippou & Christou, 2002, p. 216). That is to say, efficacy with regard to teaching any subject can be characterized as believing with conviction that an efficient and healthy learning environment can be designed and organized creatively (Philippou & Christou, 2002). Hence, self-efficacy is a belief about oneself that something can be performed effectively or a belief of one's ability to do what is supposed to be done. Relative to this, Philippou and Christou (2002) expounded that motivation is a significant component of efficacy as it serves as a driving force for every endeavour and perseverance the teacher has to confront. Philippou and Christou (2002) argued further that teachers' endeavours are highly reliant on their beliefs considerably than their knowledge or capability to accomplish something.

2.3.3 Professional Development Program

Professional development has been considered as one of the important factors in improving teaching practice and student outcomes. The effects are, however, not similar. On one hand, Guskey and Sparks (2004) claimed that teacher knowledge and practices are directly influenced by professional development activities. They are, in fact, the most immediate outcome of professional development. Wang, Frechtling, & Sanders (1999), on the other hand, espoused that professional development activities do not have a direct and exclusive effect on the improvement of students learning, but rather through the influence on teacher and school administrators' knowledge and practices.

However, results of studies regarding the effects of professional development on classroom instruction and students' learning has no consistent pattern. For instance, the study carried out by Jacob, Hill and Corey (2017) on the impact of professional development program on teachers' mathematical knowledge for teaching and instruction and student achievement disclosed that professional development programs have no effects on teachers instructional practice or on students’ outcomes. Their study employed a quasi-experimental research designed to help teachers learn more mathematics, understand how children understand mathematics and to develop effective classroom instructional strategies. This involved 105 fourth and fifth grade teachers that were divided into two groups, the control and the experimental groups. Teachers in the experimental group received the training that lasted for a week and four to six days during the school year.

Research has shown that effective professional development concentrates on instruction and student learning outcomes, promotes collaboration among peers, provides opportunities for reflection, feedback, and critical thinking, and is sustained and continuous (Corcoran & Goertz, 1995; Little, 2003; Smylie, Allensworth, Greenberg, Rodney, & Luppescu, 2001). A number of research studies, however, have not showed specific evidence of the extent of impact of professional development on teacher practice and students outcomes (Guskey & Sparks, 2004). But, a rather more specific results were shown regarding the frequency, duration and specific type of professional development. For instance, Wenglinsky (2002) found that the more time teachers engage in professional development, the more their students engage in hands-on and practical learning. Students who engage themselves in practical learning obtain higher scores on the mathematics achievement. Furthermore, Wenglinsky revealed that professional development tends to have positive relationship with students' achievement when it is about development of higher-order thinking skills.

In the study of Garet, Porter, Desimone, Birman and Yoon (2001) involving 1,027 mathematics and science teachers, the results indicated three central features of professional development activities that have significant, positive effects on teachers' improvement in classroom practice. These are focus on content knowledge; opportunities for active learning; and coherence with other learning activities.

Similarly, Huffman, Thomas and Lawrenz (2003) specifically examined five types of professional development activities recommended by Loucks-Horsley, Hewson, Love and Stiles (1998) in their study about the relationship between professional development, teachers' instructional practices and achievement of students in science and mathematics. This involved a total of 198 Grade eight science and mathematics teachers in 46 schools. Using the regression analyses, the results pointed out that only two types of professional development were significantly related to the use of standards based instructional practice, while only curriculum development type of professional development was significantly correlated with students' achievement.

Teachers need to continue to upgrade themselves and enrich their knowledge in their field of specialisation.

2.3.4 Teacher Characteristics and Students Achievement

2.3.4.1 Years of experience

Expectedly, teachers who have just graduated from a bachelor course related to teaching would probably have less confidence in teaching, which could have an effect on student performance. The confidence, however, may tend to improve as the teacher gains experience. There are a number of studies that show the effect of teacher experience on students' performance. Results, however, have shown that the magnitude of the effects is dependent on level of education and the subject area (Rice, 2010). Gibbons, Kimmel and O'Shea (1997), for example, found that students who are taught by more experienced teachers achieve higher because the teachers have most likely mastered the content of the subject area, he/she is teaching and have acquired the necessary skills in handling students in the classroom.

2.3.4.2 Level of education

The teacher's level of education and years of experience proved to be unrelated to student achievement in the study carried out by Wenglinsky (2002). The study aimed at investigating the link between teacher classroom practices and Grade Eight students' performance in Mathematics. However, teachers course programs in college that are related to the subject they are teaching led to better student performance.

Some studies (e.g., Betts, Zau & Rice, 2003; Goldhaber & Brewer, 1997, 2000) have shown that teachers advanced degrees could have positive effects on students' performance. It was revealed in the study conducted by Kosgei and colleagues (2013) involving teachers from secondary schools in the South District of Kenya.

The results disclosed that there is a positive relationship between teacher qualification in terms of educational level and students' performance, that is, as the level of teacher education increases, the student performance likewise increased. The impact of teacher educational attainment is, however, contradictory among elementary level students' achievement. Harris and Sass (2007) and Clotfelder, Ladd and Vigdor (2007) for example, found that teachers with master's degree or earning such degrees seem not to enhance students' achievement at the elementary level.

2.4 School-related Factors

Student performance is usually directly affected by either teachers' characteristics, practices, attitudes and beliefs. However, teachers, in turn, may be affected by a variety of factors at the school-level. Perhaps, common examples are the workplace conditions they are in and the opportunities that are available for them. If school management, for example, will provide an environment where teachers are motivated to work and efforts exerted are acknowledged and rewarded, teachers' quality of teaching are likely to be influenced positively (Darling-Hammond, 2000).

2.4.1 Management/Leadership Style

School principals or heads also play critical roles in students' development. They are normally held accountable for students' learning outcomes. It is, thus, important to consider their leadership styles that helped them in putting their students up the ladder of international assessments.

The principal's influence on students' learning outcomes is, however, not direct. According to Kaplan, Owings and Nunnery (2005) the principal's effect on student achievement may be indirect, but it is crucial. They indicated further that

> the principal controls the most important factors affecting a school's teaching and instructional quality, including attracting, selecting, and keeping outstanding teachers; working with the school community to establish a common mission, instructional vision, and goals; creating a school culture grounded in collaboration and high expectations; facilitating continuous instructional improvement; finding fair, effective ways to improve or remove low-performing teachers, and producing excellent academic results for all students (p. 29).

In addition, Leithwood, Seashore-Louis, Anderson and Wahlstrom (2004) concluded that leadership is second only to classroom instruction among the school-related factors in influencing student learning after their review on both quantitative and qualitative research on school leadership. Other research (e.g., Hallinger & Heck, 1996, 1998; Witziers, Bosker, & Kruger, 2003) likewise suggest that the effects of leadership are largely indirect or has a minimal direct impact on student achievement (Ross & Gray, 2006).

This shows that a school principal who takes the role of an instructional leader is able to make connections to students’ achievement through the teachers. This has been affirmed by Cotton (2003) when he wrote that "since the beginning of research about principals' impact on student results, studies have shown that principals who are knowledgeable about and actively involved in their school's instructional program have higher-achieving students than principals who manage only the non-instructional aspects of their schools." (p.25).

As reported by the Organization for Economic Cooperation and Development (OECD, 2009) that in many TALIS countries an instructional leadership style is associated with schools that make more frequent use of an appraisal process aimed at improving student learning outcomes and at teachers' use of professional development. It is also associated with adopting specific professional development plans designed to help weaker teachers improve their teaching practices. It was also indicated in the report that principals in ten participating countries adopt instructional leadership with a common objective of improving teacher practices.

A number of research studies (Bryk, Camburn, & Louis, 1999; Youngs & King, 2002) have also indicated principal leadership has a strong influence on the school's professional community. Professional community in this context refers to the extent to which teacher interaction is regular and teachers' actions are directed by common norms and standards on teaching and learning (Bryk et al., 1999; Kruse, Louis, & Bryk, 1995). However, according to Sebastian and Allensworth (2012) the scope of principal leadership may depend on the area of the principal's own expertise, the strength of departments within the schools and supports within the schools, and other contextual factors such as school size and grade level.

The study carried out by Sebastian and Allensworth (2012), where they examined the influence of principal leadership on classroom instruction and student achievement through key organisational factors, such as professional capacity, parent-community ties and the school's learning climate found that within schools, variation in classroom instruction is associated with principal leadership through multiple pathways, the strongest of which is the quality of professional development and coherence of programs. Between schools differences in instruction and student achievement, on the other hand, are related with principal leadership only via the learning climate. Their study involved the Chicago public high schools and they employed the multilevel structural equation modelling in examining the relationships among the variables included. The results suggest that establishing a safe, college-focused climate in high schools may be the most important leadership function for promoting achievement school wide. The study also found out that the positive relationship of principal leadership and instruction through the school learning climate carries through to explain differences in student achievement across schools.

Conclusively, it is the quality of classroom instruction that students receive matters for their achievement. Studies that examine the effects of principal leadership on student achievement have presupposed classroom instruction as an important mediating factor. School principals may affect students’ achievement by working with teachers in classrooms or through their efforts to improve professional capacity, parent involvement, or school climate (Sebastian & Allensworth, 2012).

2.4.2 Beliefs about the Nature of Teaching and Learning

As presented earlier, school principals' leadership greatly influences teacher practice. Beliefs are, likewise, thought to influence and shape classroom practice (Prestridge, 2012). It is therefore important to consider the beliefs of school principals.

This study has considered two dimensions of beliefs on the nature of teaching and learning, one is constructivist belief and the other is direct transmission belief. Constructivist beliefs are characterised by a view of the teacher as a facilitator of learning who gives more autonomy to students; a direct transmission belief sees the teacher as the instructor who provides information and demonstrates solutions (OECD, 2009)

The study conducted by Walker-Glenn (2010) explored a possible connection between school principals' attitudes and beliefs about mathematics and students' mathematics achievement. This involved students and secondary school administrators. Mixed method was employed, where survey questionnaires and data-base analysis were used for the quantitative research and interviews for the qualitative research. Results of the quantitative analysis did not show significant direct relationships between principal's background and students achievement. However, the interview showed interesting findings about how the principal's background in mathematics has impacted his/her way of evaluating teachers and programs related to mathematics.

OECD (2009) presented the relation between principals' beliefs about approaches to teaching and their leadership style. Instructional leadership is used in nine countries in which principals have a more constructivist belief about instruction. In countries in which principals believe that the task of teaching is to support students in their active construction of knowledge, they are also more likely to demonstrate instructional leadership. However, in 14 countries there is a similarly positive association between more administrative leadership and constructivist beliefs about instruction (OECD, 2009)

2.4.3 School Climate

School climate and its relationship to student achievement has been the focus of research interest over many years. The school climate is influenced by students, teachers and principals (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009). Brown, Anfara and Roney (2004) consider school climate as a fairly stable aspect of school environment. Several researchers have offered varying definitions of school climate.

Freiberg (1999 in Kozina, Rožman, Perše and Leban, 2008, p. 3), for example, define school climate as

> a set of internal characteristics that distinguish one school from another and influences the behaviour of school members. These internal characteristics are most commonly referred to as the quality of interpersonal relations between students and teachers; the extent to which a school is perceived as safe and caring place; the degree to which students, parents, and staff are involved in collaborative decision making and the degree to which there are high expectations for student learning.

McEvoy and Welker (2000) also suggested another definition of school climate. They state that school climate is consists of attitudes, beliefs and values and norms that underline the instructional practices, the level of academic achievement and the operation of the school. Most widely, school climate can be defined as the psychosocial context in which teachers work and teach (Johnson, Stevens & Zwoch, 2007); it is referred to as the beliefs, values and everyday interactions among school personnel, parents and students (Bryk et al., 2010); it is the quality of faculty-principal relations and the characteristics of an organisation (Miskel & Ogawa, 1988).

Research interest on school climate has now been growing because of the observed evidence, that demonstrated association with students' achievement (Choi & Chang, 2011). School climate has multilevel dimensions. Lee and Shute (2010) had listed a number of these, which include teacher efficacy, teacher affiliation, teacher empowerment, principal influence, resource support, school policies and class sizes. Lee and Shute had presented results from a number of empirical research that reveals the significant relationship between the various factors of school climate and K-12 students' academic performance. Among the factors they considered are principal influence, resource support, school policies and class sizes.

School climate can be positive or negative. According to Lehr (2004), a school that has positive school climate is perceived as welcoming and is characterised by respectful interactions between individuals. In these types of surroundings, students are also motivated to achieve. A negative school climate is exactly the opposite.

Studies reveal that a more positive school climate is connected to higher achievements. Students who attend schools with a more positive climate tend to have more positive attitudes towards school and school subject which lead to higher achievements (Lehr, 2004). Rothman and McMillan (2004) also put forward that schools that work to develop a positive climate may also develop greater academic achievement in their students. Chen (2014) also suggest that principal's perception of school climate positively predicted students' mathematics achievement.

It is believed that school climate could also impact teaching practice. If a school could provide a learning environment where teachers' morale is boosted, the teachers, in return, could impact students' learning positively. Evidence has shown that the social climate of the school and the morale of the staff can have a positive effect on students’ attitudes and learning (Miller, 1981). Enhancing the school climate and the morale of the teachers also makes teaching more satisfying. Building on these, teachers in schools with positive learning climates encourage and motivate students to engage in academic work with depth and rigor (Johnson et al., 2000).

While school climate has been reported to have influenced students’ achievement, previous research has shown that school climate has been impacted by the leadership style of the school principal (Hoy & Hoy, 2003; Marzano, Waters, & McNulty, 2005). This indicates that principals who pay attention to the needs of their teachers, staff, students and parents build a healthy environment where satisfaction is felt and support is provided.

Research has revealed that the principal, as the leader of the educational environment has a direct effect on the school climate (Cotton, 2003; Hallinger, 2003; Hallinger & Heck, 1998). As an instructional leader, principals influence student academic achievement by facilitating an environment where teachers make the most of their ability to provide quality classroom instruction (Goldring & Pasternack, 1994; Hallinger & Heck, 2002; Hallinger & Murphy, 1986). This shows that the principals' positive impact on school climate allow them to have an indirect influence on students’ academic achievement (Cotton, 2003; Hallinger & Heck, 1998). Hallinger and Murphy (1987) also added that principals are responsible for maintaining a climate that is collegial, interactive and focused on supporting the teacher and students throughout the educational process.

2.4.4 School-level characteristics

2.4.4.1 Type of School

The type of school – public (government) or private, has been considered to have a notable impact on students' achievement. This appeared to be the same case that Tooley and Dixon (2006) advocated. They found out that private schools, registered or unregistered, had achieved higher raw mean scores when matched up to government/public schools. A replication of this result has been accounted for students in Hyderabad (Ejakait, Mutisya, Ezeh, Oketch, & Ngware, 2011). The findings of their study put forward that students registered in a privately managed school (registered or unregistered) obtained higher mathematics achievement compared to students in government schools by up to 22 percentage points. They further suggested that the difference in students' performance between private and government schools appeared to be replicated in the English subject (Ejakait et al., 2011). Fuchs and Wößmann (2007) supported this earlier assertion as their studies likewise revealed that students from private schools have improved achievement using different set of achievement data from Programme for International Student Assessment (PISA).

2.4.4.2 Class Size

Class size refers to the actual number of pupils or students taught by a teacher at a particular time (Ehrenberg, Brewer, Gamoran & Willms, 2001). The size of classes greatly varies. Although, an ideal class size has been recommended or included in school policies, it may also depend on several factors, such as the availability of classrooms, teachers, resources and other facilities.

At the school or class level, class size for mathematics instruction was identified as one among the common predictors of students' mathematics achievement in both Hong Kong and Singapore (Chen, 2014). Other studies, however, revealed varying results on the relationship between class size and achievement, as well as the effect of class size on students' achievement. Previous TIMSS results show that, on average, the relationship between class size and mathematics achievement is curvilinear. This means that students with higher achievement actually belong to larger classes. This is revealed among the top four performing countries at the Eighth Grade - Singapore, Korea, Japan and Hong Kong SAR. These countries are among those with larger mathematics classes, however, their students' performance are the highest compared to those countries with smaller mathematics classes.

It is often assumed that being in small classes is advantageous to students' achievement. However, research findings show that this may not be true (Konstantopoulos, 2011; Pong & Pallas, 2001). For example, Akyüz and Berberoğlu (2010) found that bigger class size was related to higher mathematics achievement in Belgium, Hungary, Italy, Lithuana, and Netherlands, but not related in Slovak Republic, Czech Republic, Slovenia, and Turkey (Chen, 2014). Class size was also negatively related to students' mathematics achievement in Kenya (Kanyongo & Ayieko, 2017). Earlier findings also indicated that large class sizes were negatively related to students' mathematics achievement (e.g. Wößmann & West, 2006; Visser et al., 2015). Schütz (2006), however, found that school size was unrelated to students’ achievement in most countries when students’ characteristics, teacher and school effects were included. She utilised TIMSS 2003 Grade eight data to examine the relationship between school size and student achievement within different countries.

Other researchers contend that the influence of class size is rather indirect. Mullis, Martin, Gonzales, and Chrostowski (2004), for example, put forward that class size influenced pedagogical strategies. This is also consistent with what Smith and Glass (1980) suggested that reduced class size was associated with better teaching and with Bar and Dreeben's (1983) claims that the effect of class size on achievement was most likely to be evident if class size was linked to instruction. If the class size is small, teachers can be more efficient in using their instructional strategies, manage their time properly and can give more attention to individual students' needs (Ehrenberg, et al., 2001). These, in turn, would maximise students' learning and achievement in the end. Wenglinsky (2002) also suggested that the various aspects of teacher quality were related to student achievement when class size and SES were taken into consideration.

2.5 Student-related factors

Several factors may be attributed to students’ performance in mathematics aside from those contributed by their teachers and school itself. These factors may include home resources for learning, parents' support, time spent in studying, confidence in learning mathematics, beliefs about mathematics and teachers' motivation to learn.

Teodorović (2011) put forward that student-level variables are critical in determining students' achievement in industrialised countries. In his study (Teodorović, 2012), he likewise indicated that the variance in students' achievement could mostly be explained by student-level factors. Similarly, the results of Chen's (2013) investigation using TIMSS 2007 Grade four data suggest that most of the influential factors of Singaporean students' low achievement were at the student level.

2.5.1 Attitudes towards Mathematics

Several countries, including the Philippines have given students' achievement in mathematics and other subjects high regard, especially that results of standardised assessments are used to indicate the effectiveness of teaching practices, in particular and school programs, in general. Hence, a number of factors influencing students' achievement in Mathematics have been looked at considerably and different stakeholders, including the parents, teachers and researchers have been interested in examining the possible factors that influence student performance (Hemmings, Grootenboer, & Kay, 2011). Researchers have looked at different factors, one that is of interest, also in this study, is the effect of students' attitudes towards mathematics on their achievement. There have been various studies around the globe that have examined attitudes towards Mathematics at various levels and results have shown that the effects could vary.

Ker (2016) conducted an exploratory comparative study on the multilevel factors affecting students' mathematics achievement in Singapore and the United States of America (USA). Among the student-level variables of both countries, self-confidence in learning mathematics influences students' mathematical achievements the most. This means that the higher the students' self-confidence in mathematics the better they perform. For Singapore, confidence in teaching Mathematics (CTM) has negative effect on average mathematics achievement. Four out of five teacher-level variables were found to have affected students' mathematics performance. Though teachers' confidence in teaching mathematics (CTM) was also found to have significant effects on students' achievement in the USA, the effect, however, was positive, opposite to that of the Singapore results (Ker, 2016).

The study conducted by Hemmings, Grootenboer and Kay (2011) examined the extent to which several factors such as gender, attitude, ability, enabling skills and environmental setting could predict achievement in mathematics in an Australian setting. The main aim of the study was to explore the correlation among attitude towards mathematics, ability and mathematical achievement. This study was participated by Year 7 students (during the school year 2004-2005) and continued their schooling until Year 10 in the same independent co-educational secondary school in regional New South Wales. These students had sat the Literacy and Numeracy National Assessment (LANNA) tests. The results of Multivariate Analysis of Variance (MANOVA) demonstrated that Mathematics Attitude was the sole significant measure and pointed out that females, as opposed to males, were more inclined to view mathematics favourably. Gender differences did exist with respect to Mathematics Attitude. Female students were more likely to hold positive attitudes towards mathematics.

Yasąr's (2016) study aimed at determining whether or not there is a meaningful difference between the mean values of the mathematical attitude points of high school students and their gender, the gender of their mathematics teachers, their high school type, private course attendance, receiving private mathematics lessons, education level of their mother, education level of their father, and their perceived success levels. Yasąr involved 1,801 students who were studying at different high schools located in Denizli city center, Turkey. The Mathematics Attitude Scale (MAS) developed by Yasąr, Çermik, and Güner (2014) was utilised to measure students' attitudes towards mathematics classes. Analysis of variance (ANOVA), t-test and multiple linear regression were used for data analyses. Results revealed that 1) there is no meaningful difference between the mean values of the attitude points of male and female students; 2) there is no meaningful difference between the mean values of the attitude points of the male and female students when the gender of the mathematics teachers are considered; 3) results of ANOVA suggested that there is a meaningful difference between the high school types of the students and their mathematical attitude point mean values; 4) there is a meaningful difference between the mean values of the mathematical attitude points of the high school students in terms of their fathers' educational levels; and 5) there is a positive correlation between the attitudes of the high school students towards mathematics classes and the educational level of the fathers.

Ercikan, McCreith and Lapointe (2005) used different groups of variables in a mathematics study across the three countries, USA, Canada, and Norway. They found that mathematical confidence was the strongest predictor of mathematical achievement in Canada and Norway.

Confidence in Learning Mathematics

Chen (2014) found that student's self-confidence in learning mathematics had the strongest significant predictor of mathematics achievement among the Grade Four students of Hong Kong and Singapore after controlling for other predictors.

The results from the multilevel study of mathematics achievement for Malaysian and Singaporean students found that at the student level, self-confidence was the most influential factor, while at the school level, school climate perceived by school principals had the largest impact on student achievement for both Malaysian and Singaporean students (Ghagar, Othman, & Mohammadpour, 2011 in Ker 2016).

Wang, Osterlind and Bergin (2012) employed TIMSS 2003, Grade Eight data to investigate factors associated with mathematics achievement in the countries USA, Russia, Singapore and South Africa. They found that one of the student-level variables, confidence in learning mathematics has the strongest significant effect on mathematics achievement in all four countries. The other student background characteristics, teacher variables and school variables did not show significant effects.

Mathematics Anxiety

Recognised since the early 1979s, Mathematics anxiety has been defined as "feelings of tension and anxiety that interfere with the manipulation of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). It is regarded as multidimentional (Ma, 1999) having components relating to attitude, cognition and emotion that manifest in inclinations, thoughts, feelings toward mathematics. Each of these components is influenced by a range of other factors including teachers, parents and teaching (Ma, 1999; Turner et. al, 2002). As well as being considered to have an attitudinal component, mathematics anxiety is also considered to be one dimension of attitude to mathematics (Ma & Kishor, 1997), and in that context can be considered as one end of a confidence-anxiety spectrum (Jennison & Beswick, 2010).

Hembree’s (1990) meta-analysis of studies of mathematics anxiety amongst school students revealed that mathematics anxiety reaches its peak in Year 9 and 10 with Years 7 and 8 identified as significant in its development.

Ashcraft and Kirk (2001) explained that favourable attitudes and low mathematics anxiety allow an individual to enjoy and seek out mathematics experiences leading to increased mathematical competence. Conversely, poor attitudes and high anxiety are associated with avoidance behaviour and this leads to decreased mathematical competence. In addition, they found that “higher levels of mathematics anxiety are related to lower available working memory capacity” (p. 236).

Students attitudes are also believed to have connection to some variables, these include "students’ gender, grade level, school type, perceived success, mothers' education level, fathers' education level," among others (Ekizoğlu & Tezer, 2007 in Yasąr, 2016). In another study, Taşdemir (2008 in Yasąr, 2016) states there is no meaningful difference between the mean values of students' attitudes when the educational levels of their mother are considered, however, when the educational levels of the fathers are considered, there are differences in the attitudes points and the mean values at a meaningful level.

2.5.2 Parents Educational Level`

Parents' educational level has been shown to be a factor in students' academic achievement. Parents serve as a role model to their children in pursuing high educational goals. A number of studies indicated that student achievement is correlated highly with the educational attainment of parents (Coleman, 1966). This means that students whose parents had less than high school education obtained lower grades in mathematics than those whose parents had higher levels of education (Campbell, Hombo, & Mazzeo, 2000).

The effect of parents' educational level on students' achievement level has also been investigated by other researchers. For instance, Yazici (2002, in Yavuz, 2009) suggested that the more highly educated the mother is, the more the child matures in school, starting from pre-school. The correlation between the father's education and the student's academic achievement is also positive (Cabrera, Shannon & LeMonda, 2007; Smith, Atkins, & Connell, 2003).

Yavuz's (2009) hypothesised in his study that the variables mother's and father's educational level have direct effects on mathematics-science scores of randomly selected secondary students in Turkey. Results show that, on one hand, mother's educational level has direct positive effect on mathematics-science scores, however, students' scores were not affected by mother's educational level through family income and attendance at private courses. Father's educational level, on the other hand, had a direct positive effect on students' mathematics-science scores. This revealed that the higher the educational level the father has achieved, the higher the family income will be and the greater the private course attendance will be, resulting in higher mathematics-science scores.

However, research results also vary across different cultures. For instance, according to research conducted in Japan, highly educated mothers influence their daughters' academic achievement, but not their sons' (Campbell & Uto, 2002 in Yavuz, 2009). The same research has shown that educated fathers improve their children's academic achievement. In conclusion, the academic achievement of students who have highly educated parents is higher than those who do not (Gross, Mettelman, Dye, & Slagle, 2002).

2.5.3 Gender

Several literatures have also revealed other factors conceived to have influence on students’ achievement. One of the factors that continue to attract attention from mathematics education research and have stimulated the most robust examination is gender. Research revealed that gender has been connected with poor performance (Ejakait et al., 2011). For example, the study carried out by Niaz Asadullah, Chaudhury, and Dar (2007) utilising the data from Bangladesh, reveals that girls had obtained considerably lower test scores than boys. The data obtained by Ignacio et al., (2006) illustrated that the mathematics performance of the girls was lower than the boys, albeit, small. This also validates the foregoing research findings (Tsui, 2007; Meelissen & Luyten, 2008). In addition, Cobb-Clark and Moschion (2017) disclosed in their paper involving third grade pupils in Australia that boys in high-SES families have higher numeracy test scores than girls.

Contrary to what these studies have found, other investigations have unveiled that girls' achievement is more outstanding than boys (Ejakait et al., 2011). Another study carried out in the United Kingdom is that of Cassen and Kingdon (2007) which presented that there were more boys who perform poorly compared to girls. Similarly, girls who went to school in Ethiopia urban centres were also found to have outstanding performance in the national examinations when matched with boys (Abraha et al., 1991). Fennema (2000) have synthesised that gender differences may be decreasing in mathematics.

Earlier studies have identified gender as one of the factors that have an imperative influence on attitudes towards mathematics and achievement in mathematics (Ma & Kishor, 1997). Aiken (1970) exhibited in his review the effect of gender on the relationship between attitudes toward and achievement in mathematics. He wrote:

> No one would deny that sex can be an important moderator variable in the prediction of achievement from measures of attitudes and anxiety. The results of several of the investigations... suggested that measures of attitudes and anxiety may be better predictors of the achievement of females than of males. (p. 567)

This point of view resonates with Aiken's (1976) later study, which recounted that the relationship between attitude and achievement in mathematics is remarkably higher among girls. Hence, girls' attitudes can be accounted for their scores than boys' scores (Aiken, 1976). Choi and Chang (2011) conversely found the opposite in their study about the middle school students using the data from TIMSS 2007. It revealed that female students had demonstrated less positive attitudes towards mathematics compared with the males of the same grade level. A similar analysis of the relationship between gender and attitudes to mathematics was made by Ignacio, Nieto and Barona (2006) who reported that gender proved to have a link with "pupils' attitudes and general reaction to mathematics" (p. 27). Gairin (1990), however, inferred that attitudes towards mathematics are not significantly affected by gender. The meta-analysis about the association between attitudes and performance carried out by Ma and Kishor (1997) likewise revealed that there was no significant discrepancy between attitudes and performance in mathematics that is ascribed to gender. Utsumi and Mendes (2000) expressed the same observation with Ma and Kishor's analysis. Moreover, Frost, Hyde and Fennema (1994) disclosed that differences in mathematics attitude and affect is slightly attributed to gender. Liu (2009) furthermore reported the small but constant attribution of gender on students' performance on the four mathematics subtests from PISA 2003 (Choi & Chang, 2011).

2.5.4 Ethnicity

The question on whether ethnicity affects students' attitudes and achievement has been in the literature for decades. In Aiken's (1976) study, he reported that the low but significant relationship between attitudes and achievement in mathematics is comparable among ethnic groups. However, Ma and Kishor's (1997) study showed a potentially less compliant result as they reported that significantly stronger relationship between attitude and achievement in mathematics is evident among Asian students than among White or Black students. They added that the extent of the relationship for Asian and Black students is definitely not as weak as what Aiken pointed towards (Ma & Kishor, 1997). Interestingly, Secada (1992) articulated that both the findings from the cross-sectional study of the National Assessment of

Educational Progress (NAEP) and the longitudinal analysis of the National Longitudinal Study (NLS) and the High School and Beyond (HSB) reliably revealed that the difference in mathematics achievement among ethnic groups is high and will continue to rise as the student becomes older.

2.5.5 Home Possessions

Another factor that has a significant role in mathematics performance of learners is the home possession. This includes, among other, the books, desk, calculator, and computer. This study, however, considered only the possessions of calculator and computer at home.

For instance, Akyüz and Berberoğlu (2010) conducted a two-level analysis of TIMSS 1999 data from nine European countries, i.e. Belgium, Slovak Republic, Czech Republic, Hungary, Italy, Lithuania, Netherlands, Slovenia and Turkey. They found that at the student level, home educational resources were significantly related to mathematics achievement in all the countries except Netherlands (Akyüz & Berberoğlu).

In addition, Ghagar, Othman and Mohammadpour (2011), conducted multilevel analysis of mathematics achievement of Malaysian and Singaporean eighth graders in TIMSS 2003. It was found that at the student level, home educational resources were significantly associated with mathematics achievement in Singapore but not in Malaysia. Consistently, Mullis et al. (2004) found that in many countries there was a positive relationship between mathematics achievement and students from homes with a range of resources such as computers, calculators, study desks, and dictionary.

It can be noted, however, that the effect of computer on students' achievement depend on the number of hours spent and the purpose of using the computer. For example, House and Telese (2012) found that, the more time students' spent outside the school playing computer games or browsing the internet, the lower their mathematics achievement scores. It cannot be denied that students of today's generation use their computers not for academic purposes but for entertainment.

Chapter 3
Conceptualisation and Operationalisation

3.1 Introduction

The chapter discusses the theoretical framework upon which the study is grounded. Emphasis is given to establishing the practical application of the theories to the relationships between and among variables such as mathematics teachers' classroom teaching and assessment practices, as well as teachers', school principals' and students' characteristics. Various theories on teaching, assessment and learning are considered as sources to build the research model including Biggs learning theory (Biggs, 1996) and Biggs 3P Model (Biggs, 1996). It is not an attempt to explain the theories in depth or to test the truths of certain theories. Rather, it is a discussion of the theoretical elements that relate to the research variables. These become the foundation/scaffold of the research model. These theories are highlighted because they provide comprehensive, broad and well-known concepts and practices in the context of teaching and learning.

For common understanding of the terms or variables used in this study, conceptual and operational definitions are presented after the theoretical framework. The operational definition includes how the variables are being measured and what indicators are being used.

3.2 Theoretical Framework

The teachers are the central focus of the study. The school context provides a starting point for understanding the support available to teachers. The student outcomes function as criteria for assessing the extent to which a teacher has been successful in improving student performance. Thus, the study is not concerned primarily with student outcomes, but rather with understanding what makes more or less effective classroom practices of mathematics teachers and how these practices and other underlying factors influence student achievement.

The study is underpinned by Biggs' 3-P model of learning (Biggs,1996). The 3-P model suggests that students bring with them their own context and predispositions related to learning, which the teachers must consider when thinking of teaching methods to use. The model consists of the elements *presage*, *process* and *product*. This implies that the approach to learning should be a combined function of not only the learner but also the teacher characteristics (presage). Both the teachers and the students carry with them their attributes (e.g. attitudes, beliefs, knowledge) which may influence their daily encounter in the classroom or in the school, as a whole. The students then process their learning that is largely dependent on the teaching and assessment practices (process) that teachers apply in determining the extent of learning in the subject. However, the effectiveness of these practices may or may not influence students' achievement (product).

Mathematics classrooms vary depending on the characters, and their attributes, that make up the environment in it. The unique culture of each classroom is the product of what teachers bring to it in terms of knowledge, beliefs and attitudes, and how these affect the relations and interactions in the classroom. Karp (1991) finds out that the experiences of mathematics students in classes where teachers display positive attitudes are substantially different from those whose teachers show negative attitudes. It can therefore be assumed that learning takes place in an environment where meanings are shared with others.

Figure 3.2.1 presents the theoretical framework which anchors on Biggs' 3-P model. Illustrated therein are the hypothesised relationships among the variables considered in the study. Central to this framework are the mediating factors, which are cognitive and affective in nature. These factors may also affect an individual's behaviour, social and personal skills as well, that could effect change in the predetermined characteristics. In Weiner's (1972) Attribution theory, he posited on the notion of "perceived causality" which affirms that some incidents that take place inside the classroom may be caused by certain social and personal conditions. Attribution theorists investigate as to why certain events happen, in the same way, schools look into why teachers are showing certain behaviours and teachers likewise examine why students behave the way they do. Relating the idea into an achievement-related scenario, students' accomplishment may be attributed to a certain quality, ability or effort. However, individuals vary in their propensities to ascribe achievement outcomes to the attributes of ability or effort (Weiner, 1972).

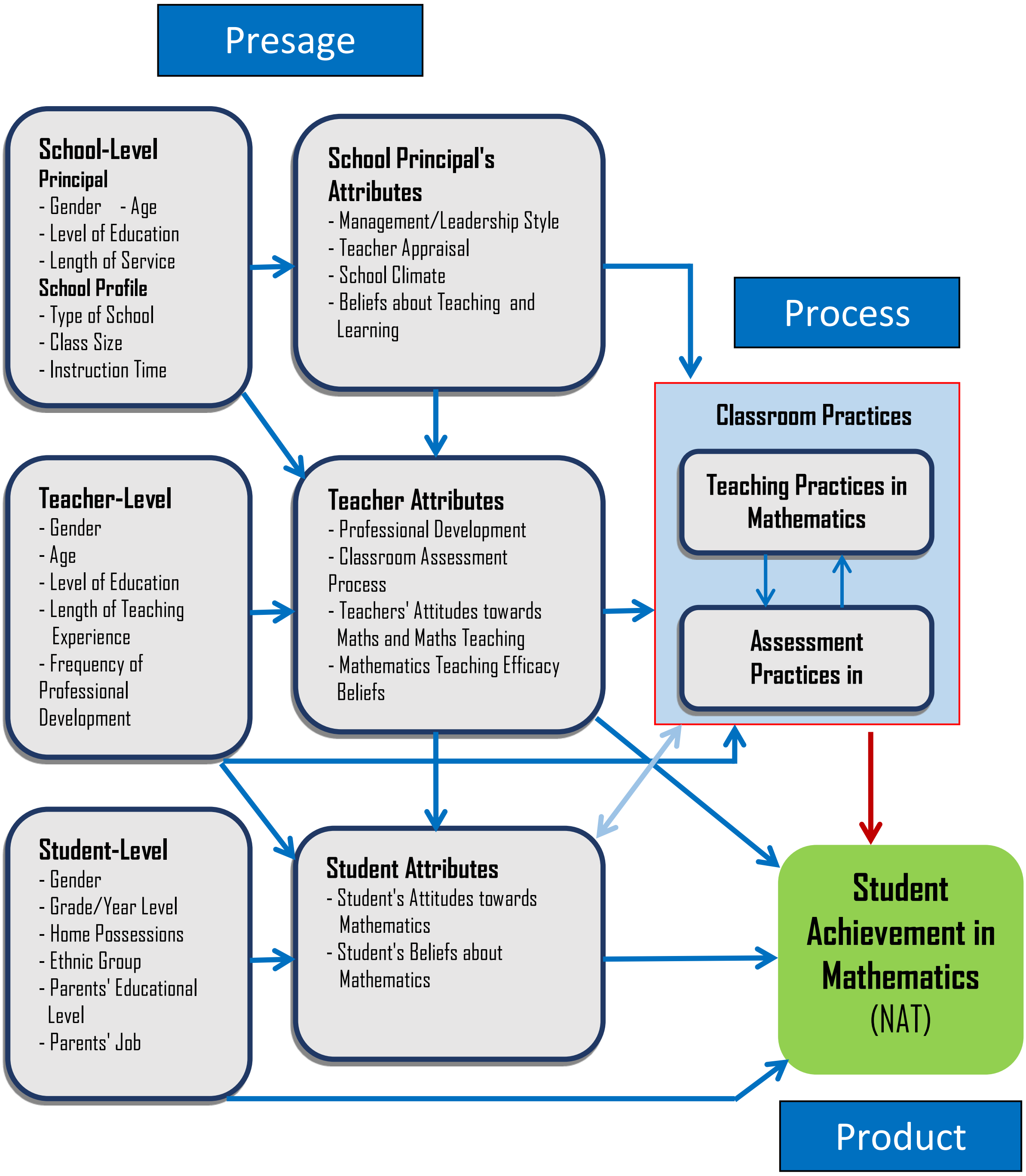


Figure 3.2.1 Theoretical Framework.

Based on a cross-sectional survey, it is not possible to determine whether professional development and feedback help teachers develop a wider repertoire of practices; or whether teachers who report greater use of professional practices are more motivated to get involved in professional learning. Similarly, it remains open whether participation in professional learning communities helps teachers develop high self-efficacy, or whether high self-efficacy helps use a diverse set of professional practices. The positive association hints that it may be worthwhile to closely examine the links and determine whether the existing programmes are effective or if it reached teachers most in need of support.

In another respect, beliefs are considered to guide the professional practices of teachers. It is likely that the relation between both aspects is reciprocal. The report confirms this association in a variety of education systems, propagating the idea to include beliefs in actions aimed at improving teaching practices (Leuchter, Pauli, Reusser and Lipowsky, 2006).

In addition, school characteristics are also seen as a factor influencing the professional practices of teachers. In some countries, school size, teachers' average working hours and parents' socio-economic background predict the school average membership for both profile characteristics (stated above) and professional practices. These associations vary considerably, however, among countries (Leuchter et al., 2006).

Based on the different theories presented above, the framework shows an amalgamation of three broad constructs, school, teacher, and student-level factors. Putting the teacher at the centre of the process, this study sought to investigate the causal relationships between these factors and how they affect students' achievement in mathematics. More specifically, the theoretical model proposes that when teachers come to the classroom, they have already with them their predetermined characteristics such as their gender, age, years of teaching experience, level of education which, could have influenced their attitudes and beliefs and in effect could also influence the way they carry out their classroom practice (both teaching and assessment practices).

The theoretical model likewise proposes that school-level factors (which includes school and principal's profile characteristics) have direct influence on principal's attributes (beliefs about the nature of teaching and learning and management/leadership styles) and school-level attributes (school climate and criteria for teacher appraisal). School-level attributes may likewise be influenced directly by principal's attributes.

The model also indicates that student-level characteristics (includes: gender, age, school level, parents' educational level, parents' employment status, ethnic group, and home possessions) directly influence their beliefs and attitudes toward mathematics, which in turn, influence their mathematics achievement.

In a multilevel context, the theoretical model suggests that students' achievement in mathematics may be directly or indirectly influenced by the school-level characteristics and attributes, as well as by the teacher-level characteristics and attributes.

Since the data collected are from the three distinct levels, school, teacher and student levels, multilevel analysis technique will be used in analysing the data. The nested nature (Resnick, 2010) of the data, which is generally the case in an education system, justifies the use of a multilevel analysis.

3.3 Operationalisation and Instrumentation

This section presents the operational definition of the constructs involved, the dimensions in each construct and the indicators for each dimension. Teacher scales are first presented being the focus of this study, followed by the scales for the Principals and the students. Howitt and Cramer (2000) note that an operational definition of a variable is merely a way of defining a concept by the way in which it is measured (p. 165). Hence, how the variables are measured is likewise provided in this chapter.

3.3.1 Teacher - Level

Classroom practices refer to both teaching and assessment processes, considered as the two central activities carried out by the teacher in the classroom, with the involvement and cooperation of the students. The term is used throughout the discussion unless otherwise teaching and assessment are specified and described separately. Teacher-level factors include teachers' individual characteristics and personal attributes. Below are the descriptions, and operational definitions of the teacher-level variables, both manifest and latent. The scales, items and indicators used to describe each construct are also presented. Figure 3.3.1 presents the different sources of the survey items reflecting the variables included in the study.

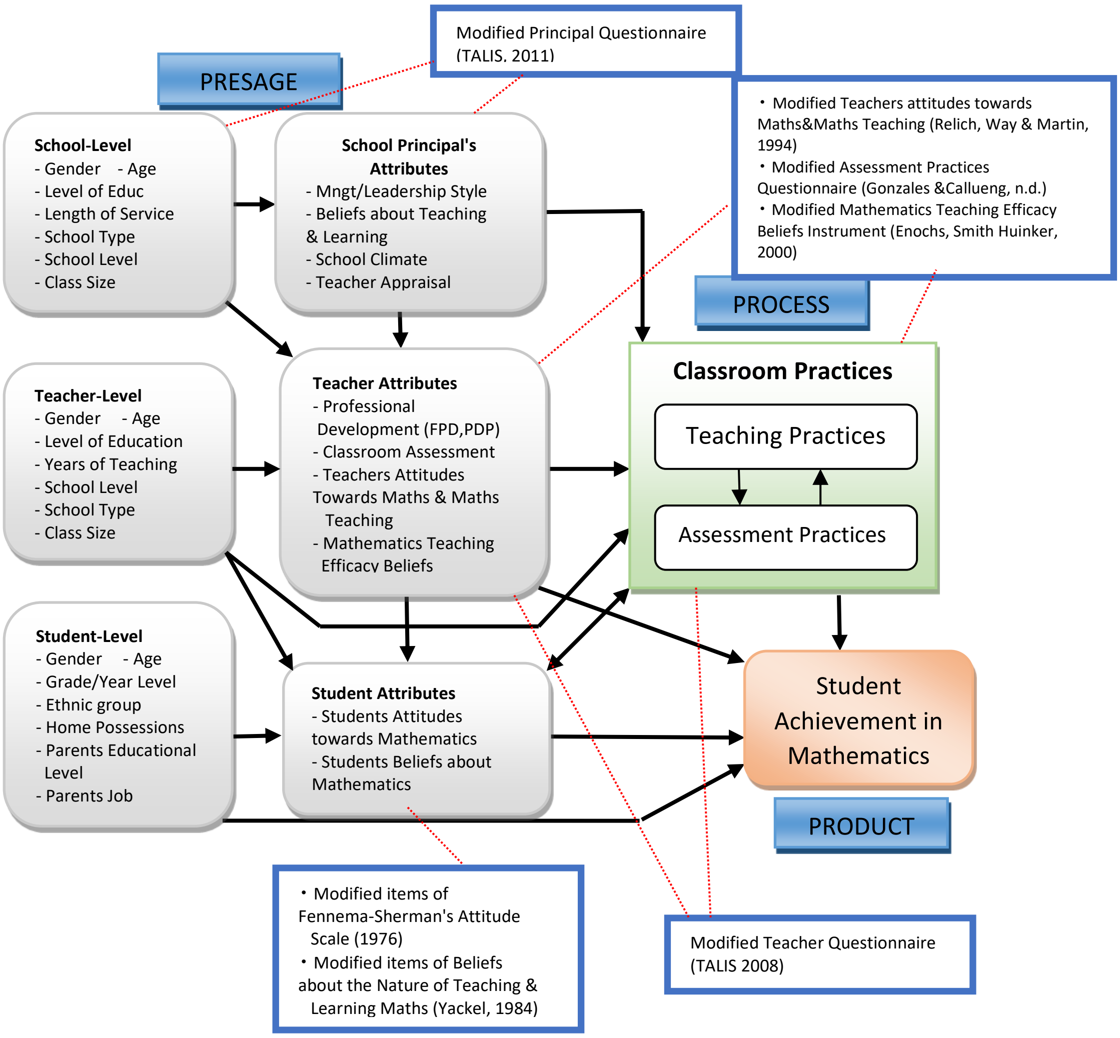


Figure 3.3.1 Conceptual Framework and Instrumentation.

Teacher-Level Variables

1. Gender (G). This refers the respondents' gender. For purposes of analysis, this is coded as 0 for Male and 1 for Female.
2. Age (A). The age of the respondents expressed in complete years.
3. Highest education level (LevEd). This measures the highest level of education completed by teachers, represented by five options namely: Bachelor degree, Bachelor degree with Masters units, Masters degree, Masters degree with

Doctorate units, and Doctorate degree, coded from 1 to 5 respectively. This begins with the Bachelor's degree because it is the minimum requirement for teaching profession.

4. Years of teaching experience (YrTch). This represents the length of their service, in complete years, rendered by the respondent as a teacher.
5. Years of teaching mathematics (YTM). This measures the length of service, in complete years, rendered by the respondent as a subject teacher in Mathematics. Not all teachers handling Mathematics have it as a field of specialization in their bachelor degree. Thus it is likely that they will have taught other subjects before they were assigned the math subjects. It is likewise possible that graduates in math courses will have taught other subjects before they handled Mathematics subjects.
6. Grade/School level (SchLev). This represents the grade level handled by the teacher respondent, either the Sixth grade in elementary or Fourth year high school level.
7. Frequency of Professional Development (FPD). This refers to the frequency of attendance to professional development programs, either bi-yearly, yearly or on a two-year basis. For analysis, these are coded as 1 for once in every six months; 2 for once a year; 3 for once in two years, and; 4 for answers not represented in any of the options.
8. Professional development program (PDP). This accounts for the specific professional development activities teachers have attended in the last three years from the time the study was conducted. This includes enhancement programs specific to mathematics or professional education in general. Examples of mathematics-specific activities are trainings/workshops on knowledge and

understanding of mathematics content, and; trainings/workshops on assessment processes for mathematics. While the education-specific one may include attendance to teachers' congress; participation in a network of teachers organized for professional development endeavours, and; membership in recognized academic organizations of teachers.

9. Teaching Practices Scale (TPS). Premised by the socio-constructivist idea, effective teaching involves cognitive development of the learners (Evensen & Hmelo-Silver, 2000; Mayer, 2004). However, empirical results from video studies (e.g. Klieme, Pauli, and Reusser, 2009; Lipowsky et al., 2009) suggest that learning is also enhanced when lessons are clearly and well-structured, and classrooms are properly managed. Combining the socio-constructivist and the empirical results, the TALIS 2008 study came up with three dimensions of Teaching practices: (a) teacher-directed practices that provide structure and clarity of the lessons and test whether students have understood the content and achieved their goals; (b) student-oriented practices involve students' participation in group work and classroom planning, and; (c) enhanced-activities incorporates students with challenging tasks and allowing them to work independently. These three dimensions are respectively considered in the study as: (a) structured teaching practices (STP), (b) student-oriented teaching practices (SOTP) and, (c) enhanced-activities teaching practices (EATP).

For these items, teacher-respondents were to indicate how frequently they applied each dimension in the TPS. Their responses manifest their general classroom teaching practices. Response categories are in Likert-type ranging from 1 (never or hardly ever) to 5 (in almost every lesson). STP dimension includes eight positive items indicating structured practices such as presenting the lesson using the lecture method. Meanwhile, six items comprise SOTP specifying whether teachers make their students as the centre of the teaching and learning process. While for EATP, four items are listed that point to how often teachers provide opportunities for independent learning activities. Table 3.3.1 below presents the items with their corresponding item code and groupings:

Table 3.3.1
Teaching Practices Scale

Factors / Variables	Item code	Indicators
STP (Structured Teaching Practice)	TPS1	I present new topics to the class (lecture-style Presentation).
	TPS2	I explicitly/clearly state learning goals.
	TPS3	I review with the students the homework they have prepared.
	TPS7	I ask my students to remember every step in a procedure.
	TPS8	I present a short summary of the previous lesson at the beginning of the class.
	TPS9	I check my students' exercise books.
	TPS13	I check, by asking questions, whether or not the subject matter has been understood.
	TPS15	I administer a test or quiz to assess student learning.
SOTP (Student - Oriented Teaching Practice)	TPS4	I require my students work in small groups to come up with a joint solution to a problem or task.
	TPS5	I give different work to the students that have difficulties in learning and/or to the fast learners.
	TPS6	I ask my students to suggest or to help plan classroom activities or topics.
	TPS11	I work with individual students.
	TPS12	I ask my students to evaluate and reflect upon their work.
	TPS17	I ask my students to work individually with the textbook or worksheets to practice newly taught subject matter.
EATP (Enhanced - Activities Teaching Practice)	TPS10	I require my students to work on projects that need to be completed in at least one week.
	TPS14	I require my students to make a product that will be useful to society.
	TPS16	I ask my students to solve word problems in which they are expected to explain their thinking or reasoning.
	TPS18	I design a class activity that requires students to present and argue for a particular point of view.

10. Classroom Assessment Process Scale (CAPS). This construct is used to determine the assessment processes employed by teachers in the classroom from the preparation to the utilisation of assessment results. Note that this does not indicate specific assessment methods that teachers use in the classroom, but

rather stipulates the general assessment processes that teachers follow in preparing for assessment and reporting for results. The scale necessitates teachers to indicate how often they used various assessment activities as: (1) very rarely or never; (2) rarely; (3) occasionally; (4) very frequently, and; (5) always. CAPS consist of 37 items spread across five dimensions: *assessment planning* (AP); *assessment item preparation* (AIP); *assessment administration and scoring* (AAS); *reporting of scores and grading* (RSG), and; *assessment data utilization and evaluation* (ADUE). This was adapted from Gonzales and Fuggan (2012) although the original 60 items were reduced to 37, removing some items not applicable in the context of mathematics. Table 3.3.2 presents the items used to measure classroom assessment process.

Table 3.3.2
Classroom Assessment Process Scale

Factors / Variables	Item Code	Indicators
AP (Assessment Planning)	CAPS1	I prepare at least 3 learning objectives.
	CAPS2	I refer to the curriculum when I organise my learning objectives.
	CAPS3	I follow taxonomy in preparing learning objectives.
	CAPS4	I prepare a test plan according to the learning of my lessons.
	CAPS5	I ensure that every topic I cover in class is included in the assessment plan.
	CAPS6	I relate to the instructional process with the assessment process.
	CAPS7	I try to include a variety of questions to measure different levels of cognitive skills.
	CAPS8	I ensure that appropriate assessment strategies are employed.
	CAPS9	I prepare table of specifications (TOS).
	CAPS10	I write clear learning objectives so that students are aware of what is to be assessed.
AIP (Assessment Item Preparation)	CAPS11	I use textbooks as references when I write test items.
	CAPS12	I include a variety of questions in a single test.
	CAPS13	I make sure I give clear instructions for every type of question I include in a test.
	CAPS14	I arrange test questions from easy to difficult.
	CAPS15	I ensure that questions and options are on the same page.
	CAPS16	I avoid including items that suggest racial, ethnic or gender biases.
	CAPS17	I try to prepare questions that minimise guessing.
	CAPS18	I explain the basis of scoring problem solving items to students.
	CAPS19	I include on the same page the diagrams or maps needed in a particular question.
	CAPS20	I proofread all test questions and instructions before printing them.

Table 3.3.2 (continued)

Factors / Variables	Item Code	Indicators
AAS (Assessment Administration and Scoring)	CAPS21	I ensure that the classroom is conducive for testing activities.
	CAPS22	I see to it that cheating is not encouraged in the classroom.
	CAPS23	I prepare scoring criteria or rubrics before I start marking test papers.
	CAPS24	I score test papers at random.
	CAPS25	I ensure that I have enough test materials before I administer a test.
	CAPS26	I follow scoring criteria strictly when marking test papers.
	CAPS27	I make sure I have enough time to score test papers.
RSG (Reporting of Scores and Grading)	CAPS28	I provide feedback to students after every test.
	CAPS29	I give a grade equivalent to the total score in a test.
	CAPS30	I explain to the students how scores are derived.
	CAPS31	I share test results to other teachers and school director if necessary.
	CAPS32	I make sure parents are informed of the test results of their children.
ADUE (Assessment Data Utilisation and Evaluation)	CAPS33	I determine the difficulty level of each test item after a test.
	CAPS34	I conduct item analysis to know whether items can discriminate students' abilities.
	CAPS35	I make a simple item banking.
	CAPS36	I post the names of students who performed well in a test to encourage them.
	CAPS37	I return all marked test papers to students on time.

11. <u>Preferred Classroom Assessment Practice (PCAP)</u>. This generally refers to the assessment practice preferred by the teacher. These practices are anchored on the purposes of classroom assessment of whether to gauge how much students have learned or how they fared compared with other students in the class; or whether assessment is done to gauge effective classroom instruction or the intention to inform various stakeholders about the progress of students in the mathematics subject. The PCAP scale was adapted from the Classroom Assessment Practices Questionnaire (CAPSQ) by Gonzales and Callueng (2014). Options are in five-point Likert-type style indicating the frequency of assessment activities. There are 18 items categorized into four purposes of assessment based on the framework used by the Western and Northern Canadian Protocol (Earl & Katz, 2006). These purposes are distinct but interrelated with each other.

The first purpose or dimension is *assessment as learning* (AASL), which refers to giving of task-based activities that allows knowledge and learning formation through metacognition. This also allows students to monitor their own learning and give personal feedback (Sanchez & Brisk, 2004). The second dimension is *assessment of learning* (AOFL), which refers to assessment activities that determine how the students are performing in terms of achieving the desired learning outcome and how they compare with other students (Earl, 2005; Harlen, 2007). This dimension is also being referred to as summative assessment (Glickman, Gordon, Ross-Gordon, 2009; Harlen, 2007) because this primarily centres on how the teachers make use of the assessment results to guide instructional and educational decisions (Musial, Nieminem, Thomas & Burke, 2009). The third dimension is *assessment for learning* (AFORL) which is also known as formative assessment. This focuses on determining the progress of the students by giving short quizzes and other activities during instruction. The fourth dimension, *assessment to learning* (ATOL), refers to the reporting of assessment results. Students and parents are normally informed of the assessment results. Results are likewise reported to other stakeholders, such as other teachers, schools and future employers. This dimension is also related to AOFL since it also aims to inform the parents of their children's achievement (Harlen, 2008). Refer to Table 3.3.3 for the items that describe teacher's preferred classroom assessment practice.

Table 3.3.3

Preferred Classroom Assessment Practice

Factors / Variables	Item Code	Indicators
AASL (Assessment AS Learning)	PCAP1	Guide students to set their goals and monitor their own learning progress.
	PCAP2	Demonstrate to students how to do self-assessment.
	PCAP3	Determine how students can learn on their own in class.
	PCAP4	Assist students to identify means of getting personal feedback and monitoring their own learning process.
	PCAP5	Help students develop clear criteria of a good learning practice.
	PCAP6	Set the criteria for students to assess their own performance in class.
AOFL (Assessment OF Learning)	PCAP7	Measure extent of learning at the end of a lesson or subject.
	PCAP8	Evaluate the level of competence of students at the end of an instructional program.
	PCAP9	Determine the degree of accomplishment of a desired learning outcome at the end of a lesson.
	PCAP10	Make the final decision about the level of learning that students achieved at the end of a lesson or subject.
ATOL (Assessment TO Learning)	PCAP11	Rank students based on their class performance to inform other school officials.
	PCAP12	Provide information to parents about the performance of their children in school.
	PCAP13	Examine how one student performs compared to others in my class.
	PCAP14	Supply information to other teachers, schools, employers regarding the students' performance in class.
AFORL (Assessment FOR Learning)	PCAP15	Help students improve their learning process and class performance.
	PCAP16	Assist students to determine their learning strengths and weaknesses in class.
	PCAP17	Identify better learning opportunities for students in class.
	PCAP18	Periodically collect learning data from students to improve instructional process.

12. Teachers Attitudes towards mathematics and mathematics teaching (TATMT).

Table 3.3.4 presents the items measuring the attitude of the teacher. This construct reflects teachers' attitudes towards mathematics and mathematics teaching. This instrument was developed by Relich, Way and Martin (1994) from a composite of subscales from Marsh's self-concept (1989), Fennema-Sherman Mathematics Attitude Scales (1976) and Nisbet's Attitudes to Teaching Mathematics (1991). This construct has two uncorrelated dimensions, which are named as 'Confidence' (10 items) and 'Insecurity' (seven items). The response to each item indicates whether a particular attitude or situation is true or false for themselves. This used an eight-point Likert-type scale, with the ninth categorised as 'Not Applicable (NA, 0)' and was not included in the analysis. The response categories are 1 = Definitely False (DF), 2 = False (F), 3 = More False (MF), 4 = More False than True (MFTT), 5 = More True than False (MTTF), 6 = More True (MT), 7 = True (T), 8 = Definitely True (DT). Analyses, however, reveal that teachers lean towards the positive (true options). This caused the deltas to be disordered in the Rasch analysis. Hence, categories were collapsed and were reduced to four: 1 = DF, 2 = F, 3 = T, 4 = DT (See Chapter 4 for the validation of results).

Table 3.3.4
Teachers Attitudes towards Mathematics and Mathematics Teaching

Factors / Variables	Item Code	Indicators
Confidence	TATMT1	Generally I feel secure about the idea of teaching mathematics.
	TATMT2	I find many mathematical problems interesting and challenging.
	TATMT5	I have always done well in mathematics classes.
	TATMT7	I am quite good at mathematics.
	TATMT8	I have generally done better in mathematics courses than other courses.
	TATMT10	Time passes quickly when I'm teaching mathematics.
	TATMT13	Teaching mathematics doesn't scare me at all.
	TATMT14	At school, my friends always come to me for help in mathematics.
	TATMT15	I am confident of the methods of teaching mathematics.
	TATMT17	It wouldn't bother me to teach a lot of mathematics at school.
Insecurity	TATMT3	Mathematics makes me feel inadequate as a mathematics teacher.
	TATMT4	I'm not the type of person who could teach mathematics very well.
	TATMT6	I do not enjoy teaching mathematics.
	TATMT9	I'm not sure about what to do when I'm teaching mathematics.
	TATMT11	I have hesitated to take courses that involve mathematics.
	TATMT12	I would get confused if I came across a hard problem while teaching mathematics.
	TATMT16	I have trouble understanding anything that is based upon mathematics.

13. Mathematics Teaching Efficacy Beliefs Scale (MTEBS). This construct measures the personal beliefs of teachers about their capacity to teach mathematics and their ability to help students achieve the desired learning

outcomes. This is a modified form of the mathematics teaching efficacy beliefs instrument (MTEBI) by Enochs, Smith and Huinker (2000). This consists of 20 items with five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). This is based on Bandura's (1977) self-efficacy beliefs theory. Consistent with Bandura's theory, this construct has two uncorrelated sub-scales, the *Personal Mathematics Teaching Efficacy* (PMTE) and *Mathematics Teaching Outcome Expectancy* (MTOE). On one hand, PMTE refers to the teachers' belief that he/she has the necessary skills to enhance students' learning (Gibson and Dembo, 1984; Gavora, 2010). The statement, "I am continually finding better ways to teach mathematics", is one of the 12 items of PMTE. On the other hand, MTOE refers to the belief that certain patterns of behaviour could bring about change or outcome (positive or negative) on students (Dellinger et al., 2008). There are eight items under MTOE, one of which is defined in a statement, "A child's interest in mathematics at school is probably due to the performance of the child's teacher." The indicators for both the PMTE and MTOE are found in Table 3.3.5.

Table 3.3.5
Mathematics Teaching Efficacy Beliefs

Factors / Variables		Item Code	Indicators
PMTE	Persistence	MTEB2	I am continually finding better ways to teach mathematics
		MTEB4	I know the steps to teach mathematics concepts effectively.
		MTEB10	I understand mathematics concepts well enough to be effective in teaching elementary/secondary school students.
		MTEB15	I am able to answer students' mathematics questions.
		MTEB19	I usually welcome student questions when teaching mathematics.
	Self – Perceived Ability	MTEB5	I am not very effective in monitoring mathematics activities.
		MTEB7	I generally teach mathematics ineffectively
		MTEB14	I find it difficult to use manipulatives to explain to students why mathematics works.
		MTEB16	I wonder if I have the necessary skills to teach mathematics.
		MTEB17	Given a choice, I would not invite the principal or other administrator (e.g. program/department coordinator, district supervisors) to evaluate my mathematics teaching.
		MTEB18	I am usually at a loss as to how to help student understand a mathematics concept better.
		MTEB20	I do not know how to motivate students in learning mathematics.

Table 3.3.5 (continued)

Factors / Variables		Item Code	Indicators
MTOE	Teachers' Effort	MTEB1	When a student does better than usual in mathematics, it is often because the teacher exert a little extra effort.
		MTEB8	The inadequacy of a student's mathematics background can be overcome by good teaching.
		MTEB9	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
		MTEB13	A child's interest in mathematics at school is probably due to the performance of the child's teacher.
	Teachers' Effectiveness	MTEB3	When the mathematics grades of students improve, it is often due to their teachers' more effective teaching approach.
		MTEB6	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
		MTEB11	The teacher is generally responsible for the achievement of students in mathematics.
		MTEB12	Students' achievement in mathematics is directly related to their teachers' effectiveness in mathematics teaching.

PMTE = Personal Mathematics Teaching Efficacy;
MTOE = Mathematics Teaching Outcome Expectancy

3.3.2 School- Level

The main scales were constructed from principals' responses about how often they undertake certain tasks and activities in the school and their beliefs about their roles as the school head. All the scales included in this questionnaire were modified from OECD - 2011 Teaching and Learning International Survey (TALIS). Presented below are the school-level variables used in this study.

<u>Principal-Level Variables</u>

1. <u>Gender</u>. The school principal's gender is coded 0 for male and 1 for female.
2. <u>Age</u>. This refers to the age of the school head/principal in complete years.
3. <u>Level of education (LevEd)</u>. Refers to the highest educational level the school principal has completed. Education levels are coded as follows: 1 = Bachelor degree, 2 = Bachelor degree with Masters units, 3 = Masters degree, 4 = Masters degree with doctorate units, 5 = Doctorate degree, 6 = Post doctorate and 7 for such other descriptors not found in the indicated choices. In such a case, the principal-respondent must specify on the space provided.

4. Length of service as a principal (YrPrin). This refers to the total number of completed years served by the respondent as the principal or head of the school.
5. Years of teaching experience (YrTch). This pertains to the number of years in the teaching service rendered by the respondent before he/she became a school head/principal.
6. Type of school (SchType). This variable determines whether the principal-respondent heads a government or pubic school, coded as 0; or a private school coded as 1.
7. Class size (CLSize). This indicates the average number of students composing one section or class in the sixth elementary grade and fourth year high school level.
8. Total Instruction time (TIT). This represents the total number of hours rendered for classroom instruction applied to all subjects taught at school in a day.
9. Mathematics Instruction time (MIT). This indicates the duration of time, in minutes, devoted to Mathematics teaching in a day.
10. Management/Leadership style (MLS). Principals carry out their functions as school head in many diverse ways, each one unique from the other. They deal with their faculty, staff and students differently. Each principal possesses a distinctive management style depending on his/her personal characteristics and beliefs. This is what MLS measures. A scale was adapted from TALIS/TIMSS school-level questionnaire, with 29 item indicators divided into two sets. The first set is presented in Table 3.3.6, which are the indicators of *management/leadership style for instruction* (MLSI). The response categories are of a four-point Likert-type, indicating the frequency (1=Never, 2=Seldom, 3=Quite often, 4=Very often) of their practice of the three dimensions of MLSI,

school goals (SG), *instructional management* (IM) and *direct supervision of instruction in the school* (DSIS).

The second set, presented in Table 3.3.7, relates to their responsibility and accountability as the head of the school. This is answerable using the scales: 1 – strongly disagree; 2 - disagree (2); 3 – agree, and; 4 -strongly agree. This set of variables is likewise taken as administrative management/leadership style, which includes accountability and bureaucratic management.

Table 3.3.6
Instructional Leadership Style

Factors / Variables	Item Code	Indicators
Below you can find statements about your management of this school. Please indicate the frequency of these activities and behaviours in this school during the current school year.		
SG (School Goals)	MLS1	I make sure that the professional development activities of teachers are in accordance with the teaching goals of the school.
	MLS2	I ensure that teachers work according to the school's educational goals.
	MLS4	I use student performance results to develop the school's educational goals.
	MLS10	I take exam results into account in decisions regarding curriculum development.
	MLS11	I ensure that there is clarity concerning the responsibility for coordinating the curriculum.
IM (Instructional Management)	MLS7	When a teacher has problems in his/her classroom, I take the initiative to discuss matters.
	MLS8	I inform teachers about the possibilities for updating their knowledge and skills.
	MLS12	When a teacher brings up a classroom problem, I assist him/her in looking for solutions.
	MLS13	I pay attention to disruptive behaviour in classrooms.
	MLS14	I take over lessons from teachers who are unexpectedly absent.
DSIS (Direct Supervision of Instruction in the School)	MLS3	I observe instructions in classrooms.
	MLS5	I give teachers suggestions as to how they can improve their teaching.
	MLS6	I monitor students' work.
	MLS9	I check to see whether classroom activities are in line with our educational goals.

Table 3.3.7

Administrative Leadership Style

Factors / Variables	Item Code	Indicators
How strongly do you agree or disagree with these statements as applied to this school, your job, and the teachers at this school?		
AMS (Accountable Management Style)	MLS15	An important part of my job is to ensure that the instructional approaches recommended are explained to the new teachers, and that more experienced teachers are using these approaches.
	MLS16	The use of test scores of students to evaluate a teacher's performance devalues the teacher's professional judgment.
	MLS17	Giving teachers freedom to choose their own instructional techniques can lead to poor teaching.
	MLS18	A main aspect of my job is to ensure that the teaching skills of the staff are always improved.
	MLS19	An important part of my job is to ensure that teachers are held accountable for the attainment of the school's goals.
	MLS20	An important part of my job is to present new ideas to the parents in a convincing way.
BMS (Bureaucratic Management Style)	MLS21	Influence decisions about this school taken at a higher administrative level.
	MLS22	I see to it that students, teachers and staff stick to the rules of the school.
	MLS23	I check for mistakes and errors in administrative procedures and reports.
	MLS24	An important part of my job is to resolve problems with the timetable and/or lesson planning.
	MLS25	An important part of my job is to create an orderly atmosphere in the school.
	MLS26	I have no way of knowing whether teachers perform well or badly in their teaching duties.
	MLS27	In this school, we work on the achievement of the school development plan.
	MLS28	I define goals to be accomplished by the staff of this school.
	MLS29	I stimulate a task-oriented atmosphere in this school.

11. Teacher Appraisal Criteria (TAC). This refers to the criteria considered by the school principal in evaluating teachers. The criteria are divided into three categories: learning outcomes (LO) teaching practices (TP), and professional development (PD). LO includes students' scores and other learning outcomes; as well as students and parents' feedback. TP, on the other hand, includes teachers' instructional practices, classroom management, content knowledge and professional development they have undertaken. Furthermore, PD includes professional development that teachers may undertake. The response categories for these items described as follows: 1 - I don't know if it was considered; 2 - not

considered at all; 3 - considered but with low importance; 4 – considered but with moderate importance, and; 5 - considered with high importance. The response of the principal-respondents to these items indicates the extent to which the criteria are considered in the appraisal of teachers. These items are presented in Table 3.3.8.

Table 3.3.8

Teacher Appraisal Criteria

Factors / Variables	Item Code	Indicators
To what extent were the following aspects considered in teacher appraisal?		
LO (Learning Outcomes)	TAC1	Student test scores
	TAC2	Retention and pass rates of students
	TAC3	Other student learning outcomes
	TAC4	Student feedback on the teaching they receive
	TAC5	Feedback from parents
	TAC17	Extra-curricular activities with students (e.g. school plays and performances, sporting activities
TP (Teaching Practices)	TAC6	How well the teacher works with you, the principal, and their colleagues
	TAC7	Direct appraisal of classroom teaching
	TAC8	Innovative teaching practices
	TAC9	Relations between the teacher and students
	TAC11	Teacher's classroom management
	TAC12	Teacher's knowledge and understanding of their main subject field(s)
	TAC13	Teacher's knowledge and understanding of instructional practices (knowledge mediation) in their main subject field(s)
	TAC15	Student discipline and behaviour in the teacher's classes
PD (Professional Development)	TAC10	Professional development undertaken by the teacher
	TAC14	Teaching of students with special learning needs
	TAC16	Teaching in a multicultural setting

12. School Climate. This refers to the kind of environment created or promoted by the school in relation to how conducive it can be for learning. This is termed in the study as *school climate for learning* (SCFL). SCFL measures the school principal's perception of the teachers' satisfaction of their job, their success in implementing the curriculum, parental support and students' desire to do well in school. School principals rated their responses using the five-point Likert scale, 1

for very low, 2 low, 3 medium, 4 high and 5 very high. Table 3.3.9 shows the items.

Table 3.3.9
School Climate for Learning

Factors / Variables	Item Code	Indicators
How would you characterise each of the following within your school?		
Teacher's Working Morale	SCL1	Teachers' job satisfaction
	SCL2	Teachers' opportunities for professional development
	SCL3	Teachers' understanding of the schools' curricular goals
	SCL4	Teachers' degree of success in implementing the schools' curriculum
Relationship	SCL5	Teachers' expectations for student achievement
	SCL6	Parental support for student achievement
	SCL7	Parental involvement in school activities
	SCL8	Students' regard for school property
	SCL9	Students' desire to do well in school

13. Beliefs about Teaching and Learning (BANTL). This construct measures the principal's belief about the nature of teaching and learning indicated in 12 items with response ranging from 1 (Strongly disagree) to 4 (Strongly agree). This dimension comes with two correlated sub-scales which are the constructivist beliefs and direct transmission beliefs about instruction. This set of indicators is presented in Table 3.3.10.

Table 3.3.10
Beliefs about the Nature of Teaching and Learning

Factors / Variables	Item Code	Indicators
How strongly do you agree or disagree with each of the following statements about teaching and learning in general?		
Constructivist Teaching Beliefs (CTB)	BANTL4	One of the roles of teachers is to facilitate students' own inquiry.
	BANTL6	Students learn best by finding
	BANTL7	Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.
	BANTL9	Students should be allowed to think of solutions to practical problems themselves before the teacher shows them how they are solved.
	BANTL12	Thinking and reasoning processes are more important than teaching specific curriculum content.

Table 3.3.10 (continued)

Factors / Variables	Item Code	Indicators
Direct Instruction Teaching Beliefs (DTB)	BANTL1	Effective/good teachers demonstrate the correct way to solve a problem.
	BANTL2	“Poor performance” means a performance that lies below the previous achievement level of the student.
	BANTL3	It is better when the teacher – not the student – decides what activities are to be done in the classroom.
	BANTL5	Teachers know a lot more
	BANTL8	How much students learn depends on how much background knowledge they have – that is why teaching facts are so necessary.
	BANTL10	“Good performance” means a performance that lies above the previous achievement level of the student.
	BANTL11	A quiet classroom is generally needed for effective learning.

3.3.3 Student - Level

The student - level variables mainly measures attitude of students toward mathematics as well as their beliefs about mathematics as a subject. Basic characteristic profile such as the gender, grade level and ethnic group; educational attainment and job status of parents are likewise considered. The description of each of the variables are presented below.

Student-Level Variables

1. Gender. The term refers to the sex of the respondent. For analysis, males are coded as 0 and females as 1.
2. Age. Two grade levels were engaged in the study, therefore the age, in complete years, of student-respondents were considered.
3. Grade/Year Level. This used to classify students based on their grade or year level, coded as 1 for Grade Six elementary pupils and 2 for Fourth Year high school students.
4. Ethnic group. This refers to the tribal affiliation of the respondents. Although Philippines, especially Mindanao, is a tri-people, only the pre-dominant, highly populated and common tribe groups in Southern Philippines are specifically

listed in the instrument. These are coded as follows: 1 - Maranao/Maguindanaon; 2 – Cebuano; 3 – Hiligaynon, and; 4 for ethnic groups other than those listed.

5. Parents' educational attainment. This indicates the highest educational level completed by the parents of the respondent. The education levels are coded as: 1 –elementary level; 2 - High school; 3– College or undergraduate level; 4 – Masters Degree or graduate level, and; 5 - Doctorate degree or post-graduate level.
6. Parents' current employment status. The variable refers to the employment status of the parents of the respondents. Employment categories are coded as follows: 1 – employed; 2 - doing housework at home; 3 – student; 4 – retired, and; 5 – unemployed.
7. Home possessions. This pertains to materials at home which may be considered as logistics for mathematics learning. Examples are calculator, computer units and study table. Student-respondents simply ticked (1) Yes if they have the thing specified and (0) or no if they don't have it.
8. Attitudes towards Mathematics. The term generally refers to the behaviour of the student-respondent toward mathematics as a subject to learn in school. The parameter indicators were adapted from Fennema-Sherman's (1976) Attitude scales. All four domains apply in the study and are thus measured using a five-point Likert's scale where 1 stands for strongly disagree and 5 for strongly agree.
   8.1 Confidence in Learning Mathematics (CLM). This measures the students' feeling of confidence in learning mathematics. This consists of 11 items, six of which are positive statements and the remaining five are negatively stated. Thus, the responses for the five items were reverse coded so that

higher score means higher level of confidence in learning mathematics. The indicators for this construct are presented in Table 3.3.11.

Table 3.3.11
Confidence in Learning Mathematics

Factors / Variables	Item Code	Indicators
Confident	CLM1	Generally I am confident when I am in a mathematics class.
	CLM2	I am sure I could do advanced work in mathematics.
	CLM3	I am sure that I can learn mathematics.
	CLM4	I think I could handle more difficult mathematics.
	CLM5	I can get good grades in mathematics.
	CLM6	I have a lot of self-confidence when it comes to mathematics.
Not Confident	CLM7	I am not good in mathematics.
	CLM8	I don’t think I could do advanced mathematics.
	CLM9	I am not the type to do well in mathematics.
	CLM10	Even though I study hard, mathematics seems difficult for me.
	CLM11	I have the tendency to fail mathematics.

8.2 Perceptions of Teachers’ Attitude Scale (PTA). This construct determines the perception of students about the attitude of their teacher towards them. The students either disagree or agree to statements like that which says their teachers are helping or motivating them to study mathematics; or that their teachers provide the necessary help they needed to understand and learn mathematics. This consists of eight items of which five are positive statements and three are negatively stated. The negative items were reverse coded, so that high scores indicate positive motivating and facilitating attitude of teachers as perceived by students. Table 3.3.12 presents in detail the indicators for PTA.

Table 3.3.12

Perception of Teachers Attitude

Factors / Variables	Item Code	Indicators
Positive attitude	PTA1	My teachers have encouraged me to study more mathematics.
	PTA2	My teachers think I'm the kind of person who could do well in mathematics.
	PTA3	Mathematics teachers have made me feel I have the ability to go on in mathematics.
	PTA4	My mathematics teachers would encourage me to take all the mathematics I can.
	PTA5	My mathematics teachers have been interested in my progress in mathematics.
Negative attitude	PTA6	When it comes to anything serious I have felt ignored when talking to mathematics teachers.
	PTA7	I have found it hard to win the respect of mathematics teachers.
	PTA8	Getting a mathematics teacher to take me seriously has usually been a problem.

8.3 Usefulness of Mathematics Scale (UOM). This refers to the students' perception of the importance of learning mathematics. This includes statements like "I study mathematics because I know how useful it is." Students were also asked to indicate the extent of agreement or disagreement to the statements. This scale has four positive statements and six negative statements. Just like the other two attitude domains, negative statements were reverse coded. Thus, higher score means strong agreement to the importance of mathematics, not only in school, but in daily life situations as well. Table 3.3.13 shows the items reflecting the construct.

Table 3.3.13

Usefulness of Mathematics

Factors / Variables	Item Code	Indicators
Mathematics is Useful (MU)	UOM1	I study mathematics because I know how useful it is.
	UOM2	Knowing mathematics will help me earn a living.
	UOM3	Mathematics is a worthwhile and necessary subject.
	UOM4	I will use mathematics in many ways.
Mathematics is Not Useful (MNU)	UOM5	Mathematics will not be important to me in my life's work.
	UOM6	Mathematics will be of no relevance to my life.
	UOM7	I see mathematics as a subject I will rarely use in my daily life.
	UOM8	Studying mathematics is a waste of time.
	UOM9	It is not important for me to do well in mathematics in Elementary or High school.
	UOM10	I expect to have little use from mathematics when I get out of school.

8.4 Mathematics Anxiety Scale (MAS). This refers to the students' feelings of "nervous," "scared," "worried," every time they are in the mathematics class or whenever they take exams. This domain has 12 items, six of which are positive statements and the other six are negatively stated. Negative statements were likewise reverse coded; hence higher score indicates feeling of ease or less anxiety towards learning mathematics. The indicators are shown in Table 3.3.14.

Table 3.3.14
Mathematics Anxiety Scale

Factors / Variables	Item Code	Indicators
Feeling of Ease	MAS1	Mathematics doesn't scare me at all.
	MAS2	It wouldn't bother me at all to take more mathematics subjects.
	MAS3	I haven't usually worried about being able to solve mathematics problems.
	MAS4	I have almost never felt nervous during a mathematics test or exam.
	MAS5	I usually have been at ease during mathematics tests.
	MAS6	I usually have been at ease in mathematics classes.
Anxious	MAS7	Mathematics usually makes me feel uncomfortable.
	MAS8	Mathematics usually makes me feel impatient.
	MAS9	I start to worry when I think of trying to solve mathematics problems.
	MAS10	I am unable to think clearly when working out/solving mathematics.
	MAS11	A mathematics test would scare me.
	MAS12	Mathematics makes me feel confused.

9. Beliefs about Mathematics. This construct measures students' beliefs about the nature of learning mathematics and as to how teaching mathematics had been in their experience. This was developed by Yackel (1984) based on Skemp's (1976) relational and instrumental understanding of mathematics. This is comprised of 19 items to which respondents will answer using the five-point Likert scale. The response categories range from 1 which stands for strongly disagree to 5 which indicates a strong agreement. The items are shown in Table 3.3.15.

Table 3.3.15
Beliefs about Mathematics

Factors	Item Code	Indicators
Relational Belief (RelBel)	BAM3	Mathematics involves relating many different ideas.
	BAM7	Getting good grades in mathematics is more of a motivation than is the satisfaction of learning the mathematics content.
	BAM8	When I learn something new in mathematics I often continue exploring and developing it on my own.
	BAM9	I usually try to understand the reasoning behind all of the rules I use in mathematics.
	BAM13	Solving mathematics problems frequently involves exploration.
	BAM14	Most mathematics problems are best solved by using a previously learned solution for that type of problem.
	BAM16	Mathematics consists of many unrelated topics.
Instrumental Belief (InsBel)	BAM1	Doing mathematics consists mainly of using rules.
	BAM2	Learning mathematics mainly involves memorizing procedures and formulas.
	BAM4	Getting the right answer is the most important part of mathematics.
	BAM5	In mathematics, it is impossible to solve a problem without looking at the examples.
	BAM6	One reason learning mathematics is so much work is that you need to learn a different method for each new type of problems.
	BAM10	Being able to successfully use a rule or formula in mathematics is more important to me than understanding why and how it works.
	BAM11	A common difficulty in taking quizzes and exams in mathematics is that if you forget relevant formulas and rules you are lost.
	BAM12	It is difficult to talk about mathematical ideas because all you can really do is explain how to solve/deal with specific problems.
	BAM15	I forget most of the mathematics I learn in a course soon after the course is over.
	BAM17	Mathematics is a rigid subject.
	BAM18	I get frustrated if I don't understand what I am studying in mathematics.
	BAM19	The most important part of mathematics is computation/solving.

3.4 Summary

The chapter presents the sources of the item indicators for each dimension used to measure the variable considered in the study. Herein described as well are the scales used to quantifiably measure the variable for the purposes of analysis. The chapter therefore provides for validation of the questionnaire used in the study as it established the sources from which they were taken.

Prior studies on the factor influences to the academic performance of students in mathematics and in general, mostly considered either the teacher- or student-level indicators. School – level factors are seldom taken as variables.

A number of factors that may influence learning in Mathematics are examined in the study. These factor influences are multilevel and are clustered into school-level factors, teacher/classroom-level factors and student-level factors. Research findings suggest that teachers play a big role in the academic performance of students. Results likewise advocate school-related and student-related factors as having a lot to do with achieving good performance in the academe.

In the Philippine education system, examinations are a major indicator and measure of the academic performance of pupils and students. This practice is deeply embedded in the curriculum at all levels; in the classroom (teacher-made) or at the national level in reference to standardised examinations. The relevance of examination results raises the need to ensure the preparedness of the students to take the examination. The notion is that preparedness is defined by how well children learn in class. A vital element in the educative process is Effective Learning, which teachers and school heads are to promptly assess. After all, it is their basic task to prepare the students for the final hurdles in the academic process.

Chapter 4
Methods of Research

4.1 Introduction

The overall objective of this study is to investigate the factors that influence achievement in mathematics among the sixth graders (elementary) and fourth year high school students in SOCCSKSARGEN (Region XII). These factors operate from the level of students to the teachers and to the school. The interrelationships between and among these multilevel factors are also examined.

To measure the factors investigated, scales adapted from existing instruments were utilized. Hence, to obtain accurate measurement, careful planning and consideration were undertaken in the selection of samples, research instruments, data collection methods, data analysis and statistical tools used.

This chapter presents the rigour that the researcher had undertaken so that accurate data and appropriate analyses can be carried out. This includes presentation of research design as well as the procedure in securing ethics approval. Methods are also described including a description of the target population, determination of the samples, data collection, the instruments used and analysis tools employed. Moreover, the limitation of the study is briefly elaborated.

4.2 Research Design

This study employed a cross-sectional survey design (Creswell, 2008). Cross-sectional survey design was used for practical reasons and that includes limitations on the time and funding/budget. In addition, Creswell (2008) asserts that the cross-sectional survey design is best used when two or more educational groups are compared in terms of attitudes, beliefs, opinions and practices. Survey questionnaires are used to gather information about the profile characteristics of all the respondents, their attributes relative to the variables, as well as the classroom teaching and assessment practices of the mathematics teachers. The survey questionnaires include the Likert- type scale. Since the study identifies and investigates the factors that influence outcomes (e.g. students' achievement), quantitative research approach is applied. In this approach, numerical data obtained from the scales of the research instruments are analysed using statistical tools and measures. The Modelling Approach, a form of quantitative research, was specifically used because maximum likelihood statistics is best used to describe, measure and analyse the causal relationships and the degree of association between two or more variables. This also extends into a more complex relationship among variables in structural equation modelling and hierarchical linear modelling.

4.3 Ethics Approval

The study commenced after obtaining ethics approval from the University of Adelaide Human Research and Ethics Committee (HREC) and permission from the Department of Education (DepEd) in the Philippines. The permission to conduct the study was particularly sought from the Regional Director of DepEd Region XII being the locale of the study. From the regional office, approval was sought from the School Division Superintendents (SDS). The SDS approval allows the researcher to conduct the study in both public and private schools within the division. Thereafter, another letter-request were sent to the school principals soliciting their engagement in the study. The approval from the school principals signalled the researcher to embark on the data collection phase. Note, however, that despite the approval of the principal to engage the school in the study, the participation of individual teachers and students remained voluntary. Invitations were sent to the teachers and only those who agreed to participate were taken as respondents. The students of the teacher-respondents were immediately considered as potential respondents, but only those who gave their personal consent, together with that of their parents', were engaged in the study.

All the respondents were assured of confidentiality. They were given the assurance that the information they share will serve only the research purposes and will not in any way be used for evaluation of personal services rendered, the teachers and principals in particular. The researcher likewise explained the benefits of the study and emphasized that there won't be any remuneration in exchange for their participation. It was also made clear to the respondents that even if they consented, they can at any time withdraw their participation but under valid grounds, with no jeopardy whatsoever to their relationship with the school and the educational services they expect to get from the system.

4.4 Methods

4.4.1 Sample and Sampling techniques

The target population for this study consists of Grade 6 (G6) Elementary and Fourth Year (Y4) High School mathematics teachers, G6 and Y4 students and the school principals in both public and private schools in Region XII, Southern Philippines. Region XII was identified as the target area because of the researchers' familiarity with the locale. G6 and Y4 students were purposely engaged because they are the target levels of the National Achievement Test (NAT) towards the end of the school year. The NAT result in the area of mathematics will indicate the learning achievement of students in that subject area. Although NAT is also administered to the third graders, they were excluded in the study because NAT for third graders applies only to public schools and Madrasah (Muslim private schools) systems. In the past, NAT was also administered to Second Year High School students but not until 2013 when the National Testing and Education Research Centre (NETRC) excluded this grade level.

There are a total of nine school divisions in Region XII, spread across the composite four provinces and five cities. Provinces are normally larger compared to city divisions, thus, there are more schools to be managed therein. Each division is clustered into a number of schools, which are spread in a wide geographical area, some of which are in remote districts. There were no exclusion criteria employed in the choice of school division to engage especially that the researcher initially planned to include all the nine school divisions. However, due to time constraints and other security considerations, only seven school divisions were included. A school which belongs to the supposed eighth division was visited and was included in the final sample. Accessibility then became the main exclusion criteria so to speak.

Because the schools in Region XII are widely spread due to its geographical location, a two-stage cluster sampling design was employed. The first stage consisted of a sample of schools and the second stage consisted of a sample of students from the different classes. From the remaining schools, cluster random sampling proportional to the size (number of schools) of the division was employed. The selection of schools was governed by the attempt to collect data from diverse locations, types and size of schools and the minimum requirement of 400 mathematics teachers in Grade 6 and Fourth Year levels at the time of the survey. However, some selected schools were not willing to participate and in most schools (especially the small ones), there was only one mathematics teacher teaching at the specified level. After randomly selecting the schools, permission to collect data from the teachers and students was obtained from the school principal. Since, participation was voluntary, there were some mathematics teachers who did not participate and there were also cases where questionnaires were not given back by the teachers. For the second stage, a minimum sample of 25 students per teacher or class was likewise randomly selected. However, in small schools (less than 30 students class size), census sampling was employed wherein all students present in class at the time of survey were engaged. Census sampling applied as well to classes where a considerable number of students were out for school competitions at the time of survey.

Logistical problems encountered along the way hindered proportionality (sample size obtained was not proportional to the population size of each school division). As a result, many of the surveyed schools belong to the Cotabato City division, where the researcher lives. Nevertheless, in the other six school divisions, more schools from bigger school divisions were surveyed and fewer in small school divisions. These caveats warrant careful interpretation of the results especially in making inferences.

4.4.2 Data Collection Procedure

Letters were sent to school principals/heads requesting participation in the study. After a school signifies participation in the study, Mathematics teachers were then specifically invited to participate in the survey, which was the primary data collection method used. Questionnaires were handed out to school Principals and Mathematics teachers. Ethical procedures were carefully observed particularly in engaging the pupils and students who initially consented to participate in the study. Before engaging students, parental consent was first sought. The questionnaire was administered only to those whose parents consented to it. In the process, teachers were coded. Student-respondents directly handled by the teacher were instructed to write their teacher's code on the survey instrument that they answered.

4.4.3 Research Instrument and Scales used in the study

Research instruments and questionnaires are the most commonly used tools in collecting quantitative data. They are generally used in research involving education and the social sciences (Amedahe, 2002). For this study, three questionnaires were utilized. The questionnaires were constructed by the researcher although the item indicators in the parameter dimensions were adapted from existing questionnaires from OECD-TALIS, TIMSS, Fennema-Sherman. The first set is the Teacher Questionnaire, devised to obtain profile information and psychographics which includes the teachers' beliefs and attitudes towards mathematics; assessment preference in mathematics and, their teaching and assessment practices. The second set is the Student Questionnaire, designed to collect their profile characteristics and psychographics which basically tackled students' beliefs and attitudes towards mathematics. The third set is the Principal Questionnaire which was used to gather information about school profile, school climate, teacher appraisal and school principal's management and leadership style.

Survey questionnaires were administered on site and students completed their questionnaires during class time. Participation in the study was voluntary and confidentiality was assured, as stipulated in the cover letter of each questionnaire.

The variables included in each questionnaire are defined and briefly described in the following section. A complete and more detailed presentation is in Chapter 3.

4.4.3.1 Questionnaires

Teacher Questionnaire: The instrument is structured in form composed of five parts. The first part asks of profile characteristics such as gender, age, type of school, educational attainment, years in teaching, grade or year levels taught, mathematics instruction time, number of students in the class and professional development activities. The second part examines the teachers' teaching practices. The third part is about the teachers' preferred purpose of assessment as well as the assessment practices he/she practices in the classroom. The fourth part consists of questions about teachers' attitudes towards mathematics and mathematics teaching. The fifth part is the Mathematics Teaching Efficacy Beliefs Scale.

Principal Questionnaire: The items in this questionnaire are mostly adapted from Teaching and Learning International Survey (TALIS) and some from the Trends on International Mathematics and Science Study (TIMSS) school-level questionnaire. This includes information about school and principal's management/leadership style.

Part I contains basic information about the school principal and includes gender, age, highest level of education, years of experience as a teacher and principal. Part II contains basic information about the school and includes type of school, class size, instruction time allocated for all subjects and for mathematics. Part III consists of management or the leadership style of the school principal, criteria for teacher appraisal. In addition, Part IV considers school climate and the principal's belief about teaching and learning.

Student Questionnaire: The first part of this instrument is designed to collect students' information, which includes questions about gender, age, ethnicity, grade level, parents' highest educational attainment and job and home possessions. The second section seeks to gather information about students' attitudes toward mathematics using Fennema-Sherman Attitude Scales. Four domains of the attitude scales are used in this study; these are: (a) Confidence in Learning Mathematics Scale, (b) Perceptions of Teachers Attitudes Scale, (c) Usefulness of Mathematics Scale and (d) Mathematics Anxiety Scale. The third part consists of items on students' beliefs about mathematics.

4.4.3.2 Mathematics Achievement

The results of the National Achievement Test (NAT) in Mathematics are used to gauge the learning achievement of students in mathematics. In some respects, it is likewise used to measure the performance of schools in terms of how well teachers are able to carry out their teaching duties; and the school heads their supervisory duties. NAT is administered annually to G6 and Y4 students towards the end of the school year (March), by the Department of Education (DepEd) through the National

Educational Testing and Research Center (NETRC). The goal is to measure the academic performance of pupils and students in five major subjects: English, Mathematics, Science, Filipino and HeKaSi (Heograpiya, Kasaysayan at Sibika - Geography, History and Social Science) in Elementary and Araling Panlipunan in High School. The test is entirely a multiple choice type, with some items having multiple answers. NAT also measures the mastery aptitude of students in all the subject areas covered, and in reiteration, the school's competency and effectiveness in managing the learning development of the school children.

4.5 The pilot study

The items in the questionnaires are adapted from existing instruments. Since they are used in different contexts, the items are modified to suit the grade level and subject context in the Philippine context. As soon as the questionnaires were ready, they were subjected to face and content validation. The questionnaires were given to English teachers to check for grammar and comprehensibility of the items. They were also scrutinized by experts in the field, professional teachers, practitioners, university-level mathematics and education teachers. A one-on-one talk with the practitioners was carried out to help ensure that they properly interpreted the questions or items specified in the questionnaires.

When the instruments were already validated in terms of face and content, further validation was done by pilot testing it to school principals, mathematics teachers and students who are neither actual nor potential respondents to the study. The statistical analysis of data from the pilot tests were used to check individual items that need clarification or rewording. Some of the items were amended based on the feedback provided by a few of the pilot respondents.

Factor analyses were carried out to examine the structure of the scales. Items were looked at closely as to how the questions were phrased. Some of these items were rephrased or modified.

4.6 Analysis of Data

The researcher believes that in order to obtain usable information, careful examination and analyses of the data collected is necessary. This requires determining the relationship of the variables involved and identifying techniques that are appropriate for answering research questions and providing inferences. Prior to the examination of the data, it is essential that the data are carefully prepared so that bias and errors can be minimized.

Presented in this section therefore are the analysis techniques employed by the researcher as well as the corresponding statistical procedures used. The preparation, coding and cleaning is presented in the first subsection. The corresponding statistical procedures and software used are discussed in the succeeding subsections.

4.6.1 Preparation of Data

After the data were collected, raw information were entered and organised in Microsoft Excel. Codes were used to connect the three sets of sample: teachers, principals and students. For categorical variables, cardinal numbers such as 1 and 0 were assigned to specific variables and categories. Gender, for example, was coded as 0 for males and 1 for females; whereas type of school was assigned 0 for public and 1 for private. Scales that contain negatively stated items were reverse coded so that high scores would indicate a higher level of the construct being measured. This procedure attempted to prevent the response bias (Pallant, 2011). However, some items were not changed in order to maintain their meaning. Number codes were also assigned to school divisions, schools, teachers and students.

After organizing the data in Excel file, they were imported to SPSS for analysis. In the SPSS file, data were likewise defined and properly labelled in the Variable view. Data cleaning was done to check for values that fell outside the range of possible values of a variable. This was carried out using the descriptive analysis in SPSS, specifically, selecting frequency distribution and graphs to check for miscoded information. A separate SPSS file was created for easier and faster access to the data at the scale level.

For any missing numerical information, the cells were simply left blank since SPSS would recognize any blank cell as missing data (Pallant, 2011). According to Schumacker and Lomax (2004), replacing the missing by mean substitution would be the best option for a small number of missing values in the data. This was, however, not recommended if there was a considerable amount of missing values as this would severely distort the results of the analysis (Pallant, 2011). According to Tabachnick and Fidell (2013), if the missing data were only five per cent or less (at random), that would be considered as small and a less serious problem. For a more in-depth analysis, such as SEM and HLM, missing values were robustly handled and accommodated by the software used. This is discussed further in the data analysis section.

4.6.2 Analysis Techniques and Statistical procedures employed in the study

This section presents the processes followed in conducting data analysis.

4.6.2.1 Descriptive statistics

In presenting the characteristics of the samples, descriptive analysis of the raw data is employed. Statistical Package for Social Sciences (SPSS) version 20 was used to calculate the percentages of categorical variables, frequency distribution of both categorical and continuous variables; as well as the means and standard deviations for continuous variables. SPSS was also used for the graphics presentations such as the error bar to explain the spread of the distribution. Pie charts and bar graphs were likewise alternately used to present categorical variables.

In collecting samples, bias in the interpretation of analyses is unavoidable and could adulterate the inference drawn from the analysis. One of the possible sources of bias is the violation of the assumptions. Hence, some of the important assumptions before performing the analyses were carefully examined.

4.6.2.2 Univariate normality

Several of the statistical procedures assume that the distribution of values is normal. Hence, prior to the conduct of the descriptive statistics analyses, the univariate normality assumption is first checked. Normality could be evaluated by simply obtaining skewness and kurtosis. In this study, the Shapiro_Wilk test of normality, which also provide skewness and kurtosis values, is employed. The Shapiro_Wilk Test suggests that the assumption of normality is violated when the significance value is less than .05. Hence, this test assumes a non-significant distribution. The Q-Q plot is another way of determining the normality of the distribution, wherein a reasonably straight line suggests normal distribution.

4.6.2.3 Instrument Level Analysis

Since the scales were adapted from existing questionnaires, administered to different groups of respondents and applied in different contexts, instrument validity and reliability is necessary to establish the utility of the scales. To validate the instruments, especially the scale structures, the Confirmatory Factor Analysis (CFA) was employed. Whereas to examine the scales at the item level, the Item Response Theory (IRT) using Rasch Model analysis was utilised. While CFA was carried out using Mplus by Muthen and Muthen (1998-2012), Rasch Model analysis was done using Conquest 2.0 by Wu, Adams, Wilson and Haldane (2007).

Validation

Face and content validity was already assessed during the pilot study. Since each scale is used to measure a particular construct, theoretical underpinnings must likewise be investigated. Construct validity, a type of validity that examines whether the scales measure what they purport to measure, must therefore be achieved. According to Messick (1990), construct validity is assessed by determining the degree to which certain explanatory concepts or constructs account for performance on the test; or CFA deals directly with how well our measures reflect their intended construct (Kelloway, 1998). There are several ways of conducting construct validity.

Since the scales were constructed based on existing theories and empirical studies, confirmatory factor analysis is therefore more appropriate. Confirmatory factor analysis (CFA) by way of Mplus was therefore used in the study.

CFA is a statistical technique used to verify the factor structure of a set of observed variables. It specifies the relationship between the latent variables and observed variables in the model. Its confirmatory nature implies that the researcher must have a priori evidence of which indicators are related to which factors and of the number of factors involved (Brown & Moore, 2012). This indicates further that prior to testing the hypothesised structure, the researcher must already have knowledge of the theory where the constructs involved are based from, empirical results or both.

Mplus version 7 software (Muthen & Muthen, 1998-2012) was used to perform CFA. It is a statistical modelling program that is based on either the analysis of covariance structures or the analysis of mean and covariance structures. Mplus allows for cross-sectional, single-level and multilevel data and even data that have missing values. Likewise, analysis can be carried out for observed variables that are of different types, like continuous, ordered categorical (ordinal) and unordered categorical (nominal). As its modelling framework, Mplus can analyse latent variables that are either continuous or categorical or both.

Mplus uses maximum likelihood (ML) estimation method for all models, except with models that have censored and categorical outcomes, where weighted least square estimator is used alternatively. In addition, robust estimation of the standard errors and chi-square tests are also provided. These procedures, according to Muthen and Muthen (1998-2010), take into account non-normality and non-independence of observations due to cluster sampling. Linear and non-linear parameter constraints are as well allowed.

In order to determine whether an observed variable belongs to the underlying latent construct, a standardized regression weight also called a factor loading is used as an indicator. The cut-off value, as suggested by Hair, Anderson, Tatham and Black (1998), is 0.40. Stevens (2009) also suggests than an R squared of 15 percent, which is equivalent to a factor loading of approximately 0.40 is acceptable. However, Tabachnick and Fidell (1996) contend that 0.32 factor loading is acceptable. Hence, in view of Tabachnick and Fidell's suggestion, items with factor loadings of 0.32 and above are retained for the following reasons: a) if the items are important indicators of the construct they are measuring, b) if removing the items do not significantly improve the fit and c) if removing the items would worsen the fit.

Model Fit Indexes Guidelines

An important part of the estimation process in confirmatory factor models is to fit the sample variance-covariance data to the model. To assess which model best fits the data, different model fit indexes are used as indicators. These indexes are used to illustrate how different or similar the empirical structure is from the theoretical structure. It is important to note that there is no such thing as the best or the most ideal fit index. Thus, it is advisable to use multiple criteria to assess model fit. Chi-square (χ^2) test is used to indicate the degree of similarity between the expected and observed variance-covariance matrix. The smaller the chi-square the better the fit. It is, however, sensitive to sample size and often violates the assumption of multivariate normality. Others use instead the ratio of chi-square and degrees of freedom (χ^2/df) to address the issue on sample size. Kline (2005) suggests that a ratio of less than or equal to three (≤ 3) is an acceptable threshold for good fit, while Tabachnick and Fidell (2007) suggest a ratio of less than two (< 2). If chi-square is not good enough, then other fit indexes are considered.

In conjunction with the chi-square, the incremental and absolute fit indices can likewise be used to assess model fit. Incremental or relative indexes measure 'how much better the model fits compared to a baseline model' (Diamantopoulos & Siguaw, 2000, p. 88). This includes comparative fit index (CFI) and Tucker-Lewis index (TLI). CFI and TLI values range from 0 to 1, with higher values demonstrating better fit. As a rule of thumb, values greater than or equal to 0.95 indicate good fit (Kline, 2005). However, in this study, values greater than or equal to 0.90 are considered as adequate fit.

Root mean square error of approximation (RMSEA) and standard root mean square residual (SRMR) indexes are also used to assess model fit. These are residual indexes that measure the discrepancies between the expected and observed covariances. Just the same, the values of both RMSEA and SRMR range from 0 to 1. Conversely, lower values indicate better fit. Hu and Bentler (1999) suggest that acceptable fit for SRMR is less than 0.08, whereas for RMSEA it is less than 0.06. Browne and Cudeck (1993) suggested that RMSEA values of .08 and more indicate a reasonable error of approximation. Hence, a value of .10 is considered as a reasonable fit in this study.

Missing data

Missing data is inevitable. This can have a dramatic effect in the analysis if not addressed properly. Deleting cases with missing data, however, is not the best solution as this will reduce the number of samples available for analysis. This likewise will distort the analysis. Mplus has its own robust way of dealing with missing values. It uses full information maximum likelihood (FIML) estimation of missing data as its default function. Mplus has several options for the estimation of models with missing data (Muthén & Muthén, 1998-2010). Mplus provides maximum likelihood estimation under MCAR (missing completely at random), MAR (missing at random), and NMAR (not missing at random) for continuous, censored, binary, ordered categorical (ordinal), unordered categorical (nominal), counts, or combinations of these variable types (Little & Rubin, 2002).

Rasch Analysis

After the scale structure of each scale has been validated, the scale underwent further validation process using item response theory (IRT), in particular, Rasch Model analysis. This process involves examination of the scale at the item level.
Rasch modelling is concerned with assessing the ability of the respondents to agree (or disagree) with each item as well as the probability to endorse a particular option on each item. There are a variety of item response models. This study utilised both the rating scale model (RSM) introduced by Andrich (1978) and multidimensional item response models (e.g. Wang, 1995; Adams, Wilson and Wang, 1997).

Survey questionnaires normally involve rating items that have multiple category response patterns using the Likert style. These categories may include ordered ratings to signify the respondents’ extent of agreement (or disagreement) towards a particular construct being measured. Response categories that range from “strongly disagree” to “strongly agree” is a classic example. These rating scales, however, produce ordinal data. Ordinal scale does not have the property that indicates whether or not the difference between the ratings is equal. It does not assume that the difference between one and two is the same as the distance between three and four. Unlike the ordinal scale, interval scale has the property to determine the relative distance between the ratings. With interval scale, it is assumed that the distance between one and two is the same as the distance between three and four. Hence, by using the Rasch analysis, ordinal scales are being transformed to interval scales to be useful for analyses.

Rasch model analysis also provides information that reveals how well the items reflect the construct being measured. This is being assessed using the fit statistics. This concept of fit serves as the quality-control mechanism according to Bond and Fox (2007). Conquest version 2.0 (Wu, Adams, Wilson and Haldane, 2007) was used to perform Rasch Model analysis. Conquest produces both the unweighted (OUTFIT) and weighted (INFIT) fit indexes, which are used to assess model fit.

The OUTFIT mean square is based on a sum of squared standardized residuals. It is the shorthand for "out-lier sensitive mean square residual goodness of fit statistic" (Wright & Masters, 1982, p. 99). This implies that it is sensitive to extreme values and off-target responses. Moreover, OUTFIT is influenced by unexpected responses to very easy and very difficult items.

As an alternative to OUTFIT mean square, INFIT mean square can be used to assess whether the data fit the Rasch model. INFIT stands for "information weighted mean square residual goodness of fit statistics" (Wright & Masters, 1982). It is computed by taking the weighted average squared residuals so that responses which are closer to the true ability of the participants are given more weight than the outliers. Although the OUTFIT mean squares were examined in this study, the decision for identifying good fit of the items was based on the INFIT mean squares. The suggested range for IMS threshold used to indicate good fit is 0.6 – 1.4 (Wright & Linacre, 1994), which is more appropriate for rating scales used in survey questionnaires.

In reality, survey instruments are normally designed to measure one or more attributes or aspects of the constructs maintained by the sample respondent. These aspects may be called the instrument 'dimensions' (Neumann et al., 2011) and these dimensions can be multi-dimensional. In the same line of argument, Curtis (2004) asserts that constructs under study in the social sciences are characterized by sheer intricacies and may be represented by set of correlated factors. Though Rasch model analysis assumes the uni-dimensionality of the construct being measured, treating a multi-dimensional construct as uni-dimensional would, however, potentially create problems. Hence a multi-dimensional Rasch model analysis was likewise used in this study. Briggs and Wilson (2003) argue that a considerable amount of work related to multi-dimensional IRT has been recognized for its potential utility.

Rasch modelling would identify a research participant who had responded carelessly (underfitting) or redundantly or too predictably (overfitting) to the instrument or specifically to a few items. Consequently, case fit was done to identify cases or participants who overfit or underfit on the basis of their response patterns. Person fit investigates at how the respondents answered the items on the instrument or test. There can be many reasons why a person misfits. Once identified, a respondent who misfits need not be removed from analysis completely. In this aspect, the current study also took note that there can be no single model that would perfectly fit the data. Thus, misfitting items have been identified and were probably removed to improve the fit. Whereas, the interpretation of mean-square fit statistic values has been provided by Wright and Linacre (1994).

Reliability

In reporting the reliability of the scales used in the study, the item and person separation reliability indexes are preferred over other measures of reliability that are based on the classical test theory. These indexes are produced in the Rasch analysis, which is based on item response theory. Since, the Rasch analysis considers both the item's and person's estimates against a standard measure, the results are therefore more meaningful and dependable as compared to the classical test theory.

If the person separation denotes how the set of items are able to separate the persons being measured, item separation, on the other hand, signifies how the persons involved are able to separate the items (Wright & Stone, 1999). Conceptually, separation index is similar to a *t* test between two groups (Duncan, Bode, Min Lai, & Perera, 2003). The larger the index, the more distinct levels of functioning can be distinguished in the measure (p. 953). Hence, a separation index of 1.50 represents an acceptable level of separation, an index of 2.00 represents a good level of separation and an index of 3.00 represents an excellent level of separation (Duncan et al., 2003). The person and item separation reliabilities are equivalent to Kuder-Richardson 20 or Cronbach's alpha (www.rasch.org), where its value ranges from .00 to 1.00. A separation reliability coefficient of 0.70 is considered acceptable and is comparable to a separation index of 1.50, a reliability coefficient of 0.80 is good (comparable to separation index of 2.00) and a reliability coefficient of 0.90 is considered excellent (equivalent to separation index of 3.00) (Duncan et al., 2003; www.winsteps.com).

4.6.2.4 Single-level analysis

Mplus version 7 software (Muthen & Muthen, 1998-2012) was also used to analyse structural equation modelling (SEM). Hence, the model can run with missing data. The same mechanisms as with CFA are used in dealing with missing data. SEM was employed to ascertain the causal relationship between the variables in each level. It is therefore necessary to first examine the assumption on linearity among pairs of measured variables by simple inspection of the scatterplots. SEM is a statistical method that is based on covariances. Like CFA, it also uses confirmatory approach to analyse the data. Thus, the underlying theory/ies and empirical data are used as basis in testing the patterns of relationship among a set of observed (measured) and unobserved (latent) variables.

SEM is used because it can incorporate both unobserved and observed variables in the model. It is used for multivariate relations and for estimating effects. It has two goals, according to Kline (1998). First, it is used to understand the patterns of correlation/covariance among the set of variables. Second, it is used to explain as much of their variance as possible with the particular model.

Assumptions

Since SEM involves regression models, the assumptions for regression models also apply with SEM (Civelek, 2018). Some of the assumptions have already been assessed earlier, hence in the SEM chapters only the multivariate normality and lack of multicollinearity assumptions are reported.

SEM Measurement and Structural Models

SEM has two component models, measurement model and structural model; both of which are presented herein. The measurement model illustrates the relationships between the manifest variables of a certain construct. Confirmatory factor analysis (CFA) is used in analysing the measurement model, hence the same rule is applied in the interpretation of the factor loading. While, measurement model is tested first prior to the examination of the structural model so that the best indicators of the latent variables can be obtained (Schreiber et al., 2006). Structural model, on the other hand, illustrates the hypothesised relationships between and among the latent variables and the manifest variates.

Fit Indexes

To assess if the model fits the data, fit indices are examined. Different software programs could provide various fit indexes, however, not all fit indexes need be reported. In this section, the same fit indexes, as used in the confirmatory factor analysis (CFA) discussed earlier, are employed to assess good model fit.

Results from SEM

Relationships between the variables are expressed both in standardised and unstandardised regression coefficients. The standardised coefficients forming the structural model are indicated by the β symbol. Estimates of both the direct and indirect effects are used to indicate the degree of relationship between and among the variables. Direct effect is illustrated by the direct line from one variable to the other. An indirect effect, on the other hand, is the relationship between an independent latent variable and a dependent latent variable that is mediated by one or more latent variables (Baron & Kenny, 1986 in Weston & Gore, 2006).

4.6.2.5 Multi-level analysis

The study involves three levels of data, teacher-, students- and principal-level. The goal was to determine if causal relationships exist between student and teacher attributes and between classroom practices and student achievement. Hence multi-level analysis was employed. Multilevel analysis is more appropriate to be used as, by nature, students (level one) would be considered as nested within classrooms/teachers (level two), as teachers would be nested within schools or principals (level three). This implies that the observations are not fully independent (Osborne, 2000).

In particular, Hierarchical Linear Modelling (HLM) version 6 (Raudenbush, Bryk, Cheong and Congdon, 2004) software was used to analyse multi-level data. The multilevel analysis begins with the unconditional/null model, which has no predictor from any level. This leads to the determination of the ICC (interclass correlation). After predictor variables have been added at each level, significance tests were carried out. After removing the insignificant variables (removing one-by-one those with highest *p*-value first), the final model was drawn.

4.7 Delimitation of the study

The findings of the study cannot be extrapolated to the whole population of mathematics teachers and their students in the Philippines because of the fact that only a selection of schools in Region XII was considered. Therefore, generalizations beyond the schools selected in Region XII need to be taken with caution. However, the study is a good source of literature that can serve as basis or guides for future researches in mathematics education. Furthermore, the generalizations drawn by the study cannot speak of the overall academic achievement of the pupils and students; but probably only in terms of numeracy since only the NAT results in Mathematics are used in the research against the factor influences to learning only the mathematics subject.

In addition, the study used the large-scale test results as the basis of students' achievement and was limited only to Grade 6 Elementary and Fourth Year High School students in the southern part of the Philippines. In like manner, only the sixth grade mathematics teachers, and those in fourth year high school level, were surveyed.

Drawing conclusions from cross-sectional data is likewise limited by the fact that the collected data was only a snapshot of a particular period. The likelihood that the situation may provide differing results if another time-frame had been chosen cannot be disregarded. It is also not possible to make inferences about the direction of causation for the associations between variables (Wenglinsky, 2002).

4.8 Summary

The research methods applied in any study are crucial in establishing its validity, therefore its value and utility. When correct methods and tools for analysis are used, the quality of the data is assured thus the validity of the generalizations and conclusions drawn from the findings are ensured. Thus, careful selection of the appropriate methods and techniques, from the design to the interpretation of the results, must be carefully considered. Ideally, the methods guide the researcher on how things should exactly be carried out.

As presented in the chapter, careful planning and particular considerations in all phases of the study were undertaken. Planning the research design, obtaining the ethics approval, conducting data collection and pilot study; as well as data preparation, treatment and analysis were thoroughly discussed in the chapter. Reliability and validity of the items used in each scale were presented using various techniques. Experts in the area of study were engaged to validate the instruments in terms of content. Further validation was done applying the CFA and Rasch analysis for the structure and item-level analysis, respectively. Structural equation modelling (SEM) was employed to determine the relationships of the variables within the single-level multivariate analysis. Lastly, three-level hierarchical linear modelling (HLM) was used out to examine the factors that influence the achievement of pupils and students in mathematics.

Acknowledging the caveats of every statistical tool, data collection and interpretation techniques, the researcher exercised considerable caution in making inferences so as to minimize, if not completely avoid, biases that are inherent in research studies.

Chapter 5
Validation of the Scales of Teacher- School- and Student-level Factors: Confirmatory Factor Analysis

5.1 Introduction

Survey questionnaires intended to measure theoretical constructs are the most commonly used instrument in collecting educational research data. These are either adapted from prior related researches or researcher-made based on existing literature. Either case, the instruments require validation to ensure quality and utility. Consistency and validity are fundamental to ensure the quality of a research instrument. It has been a common observation that a research instrument may not always function in the same way from one context to another and across cultures. Thus, macro and micro level validation is mandatory in educational research studies which involves the use of instruments for data collection and measurement. According to Messick (1990), validation does not only strengthen the interpretation and findings of the study, but it also produces meaningful data and at the same time, strengthens the accuracy of the measurements.

Underscored in the current study are the classroom practices which covered both teaching and assessment practices of mathematics teachers in the elementary and high school levels. The classroom practices were taken as the main outcomes at the teacher level. How these outcomes and other factor influences to the performance of students in mathematics, as indicated in the National Achievement Test, are likewise highlighted in the study. Factor influences including teachers' attitudes towards mathematics and mathematics teaching (TATMT); their beliefs about teaching mathematics (MTEBS) and professional development programs (PDP) attended, were measured herein as these may have probably influenced the classroom practices of teachers, which in turn could spell an effect as to how pupils and students attune in the aspect of attitudes, beliefs and achievement.

In this chapter, the validation techniques and analyses of the scales used in the study are presented. Discussed first are the validation results of the Teacher-level factors, followed by the School-level and lastly the Student-level factors. The Teaching Practices Scale (TPS) was adapted from the Teaching and Learning International Survey (TALIS 2008, OECD, 2010); while, the Preferred Classroom Assessment Practice (PCAP) and Classroom Assessment Processes Scale (CAPS) are both adapted from Gonzales and Callueng (2014), and Gonzales and Fuggan (2012), respectively. TATMT (Relich, Way and Martin, 1994) and MTEBS (Enochs, Smith and Huinker, 2000) were adapted from prior studies, and the PDP which was adapted from TALIS 2008 (OECD, 2010).

School-level factors and characteristics which may pose influence to the classroom practices of teachers were also assessed. These school-level factors may as well influence students' achievement in mathematics and their attitudes and beliefs. All the factors or scales considered in the School-level factors are adapted from the TALIS 2008 study. This includes Management and Leadership style (MLS) of the school principal, school climate, teacher appraisal and the beliefs of school principals on the nature of teaching and learning (BANTL).

Student-level factors are adapted from existing questionnaires. Student attitudes towards mathematics are measured using four of the Fennema-Sherman Attitude Scales. This includes students' *confidence in learning mathematics* (CLM), teachers' attitudes (PTA), *usefulness of mathematics* (UOM) and *mathematics anxiety* (MAS). The beliefs about mathematics are likewise adapted from Yackel (1984).

Each of these scales and the corresponding items are already described in Chapter 3. In this chapter, confirmatory factor analysis (CFA) is used for the scale-level (macro-level) validation of the hypothesized and alternative models so called, measurement models as distinct from the structural models. After the thorough examination on the model fit indices and factor loadings, the final models of all the factors are presented.

5.2 Validity

To examine the utility of the instruments and to investigate whether the instruments measure or assess what they are intended to measure, construct validation using confirmatory factor analyses (CFA) was carried out. Construct validity was used to confirm whether the scales fit the conceptual framework or the underlying theories in the study (Darmawan, 2003).

5.2.1 Instrument Measurement Analyses

A validation analysis is undertaken in the study on the teacher-, school- and student-level factors and involves the confirmatory factor analysis (CFA) to examine the measurement characteristics of the factors. Confirmatory factor analysis is used in this study to validate whether the sample data support and confirm the theoretical measurement models (Schumacker & Lomax, 2010). The factors or constructs are not directly observable and are thus called *latent variables*. The items in each factor, which are called *observed*, *indicator* or *manifest variates* are used to construct the latent variables. Confirmatory factor analysis examines the validity of the latent and observed variables. CFA is carried out in order to demonstrate whether the hypothesised reflection on the measurement model is supported by the data.

This section presents the results of the validation analyses using confirmatory factor analyses (CFA) with the data collected from mathematics teachers of Grade 6 and Fourth Year students in both public and private schools in Region XII, south of Philippines. The method used to examine the characteristics of the scale measurements for classroom teaching practices was CFA using the Mplus 7 (Muthén & Muthén, 1998-2012) software program.   However, AMOS 21 (Arbuckle, 2012) was used to draw the CFA results.

5.2.2 Model fit indices

In order to assess which model best fits the data, different model fit indices were used. These indices estimated how different or similar the empirical or observed characteristics are to the theoretical or expected reflection characteristics. Stapleton (1997) contends that the data might accurately support more than one model, thus, various fit indices need to be employed to assess the fit of the different models. The fit indices used to assess the models are already presented in Chapter 4, the acceptable range is summarised in Table 5.2.1 below:

Table 5.2.1

Fit indices used in the validation of the scales

Fit Index	Acceptable fit value
Ratio of Chi-square and df (χ^2/df)	$\chi^2/df \leq 5$
Comparative fit index (CFI)	$\geq$ .90
Tucker-Lewis Index (TLI)	$\geq$ .90
Root mean square error of approximation (RMSEA)	$\leq$ .05
Standardized root mean square residual (SRMR)	$\leq$ .05

After examining the goodness of fit indices, the loading of each of the observed variates into its latent factor were also assessed. A cut-off value for the factor loading or the so-called standardized coefficient is .40 as recommended by Hair, Anderson, Tatham and Black (1998). However, Tabachnick and Fidell (1996) say that a .32 factor loading could be acceptable.

5.3 Validation of the Measures of Teacher-level Factors

As discussed earlier, the survey questionnaires were subjected to construct validity analysis. This was carried out by examining a number of measurement models including (1) one factor model, (2) orthogonal or uncorrelated factor model, (3) correlated factor model, and (4) hierarchical model. Although each scale has already a proposed model, alternative models need to also be tested as Stapleton (1997) argued that examining for alternative models of underlying data structure is deemed necessary as more than one model may more precisely explain the data.

5.3.1 Comparison of the fit indices of alternative models

In all the scales examined, items used for the analysis were first considered as belonging to a single factor. In the next alternative models, orthogonal and correlated first-order factors were examined and finally the hierarchical or the second-order factor. The models were compared using the different fit indices. Models that satisfied all the standard and acceptable values, were deemed to best fit the data. The final measurement models and the factor loadings for each scale are also presented. Below are examples of the models that were tested consisting of one-factor model, two-factor orthogonal model, two-factor correlated and hierarchical model. It is important to note that the sample models below do not represent any of the scales used in this study.

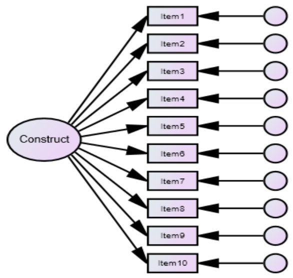


Figure 5.3.1 One-factor Model

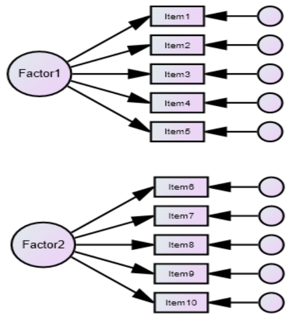


Figure 5.3.2 Two-factor Orthogonal Model

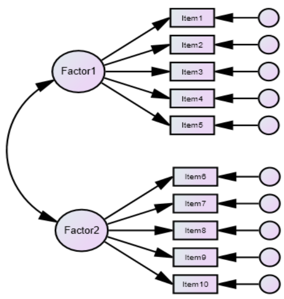


Figure 5.3.3 Two-factor Correlated Model.

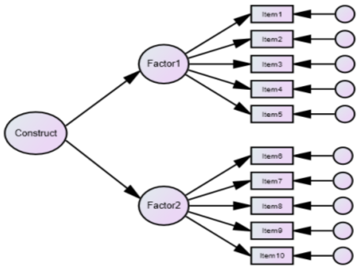


Figure 5.3.4 Hierarchical Model.

The goodness of fit indices of the models for each of the teacher-level factors are summarised in Table 5.3.1.

Table 5.3.1
Comparison of the Confirmatory Factor Analysis (CFA) model-data fit for all Teacher-level factors/scales

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Teaching Practices Scale (TPS)							
One-factor model	463.92	135	3.44	.82	.80	.09	.07
Three-factor orthogonal model	799.99	135	5.93	.65	.60	.12	.23
Three-factor correlated model	354.98	132	2.69	.88	.86	.07	.06
Hierarchical model	363.14	133	2.73	.88	.86	.07	.06
Preferred Classroom Assessment Practice (PCAP)							
One-factor model	639.01	135	4.73	.81	.79	.11	.07
Four-factor orthogonal model	797.97	135	5.91	.75	.72	.12	.30
Four-factor correlated model	251.63	129	1.95	.95	.95	.05	.04
Hierarchical model	262.45	132	1.99	.95	.94	.06	.04
Classroom Assessment Process Scale (CAPS)							
One-factor model	2302.90	629	3.66	.76	.74	.09	.08
Five-factor orthogonal model	2563.75	629	4.08	.72	.70	.10	.31
Five-factor correlated model	1454.48	619	2.35	.88	.87	.06	.06
Hierarchical model	1496.48	625	2.39	.87	.87	.07	.06
Teachers Attitudes towards mathematics and teaching (TATMT)							
One-factor model	895.61	119	7.53	.46	.39	.14	.15
Two-factor orthogonal model	220.29	90	2.45	.90	.89	.07	.06
Two-factor correlated model	218.73	89	2.46	.90	.89	.07	.06
Mathematics teaching efficacy beliefs scale (MTEBS)							
One-factor model	1041.03	170	6.12	.40	.33	.13	.14
Two-factor orthogonal model	691.99	170	4.07	.64	.60	.10	.12
Two-factor correlated model	690.43	169	4.09	.64	.59	.10	.12
One-factor PMTE	234.97	54	4.35	.77	.71	.10	.09
Two-factor orthogonal PMTE	97.67	54	1.81	.94	.93	.05	.07
Two-factor correlated PMTE	87.35	53	1.65	.96	.95	.05	.04
Hierarchical Model PMTE	87.35	53	1.65	.96	.95	.05	.04

Table 5.3.1 (continued)

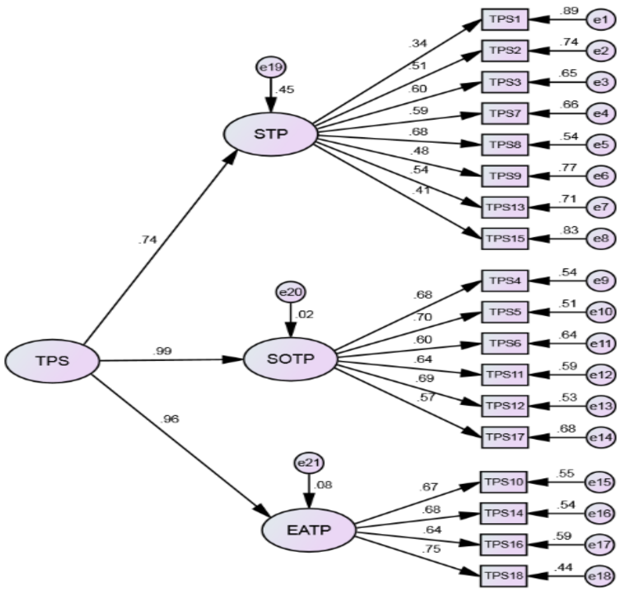
Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
One-factor MTOE	89.77	20	4.49	.83	.76	.10	.06
Two-factor orthogonal MTOE	82.67	9	9.19	.79	.65	.16	.14
Two-factor correlated MTOE	33.69	8	4.21	.93	.86	.10	.05
Hierarchical Model MTOE	33.69	8	4.21	.93	.86	.10	.05
Professional Development Program (PDP)						WRMR	
One-factor model	228.58	44	5.20	.88	.85	.11	1.66
Two-factor orthogonal model	171.33	44	3.89	.92	.90	.09	1.88
Two-factor correlated model	48.92	34	1.44	.99	.99	.04	0.76
Hierarchical model	48.92	34	1.44	.99	.99	.04	0.76

Teaching Practices Scale (TPS)

The results indicated that the χ^2/df ratio of three of the four models examined are within the recommended range ($2 \leq \chi^2/df \leq 5$). Results of all the other fit indices showed that the four models fall below of the acceptable threshold. However, among the four, the three-factor correlated model indicated the best fit into the data. Although the CFI (.88) and TLI (.86) fall a little short of the acceptable range and the RMSEA (.07) and SRMR (.06) a little above the acceptable range, the values may still be considered reasonable to indicate an acceptable model fit. When these three factors are considered as the first-order factors in a second-order or hierarchical model, the indices are slightly decreased, but are still reasonable to indicate good fit. The three-factor orthogonal model shows the worst fit with the χ^2/df ratio (5.93) above the acceptable value and other fit indices (CFI=.65, TLI=.60, RMSEA=.12 and SRMR=.23) outside the acceptable range.

Final structure of the Teaching Practices Scale (TPS)

The foregoing discussion established the three-factor correlated model as best fit into the data. The hierarchical model likewise shows better fit. Considering the parsimony of the model, this study adopted the hierarchical model of TPS. The model is illustrated in Figure 5.3.5



Key:
TPS - Teaching Practices Scale
STP - Structured Teaching Practice
SOTP - Student-Oriented Teaching Practice
EATP - Enhanced-activities Teaching Practice

Figure 5.3.5 Hierarchical model of the Teaching Practices Scale.

The Teaching Practices Scale consisted of 18 items clustered into three subscales. In a hierarchical model, all the three subscales are considered the first order factors and loaded onto a single second order factor. All the 18 items, except Item 1, have values above .40, which indicates ‘good fit.’ Although item 1 (TPS1) loaded below .40, it was retained. Removing it increases the RMSEA and SRMR and decreases the other fit indices. This is an indication that Item 1 carried a ‘halo effect’; thus, retaining it is a better option. In addition, Tabachnick and Fidell (2000) had argued that a value of .34 factor loading, which is greater than .32 is considered ‘acceptable.’ Looking at the structure of the three-factor model, TPS18 has the highest factor loading of .75. It is followed by TPS8 (.68), TPS4 (.68), TPS12 (.69) and TPS14 (.68). The rest of the items indicated values considered as ‘moderate factor loadings.’

Results of CFA also indicated probable relationships between the factors. Consistent with the results of TALIS, the correlation between SOTP and EATP is generally higher than the correlation between STP and SOTP and between STP and EATP.

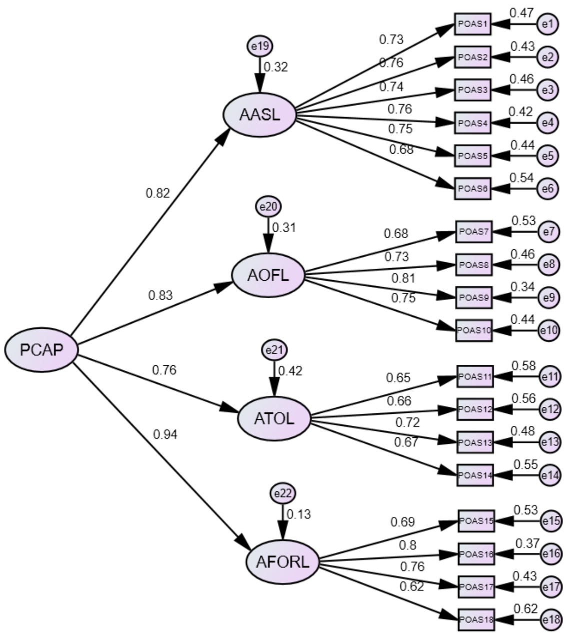
This is possible in practice since SOTP and EATP both pertained to students. Empirical results revealed a rather very high correlation (.96) between SOTP and EATP. This can mean that the mathematics teachers in Region XII, Philippines perceive both SOTP and EATP as student-oriented teaching practices.

Preferred Classroom Assessment Practice (PCAP)

Compared to other alternative models, the four-factor correlated model showed the best fit to the data. The χ^2/df ratio (1.95) obtained therein is the lowest suggesting that it is the best applicable model. This model also generated better fit indices among all other models in terms of CFI (.95), TLI (.95), RMSEA (.05) and SRMR (.04). The hierarchical model likewise showed best fit to the data with fit indices (χ^2/df = 1.99, CFI = .95, TLI = .94, RMSEA = .06 and SRMR = .04) which is almost the same as the four-factor correlated model. Consistent with the result of TPS, the four-factor orthogonal model proved to be the worst fit having a ratio (χ^2/df = 5.91), which is above the acceptable value; while all its other indices (CFI = .75, TLI = .72, RMSEA = .12 and SRMR = .30) were outside the acceptable values. This implied that teachers may have different preferences in classroom assessment techniques despite having some common characteristics.

Final structure of the Preferred Classroom Assessment Practice (PCAP)

The second-order factor or hierarchical model was applied on the preferences of teachers regarding classroom assessment (PCAP). It consisted 18 items in four dimensions or subscales (AASL, AOFL, ATOL, and AFORL). The four latent variables were taken as the first order factors and loaded onto a single second-order factor (PCAP) in the model. The results of the CFA analysis indicated that all the first layer factors load significantly on the common factor (PCAP). From the four factors, one of them (AFORL) came out very strong (.94) in relation to the common factor. The other three factors, AASL, AOFL and ATOL also yielded significant values (.82, .83 and .76, respectively) in relation to the common factor. This model is shown in Figure 5.3.6.



Key:

PCAP - Preferred Classroom Assessment Practice
AASL - Assessment AS Learning
AOFL - Assessment OF Learning
ATOL - Assessment TO Learning
AFORL - Assessment FOR Learning

Figure 5.3.6 Hierarchical Model for Preferred Classroom Assessment Practice.

Specifically, Figure 5.3.6 exhibits that the factor loadings of all the items in PCAP were acceptable. The values range from 0.62 to 0.81, which are all above the 0.40 threshold. Among the 18 items, Item 9 (PCAP9), which is an indicator of the assessment of learning (AOFL) dimension, generated the highest factor loading of 0.81. This suggests that teachers “determine the degree of accomplishment of a desired learning outcome at the end of a lesson,” which is indicative of a summative assessment of learning. The lowest factor loading (0.62) is that of Item 18 (PCAP18) which still indicates a high correlation among the other items within the subscale

AFORL. Generally, since all the factor loadings are greater than 0.50, this indicates that all the items are good indicators for the latent scales they intend to measure.

Classroom Assessment Process Scale (CAPS)

Results shown in Figure 5.3.7 reveal that the five factors of the classroom assessment processes can be correlated or hierarchical. All the fit indices for the five-factor correlated model are just within the acceptable range with χ^2/df = 2.35, CFI = 0.88, TLI = 0.87, RMSEA = .06 and SRMR= .06. The hierarchical model slightly differs in the values of the ratio of chi-square and degrees of freedom (χ^2/df = 2.39) and RMSEA (.07). Although the respective χ^2/df values of the one-factor and the five-factor orthogonal models are still within the acceptable range, the values for the other fit indices are outside of the range of good fit. This implies that the mathematics teachers consider the five assessment processes as interrelated with each other.

Final structure of the Classroom Assessment Process Scale (CAPS)

Consistent with the previous scales, the hierarchical structure (Figure 5.3.7) was chosen for CAPS due to its more parsimonious nature compared to the five-factor correlated model. The 37 items were clustered into five factors, consistent with the theoretical structure of classroom assessment practices. Of the five factors, the assessment administration and scoring (AAS) factor loaded very highly (0.98) onto the common factor. It consisted seven items indicating appropriate practices in administering and scoring students' assessment. The seventh item, "I make sure I have enough time to score test papers," produced the highest loading of 0.83. The other two factors (AIP and RSG) both yielded equally high loading of 0.94 onto the common factor. Moreover, the fifth factor (ADUE), came out as having the least correlation (.39) with the second-order factor. Nevertheless, all the five lower-order factors showed that they are associated with each other. Figure 5.3.7 shows the second-order factor or hierarchical model of CAPS.

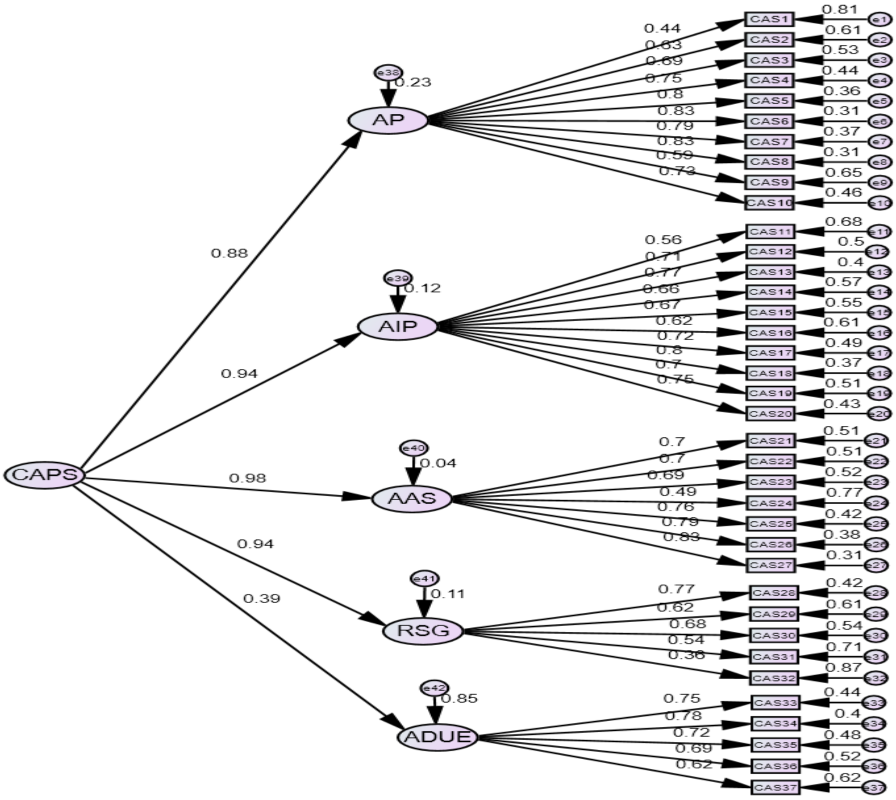


Figure 5.3.7 Hierarchical Model for Classroom Assessment Process Scale.

Key:
CAPS - Classroom Assessment Process Scale; AP - Assessment Planning; AIP - Assessment Item Preparation; AAS - Assessment Administration and Scoring; RSG - Reporting of Scores and Grading; ADUE - Assessment Data Utilisation and Evaluation

Figure 5.3.7 likewise displays the individual item loadings to the respective scales. Except for Item 32 (CAPS32), all the factor loadings are above the 0.40 threshold, which indicates that the items are highly linked to the scales they are measuring. Item 32 was, however, retained, since the loading of 0.36 is still acceptable and removing it does not make any significant change to the indices. Likewise, it was also inappropriate to remove this item because it is an important indicator of the item, 'reporting of scores and grading' (RSG) factor. The highest factor loading of

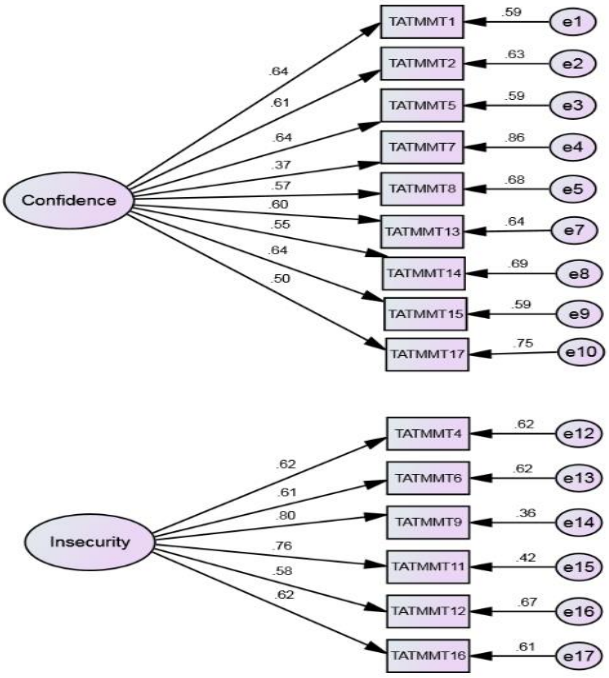
0.83 was generated in items CAPS6 (“I relate to the instructional process with the assessment process”) and CAPS8 (“I ensure that appropriate assessment strategies are employed”). These items belong in both the AP factor and item CAPS27 of the AAS factor.

Teachers Attitude towards Mathematics and Teaching (TATMT)

Results revealed that the indices of the one-factor model are either greater than the acceptable values in terms of the χ^2/df (7.53), RMSEA (.14) and SRMR (.15); or way below the acceptable range in terms of CFI (0.46) and TLI (0.39). Both the orthogonal and correlated two-factor model have equally better and acceptable fit (χ^2/df = 2.45, CFI = 0.90, TLI = 0.89, RMSEA = .07 and SRMR = .06) compared to the one-factor model. This confirms that teachers’ attitudes towards mathematics and mathematics teaching can be described by the Confidence and Insecurity factors. Although these two orthogonal and correlated models yielded the same fit indices, the correlation between the two factors is very low and negative (-.08), which is considered not significant. Hence, the uncorrelated or orthogonal was accepted as the model of better fit.

Final structure of the Teachers Attitudes towards Mathematics and Mathematics Teaching (TATMMT)

Figure 5.3.8 illustrates the two-factor orthogonal or uncorrelated model of teachers’ attitudes, which is the final model to be used in this study. Results revealed that mathematics teachers consider Confidence and Insecurity factors as two independent variables. This also implies that the teacher could feel confident and insecure, at the same time, when dealing with mathematics or when teaching mathematics, the same as what White et al. (2005/2006) found.



Key:

TATMMT - Teachers' Attitudes towards Mathematics and Mathematics Teaching

Figure 5.3.8 Two-factor orthogonal model of Teachers' Attitudes towards Mathematics.

As shown in Figure 5.3.8, the factor loadings of all the items (last two columns), except item 7 (TATMMT7), indicate that the items within each contract are highly related to each other and are therefore measuring the same scale. The table also shows that there were two items deleted, one from each subscale. Item 3 was deleted from the scale Insecurity as it is negatively correlated with all the items within the scale. Removing it did not only improve the factor loadings, but also improved the fit of the model into the data. Moreover, Item 10 (TATMMT10) from the scale Confidence, with a factor loading of .31, was likewise removed because in so doing, better fit indices were realized. However, though item TATMMT7 ("I am quite good at mathematics") produced a factor loading below 0.40, it was retained for two reasons: that the item is an important indicator of confidence and, its factor loading is nonetheless acceptable.

Mathematics Teaching Efficacy Beliefs Scale (MTEBS)

Results in Figure 5.3.8 confirms the orthogonal two-factor model structure of the scale, which was based on Bandura's (1977) self-efficacy beliefs theory. However, in this study, the measurement characteristics of the models separating the two independent factors (PMTE and MTOE) and having their own two correlated factors, indicated a more acceptable and reasonable fit to the data. It can be gleaned from the table that both the one-factor and two-factor (both orthogonal and correlated) models of MTEBS have poor fit to the data. Although both the orthogonal and correlated two-factor models of MTEBS have almost the same fit indices, the correlation between the two factors, however, produced a negative very low correlation (r = -.08). This implies that the factors are not correlated, which is consistent with the self-efficacy theory having two independent factors. Putting the two uncorrelated factors in one model neither yield good fit nor acceptable factor loadings. Hence, PMTE and MTOE with their respective scale characteristics were examined separately as alternative models. The results indicated better fit for both PMTE and MTOE models. For the PMTE, a two-factor correlated model yielded the best fit to the data with χ^2/df = 1.65, CFI = 0.96, TLI = 0.95, RMSEA = .05 and SRMS = .04. The hierarchical model, which is a simpler model, produced the same fit indices as that of the two-factor correlated model.

Final structure of the Mathematics Teaching Efficacy Beliefs Scale (MTEBS)

According to Bandura's (1977) theory on self-efficacy beliefs, self-efficacy has two independent factors, recorded in this study as personal mathematics teaching efficacy (PMTE) and mathematics teaching outcome expectancy (MTOE). The results, however, implied that a research instrument may not necessarily work within the same indications when used in a different context. It was found out that each of the independent factors form a hierarchical structure further implying that the first-order factors are also influenced by the second-level factors. For example, the indicators which point to ‘persistence’ and ‘self-perceived ability’ in teaching mathematics are also influenced by mathematics teaching efficacy. The MTOE factor was also recorded as a similar case. The hierarchical nature assumes that the two subscales are correlated with each other. Figure 5.3.9 and Figure 5.3.10 present the hierarchical models of PMTE and MTOE, respectively.

The factor loadings for the PMTE range from 0.45 to 0.70 as displayed in Figure 5.3.5, which indicates moderate to high correlations between and among the items in each of the two correlated factors. It is likewise recorded that the first-order factor ‘Persistence’ loads on PMTE higher than the ‘Self-perceived Ability’ factor (Persistence = 0.61, SPAbility = 0.40).

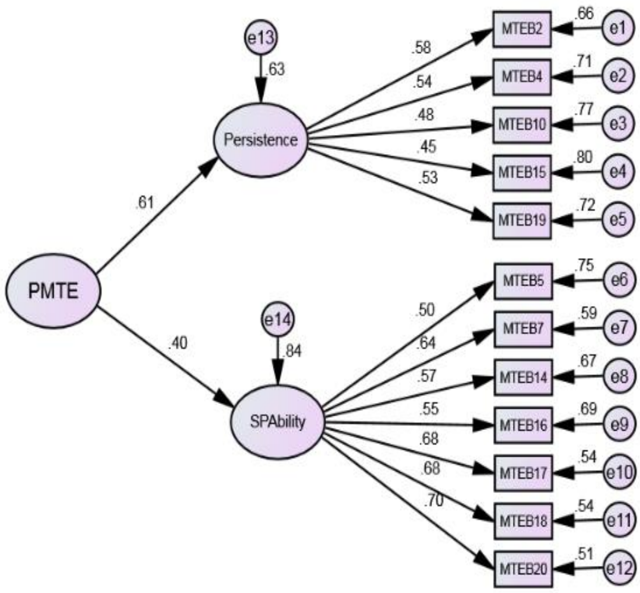


Figure 5.3.9 Hierarchical model of PMTE.

Key: PMTE - Personal Mathematics Teaching Efficacy; MTEB - Mathematics Teaching Efficacy Beliefs; SPAbility - Self-perceived Ability

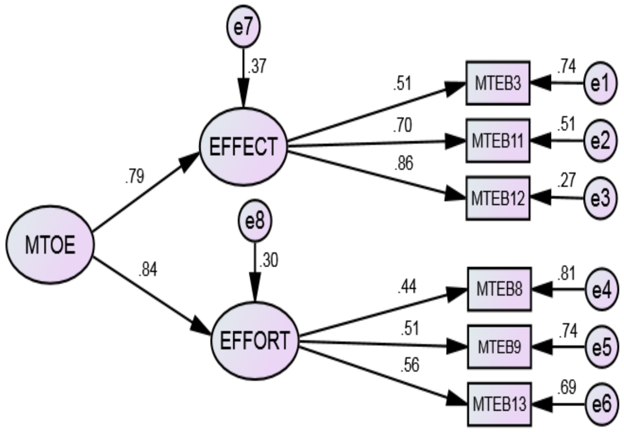


Figure 5.3.10 Hierarchical model of MTOE.

Key: MTOE - Mathematics Teaching Outcome Expectancy

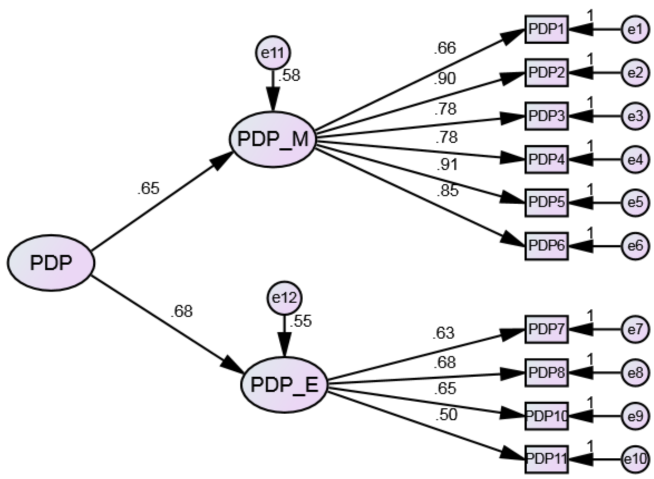
Figure 5.3.10 presents that all the items in MTOE, except item MTEB8, have factor loadings above 0.50, which indicated a high correlation with each other. MTEB8 has a factor loading of 0.44, which is also above the acceptable threshold, therefore a good indicator of teachers' effort to help students achieve better numeracy goals. In this scale, two items were deleted, one from each of the two first-order correlated factors of MTOE. Item MTEB6 had the lowest factor loading of 0.22 and MTEB1 with a factor loading of 0.32. As expected, MTEB6 was deleted first so to improve the fit indices. On the contrary, deleting MTEB6 led to a worse fit rather than an improved one. However, deleting the other item MTEB1 offset the effect. Thereafter, the fit indices improved compared to that prior to the removal.

Figure 5.3.10 presents the final items that reflect teachers' effort and effectiveness in mathematics teaching outcome expectancy. The item that yielded the highest factor loading was MTEB12 with a loading of 0.86. The subscale 'effort' is closely related to the common factor MTOE with the loading of 0.84 compared to the loading of 0.79 for the other subscale 'effect.'

Professional Development Program (PDP)

Results indicated that mathematics teachers view the two areas of professional development differently but are correlated. The values generated by the two-factor correlated model specified good fit compared to the one-factor model. Since it was answerable by a 'yes (1)' or 'no (0)', the variable was treated as categorical when analysed using Mplus 7. Thus, the weighted root mean square residual (WRMR) was produced instead of SRMR. WRMR is more suitable for the non-normal continuous outcomes. Yu and Muthén (2001) suggested that WRMR value of less than 0.90 is good for models with continuous as well as with categorical outcomes. Hence, both the two-factor correlated and hierarchical models indicate good fit with the ratio of less than five (χ^2/df = 1.44), CFI = 0.99, TLI = 0.99, RMSEA = .04 and WRMR = .76.

Final structure of the Professional Development Program (PDP)



Key:

PDP - Professional Development Program
PDP_M - Professional Development Program-Mathematics
PDP_E - Professional Development Program - Education

Figure 5.3.11 Hierarchical model of Professional Development Programs.

Figure 5.3.11 presents the final form of the model of the professional development programs attended by the mathematics teachers in the last three years. The programs listed were either mathematics-related or professional education-related. Results revealed that teachers had made a distinction between the two areas (mathematics and general education). However, these two factors are related to each other and are loaded to a common factor, professional development program (PDP). This explains the reason for adopting a hierarchical form as the model. Note that the two subscales are also almost equally associated to PDP with 0.65 and 0.68 loadings for PDP mathematics and PDP education, respectively. Surprisingly, the diagram shows no residuals for the individual items though the data were treated as categorical.

The factor loadings, as shown in Figure 5.3.10, range from 0.50 to 0.91, denoting high to very high correlations between and among the items within the scale they are measuring. It can be observed that Item 9 (PDP9) was deleted because it recorded a suppressor effect with a factor loading of greater than 1.00. Deleting it, however, did not have any significant change to the fit indices neither to the factor loadings of the other items.

5.4 Validation of the Measures of School-level factors

In order to examine the structure of the scales at the school level, data were obtained from a sample of 146 school principals of selected elementary and secondary, public and private schools, in Region XII, Philippines. Consistent with the teacher-level factors, four models were examined in each of the factors or scales. It involved the following: (1) one factor model, (2) orthogonal or uncorrelated factor model, (3) correlated factor model, and (4) hierarchical model.

5.4.1 Comparison of fit indices of the alternative models

In comparing the models, same fit indices were used to determine which would come out the best fit. Same criteria and acceptable value were also applied. The factor loadings were likewise reviewed to adjudge whether the items are true reflections of the scales they intend to measure. The final forms of the models are presented in this section, particularly in Table 5.4.1 wherein the comparison of the fit indices of the models for each of the school-level factors are shown.

Table 5.4.1

Comparison of model-data fit for all School-level factors/scales

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Management/Leadership Style –Instruction (MLSI)							
One-factor model	131.86	77	1.71	.89	.87	.07	.06
Three-factor orthogonal model	307.41	77	3.99	.54	.46	.14	.23
Three-factor correlated model	113.82	74	1.54	.92	.90	.06	.06
Hierarchical model	129.52	75	1.73	.89	.87	.07	.07
Management/Leadership Style – Accountable (MLSA)							
One-factor model	254.91	90	2.83	.76	.72	.11	.09
Two-factor orthogonal model	185.72	54	3.44	.78	.73	.13	.22
Two-factor correlated model	106.92	53	2.02	.91	.89	.08	.06
Hierarchical model	106.92	53	2.02	.91	.89	.08	.06
School Climate for Learning (SCFL)							
One-factor model	198.17	27	7.34	.79	.71	.21	.09
Two-factor orthogonal model	144.70	27	5.36	.85	.80	.18	.27
Two-factor correlated model	83.44	26	3.21	.93	.90	.12	.05
Hierarchical model	83.44	26	3.21	.93	.90	.12	.05
Beliefs about the Nature of Teacher and Learning (BANTL)							
One-factor model	135.07	54	2.50	.85	.82	.10	.08
Two-factor orthogonal model	172.29	54	3.19	.78	.73	.12	.20
Two-factor correlated model	50.01	34	1.47	.97	.96	.06	.05
Hierarchical model	50.01	34	1.47	.97	.96	.06	.05
Teacher Appraisal Criteria (TACrit)							
One-factor model	383.20	119	3.22	.79	.76	.12	.08
Three-factor orthogonal model	400.69	118	3.40	.77	.74	.13	.27
Three-factor correlated model	244.32	114	2.14	.89	.87	.09	.07
Hierarchical model	253.62	115	2.21	.89	.87	.09	.07

Management/Leadership Style - Instructional (MLSI)

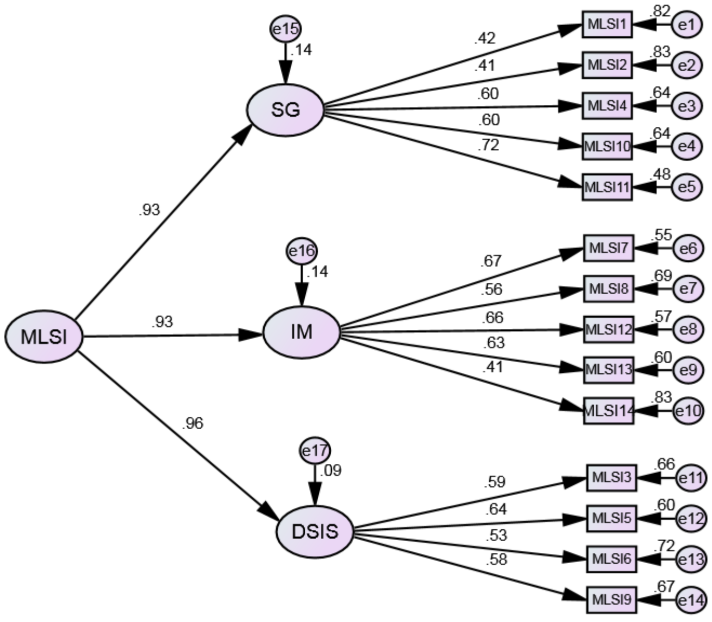
The management or leadership style of school principals were considered in two broad scales –the instructional and administrative leadership scales. Each of these scales was examined further within the respective subscales. Foremost, the

Instructional leadership style which was examined as one factor model. Results generated acceptable fit indices. Albeit the CFI (.89) and TLI (.87) values falling a little short of the criteria, they still signify a considerable data fit. When the items are loaded into the three uncorrelated or orthogonal factors, the fit indices significantly dropped into poor indices. However, when the three factors were correlated, there was a significant increase in the fit indices compared to the uncorrelated model. The ratio χ^2/df changed from 3.99 to 1.54, CFI from 0.54 to 0.92, TLI from 0.46 to 0.90, RMSEA from .14 to .06 and SRMR from .23 to .06. In fact, the table shows that the three-factor correlated model best fits the data. However, the correlation between the factors *instructional management* (IM) and *direct supervision of instruction in the school* (DSIS) is greater than one, implying that these two may be measuring one construct. Thus, signalling an examination using a hierarchical model. In so doing, it was observed that the fit indices for the hierarchical model slightly decreased. This is due to the constraint applied to the residual of the third factor (DSIS) since its correlation with the second order factor (Instructional leadership, MLSI) is also greater than one; causing its residual to become negative. This indicates multicollinearity and was resolved by constraining the residual of the factor into a value lesser than zero. The results showed an acceptable level of fit indices regardless of the slightly lower than acceptable values of the CFI and TLI for the hierarchical factor model.

Final structure of the Management/Leadership Style - Instructional (MLSI)

As stated above, the hierarchical model of MLSI is the preferred model for this scale due to its simplicity. As discussed earlier (in the section where fit indices of the different models are being compared), the decrease in fit indices of the hierarchical model was due to the constraints imposed on the residual of one latent scale (DSIS) as it exhibited a correlation value greater than one. Nevertheless, the hierarchical model still demonstrates a reasonable fit to the data.

After constraining the error of DSIS, its correlation with the second-order factor (MLSI) decreased to .96. The other two factors showed the same correlation value with that of MLSI, which were also high. Figure 5.4.1 points that the items were loaded from moderate to high onto their respective scales. All the factor loadings are above .40 which indicate that the items correlate highly as they reflect the scale that they measure. The hierarchical structure implies that the items are also reflected by the second-order factor, MLSI.



Key:

MLSI - Management/Leadership Style - Instructional
SG - School Goals
IM - Instructional Management
DSIS - Direct Supervision of Instruction in the School

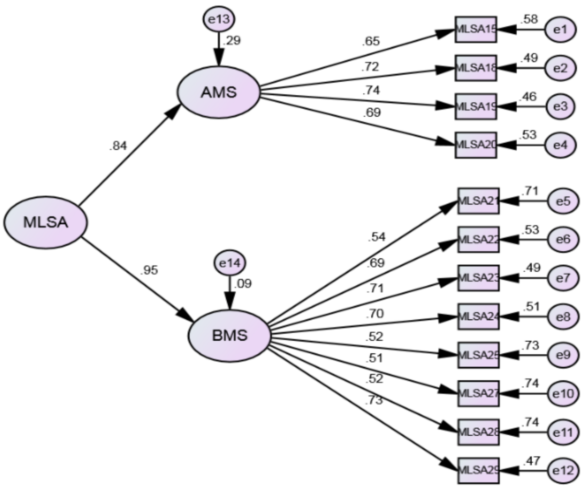
Figure 5.4.1 Hierarchical model of MLSI.

Management/Leadership Style - Administrative (MLSA)

Another management or leadership style considered in this study is the Administrative style. Results show that the one-factor model yielded the poorest fit to the data. Hence, a two-factor orthogonal model was applied. Results indicated that there was only a slight improvement in the fit indices, which still produced poor fit indices. Both the two-factor correlated model and hierarchical model show the same indices which indicate better fit to the data with the $\chi^2/df = 2.02$, CFI = 0.91, TLI = 0.89, RMSEA = .08 and SRMR = .06. This signifies that while the items are reflecting the two correlated subscales, they are greatly influenced by the second-order factor.

Final structure of the Management/Leadership Style - Administrative (MLSA)

Figure 5.4.2 illustrates the hierarchical structure of administrative management or leadership style MLSA) of the school principals. The first–order factors show that the Bureaucratic management/leadership style (BMS) is very highly correlated (r = .96) with the second-order factor (MLSA).



Key:
MLSA - Management & Leadership Style- Administrative
AMS - Accountable Management/ Leadership Style
BMS - Bureaucratic Management/ Leadership Style

Figure 5.4.2 Hierarchical model of MLSA.

Figure 5.4.2 also displays that all the factor loadings are greater than .50, which indicates that the items are highly related to the respective scales that they measure. Item MLSA19 recorded the highest factor loading under the subscale *accountable management/leadership style* (AMS). This means that the school principals consider ‘ensuring that the teachers are held accountable for the attainment of the school goals’ as an important part of their work.

Three items were removed from the final analysis because of their very low factor loadings. These were items MLSA16 (.26) and MLSA17 (.26) under the subscale AMS and MLSA26 (.16) under BMS. These three were deleted one after the other, starting from the smallest (MLSA26) using the two-factor correlated model. As each item was removed, the fit indices significantly improved from (χ^2/df = 2.65, CFI = 0.79, TLI = 0.75, RMSEA = .11 and SRMR = .10), to new indices (χ^2/df = 2.02, CFI = .91, TLI = .89, RMSEA = .08 and SRMR = .06). A very slight change was observed in the factor loadings of all the items after the removal of the three items. Therefore, the deleted items did not exhibit a halo effect. Their low factor loadings simply imply that they do not correlate well with the other items in scale they are measuring.

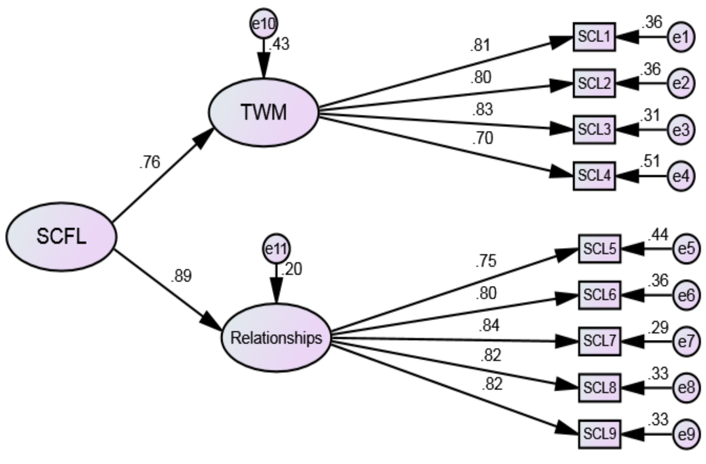
School Climate for Learning (SCFL)

A comparison of the four models revealed that the one-factor model came out unfitting to the data. The fit indices for the two-factor orthogonal model increased but still showed a slight lack in model-data fit. The two-factor correlated and hierarchical model exhibited good fit of the models onto the observed data (χ^2/df =

3.21, CFI = 0.93, TLI = 0.90, RMSEA = .12 and SRMR = .05). From the two-factor orthogonal model, the indices significantly improved when the two subscales were correlated. This is most likely due to the high correlation between the two factors (r = .68), which also made it possible for the hierarchical model to fit the data. However, the RMSEA, exhibited poor fit. With further examination, this can be improved by correlating the errors of the two items, SCFL6 and SCFL7 (since both indicate parental support and involvement in school activities). This is usually done in cases when the other fit indices command a good fit to the data.

Final structure of the School Climate for Learning (SCFL)

School climate for Learning (SCFL) was assessed by the two latent subscales *teacher working morale* (TWM) and *Relationships* (Rel), which were highly correlated at .71. The high correlation between the two subscales surfaced that the two factors are also reflecting one single factor, the SCFL. The hierarchical model is presented in Figure 5.4.3; wherein exhibited the idea that the two factors (TWM and Relationships) Relationships had a higher positive loading with the second-order single factor of 0.89.



Key:

SCFL - School Climate for Learning
TWM - Teacher's Working Morale

Figure 5.4.3 Hierarchical model of SCFL.

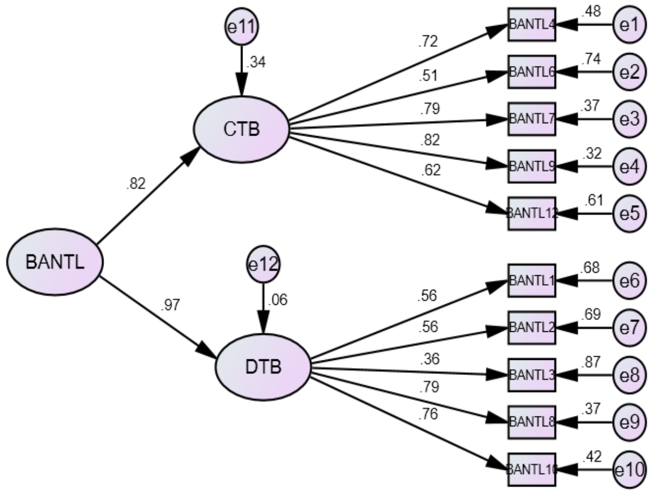
In addition, Figure 5.4.3 reflects that the items are highly loaded onto the two subscales with factor loadings ranging from 0.70 to 0.84. The highest loading was generated at item SCL7 (“parental involvement in school activities) with the ‘Relationships’ scale. This implies that school principals put high regard on parents’ involvement in maintaining a school environment that encourages learning.

Beliefs about the nature of teaching and learning (BANTL)

Results show that models 3 and 4 provide the best fit to the data having satisfactory fit indices (see Table 5.4.1). All the fit indices, especially CFI (0.97) and TLI (0.96) indicate that the values are above the criteria set for this study. The two factors, namely constructivist belief and direct transmission belief, likewise exhibited a high correlation (r = .79) between them. Moreover, the one-factor model recorded a slightly lack of model-data fit. The two-factor orthogonal model recorded the poorest fit to the data among the models tested. All the fit indices are far from the acceptable values.

Final structure of the Beliefs about the nature of teaching and learning (BANTL)

Items relating to the belief of school principals about the nature of mathematics are based on either 'constructivism' or 'direct transmission' theories. Referring to Table 5.4.1, both the two-factor correlated model and hierarchical model exhibited a very good model-data fit. However, the hierarchical model is the preferred form, again by simplicity of form.



Key:

BANTL - Beliefs about the Nature of Teaching and Learning
CTB - Constructivist Beliefs
DTB - Direct Transmission Beliefs

Figure 5.4.4 Hierarchical model of School Principal's BANTL.

The two subscales of BANTL are highly correlated with coefficient of .78, making it plausible for a hierarchical structure. Figure 5.4.4 above shows that the second subscale (direct transmission belief) is very highly correlated (r = .97) with the school principals' belief on the nature of teaching and learning. The constructivist belief also yielded a high loading with BANTL of r = .82.

The standardised estimates (factor loadings) of the items are also presented in Figure 5.4.4. The estimates range from .36 to .82 indicating that they, except BANTL3, are highly correlated with each other as they reflected a single scale. Yet again, the items also reflected the second-order factor BANTL with its hierarchical form. From the beginning of the analysis, two items (BANTL11 and BANTL5) had low loadings. Therefore, they were removed one after another, beginning with that which had the least estimate, the BANTL11. When both items were already removed, the fit indices boasted a very good fit to the data. In another respect, BANTL3 yielded an estimate of below .40 but was retained because the attempt to exclude it slightly decreased the fit.

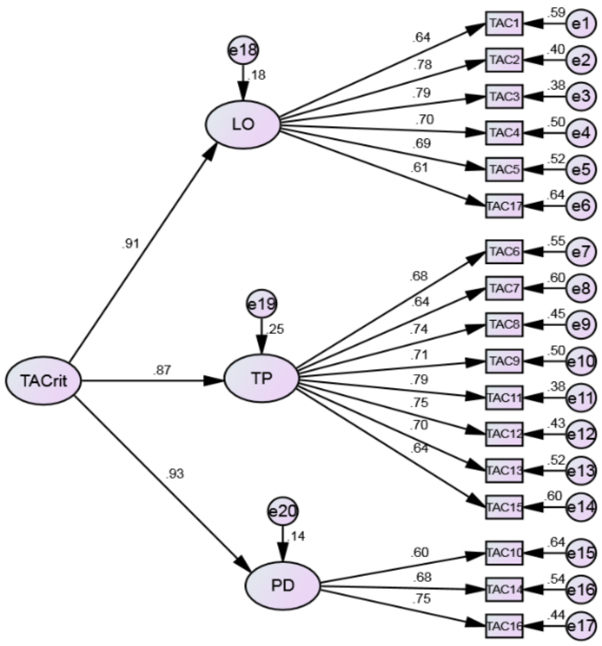
Teacher Appraisal_Criteria (TAC)

Results show that the three-factor correlated hierarchical model of the TACrit among school principals generated fit indices of χ^2/df = 2.21, CFI = 0.89, TLI = 0.87, RMSEA = .09 and SRMR = .07. It is therefore the more acceptable model compared to the one-factor and three-factor hierarchical models. Although CFI and TLI were both slightly short of the acceptable value, they still indicated a good fit between the model and the observed data. Among the models assessed, the three-factor orthogonal model yielded the poorest fit with χ^2/df = 3.19, CFI = 0.78, TLI = 0.73, RMSEA = .12 and SRMR = .20. The school principals recorded that although the three factors have their distinct features, they still are linked with each other.

Final structure of the Teacher Appraisal_Criteria (TAC)

Figure 5.4.5 shows the hierarchical factor model, the preferred model of scale, for teacher appraisal. It depicted further that among the three factors which were highly connected with the second order single factor, the highest was the criteria for professional development with a coefficient of 0.93, followed by the criteria on students' learning outcomes with r = .91. Meanwhile, the third factor (Teaching practices) had the lowest coefficient at 0.87.

Figure 5.4.5 presents that the standardised estimates of the 'teacher practice' (TP) criteria obtained the highest values ranging range from 0.64 to 0.79. Overall, the standardised estimates (factor loadings) are greater than .50 indicating that the items are all highly loaded onto the scale they are reflecting. It further denotes that the items reflect the scale they are intended to reflect.



Key:
TACrit - Teacher Appraisal - Criteria
LO - Learning Outcomes
TP - Teacher Practice
PD - Professional Development

Figure 5.4.5 Hierarchical model of TAC.

5.5 Validation of the Measures of the Student-level factors

For the analyses of the nature of scales at the student-level, data were collected from a total of 6,672 elementary and secondary students coming from both the public and private schools in Region XII, Philippines. Four distinct models, similar to the Teacher- and school level factors, were applied to determine the model of best fit. Similarly, it included: (1) one factor model; (2) orthogonal or uncorrelated factor model; (3) correlated factor model, and; (4) hierarchical model.

5.5.1 Comparison of fit indices of the alternative models

Table 5.5.1 records the fit indices of the four different models of the student-level factors. The same fit indices were used to examine the models to determine that which best fits the data.

Confidence in Learning Mathematics (CLM)

The one-factor model of CLM was examined first and resulted in a poor fit. The two-factor structure correlated and orthogonal models came next, which revealed that the indices of the correlated two-factor model are higher than the orthogonal model. The indices for the correlated factors are above the threshold in the case of CFI and TLI (CFI = 0.97 and TLI = 0.96) and lower than the threshold in terms of RMSEA (.04) and SRMR (.03). Thus, the two factors are moderately correlated with a coefficient of .50. This indicates that the two correlated factors may also be assessing a single factor, in this case, the CLM. The two correlated factors were placed as the first-order factor, while the CLM as the second-order factor. The indices for the hierarchical factor model are approximately the same as that of the two-correlated factor model, indicating best fit of the model to the data. It can be observed that the ratio of chi-square statistics and degrees of freedom are all way above the level of five ($\chi^2/df \leq 5$). This is due to the very large sample size. Since chi-square is sensitive to sample size, the tendency is for it to be high as the sample size, affecting the estimated fit ratio. Therefore, in using this index, the model that fits the data better is that which surfaced the lower ratio.

Final model of the Confidence in Learning Mathematics (CLM)

As recorded in Table 5.5.1, the hierarchical factor model of the confidence in learning mathematics was determined as the best model. It consisted of 11 items, which are used generally to describe students' confidence. Six items were positively stated while the other five items were negatively stated. Prior to the subsequent analyses, the negatively stated items were reverse coded. Results of CFA indicated that the students treat the positively stated and negatively stated items as two distinct but correlated factors of CLM. Thus, the two sub-factors were labelled as 'confident' for the positively stated items and 'not confident' for the negatively stated items. The figure further showed that the two first order factors are highly related to the second order single factor. The factor loadings of each of the items are likewise shown in Figure 5.5.1.

Table 5.5.1
Comparison of model-data fit for all Student-level factors/scales

Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Confidence in Learning Mathematics (CLM)							
One-factor model	4386.32	44	99.69	.73	.66	.12	.09
Two-factor orthogonal model	1503.93	44	34.18	.91	.89	.07	.11
Two-factor correlated model	605.74	43	14.09	.97	.96	.04	.03
Hierarchical model	605.74	43	14.09	.97	.96	.04	.03
Perception of Teachers Attitude (PTA)							
One-factor model	3305.69	20	165.28	.66	.53	.16	.11
Two-factor orthogonal model	349.93	20	17.50	.97	.95	.05	.05
Two-factor correlated model	252.45	19	13.29	.98	.97	.04	.02
Hierarchical model	252.45	19	13.29	.98	.97	.04	.02
Usefulness of Mathematics (UOM)							
One-factor model	4077.30	35	116.49	.75	.68	.13	.08
Two-factor orthogonal model	2027.01	20	101.35	.86	.81	.12	.17
Two-factor correlated model	418.39	19	22.02	.97	.96	.06	.03
Hierarchical model	418.39	19	22.02	.97	.96	.06	.03
Mathematics Anxiety Scale(MAS)							
One-factor model	7144.27	54	132.30	.64	.57	.14	.11
Two-factor orthogonal model	2322.68	54	43.01	.89	.86	.08	.10
Two-factor correlated model	1742.39	53	32.88	.92	.89	.07	.04
Hierarchical model	1742.39	53	32.88	.92	.89	.07	.04
Beliefs about Mathematics (BAM)							
One-factor model	5871.90	152	38.63	.68	.65	.08	.07
Two-factor orthogonal model	3486.47	44	79.24	.70	.63	.11	.14
Two-factor correlated model	1104.52	43	25.69	.91	.88	.06	.04
Hierarchical model	1104.52	43	25.69	.91	.88	.06	.04

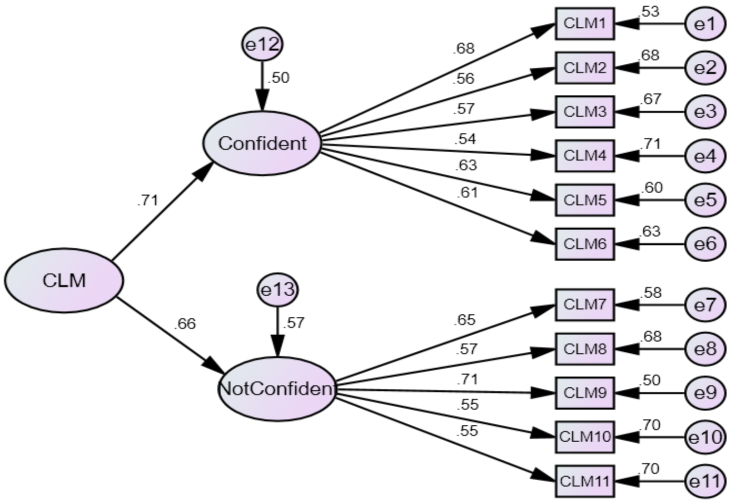


Figure 5.5.1 Hierarchical model of Students' Confidence in Learning Mathematics.

Figure 5.5.1 exhibits that the standardised factor loadings are all positive and moderately high, with standardised values ranging from 0.55 to 0.71. This implies that the items highly reflect the scale that they intend to measure in the same way that the items are also reflected by the second-order factor (CLM) due to its hierarchical structure.

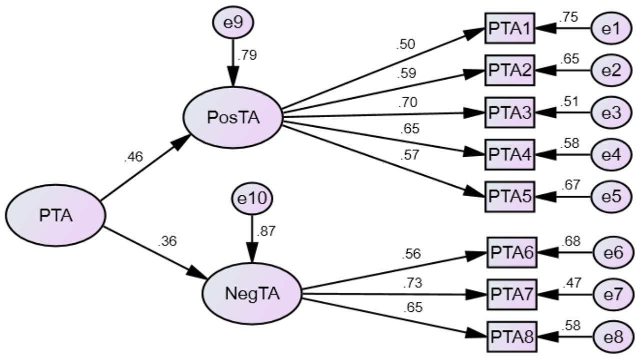
Perceived Teachers' Attitudes (PTA)

Table 5.5.1 reflects too that three of the four models examined produced good fit of the models to the data. Only the one-factor model did not fit the data, which implies that the students were able to treat separately the positively worded and negatively worded items into two factors, but was understood to correlate with each other. Of the eight items, five were positively worded, while three were negatively worded. Both the two-factor correlated model and hierarchical factor model demonstrated the best fit model to the data with χ^2/df = 13.29 (the lowest among the other models), CFI = 0.98, TLI = 0.97, RMSEA = .04 and SRMR = .02.

Final Structure of the Perception of Teachers' Attitudes (PTA)

Based on the foregoing results, the decision was to employ the hierarchical model in the final structure of perceived teachers' attitudes towards students. Figure 5.5.2 presents the hierarchical structure of the model. In the model, there were five items describing teachers' positive attitudes towards helping or motivating students to learn. On the contrary, there were three of the items pertaining to the negative attitudes of the teachers. The results show that perceived teachers' attitudes loaded moderately on the two subscales.

The standardised estimate of teachers' attitudes on positive teachers attitudes and negative teachers attitudes are 0.46 and 0.36, respectively. The standardised estimates of the items are also illustrated in Figure 5.5.2. The estimates or the factor loadings range from 0.50 to 0.73, indicating that the items are highly reflective of the scale they are measuring.



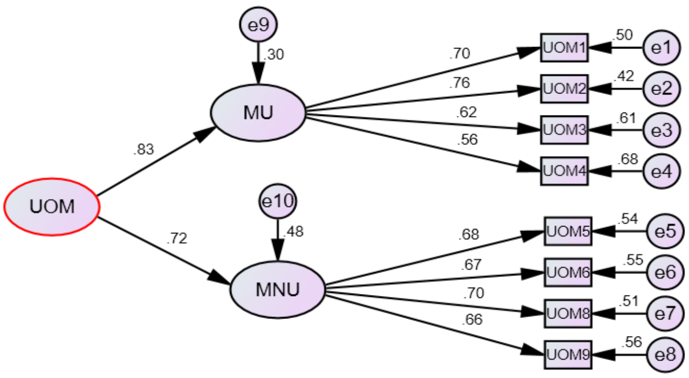
Key:
PTA - Perceived Teacher Attitude
PosTA - Positive Perception of Teacher Attitude
NegTA - Negative Perception of Teacher Attitude

Figure 5.5.2 Hierarchical model of Students' Perception of Teacher's Attitudes.

Usefulness of Mathematics (UOM)

A comparison of the four models assessed for the Usefulness of Mathematics Scale (UOM), pointed at the two factor correlated model and the hierarchical model which surfaced an acceptable level of fit (see Table 5.5.1). The indices resulting from both models of UOM, (χ^2/df = 22.02, CFI = 0.97, TLI = 0.96, RMSEA = .06 and SRMR = .03), established the validity of the scale. The one-factor model exhibited the poorest fit indicating that the items do not measure just one single scale. The UOM Scale has 10 items, four of which were positively worded and the remaining six items were negatively worded. With this clustering, students viewed mathematics as either 'useful' (MU) or 'not useful' (MNU) in their daily lives. Figure 5.5.3 shows the hierarchical model of UOM as the final model for this scale.

Final Structure of the Usefulness of Mathematics (UOM)



Key:

UOM - Usefulness of Mathematics
MU - Mathematics is Useful
MNU - Mathematics is not Useful

Figure 5.5.3 Hierarchical model of UOM.

Figure 5.5.3 illustrates that the MU subscale correlates highly with the single second-order factor (UOM) at 0.83, although the other subscale (MNU) also displays a high correlation with UOM at 0.72. The factor loadings of the items range from 0.56 to 0.76. High factor loadings indicate that the items were highly reflective of the scale they are measuring. It can be observed, however, that only eight items were presented in the final model.

Two items (UOM7 and UOM10) were removed due to very low factor loading values. In the initial analysis, UOM7 and UOM10 load to MNU by .14 and .29, respectively. Although the fit indices still indicate a good fit (χ^2/df = 41.80, CFI = 0.91, TLI = 0.88, RMSEA = .08 and SRMR = .05), removing the items remarkably improved the fit with an assurance that there was no change in the factor loadings of the items after the removal of the two unfitting items.

Mathematics Anxiety Scale (MAS)

Results revealed that the two-factor correlated model and the hierarchical model fit well into the data with fit indices of χ^2/df = 32.88, CFI = 0.92, TLI = 0.89, RMSEA = .07 and SRMR = .04. These fit indices reflect an acceptable level regardless of the slightly lower than the threshold value of TLI. The two-factor orthogonal model yielded acceptable fit, though the correlation between the two subscales (r = .37) generated a higher and more acceptable fit of the model.

Final Structure of the Mathematics Anxiety Scale (MAS)

Figure 5.5.4 presents the final structure (Hierarchical model) of the model for MAS. The figure shows that both subscales have approximately the same standardised estimates at 0.62 and 0.60 for ‘ease’ and ‘anxious’ subscale, respectively. This indicates that the single second-order factor shared almost the same variance explained on both.

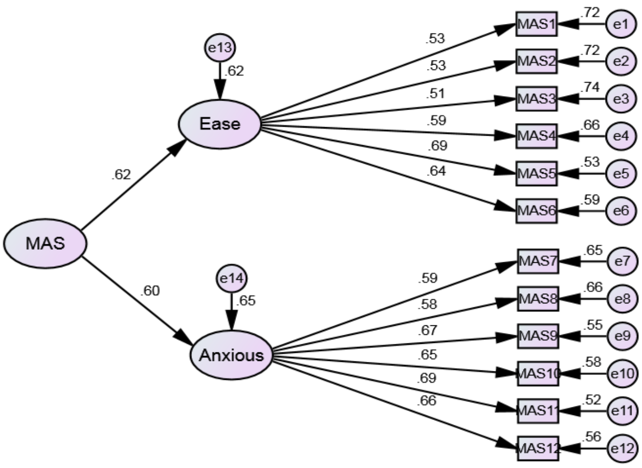


Figure 5.5.4 Hierarchical model of Mathematics Anxiety Scale (MAS).

Figure 5.5.4 says that all factor loading values are above the threshold of .40, indicating that all items have measured meaningfully their respective scales. The factor loading values that range from 0.51 to 0.69 implies that the items are highly reflective of the scales.

Beliefs about Mathematics (BAM)

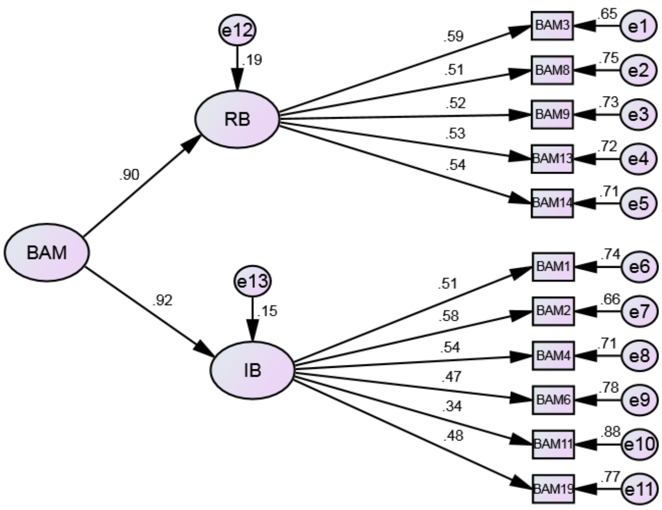
The items for the Beliefs about Mathematics (BAM) scale were developed by Yackel (1984) using Skemp's (1976) relational and instrumental understanding of mathematics (see Chapter 3). Yackel and other authors who adapted the scale did not report a validation of the scale. Hence, the construct validation carried out in this study is the first reported for this scale. For the reason that the theory on which the scale is based is already known, it is therefore meaningful to perform a confirmatory factor analysis to validate the theory. Exploratory factor analysis (EFA) was no longer applied because such is more commonly used for theory building or to generate a new theory (Henson & Roberts, 2006). It allowed the researcher to explore the main dimensions or model (Williams, Onsman, & Brown, 2010). Whereas, confirmatory factor analysis (CFA) is used to examine a proposed theory or model. In order to identify which item belongs to which subscale, logical or theoretical groupings was done. The items were matched based on Skemp's definition of 'relational understanding' and 'instrumental understanding' of mathematics through the help of experts (senior lecturers/professors, fellow researchers) in the field. After the groupings were verified by the experts, the scale underwent confirmatory factor analysis.

Although, it has been argued that the scale had two subscales, the 19 items were first considered to belong to one factor (one-factor model) because Kline (1998, p. 212) argued that even when the theory is precise about the number of factors, it is still necessary to determine whether the fit of a simpler model was better. The results in Table 5.5.1 revealed that the one-factor model did not fit into the data evidenced by the very low CFI and TLI values. Although the RMSEA and SRMR were acceptable, results implied that the items do not measure only one scale. The items are also loaded on two uncorrelated (orthogonal) factors. The confirmatory factor analyses (CFA) results likewise indicated poor fit of the model to the data.

The two-factor correlated model was examined and the indices produced (χ^2/df = 25.69, CFI = 0.91, TLI = 0.88, RMSEA = .06 and SRMR = .04) commanded a good fit to the data. Although TLI fell slightly below the threshold, it was still considered acceptable. The two factors correlate highly at 0.83 coefficient, hence the hierarchical model was deemed adequate. It likewise produced fit indices similar with that of the two-factor correlated model. The final structure of the model is presented in Figure 5.5.5.

Final Structure of the Beliefs about Mathematics (BAM)

Figure 5.5.5 illustrates the hierarchical factor model of students Beliefs about Mathematics. It depicts that the two factors are very highly correlated with the single second-order factor indicating that the two factors are also each measuring one factor.



Key:
BAM - Beliefs about Mathematics
RB - Relational Beliefs
IB - Instrumental Beliefs

Figure 5.5.5 Hierarchical model of BAM.

The factor loading values slightly differ except for item BAM11. The loadings range of .47 to .59 were considered as generally high as most of the items have loadings above .50. This indicates that the items are reflective of the scale they are measuring. Note, however, that out of the 19 original items, only 11 items were listed in the final figure. It says that eight items were deleted, one after another in the course of assessment and analysis of the model. The deleted items yielded low factor loading values ranging from .16 to .38. Deleting the items, beginning in the least factor loading, remarkably improved the fit indices. However, one item (BAM11) had a factor loading value below .40 but was retained in the final analysis because in attempting to exclude it, the CFI and the TLI slightly decreased. This is rather a valid move as explained in Chapter 4 (Methods of Research) that an item with a factor loading less than .40 but greater than .32 can be retained if removing it decreases rather than improve the fit.

5.6 Summary

Research studies that utilize survey questionnaires as the prime instrument for data collection need to establish the suitability therefore the validity of the instrument. The validation process is rather tedious but is highly necessary because the scales that are adapted and used in a different context may not generate the same values in another context. Instrument validation are done in various ways and for many different reasons. Most important of which is the Construct Validation. This necessitates the use and examination of construct models to prove the validity. Likewise, it requires that a theory or model is already known prior to its application.

The current study applied confirmatory factor analysis (CFA) in the examination of the construct validity of a scale. CFA was done to confirm and if necessary, re-specify the expected dimensional structure of a scale (OECD, 2014). Most of the scales in this study adapted, validated and confirmed the theories and structures of the scales. With the exception of some scales that formed new structures, such as from a single factor to a correlated two-factor structure. Since the results of this validation process are used in the structural equation modelling, it was necessary to examine the more parsimonious model. Finally, the hierarchical model was taken as the final structure of the scales, except for Teachers' attitudes towards mathematics and teaching mathematics (TATMT). These scales used two uncorrelated factors, confirming the theory upon which the analysis was grounded.

While the foregoing analyses validated the scales at the structure-level, the next chapter discusses the validation undertaken at item level. Using the item response theory (IRT), the items were examined as to whether or not they conform to the requirements of *good fit* items.

Chapter 6
Validation of the Measures of Teacher-, School- and Student-level factors: Rasch Model analysis

---

6.1 Introduction

This study examines the factors affecting the learning outcomes of students in Mathematics. Multilevel factors were considered and a number of scales were used to measure its constructs. Since all the scales employed in this study were adapted from existing questionnaires, validation is warranted. After the macro-level analysis, the scales were subjected to micro-level analysis. In the previous chapter (Chapter5), the scales employed in this study were validated at the scale level by examining the structure using confirmatory factor analysis (CFA). Since the theories underpinning the scales are already known, CFA results, therefore, confirmed the structure of the scales. Validation examined whether a scale appropriately measures what it purports to. CFA results provided the assurance that the scales met the needs of the investigation as well as the meanings expressed by the respondents. Likewise, validation indicated that the scale used is compatible with the context where respondents come from or are situated in.

Examination of the items at the item level is the main focus of this chapter. This process evaluates whether or not the items comply with the requirements, specifications or standards of a so-called *good item*. This was carried out using the simplest form of the item response theory (IRT) models, the Rasch model. Thus, in this case, data were assessed whether they fit the Rasch model, which specifies the characteristics of a *good item* based on set threshold values. In this study, the model estimates were calculated using the software program Conquest 4 by Wu, Adams, Wilson and Haldane (2007). For this analysis, items that were identified as misfitting in CFA were excluded in the measure and in the subsequent analyses.

The Item response theory (IRT), which was applied in the study, is ‘a general statistical theory that examines item and test performance and how this performance associates with the abilities and capabilities that are measured by the items in the test’ (Hambleton & Jones, 1993, p. 40). The type of IRT used was Rasch Modelling, which is accordingly the most widely used IRT procedure (Bode & Wright, 1999; Liu & Boone, 2006). Unlike the classical test theory (CTT), the Rasch model uses an interval scale that allows direct measurement of student performance, thus providing rigor in the assessment of students’ abilities.

6.1.1 Unidimensionality

One important requisite in Rasch analysis is unidimensionality of the scale, meaning only one construct or concept is being measured by the scale. As discussed in the preceding chapter, CFA results indicated that most of the proposed instruments are multidimensional. This does not consequentially mean, however, a violation of unidimensionality (see Chapter 4).

As stated in Chapter 4, although, unidimensionality is a basic assumption of Rasch analysis, multidimensional Rasch model analysis was used in this study due to the fact that the scales used contain several dimensions or subscales. Treating a complex unidimensional models on multidimensional scales will not only bias parameter estimation (Folk & Green, 1989), but will also result to a loss of information on subscales (Baghaei, 2012). Moreover, analysing each dimension separately will only lower the reliability of the subscales.

A further examination of the item fit statistics establishes whether the items in a scale (or subscale) measure only one construct. An item with fit statistics that fall outside of an acceptable range indicate that the item is measuring more than one concept. Unidimensional scales also indicate internal validity which, can be improved by removing misfitting items.

Item fit statistics examine whether the items are measuring a concept other than the one being assessed by the remaining items in that instrument for measurement. The internal validity of the measures can be increased by removing items that are not related to the concept being measured, or add in other items that increase the strength and meaning of the concept assessed in the scale.

Rasch model analysis also provide point-biserial correlations, indicating how much the responses to each item within a scale are correlated with the overall scale. The item fit statistics and point-biserial correlations are used to verify that the scale only includes items that measure the degree to which people endorse a single, underlying concept.

6.1.3 Missing data

Rasch scaling can handle well the missing data. There is no need to replace the missing data nor apply any of the methods in dealing with missing data, such as the case-wise and list-wise deletion as well as the multiple imputation method because

Rasch analysis can be used on incomplete datasets. It requires only enough data from which estimates can be calculated.

6.2 Case Fit

In this study, the use of Rasch model analysis was not only confined to the examination of item fit, but person fit as well. This is to ensure that the instrument is working or functioning properly. Person fit investigates how the respondents answer the items on the instrument. There can be many reasons why a person misfits, however, once identified, a person who misfits need not be removed from analysis completely. In this study, misfitting persons, particularly the underfitting ones, were removed to evaluate the item fit. This move considers that there can be no perfect data or model that perfectly fits the data.

Using Conquest 4.0, both item and person fit statistics were examined. Misfitting persons, specifically the underfitting, were initially identified and removed for item fit analysis. Underfitting persons are those persons classified in the analysis as "low ability" (or capability), referring to those who were unable to answer difficult items correctly. Curtis (2004) identified those underfitting persons as having the Infit Mean Square (IMS) values that are greater than 1.5 and those overfitting persons with IMS of less than 0.60. For validation purposes, only the underfitting persons were temporarily removed since over half of the sample appeared to be overfitting. Removing overfitting persons may drastically reduce the sample size and further analysis (such as SEM and HLM) may therefore no longer be permissible. The decision to remove only the underfitting persons was guided by the interpretation of the mean-square fit statistic values (0.5-2.0) provided by Wright and Linacre (1994) demonstrating that a mean-square fit value of < 0.5 (as well as, 1.5< case fit < 2.0) may be less productive for measurement but still not degrading. Substantiating this, Curtis (2004), in a simulated study reported that the exclusion of the underfitting cases has a stronger influence on parameter estimates.

In this report, Case Fit was examined and discussed for each scale. The underfitting persons, or those with case fit of 2.0 and above, were temporarily deleted. Table 6.2.1 records the number of cases deleted from each scale before re-running the analysis to examine the fit of the items.

Table 6.2.1
Number of Underfitting Cases temporarily deleted from each Scale

Teacher-level		School-level		Student-level	
Factors	No. of Cases Removed	Factors	No. of Cases Removed	Factors	No. of Cases Removed
TPS	9	MLSI	None	CLM	803
PCAP	10	MLSA	9	PTA	679
CAPS	25	SCFL	6	UOM	603
Confidence	34	BANTL	6	MAS	836
Insecurity	31	TACrit	4	BAM	740
PMTE	28				
MTOE	15				
PDP	4				

Key: TPS - Teaching Practices Scale; PCAP - Preferred Classroom Assessment Practice Scale; CAPS - Classroom Assessment Processes Scale; PMTE - Personal Mathematics Teaching Efficacy; MTOE - Mathematics Teaching Outcome Expectancy; PDP - Professional Development Program; MLSI - Management/Leadership Style-Instructional; MLSA - Management/Leadership Style-Administrative; SCFL - School Climate for Learning; BANTL - Belief about the Nature of Teaching and Learning; TACrit - Teacher Appraisal-Criteria; CLM - Confidence in Learning Mathematics; PTA - Perceived Teachers Attitudes; UOM - Usefulness of Mathematics; MAS - Mathematics Anxiety Scale; BAM - Beliefs about Mathematics

The number of cases that were temporarily deleted is acceptable and considered not high enough to distort the results of analysis. The number of cases deleted from the teacher-level factors range from 4 to 34; for the school-level factors, a maximum of

9 cases were temporarily removed; and for the student-level factors, the number of persons temporarily deleted range from 603 to 836.

6.3 Rasch Analysis of Teacher-level factors

After removing the underfitting cases, item fit statistics were obtained. The items that were already deleted from the CFA, were no longer included in the analysis. Those items with Infit mean square statistics (Outfit and Infit) outside the acceptable range of 0.6 to 1.4 (see Chapter 4) do not measure the same underlying construct and were therefore excluded in the further analysis. After all of the misfitting items were removed, the remaining items still represent a quality instrument and are thereby used in the study. The statistics resulting from these analyses are reported in the tables in the following sections. Subsequently, the estimates of the items are then anchored to calibrate the items after putting back the persons who were deleted temporarily. The weighted likelihood estimates (WLE) (Warm, 1989) for each case, in each scale and subscale, were generated and were used in the subsequent analysis.

In each Rasch analysis results table, the estimates and their corresponding standard errors, mean square fit statistics (Outfit and Infit), as well as the class interval and *t*-value statistics are reported. To assess the fit of the items, infit mean square statistic is preferred for use as the indicator of good fit in this study as it better indicates the ability or capability of the person who is relatively close to the difficulty of the items. The outfit statistics are more sensitive to outliers (Boone et al., 2011; Green & Frantom, 2002). Although, checking on the outfit value first was found to be the most appropriate procedure. The mean square statistics (Outfit and Infit) are expected to be 1.0. Those with Infit values greater than 1.0 indicate more variated responses than expected (Luppescu and Ehrlich, 2012), which exhibits so-called *noise* and *bias*. Items with an Infit value of less than 1.0 indicate less variation and may indicate the redundancy of the item, which are not considered as a problem.

The estimates of each item specifies 'difficulty' or the 'endorsability'. The average difficulty is expected to have an estimate of 0.0 on the logit scale. The items with positive logit scale values mean that they are difficult items. On survey questionnaire items, these positive logit scales mean that it is difficult or harder for the respondents to agree with or endorse the statements in the items. While those with negative logit scales imply that the items are easily endorsed. The standard errors also provide an indicator or the 'precision of the measure'.

6.3.1 Teaching Practices Scale (TPS)

Table 6.3.1 presents overall information whether the data show acceptable fit to the model. For these data, the mean square fit statistics are examined first. Table 6.3.1 presents that the Outfit and Infit of all 18 items are within the acceptable range, indicating that the data adequately fit the standard Rasch model. There are few items where the Infit values are higher than 1.0, which indicates that the teachers' responses were more varied than expected. While those with fit indices lower than 1.0 (6 items) imply that there was less variation in the responses than expected; which may not provide meaningful information. The Outfit values vary and range from 0.75 to 1.42; while the Infit values from 0.75 to 1.36. These Infit values indicate the model's good fit. Although the outfit for TPS1 is slightly higher than the upper threshold of 1.40, the item is still retained because its Infit value is within the acceptable range. The Infit values likewise imply that unidimensionality within each subscale is met. The *t*-statistics is dependent on the sample size thus it tends to increase when the sample is large. However, it can also be used as a reference to assess good fitting items. A *t*-value of 5.0 and below is acceptable and is indicative of the adequate fit of the items.

Table 6.3.1 also records the estimates and standard errors of measurement for the items. The estimates of the item measure indicate the position of the items on the logit scale. Item TPS8 is near the average on the scale, items TPS4, TPS12, TPS13, TPS15-TPS17 are easier having negative logit values; whereas items TPS1-TPS3, TPS6, TPS7, TPS9-TPS11, TPS14 and TPS18 have positive logit values, indicating that they are more difficult.

The items TPS6 “I ask my students to suggest or to help plan classroom activities or topics” (est. = 0.81) and TPS1 “I present new topics to the class using lecture-style presentation” (est. = 0.78) turned out to be the most difficult statements to endorse. Additionally, TPS15 “I administer a test or quiz to assess student learning” (est. = -1.31) appeared the easiest item to agree with. This is probably because giving a quiz or test is a common classroom activity of teachers, which also is a major basis of students’ grades at the end of each school term. Hence, it is easier for teachers to endorse this item. The standard errors were small and were indicative of precision in the measures.

Table 6.3.1 also records the confidence intervals (CI) and *t*-statistics of the items. These were also used to assess good fit and are complementary to Infit. However, more emphasis is given to Infit values. Both measures indicated adequate fit of the items to the TPS scale.

Table 6.3.1
Estimates and Mean Square Fit of the items of TPS

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
TPS1	0.78	.07	1.42	1.36	(0.85, 1.15)	4.1
TPS2	0.14	.08	1.11	1.10	(0.84, 1.16)	1.2
TPS3	0.12	.08	1.06	1.16	(0.84, 1.16)	1.8
TPS4	-0.32	.07	0.79	0.81	(0.85, 1.15)	-2.7
TPS5	0.16	.06	0.80	0.79	(0.85, 1.15)	-3.1
TPS6	0.81	.07	1.25	1.23	(0.85, 1.15)	2.9
TPS7	0.16	.08	1.05	1.08	(0.84, 1.16)	1.0
TPS8	-0.01	.08	1.07	1.22	(0.83, 1.17)	2.5
TPS9	0.56	.07	1.28	1.34	(0.84, 1.16)	3.9
TPS10	0.24	.06	1.02	1.06	(0.85, 1.15)	0.8
TPS11	0.54	.07	0.80	0.79	(0.85, 1.15)	-2.9
TPS12	-0.38	.07	0.75	0.75	(0.85, 1.15)	-3.4
TPS13	-0.43	.09	1.08	1.10	(0.82, 1.18)	1.1
TPS14	0.44	.06	0.94	0.96	(0.85, 1.15)	-0.6
TPS15	-1.31*	.11	1.07	1.15	(0.79, 1.21)	1.4
TPS16	-0.89	.07	0.83	0.80	(0.83, 1.17)	-2.5
TPS17	-0.81*	.07	0.89	0.92	(0.84, 1.16)	-0.9
TPS18	0.21*	.06	0.76	0.76	(0.85, 1.15)	-3.4

* TPS - Teaching Practices Scale; S.E. - standard error; CI - Confidence interval; t-value

6.3.2 Preferred Classroom Assessment Practice (PCAP)

Table 6.3.2 presents the results of Rasch analysis. The results of CFA indicate that all items are reflective of the scales and subscales they are purported to measure as evidenced by their factor loading values, which all fall within the acceptable range of values. However, the Rasch scale analysis for item 11 (PCAP11) “I rank students based on their classroom performance to inform other school officials” resulted in Outfit and Infit values of 1.58 and 1.61, respectively. This indicates that there are more variations in the teachers’ responses than expected. This implies a so-called ‘noise’ in the item. The *t*-statistic of 6.2 for this item also implies misfit. The estimate for this item is -0.19, which falls below the average value specifying that it is easier to endorse. With all the evidences of being misfitting, PCAP11 was deleted.

In addition, two items (PCAP14 and PCAP12) have Infit mean squares slightly higher than the upper threshold of 1.40 (1.43 and 1.41, respectively). Inspecting the other indices (Outfit, CI and *t*-statistic), they appear to fall within the recommended ranges. The estimate (0.57) obtained for PCAP14 “I supply information to other teachers, schools, employers regarding students’ performance in class” indicated that the teachers have found this item somewhat difficult to endorse. While this can be done by teachers in special cases and upon the approval of the students, this is, however, practised with caution. Conversely, PCAP12 (I provide information to parents about the performance of their children in school) is an "easier-to-endorse" item as indicated by its estimate of -0.83. This is plausible because teachers are required to inform the parents of their children’s progress at school through report cards and parent-teacher meetings. After thorough investigation, the two items (PCAP14 and PCAP12) were retained.

Table 6.3.2
Estimates and Mean Square Fit of PCAP

			Mean Square Fit			
Items	Estimates	S.E.	Outfit	Infit	CI	t
PCAP1	-0.58	.10	1.05	1.09	(0.84, 1.16)	1.0
PCAP2	0.48	.10	0.98	1.00	(0.84, 1.16)	0.1
PCAP3	-0.14	.10	0.94	0.93	(0.84, 1.16)	-0.8
PCAP4	0.57	.10	0.91	0.89	(0.84, 1.16)	-1.4
PCAP5	-0.16	.10	0.94	0.98	(0.84, 1.16)	-0.3
PCAP6	-0.17*	.10	0.97	1.00	(0.84, 1.16)	0.1
PCAP7	-0.38	.10	0.98	1.04	(0.84, 1.16)	0.5
PCAP8	-0.20	.10	0.99	1.02	(0.84, 1.16)	0.2
PCAP9	0.17	.10	0.79	0.81	(0.84, 1.16)	-2.5
PCAP10	0.40*	.10	1.00	1.00	(0.84, 1.16)	-0.0
PCAP12	-0.83	.09	1.29	1.41	(0.83, 1.17)	4.3
PCAP13	0.25	.09	1.11	1.15	(0.84, 1.16)	1.7

PCAP14	0.57*	.09	1.34	1.43	(0.84, 1.16)	4.6
PCAP15	-0.58	.10	0.79	0.86	(0.84, 1.16)	-1.8
PCAP16	-0.13	.10	0.72	0.78	(0.84, 1.16)	-2.8
PCAP17	0.15	.10	0.84	0.89	(0.84, 1.16)	-1.4
PCAP18	0.56*	.10	1.07	1.12	(0.84, 1.16)	1.4

* PCAP - Preferred Classroom Assessment Practice; S.E. - standard error; CI - Confidence interval; t-value

The rest of the items seem to fit well as their Outfit and Infit values fall within acceptable ranges threshold as well as their CI and *t*-statistic values. The estimates indicated that PCAP14 (Supply information to other teachers, schools, employers regarding the students' performance in class) and PCAP4 (I assist students to identify means of getting personal feedback and monitoring their own learning process), are the most difficult items to endorse, each having an estimated value of 0.57. Whereas, PCAP12 with an estimated value of -0.83 is the easiest item to endorse which is credible because it is one of the basic duties of teachers.

6.3.3 Classroom Assessment Process Scale (CAPS)

Like the other scales, the five subscales of CAPS were subjected to multidimensional Rasch analysis. However, problems occurred as the data did not converge causing it not to produce results. It was due to the relatively large number of items (37 items) compared to the sample size of teachers (n=326). The recourse was to analyse the five subscales separately. It is argued that if the scale contains multiple dimensions and a separate Rasch analyses are needed, they can be conducted for each of the five subscales - *Assessment Planning* (AP), *Assessment Item Preparation* (AIP), *Assessment Administration and Scoring* (AAS), *Reporting of Scores and Grading* (RSG) and *Assessment Data Utilisation and Evaluation* (ADUE).

The CFA results (Chapter 5) indicated that not a single item misfit, having generated factor loadings within the acceptable ranges of values. However, the item analyses carried out signalled some misfitting items. There were only three items removed because their weighted mean square fit (Infit) values went higher than the upper limit of 1.40. From a careful inspection of the factor loadings in the CFA, it was noticed that the items identified to be misfitting in the Rasch analysis, were the items with smaller factor loadings or were above the .40 threshold. Two of the three items removed are from the *assessment planning* (AP) (CAPS1 and CAPS9) subscale, while the other one (CAPS24) is from the *assessment administration and scoring* (AAS) subscale. When the three items were removed, leaving only 34 items for the re-analysis, all indices showed good fit.

The estimates, Outfit and Infit, CI and *t*-value of the remaining 34 items are recorded in Table 6.3.3. It can be observed that CAPS23 (I prepare a scoring criteria or rubrics before I start marking test papers) is the most difficult item to endorse with an estimated value of 1.44. This is probable because, in most cases, mathematics teachers no longer prepare a rubric to check or score test papers; since most short and long tests in mathematics require just a single answer. CAPS31 comes next, with an estimated value of 1.05. Again, this is probable because sharing test results to other teachers and school director, is not a common practise. It is, however, done only when necessary.

Table 6.3.3

Estimates and Mean Square Fit of CAPS

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
CAPS2	-0.41	.12	1.28	1.37	(0.83, 1.17)	3.9
CAPS3	0.94	.12	1.08	1.10	(0.84, 1.16)	1.2
CAPS4	-0.90	.13	0.81	0.95	(0.83, 1.17)	-0.6
CAPS5	-0.73	.12	0.75	0.85	(0.83, 1.17)	-1.8
CAPS6	0.13	.12	0.92	0.79	(0.83, 1.17)	-2.6
CAPS7	0.46	.11	0.89	0.94	(0.83, 1.17)	-0.8
CAPS8	0.36	.11	0.78	0.79	(0.83, 1.17)	-2.7
CAPS10	0.16	.12	1.25	1.30	(0.83, 1.17)	3.3
CAPS11	-0.15	.11	1.40	1.47	(0.83, 1.17)	4.7
CAPS12	0.56	.10	0.92	0.95	(0.83, 1.17)	-0.6
CAPS13	-0.75	.11	0.74	0.81	(0.82, 1.18)	-2.3
CAPS14	0.01	.10	1.06	1.09	(0.83, 1.17)	1.0
CAPS15	0.02	.10	0.97	1.04	(0.83, 1.17)	0.5

Table 6.3.3

Continued

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
CAPS16	-0.17	.11	0.99	1.09	(0.83, 1.17)	1.0
CAPS17	0.34	.10	0.97	0.93	(0.83, 1.17)	-0.8
CAPS18	0.08	.10	0.79	0.85	(0.83, 1.17)	-1.8
CAPS19	0.63	.10	1.05	1.06	(0.83, 1.17)	0.7
CAPS20	-0.56	.11	0.82	0.87	(0.83, 1.17)	-1.5
CAPS21	-0.28	.12	1.17	1.01	(0.82, 1.18)	0.2
CAPS22	-0.87	.13	0.81	1.06	(0.81, 1.19)	0.7
CAPS23	1.44	.12	1.24	1.27	(0.83, 1.17)	2.9
CAPS25	-0.56	.12	1.05	0.98	(0.82, 1.18)	-0.2
CAPS28	-0.05	.09	0.84	0.83	(0.84, 1.16)	-2.2
CAPS29	-0.79	.10	0.80	0.87	(0.82, 1.18)	-1.5
CAPS30	-0.70	.10	0.83	0.84	(0.83, 1.17)	-1.9
CAPS31	1.05	.09	1.20	1.22	(0.84, 1.16)	2.6
CAPS32	0.50*	.08	1.13	1.14	(0.84, 1.16)	1.7
CAPS33	-0.54	.09	0.93	0.90	(0.83, 1.17)	-1.2
CAPS34	0.59	.09	0.94	0.95	(0.83, 1.17)	-0.6
CAPS35	0.21	.09	0.93	0.97	(0.83, 1.17)	-0.4
CAPS36	0.72	.09	1.18	1.19	(0.83, 1.17)	2.2
CAPS37	-0.97	.10	0.95	0.98	(0.83, 1.17)	-0.2

* CAPS - Classroom Assessment Process Scale; S.E. - standard error; CI - Confidence interval; t-value

Moreover, CAPS37 with an estimated value of -0.97, is the easiest to endorse. In this item, the teachers are asked to respond to the frequency of the practise "I return all marked test papers to students on time." This was conceived to be a common practise as many found it easier to endorse. Examining the corresponding estimates for the other items, it is also easy to endorse CAPS4 (I prepare a test plan according to the learning of my lessons) with an estimated value equal to -0.90. This again speaks of a likely scenario that it is easier to agree with something that is regularly practised.

Finally, results indicated that the scale values for each item are ordered which means that the teachers are consistent with the intended order of the response categories.

6.3.4 Teachers Attitudes towards Mathematics and Teaching Mathematics (TATMT)

The results of the Rasch analysis for TATMT items are presented in Table 6.3.4. The 17-item teacher attitudes scale is clustered into two uncorrelated factors, Confidence and Insecurity. Confidence factors consisted of 10 items (1,2,5,7,10,13,14,15,17), while the remaining seven items (3,4,6,9,11,12,16) belong to Insecurity factors. Since this analysis verifies the items that are retained after CFA, item 10 was excluded in the Confidence subscale. All the Infit mean square values are within the acceptable level, since the items adequately fit the Rasch model. The Outfit and *t*-statistic likewise suggested good fit. The estimates indicated that TATMT14 (At school, my friends always come to me for help in mathematics) was the hardest item to endorse among the Confidence subscale. Whereas item TATMT2 (I find many mathematical problems interesting and challenging) was the easiest to endorse in the Confidence subscale.

The items in the Insecurity subscale have both the Outfit and Infit indices within the acceptable range, the CI and *t*-values likewise show the values are within the recommended levels. These indicated good fit of the data to the model. One item (TATMT3) was however excluded since it was deleted already in the CFA. The estimated value for TATMT12 (I would get confused if I came across a hard problem while teaching mathematics) is 0.47 making it the hardest item to endorse. Moreover, teachers find TATMT9 (I'm not sure about what to do when I'm teaching mathematics) the easiest item to endorse, with an estimated value of -0.30.

Table 6.3.4
Estimates and Mean Square Fit of TATMT

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
Confidence						
TATMT1	-0.59	.07	0.99	1.08	(0.78, 1.22)	0.7
TATMT2	-0.81	.08	0.92	0.96	(0.78, 1.22)	-0.3
TATMT5	-0.08	.06	0.77	0.77	(0.79, 1.21)	-2.3
TATMT7	0.38	.05	1.35	1.23	(0.81, 1.19)	2.2
TATMT8	0.24	.05	1.06	1.09	(0.80, 1.20)	0.9
TATMT13	0.06	.06	1.26	1.35	(0.79, 1.21)	3.1
TATMT14	0.52	.05	1.36	1.18	(0.82, 1.18)	1.9
TATMT15	-0.06	.06	0.79	0.77	(0.79, 1.21)	-2.2
TATMT17	0.34*	.05	1.25	1.27	(0.81, 1.19)	2.5
Insecurity						
TATMT4	0.20	.04	1.34	1.33	(0.82, 1.18)	3.4
TATMT6	-0.24	.05	1.18	1.21	(0.78, 1.22)	1.7
TATMT9	-0.30	.05	0.83	0.86	(0.77, 1.23)	-1.3
TATMT11	-0.20	.05	1.00	1.04	(0.79, 1.21	0.4
TATMT12	0.47	.04	1.14	1.04	(0.84, 1.16)	0.5
TATMT16	0.06*	.04	1.02	0.94	(0.81, 1.19)	-0.6

* TATMT - Teachers Attitudes towards Mathematics and Mathematics Teaching; S.E. - standard error; CI - Confidence interval; t-value

When item deltas were examined, disordered response categories were detected. This hinted that there was confusion in the selection of categories. The eight-response categories (see Chapter 3) may be a reason for the inverse deltas, especially when the meanings of the categories are close to each other, particularly the four middle categories. Disordered deltas may also be due to the low response rates in other categories or that responses are located towards one end of the continuum. In order to address this issue, the categories were collapsed by joining together adjacent categories, adhering to Linacre's (2002) opinion to merge adjacent categories, or that with less than 10 responses). In the case of this study, categories in the lower end have fewer responses compared to the categories in the upper end as the respondents tend to agree that the statements relate to their attitudes. It could therefore be collapsed, and in so doing, the number of categories reduced from eight to four. Another criterion for merging is when the steps are not adequately different. In the scale, there are two main responses, 'False' and 'True'. But these were expanded into eight categories with varying degrees of 'falseness' and 'trueness.'. For instance, 'definitely false' (1), 'false' (2), 'more false' (3) and 'more false than true' (4) in the lower end of the scale. The same applies to the other half or upper part of the scale. After collapsing the categories, the deltas have come out ordered with no misfitting items.

6.3.5 Mathematics Teaching Efficacy Beliefs Scale (MTEBS)

Table 6.3.5 records the weighted mean square (Infit) values of the items under Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) after they were each subjected to two dimensional Rasch analyses. All the items of PMTE showed good fit as indicated by their fit indices. However, one item (MTEB7) (I generally teach mathematics ineffectively) was removed due to its misfitting Infit value. A closer look at the item, it appeared to be the easiest item to endorse with an estimate value of -1.01. This item likewise had a high factor loading in the CFA, but apparently misfitting in the Rasch analysis. The controverting results only proves that the particular item is either a negative restatement or a summary item, and is therefore subject to deletion. A typical case of items which exhibits strong correlation in the CFA, but not in Rasch analysis.

Table 6.3.5
Estimates and Mean Square Fit of MTEBS

Items	Estimates	S.E.	Mean Square Fit Outfit	Mean Square Fit Infit	CI	t
Personal Mathematics Teaching Efficacy (PMTE)						
MTEB2	-0.66	.11	0.86	0.87	(0.85, 1.15)	-1.7
MTEB4	0.68	.11	0.85	0.80	(0.80, 1.20)	-2.1
MTEB5	0.30	.08	1.21	1.13	(0.83, 1.17)	1.5
MTEB10	0.59	.11	0.83	0.80	(0.80, 1.20)	-2.1
MTEB14	0.72	.08	1.10	1.02	(0.84, 1.16)	0.3
MTEB15	0.41	.11	0.90	0.88	(0.81, 1.19)	-1.2
MTEB16	0.71	.08	1.35	1.23	(0.84, 1.16)	2.7
MTEB17	-0.60	.09	1.17	1.16	(0.81, 1.19)	1.6
MTEB18	-0.12	.09	1.03	1.04	(0.82, 1.18)	0.4
MTEB19	-1.02*	.11	1.10	1.12	(0.86, 1.14)	1.6
MTEB20	-1.01*	.10	1.11	1.09	(0.80, 1.20)	0.9
Mathematics Teaching Outcome Expectancy (MTOE)						
MTEB3	-0.36	.10	1.02	1.04	(0.82, 1.18)	0.4
MTEB8	-0.39	.09	1.16	1.17	(0.81, 1.19)	1.7
MTEB9	0.01	.09	1.17	1.23	(0.82, 1.18)	2.3
MTEB11	0.17	.09	0.84	0.87	(0.82, 1.18)	-1.5
MTEB12	0.19*	.09	0.73	0.75	(0.82, 1.18)	-3.0
MTEB13	0.38*	.09	1.15	1.15	(0.82, 1.18)	1.6

* MTEB -Mathematics Teaching Efficacy Beliefs; S.E. - standard error; CI - Confidence interval; t-value

Examining the remaining items in Personal Mathematics Teaching Efficacy (PMTE), the table presents two items (MTEB14 and MTEB16) which are the hardest to agree with. One is Item 14 (MTEB14) “I find it difficult to use manipulatives to explain to students why mathematics works” seemed difficult to endorse because of the presence of the use of manipulatives. Manipulatives are the materials, such as sticks, blocks, and geometric shapes, used for hands-on activities in Mathematics. By far, the use of manipulatives is uncommon because of the general lack of it in schools. Another is Item 16 (MTEB16) “I wonder if I have the necessary skills to teach mathematics”, which may be difficult to endorse because not all teachers are specialized in Mathematics. In practise, not all subject teachers in mathematics are mathematicians. There are many who have taken non-math degrees but are teaching mathematics. Meanwhile, items which came out easiest to endorse are MTEB19 (I usually welcome student questions when teaching mathematics) and MTEB20 (I do not know how to motivate students in learning mathematics).

For MTOE, only six items were considered in the subscale after deleting items MTEB1 and MTEB6 during the CFA. These items read as follows: MTEB1 ("When a student does better than usual in mathematics, it is often because the teacher exert a little extra effort") and, MTEB6 ("If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching"). Just like the other scales, MTOE's Infit statistics and all other criteria, fall within the recommended level. This indicated that the data adequately fit the model. Hardest to agree with is Item 13 (MTEB13 "A child's interest in mathematics at school is probably due to the performance of the child's teacher"). Whereas, Item 8 (MTEB8 "The inadequacy of a student's mathematics background can be overcome by good teaching") is the easiest to endorse.

6.3.6 Professional Development Program (PDP)

Table 6.3.6 reveals that all the items of the PDP scale satisfied the criteria of good-fitting items. This scale measures the type of professional development programs that mathematics teachers normally attended. A two-dimensional Rasch scale was employed to assess the items. Item 5 (PDP5) turned out to be the hardest to endorse, probably because training and workshops on mathematics content and performance standard are rarely provided in 'Professional Development programs'. Whereas PDP1 is the easiest to endorse since most teachers have attended trainings and workshops related to mathematics or other education-related topics.

Table 6.3.6
Estimates and Mean Square Fit of PDP

Items	Estimates	S.E.	Mean Square Fit Outfit	Infit	CI	t
PDP1	-2.24	.18	1.02	1.14	(0.82, 1.18)	1.5
PDP2	0.03	.14	0.82	0.89	(0.85, 1.15)	-1.5
PDP3	-0.59	.14	1.07	1.08	(0.85, 1.15)	1.1
PDP4	0.47	.15	1.01	1.08	(0.84, 1.16)	1.0
PDP5	1.29	.16	0.83	0.87	(0.82, 1.18)	-1.5
PDP6	1.04*	.16	1.07	1.01	(0.83, 1.17)	0.2
PDP7	-0.10	.15	1.08	1.05	(0.80, 1.20)	0.5
PDP8	0.08	.16	0.92	0.96	(0.79, 1.21)	-0.4
PDP9	0.99	.20	0.67	0.84	(0.69, 1.31)	-1.1
PDP10	-1.73	.15	1.10	1.06	(0.89, 1.11)	1.0
PDP11	0.76*	.18	1.27	1.09	(0.72, 1.28)	0.6

* PDP - Professional Development Program; S.E. - standard error; CI - Confidence interval; t-value

6.4 Rasch Analysis of School-level factors

There were five scales used in the assessment of school principals as a factor influence. These are the following: management styles and leadership styles of the principals; school climate for learning; Principal's beliefs about the nature of teaching and learning mathematics, and; criteria used to appraise teachers.

6.4.1 Management/Leadership Style - Instructional (MLSI)

Table 6.4.1 presents an overall fit of the items to the model. Infit and Outfit mean square indices have an expected value of 1.00. Values above 1.00 means there is greater variability in the response. Therefore, values beyond 1.40 are subject for exclusion. The results, however, in Table 6.4.1 fall below 1.40 which indicates a good fit. Initially, MLSI consisted 14 items but only 13 qualified for further analysis. MLS14 was deleted as it turned out to be misfitting.

Table 6.4.1

Estimates and Mean Square Fit of MLSI

Items	Estimates	S.E.	Mean Square Fit Outfit	Infit	CI	t
MLS1	-0.99	.24	1.87	1.04	(0.66, 1.34)	0.3
MLS2	-1.95	.30	0.65	0.93	(0.54, 1.46)	-0.2
MLS3	0.45	.18	1.05	1.12	(0.77, 1.23)	1.0
MLS4	0.42	.19	0.96	0.98	(0.75, 1.25)	-0.2
MLS5	-0.43	.20	0.86	0.87	(0.74, 1.26)	-1.0
MLS6	1.59	.18	1.11	1.15	(0.78, 1.22)	1.3
MLS7	0.24	.18	0.79	0.85	(0.76, 1.24)	-1.3
MLS8	-0.69	.21	0.83	0.97	(0.73, 1.27)	-0.2
MLS9	-0.55*	.20	1.17	1.04	(0.73, 1.27)	0.3
MLS10	1.57	.19	0.98	0.98	(0.78, 1.22)	-0.1
MLS11	0.95*	.19	0.72	0.81	(0.77, 1.23)	-1.7
MLS12	-0.52	.20	0.85	1.03	(0.74, 1.26)	0.3
MLS13	-0.09*	.19	1.12	1.21	(0.75, 1.25)	1.6

* MLS - Management/Leadership Style; S.E. - standard error; CI - Confidence interval; t-value

Table 6.4.1 further shows that MLS6 (I monitor students' work) and MLS10 (I take exam results into account in decisions regarding curriculum) are the hardest to endorse. This indicates that school principals do not frequently practise the above statements. Conversely, MLS2 (I ensure that teachers work according to the school's educational goals) is the easiest item to endorse. The reason is quite obvious because the statement suggests a common duty or obligation of the school principal.

6.4.2 Management/Leadership Style - Administrative (MLSA)

Items (MLS16, MLS17 and MLS26) were previously deleted following CFA and the Rasch analysis. This leaves only 12 items subjected for further analysis using the two-dimensional Rasch model. The results are recorded in Table 6.4.2. After the initial analysis, MLSA28 (I define goals to be accomplished by the staff of this school) came out to be underfitting (Infit value is greater than 1.40), which indicates that the school principals have not responded to this item as expected. This particular item was deleted and therefore excluded in the following analysis.

Table 6.4.2
Estimates and Mean Square Fit of MLSA

Items	Estimates	S.E.	Mean Square Fit Outfit	Infit	CI	t
MLS15	0.03	.19	1.14	1.32	(0.72, 1.28)	2.1
MLS18	-0.44	.20	0.90	1.12	(0.71, 1.29)	0.8
MLS19	-0.20	.20	0.96	1.10	(0.72, 1.28)	0.7
MLS20	0.62*	.19	1.04	1.07	(0.74, 1.26)	0.5
MLS21	1.95	.21	1.13	1.07	(0.72, 1.28)	0.5
MLS22	-0.49	.21	1.05	1.00	(0.77, 1.23)	0.0
MLS23	1.26	.20	0.87	0.98	(0.73, 1.27)	-0.1
MLS24	0.43	.20	0.88	0.96	(0.76, 1.24)	-0.3
MLS25	-2.25	.27	0.59	0.93	(0.65, 1.35)	-0.3
MLS27	-1.16	.22	1.00	1.04	(0.75, 1.25)	0.3
MLS29	0.26*	.20	0.79	0.84	(0.76, 1.24)	-1.3

* MLS - Management/Leadership Style; S.E. - standard error; CI - Confidence interval; t-value

The remaining 11 items generally indicated good fit evidenced by the mean square fit indices and other criteria (CI and *t*-value). The confidence intervals show that the item indices could go as low as .65 and as high as 1.35. In addition, the estimated value for MLS21 (I influence decisions about this school taken at a higher administrative level) demonstrate that the school principals find it hard to agree or disagree with the statement. On the contrary, MLS 25 is the easiest to agree or disagree with possibly because the statement clearly stipulates one of the basic functions of principal. As the head of school, they are to create an orderly atmosphere in the school.

6.4.3 School Climate for Learning (SCFL)

One of the duties of a school principal is to ensure that students are offered an environment that encourages learning, namely, the school climate for learning (SCFL). The nine items in this scale involved a two correlated factor model. All items are retained after the conduct of the CFA and therefore all items are included in the Rasch analysis.

The results of Rasch analysis are presented in Table 6.4.3. All the indices are within the recommended values indicating adequate fit of the items. The table further shows that SCFL1 and SCFL7 indicated the same degree of difficulty in endorsing the items. The school principals rated the items from 'very low' to 'very high' to indicate the impact of the items in defining the school climate for learning. Item 1 is about teachers' job satisfaction, while item 7 is about the involvement of parents in school activities.

Table 6.4.3
Estimates and Mean Square Fit of SCFL

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
SCFL1	0.62	.19	1.00	0.95	(0.73, 1.27)	-0.4
SCFL2	-0.00	.19	1.23	1.26	(0.73, 1.27)	1.8
SCFL3	-0.80	.19	0.80	0.95	(0.74, 1.26)	-0.3
SCFL4	0.18*	.19	0.91	0.95	(0.73, 1.27)	-0.3
SCFL5	-0.92	.20	0.94	1.02	(0.72, 1.28)	0.1
SCFL6	0.19	.19	1.08	1.23	(0.72, 1.28)	1.6
SCFL7	0.63	.19	0.98	1.00	(0.73, 1.27)	0.1
SCFL8	0.59	.19	1.01	0.96	(0.73, 1.27)	-0.3
SCFL9	-0.49*	.19	1.07	1.00	(0.72, 1.28)	0.0

* SCFL - School Climate for Learning; S.E. - standard error; CI - Confidence interval; t-value

6.4.4 Beliefs on the Nature of Teaching and Learning (BANTL)

Of the 12 items of the BANTL scale, two items (BANTL5 and BANTL11) are found to be misfitting in confirmatory factor analysis. Both items belong to the Direct Transmission Belief (DTB) subscale. These two items are not included in further analysis. The results of the two-dimensional Rasch analysis are recorded in Table 6.4.4. The results indicate that all items, except BANTL3, yielded adequate fit of the data to the model.

Table 6.4.4
Estimates and Mean Square Fit of BANTL

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
BANTL1	-1.71	.19	1.04	1.00	(0.76, 1.24)	0.0
BANTL2	0.98	.14	1.23	1.19	(0.75, 1.25)	1.5
BANTL3	1.12	.14	1.71	1.59	(0.75, 1.25)	4.0
BANTL4	-0.21	.16	0.83	0.71	(0.73, 1.27)	-2.3
BANTL6	0.38	.16	1.30	1.29	(0.73, 1.27)	2.0
BANTL7	-0.43	.17	0.75	0.78	(0.73, 1.27)	-1.7
BANTL8	-0.53	.15	0.71	0.76	(0.74, 1.26)	-1.9
BANTL9	-0.65	.17	0.67	0.79	(0.74, 1.26)	-1.7
BANTL10	0.15*	.14	0.77	0.79	(0.73, 1.27)	-1.6
BANTL12	0.91*	.15	0.88	0.79	(0.73, 1.27)	-1.6

* BANTL - Beliefs about the Nature of Teaching and Learning; S.E. - standard error; CI - Confidence interval; t-value

In Item 3 (BANTL3), both the Outfit and Infit indices are above the upper limit of 1.40, indicating poor fit of the item. However, its *t*-value still indicates adequate fit. The item "it is better when the teacher, not the student, decides what activities are to be done in the classroom" belongs to the DTB subscale and strongly describes 'direct transmission' of beliefs. The item deltas also indicated that reversals of the categories do not occur. After careful consideration of the criteria, such as CI and *t*-value and item delta, as well as the nature of the statement itself, the item is retained.

The estimated value for BANTL3 is 1.12 making it the hardest to agree or disagree with. This can probably be one of the reasons of the high fit index. The easiest item to endorse is BANTL1 with an item estimated value equal to -1.71. This indicates that a 'direct transmission' involves the belief that "effective/good teachers demonstrate the correct way to solve a problem."

6.4.5 Teacher Appraisal - Criteria

This scale measures the criteria used to evaluate teachers' performance. The principal simply indicates whether the student-related or teacher-related criteria are considered in teacher appraisal.

The CFA results proved that all items herein are of good fit and were therefore retained. All items were subjected to Rasch model analysis, the results of which are presented in Table 6.4.5. Both the Outfit and Infit indices exhibited good fit to the model. The CI showed that the fit values are very close to the borderlines, but do not go beyond the limits. The *t*-value likewise indicated good fit of the items. However, Item 1 (BANTL1), was deleted because its Infit value exceeds the recommended level. Although, the other criteria, such as the *t*-value resulted in acceptable fit, careful examination of the statement indicated otherwise. It is not a common practise that students' test scores are directly used as basis for teacher appraisal.

Table 6.4.5
Estimates and Mean Square Fit of TACrit

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
TAC2	-0.78	.19	0.82	1.10	(0.67, 1.33)	0.6
TAC3	0.18	.17	0.88	0.99	(0.69, 1.31)	-0.0
TAC4	0.30	.17	0.82	1.01	(0.69, 1.31)	0.1
TAC5	0.31*	.17	0.91	1.16	(0.69, 1.31)	1.0
TAC6	-0.30	.23	0.67	1.01	(0.66, 1.34)	0.1
TAC7	-0.06	.21	0.79	1.04	(0.67, 1.33)	0.3
TAC8	-0.47	.23	0.61	0.79	(0.65, 1.35)	-1.2
TAC9	-0.21	.22	0.56	0.83	(0.66, 1.34)	-1.0
TAC10	-0.34	.23	1.28	0.98	(0.66, 1.34)	-0.0
TAC11	-1.13	.27	0.37	0.72	(0.61, 1.39)	-1.5
TAC12	-1.21	.27	0.45	0.81	(0.60, 1.40)	-0.9
TAC13	-0.91	.26	0.80	0.87	(0.62, 1.38)	-0.6
TAC14	1.37	.19	1.19	1.32	(0.70, 1.30)	1.9
TAC15	-0.30	.22	0.62	0.95	(0.66, 1.34)	-0.3
TAC16	1.97	.18	1.15	1.09	(0.71, 1.29)	0.6
TAC17	1.58*	.18	1.11	1.17	(0.71, 1.29)	1.1

* TAC - Teacher Appraisal-Criteria; S.E. - Standard error; CI - Confidence interval; t-value

Moreover, TAC16 came out as the hardest item to endorse with an estimated value of 1.97. This indicates that school principals have a hard time deciding whether teaching in a multicultural setting is considered for appraisal. In contrast, TAC12 (Teacher's knowledge and understanding of their main subject field) is the easiest item to endorse with an estimated value equal to -1.21. This clearly demonstrates that school principals are confident about having this criterion considered.

6.5 Rasch Analysis of Student-level factors

The student-level factors are comprised by the following attitudinal scales: *Confidence in Learning Mathematics* (CLM), *Teachers Attitudes* (PTA), *Usefulness of Mathematics* (UOM), *Mathematics Anxiety* (MAS) and *Beliefs about Mathematics* (BAM).

6.5.1 Confidence in Learning Mathematics (CLM)

This scale measures the confidence level of students in learning mathematics. The 11 items are loaded onto either 'confident' or 'not confident' subscales. All items were included in the Rasch analysis after having qualified in the CFA. Table 6.5.1 presents the results of the Rasch analysis.

Table 6.5.1
Estimates and Mean Square Fit of CLM

Items	Estimates	S.E.	Mean Square Fit Outfit	Mean Square Fit Infit	CI	t
CLM1	-0.14	.02	0.85	0.86	(0.96, 1.04)	-8.3
CLM2	0.53	.02	0.94	0.94	(0.96, 1.04)	-3.7
CLM3	-1.29	.02	0.99	1.02	(0.96, 1.04)	1.3
CLM4	0.73	.02	0.98	0.98	(0.96, 1.04)	-1.4
CLM5	-0.12	.02	0.85	0.86	(0.96, 1.04)	-8.3
CLM6	0.29*	.02	0.91	0.91	(0.96, 1.04)	-5.4
CLM7	-0.24	.02	1.08	1.09	(0.96, 1.04)	4.6
CLM8	0.13	.02	1.05	1.05	(0.96, 1.04)	2.7
CLM9	-0.18	.02	0.97	0.98	(0.96, 1.04)	-1.0
CLM10	0.53	.02	1.27	1.27	(0.96, 1.04)	14.0
CLM11	-0.24	.02	1.31	1.31	(0.96, 1.04)	15.9

* CLM - Confidence in Learning Mathematics; S.E. - Standard error; CI - Confidence interval; t-value

Consistent with the CFA results, all items yielded values of good fit. Apparently, not any one of the items is misfitting. This was on the basis of all the criteria shown in the table, except the *t*-value. It can be observed that the *t*-values are high, this is because of the large sample size (n=6,672) and *t*-value is sensitive to sample size. This value tends to increase or get high if the sample size is increased.

Among the 11 items, the students find CLM4 (I think I could handle more difficult mathematics) is the hardest to endorse. This may mean that they themselves are not sure whether they can handle more difficult mathematics. Conversely, CLM3 (I am sure that I can learn mathematics) is the easiest item to agree with. This records their confidence in learning the subject.

6.5.2 Perceived Teachers Attitudes (PTA)

In this scale, students indicate whether they feel the support or motivation of their mathematics teachers towards their learning. They either agree or disagree with the statement provided.

Just like that of CLM, all items of PTA are also included in the Rasch analysis because they all have good fit in CFA. Most of the fit indices (Outfit and Infit) shown in Table 6.5.2 are close to the expected value of 1.00, demonstrating good fit. The CI also indicates that the fit indices are very close to the expected value.

Table 6.5.2
Estimates and Mean Square Fit of PTA

Items	Estimates	S.E.	Mean Square Fit Outfit	Mean Square Fit Infit	CI	t
PTA1	-1.12	.02	1.10	1.16	(0.96, 1.04)	8.1
PTA2	0.64	.02	0.96	0.95	(0.96, 1.04)	-2.9
PTA3	-0.03	.02	0.87	0.88	(0.96, 1.04)	-7.1
PTA4	0.11	.02	0.97	0.98	(0.96, 1.04)	-1.3
PTA5	0.40*	.02	0.97	0.97	(0.96, 1.04)	-1.9
PTA6	-0.17	.02	1.09	1.09	(0.96, 1.04)	5.0
PTA7	0.20	.02	1.14	1.14	(0.97, 1.03)	7.4
PTA8	-0.04	.02	1.07	1.08	(0.97, 1.03)	4.1

* PTA - Perceived Teacher Attitude; S.E. - Standard error; CI - Confidence interval; t-value

Inspecting the estimated value, the results record that PTA2 (My teacher think I'm the kind of person who could do well in mathematics) is the most difficult item to endorse. This indicates that it is hardly that teacher sees the students' potential to learn. Whereas the item that the students find very easy to endorse is PTA1 (My teachers have encouraged me to study more mathematics). This indicates that the students get more encouragement from their teachers to study more mathematics.

6.5.3 Usefulness of Mathematics (UOM)

One of the negative statements made about mathematics is that it has no application in real life situations. Hence, students are asked to agree or disagree with the statements that specify that mathematics is 'useful' or 'not useful'. Of the 10 items, two are found to misfit in CFA and therefore they are deleted and excluded in the Rasch analysis. Consistently, there are no other misfitting items that are recorded after the Rasch analysis. All the remaining eight items are retained and are exhibiting adequate fit to the model. The fit indices are generally recording that they are close to the expected fit value of 1.00 as presented in Table 6.5.3.

Table 6.5.3
Estimates and Mean Square Fit of UOM

Items	Estimates	S.E.	Mean Square Fit		CI	t
			Outfit	Infit		
UOM1	-0.12	.02	0.90	0.92	(0.96, 1.04)	-3.9
UOM2	-0.13	.02	0.81	0.82	(0.96, 1.04)	-9.1
UOM3	0.27	.02	0.97	0.92	(0.96, 1.04)	-3.9
UOM4	-0.02*	.02	1.04	1.08	(0.96, 1.04)	4.0
UOM5	-0.09	.02	0.95	1.08	(0.96, 1.04)	3.7
UOM6	0.35	.02	1.17	1.18	(0.96, 1.04)	8.0
UOM8	-0.17	.02	1.04	1.20	(0.96, 1.04)	8.7
UOM9	-0.10	.02	1.14	1.21	(0.96, 1.04)	9.0

* UOM - Usefulness of Mathematics; S.E. - standard error; CI - Confidence interval; t-value

On the one hand, among the eight items, the most difficult to endorse is UOM6. This indicates that the students are not sure that "mathematics will be of no relevance in their lives." On the other hand, UOM8 is the easiest statement to endorse. This indicates that it is easier for the students to agree or disagree that "studying mathematics is a waste of time."

6.5.4 Mathematics Anxiety Scale

In this scale, all items are included in the Rasch analysis. Table 6.5.4 records that the items generally fit the model well. Both the Outfit and Infit values are close to the expected value.

As shown in the table, the estimated values are very close to each other. The values are recorded within the -0.31 to 0.40 logits range. This indicate that the students have interpreted the items equally. But even with the small gaps between the items, MAS9 is considered to be the most difficult to endorse. The students find it hard to agree or disagree whether they "start to worry when they think of trying to solve mathematics problems." On the contrary, MAS7 is the easiest item to endorse. It means it is likely that "mathematics usually makes them feel uncomfortable."

Table 6.5.4
Estimates and Mean Square Fit of MAS

Items	Estimates	S.E.	Mean Square Fit Outfit	Mean Square Fit Infit	CI	t
MAS1	0.03	.02	1.27	1.27	(0.96, 1.04)	14.0
MAS2	-0.08	.02	1.00	1.00	(0.96, 1.04)	-0.2
MAS3	-0.03	.02	1.05	1.04	(0.96, 1.04)	2.3
MAS4	0.32	.02	1.16	1.16	(0.97, 1.03)	8.6
MAS5	0.00	.02	0.86	0.86	(0.96, 1.04)	-8.3
MAS6	-0.23*	.02	0.88	0.88	(0.96, 1.04)	-6.9
MAS7	-0.31	.02	1.01	1.02	(0.96, 1.04)	1.2
MAS8	-0.20	.02	1.09	1.09	(0.96, 1.04)	5.1
MAS9	0.40	.02	0.96	0.96	(0.96, 1.04)	-2.5
MAS10	0.02	.02	0.98	0.98	(0.96, 1.04)	-1.2
MAS11	-0.26	.02	1.05	1.05	(0.96, 1.04)	3.0
MAS12	0.33	.02	1.04	1.04	(0.96, 1.04)	1.9

* MAS - Mathematics Anxiety Scale; S.E. - Standard error; CI - Confidence interval; t-value

6.5.5 Beliefs of Mathematics

Results of confirmatory factor analysis indicate that eight items do not fit adequately. Thus, these items are not included in the Rasch analysis. Results are shown in Table 6.5.5. However, one more item has a value that indicates misfit, namely Item 6 (BAM6). With careful examination of the other criteria and the item statement, the item is removed. After removing BAM6, the remaining items are re-analysed to investigate if there is another item that appear to misfit due to the 'halo effect' (see Chapter 5) of the removed or other items. Thus, out of the 19 items, only 10 items remain. The results of the Rasch analysis are presented in Table 6.5.5.

All the remaining 10 items have acceptable fit values ranging from 0.84 to 1.37 (Infit). There are two items (BAM4 and BAM19) with Infit values close to the upper boundary, that need to be examined closely. Checking on how the items are worded is one way to examine the items to avoid obtaining high Infit values.

Table 6.5.5
Estimates and Mean Square Fit of BAM

			Mean Square Fit			
Items	Estimates	S.E.	Outfit	Infit	CI	t
BAM1	0.26	.02	1.06	1.04	(0.96, 1.04)	2.0
BAM2	-0.01	.02	1.01	1.03	(0.96, 1.04)	1.6
BAM3	-0.24	.02	0.88	0.90	(0.96, 1.04)	-4.8
BAM4	-0.31	.02	1.36	1.37	(0.97, 1.03)	16.0
BAM8	0.17	.02	1.02	1.01	(0.96, 1.04)	0.4
BAM9	0.14	.02	0.87	0.87	(0.96, 1.04)	-6.4
BAM11	0.61	.02	1.28	1.22	(0.96, 1.04)	10.7
BAM13	-0.02	.02	0.87	0.87	(0.96, 1.04)	-6.4
BAM14	-0.05*	.02	0.84	0.84	(0.96, 1.04)	-8.0
BAM19	-0.55	.02	1.32	1.35	(0.96, 1.04)	15.2

* BAM - Beliefs about Mathematics; S.E. - Standard error; CI - Confidence Interval; t-value

Of the remaining items, BAM11 (A common difficulty in taking quizzes and exams in mathematics is that if you forget relevant formulas and rules you are lost) is the hardest to endorse. One reason is probably the long statement, which may confuse the students. Therefore, this item needs to be rephrased to be concise and brief. The item that appears to be the easiest to endorse is BAM4 (Getting the right answer is the most important part of mathematics). The statement is clearly worded making it easiest to endorse.

6.6 Reliability Indices

In Rasch analysis, reliability can be considered from the viewpoints of items as well as of persons (Bond & Fox, 2007). The item-separation reliability indicates the consistency of the items and the reproducibility of the scale. A high item-separation reliability indicates that the items in the scales have relatively the same order of difficulty when administered to a different group of respondents. The person-separation reliability (Wright and Masters, 1982) indicates the ability of the items to separate between the person with high and low ability or capability of the constructs measured. A few items in each scale can influence the person-separation reliability. Likewise, a low item-separation reliability is obtained if the sample is not large enough to confirm the construct. The item-separation reliability and person-separation reliability for Teacher-level factors are shown in Table 6.6.1.

Table 6.6.1
Item and Person Reliability Indices of Teacher-level Factors

Scales	Subscales	ISR	PSR
TPS	STP	.98	.71
	SOTP		.76
	EATP		.69
PCAP	AASL	.95	.85
	AOFL		.73
	ATOL		.76
	AFORL		.73
CAPS	AP	.97	.82
	AIP	.94	.80
	AAS	.98	.73
	RSG	.99	.62
	ADUE	.98	.79
TATMT	Confidence	.98	.88
	Insecurity	.98	.66
PMTE	Persistence	.97	.61
	SPAbility		.83
MTOE	Effect	.89	.60
	Effort		.62
PDP	PDP_Math	.98	.62
	PDP_Educ		.55

ISR - Item-separation reliability; PSR - Person-separation reliability

The results show that all the Teacher-level subscales are showing very high ISR values indicating that the consistency and reproducibility of the items are highly achievable when administered to another group of respondents. In addition, PSR shows varying results that range from .55 to .88 indicating that if this group of respondents are to take the same or parallel survey questionnaires again, a similar result is most likely be recorded.

The results for school-level factors are presented in Table 6.6.2

Table 6.6.2
Item and Person Reliability Indices of School-level Factors

Scales	Subscales	ISR	PSR
	SG		.34
MLSI	IM	.96	.63
MLSA	AMS	.97	.52
	BMS		.71
SCFL	TWM	.92	.81
	Relationships		.87
BANTL	CTB	.97	.63
	DTB		.73
TACrit	LO	.94	.58
	TP		.71
	PD		

ISR - Item-separation reliability; PSR - Person-separation reliability

The ISR for school-level factors are also very high as recorded in Table 6.6.2. Values range from 0.92 to 0.97 which indicates that the relative order of item difficulty and the high reproducibility of the items are consistent. The PSR, is indicating greater variation in the results, with one subscale having a low reliability (0.34). This is probably due to the small number of items included in this subscale. The rest of the subscales are from moderate to high person-separation reliability.

Table 6.6.3 presents the ISR and PSR of student-level factors. It can be observed that the ISR values range from very high to perfect reliability. This is because of the very high sample size. There is a large enough sample to provide a high value of the reliability of the construct. All the PSRs are also recording high reliability values which indicate that the items are able to separate or classify the ability or capability of the respondents well.

Table 6.6.3

Item and Person Reliability Indices of Student-level Factors

Scales	Subscales	ISR	PSR
CLM	Confident	1.00	.79
	Not Confident		.83
PTA	PosTA	1.00	.77
	NegTA		.77
UOM	MU	.99	.67
	MNU		.70
MAS	Ease	.99	.82
	Anxious		.85
BAM	RB	1.00	.73
	IB		.68

6.7 Summary

Upon confirmation of the structure of the scales (macro level), validation of the items at the micro level is warranted. The assertion was for the items to comply with and qualify in the Rasch model. Items which came out as misfitting in the confirmatory factor analysis were no longer included in the Rasch analysis. For a more robust analyses, misfitting cases, particularly the underfitting cases, were temporarily removed before examining the items for each scale. The deleted misfitting items were consequently disregarded in the subsequent analyses. The entire process was done with careful and thorough examination of not just the indices generated by the models but also the very nature of the item statements themselves.

The results of Rasch Analysis led to the removal of additional items in the teacher-level scales. There were items in the *preferred classroom assessment practice*

(PCAP), *classroom assessment process scale* (CAPS), *teacher attitudes toward mathematics and mathematics teaching* (TATMT), *mathematics teaching efficacy beliefs* (MTEB) and *professional development program* (PDP) dimensions which qualified the CFA but failed to satisfy the Rasch Model. These specific items were thus deleted from the list. Similarly, for the School-level scales, dimensions *instructional leadership style* (MLSI), *administrative leadership style* (MLSA), and *teacher appraisal criteria* (TAC) had additional misfitting items. The particular misfitting items were likewise removed. Students' *beliefs about mathematics* (BAM) also yielded one additional item that did not fit the Rasch model.

There were, however, items which yielded values of poor fit but were retained. Deliberation was based on careful examination of the other criteria parameters and the very nature of the item statement itself in terms of its importance to the entire construct. When deemed acceptable, the items' relevance outweighed the poor fit and were thus retained.

The item- and person-separation reliabilities of each scale were likewise determined. These reliability indices indicate consistency and reproducibility of the items. They identify and separate as well the ability and capability of the persons. As the rule requires, low item separation reliability required more cases to be included, while low person separation reliability necessitated more items to be included.

Chapter 7
Examining the sample's demographic and general characteristics: Descriptive Statistics

---

7.1 Introduction

This chapter presents the distribution of the general characteristics of the three sets of respondents, teachers, principals and students. Frequency distribution, percentage and graphs are used to describe the categorical variables, while mean and standard deviations are used to present continuous data. The response patterns of the respondents in individual-level scales are also presented. Error bar is used to illustrate the distribution of the responses. This chapter concludes with a summary.

7.2 Teacher Level

7.2.1 Profile characteristics of Teachers

Data were collected from 326 mathematics teachers teaching in the elementary and secondary levels from both public (government) and private schools in Region XII, Philippines (Table 7.2.1). The distribution of teachers according to school level, school type, and gender are presented using the pie graph.

In the Philippine education setting, there are more elementary schools than secondary schools, especially, that the government has made elementary schooling compulsory. Consequently, there are more elementary schools involved in the study. Figures 7.2.1 and 7.2.2 show the school levels and type of schools of the teacher-respondents, respectively. Figure 7.2.1 shows that 55.21% of the teachers are teaching in the elementary level, while the remaining 44.79% are teaching in secondary schools. Additionally, there is a large difference in the number of teachers according to the type of schools. Majority of them (74.77%) are teaching in public schools, while only 25.23% are teaching in private schools.

Table 7.2.1

Distribution of teacher-respondents according to School level, School type and Gender

	Frequency	Percent
School Level		
Elementary	180	55.21
Secondary	146	44.79
School Type		
Public	243	74.77
Private	82	25.23
Gender		
Male	125	38.82
Female	197	61.18

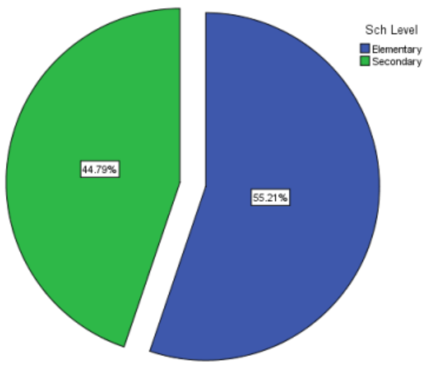


Figure 7.2.1 Mathematics teacher School level.

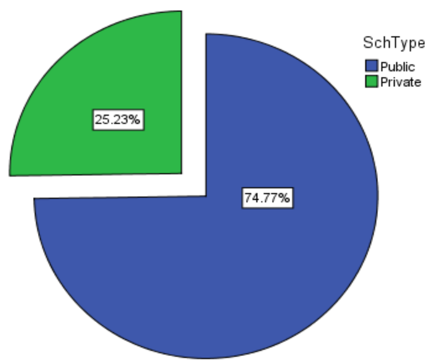


Figure 7.2.2 Mathematics teachers School type.

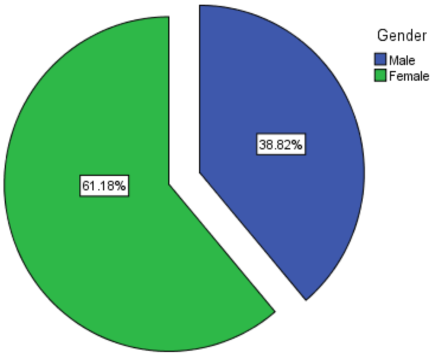


Figure 7.2.3 Gender of Mathematics teachers.

It is a common knowledge that more females are joining the teaching force. It is also evident in the distribution of teachers involved in this study. Of the 326 teachers, 61.18% of them are females, while 38.82% are males as presented in Figure 7.2.3.

Teachers' highest educational attainment is also obtained (Table 7.2.2). It is expected that they all finished the four-year Bachelor's degree because it is the basic requirement to become a teacher. Teachers are also expected to pursue higher degree programs, such as Master's and Doctorate degrees, especially if they are aiming for promotion. Figure 7.2.4 shows that majority of the teachers (125) have taken some Master's units. It is followed by those who only have Bachelors' degree (115). It is interesting to see that the number of teachers with Masters' degree is quite large (71), but discouraging to know only a few pursue Doctorate degree. Only eight teachers have started taking doctorate and only two finished a Doctorate degree in education.

Table 7.2.2

Distribution of teacher-respondents according to Level of education and Frequency of attendance to PD sessions

	Frequency	Percent
Level of Education		
Bachelor's Degree	115	35.3
Bachelor's with Master's units	125	38.3
Master's Degree	71	21.8
Master's Degree with Doctorate units	8	2.5
Doctorate Degree	2	0.6
Frequency of PD sessions		
Once in every six months	56	17.2
Once a year	178	54.6
Once in two years	29	8.9
Others	39	12.0

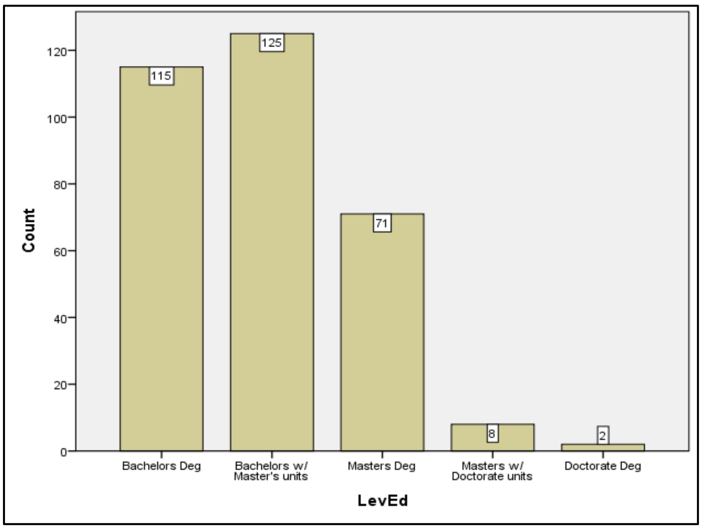


Figure 7.2.4 Mathematics teachers' level of education.

The Department of Education (DepEd) provides in-service professional development (PD) activities to teachers, such as seminars, trainings, workshops and conferences. These are mostly compulsory to public (government) school teachers. The frequency of which depends on the need or the availability of funding. Aside from the government's PD program, teachers also have the opportunity to PD programs sponsored by other government institutions, non-government organisations and private institutions. If the seminars and trainings are not DepEd sponsored, the teachers need to request for approval and for funding. Most often, what hinders teachers from attending conferences, seminars and trainings is the expenses incurred and the distance from the venue. Unless, they are being sent and sponsored by the school. In this item, the teacher-respondents are asked of the number of times they attended PD programs in the last three years from the time the study was conducted (Table 7.2.2). Looking at Figure 7.2.5, most of the teachers (178) have attended PD sessions only once a year. This may probably be the DepEd sponsored PDs. While 56 teachers have indicated that they attended PD programs quite more frequently than the rest (once in every six months), only 29 have answered that they only attended PD sessions once in every two years. The remaining 39 teachers have answered others, meaning the frequency of their attendance to PD programs is beyond the options provided. It could be that they have not attended any PD program in the last three years or they have attended more than twice a year.

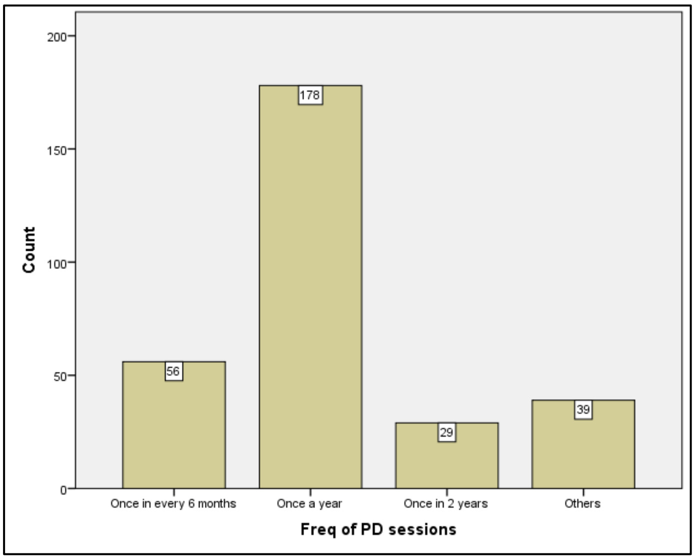


Figure 7.2.5 Distribution of teachers according to frequency of PD sessions.

Since age and years of teaching experience are continuous data, their means and standard deviations are presented in Table 7.1.3. Many of the teacher-respondents are not open about their age, hence, many have left it blank as presented in the table. A fresh graduate from Bachelor's degree is normally between 20-22 years old. With the certificate they obtained from completing a four-year course, they can already teach in private schools. Public schools, however, require a license, which can be obtained after passing the Licensure Examination for Teachers (LET). Table 7.2.3 presents that teachers' average age is 39 years old with a standard deviation of 10.58. This indicates that the sample are generally middle aged. This means that the teachers have more than 10 years of teaching experience. The table shows that, on average, teachers have almost 14 years of teaching experience (sd = 9.18). Not all teachers have completed mathematics education but were assigned to teach mathematics. Others may have majored mathematics but were not immediately assigned to teach mathematics. On average, teachers have been teaching mathematics for about 12 years (sd = 8.77).

Table 7.2.3
Mean and standard deviation of teachers' age and years of teaching experience

	n	Mean	sd
Age	271	39.12	10.58
Years as Teacher	318	13.76	9.18
Years Teaching Maths	315	11.57	8.77

7.2.2 Teacher-Level Factors

Aside from the demographic information and teachers' characteristics, teachers' classroom practices are also measured. Classroom practices is the collective name of the two important activities of teachers inside the classroom- teaching and assessment. Other teacher attributes (attitudes and beliefs) are also presented.

It is important to note that after the validation of the scales at the item level, the raw scores are transformed into Rasch scores (weighted likelihood estimate, WLE). Hence, the means, standard deviations, skewness and kurtosis are presented in Table 7.1.4. Additionally, error bars are used to show the variability of the data and the 95% confidence interval.

Table 7.2.4 shows that the variables are generally normally distributed indicated by the skewness and kurtosis values, which are within the acceptable range of ± 2 (Trochim & Donnelly, 2006; George & Mallery, 2010). The means and the spread of the data are also illustrated using error bars in Figure 7.1.6.

Table 7.2.4
Means, standard deviation, skewness and kurtosis of teacher-level factors

	n	Mean	sd	Sk	Ku
PDP_Math	326	-0.14	2.13	0.09	-1.01
PDP_Educ	326	-1.71	1.38	0.95	0.66
STP	326	2.08	1.19	0.48	0.49
SOTP	326	0.93	1.17	0.59	0.68
EATP	326	1.10	1.38	0.57	0.23
AASL	325	2.83	2.23	0.07	-0.31
AOFL	325	3.84	2.15	-0.41	-0.22
ATOL	325	2.78	2.47	-0.01	-0.62
AFORL	325	3.61	2.12	0.03	-0.44
CAPS_AP	324	4.16	2.13	0.06	-0.71
CAPS_AIP	324	3.11	1.70	0.45	-0.45
CAPS_AAS	324	4.91	2.13	-0.26	-0.78
CAPS_RSG	324	1.99	1.87	0.44	-0.02
CAPS_ADUE	322	1.76	1.81	0.58	-0.03
CNFIDNCE	323	0.42	1.71	0.31	1.38
INSECURITY	319	0.27	1.59	-0.11	0.77
PMTE_Persist	325	3.12	1.58	0.43	0.04
PMTE_SPC	325	1.00	1.75	-0.01	3.27
MTOE_Effect	325	2.88	1.98	0.38	-0.68
MTOE_Effort	325	2.21	1.89	0.51	-0.30

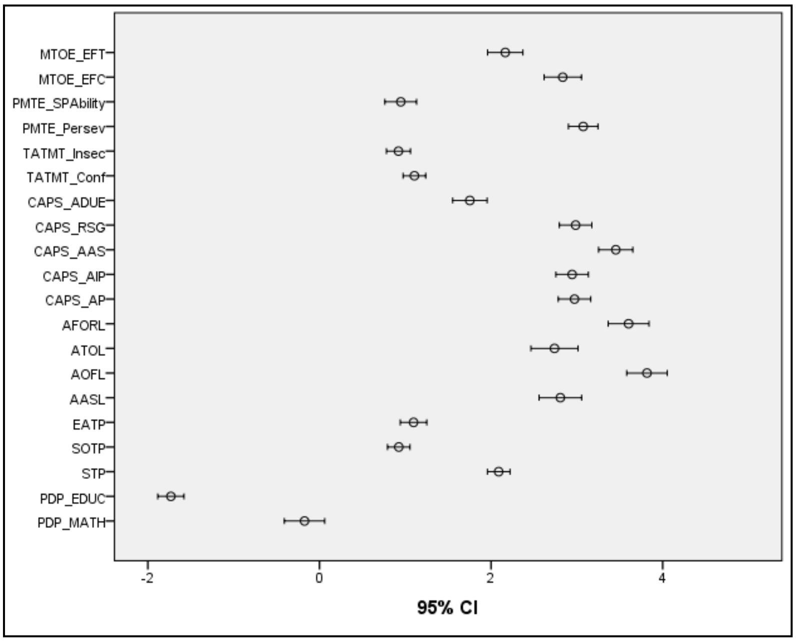


Figure 7.2.6 Error bars of Teacher-level factors.

Figure 7.2.6 show the variability of the responses of each of the factors at the teacher-level. The errors bars are used simply to indicate the 95% confidence interval of the mean values.

The figure shows that, generally, the responses of the teachers are consistent and are close around the mean. The spread is, however, larger in the preferred classroom practices (PCAP) as compared to the rest of the factors. This indicates less consistency in these responses.

7.3 School Level

7.3.1 Profile Characteristics of School Principals

One hundred forty-six (146) school principals participated in the study. These school principals are heads of either elementary or secondary or both levels from both public and private schools in Region XII. Tables and pie charts are used to describe the demographic profile of school heads/principals.

Table 7.3.1
Demographic Profile of the School Principal

	Frequency	Percent
School Level		
Elementary	79	54.86
Secondary	53	36.81
Elementary & Secondary	12	8.33
School Type		
Public	101	71.63
Private	40	28.37
Gender		
Male	52	37.14
Female	88	62.86
Level of Education		
Bachelor's Degree	7	5.00
Bachelor's degree with Master's Units	37	26.43
Master's Degree	57	40.71
Master's Degree with Doctorate Units	25	17.86
Doctorate Degree	11	7.86
Post Doctorate	3	2.14

A common set up in the Philippines is that High Schools are separate from Elementary schools, in terms of the location, or buildings. They also have different operations and programs. This, therefore, requires different school heads. There would, however, be cases were a High School is located on the same campus as the Elementary school. In this situation, especially if the school is small, there would only be one school head for both the Elementary and High School. Table 7.3.1 shows that majority of the school principals (54.86%) are handling elementary levels because, as mentioned earlier, there are more Elementary schools than High Schools in the region. It is followed by secondary-level school heads (36.81%). As expected, the lowest number are from both elementary and high school with only 8.33 percent.

Table 7.3.2
Means, standard deviation, skewness and kurtosis of school Principals' age, years as teacher and as principal

	n	Mean	sd	Sk	Ku
Age	129	49.50	9.30	-0.16	-0.06
Years as Principal	137	9.07	6.90	1.36	2.44
Years as Teacher	135	14.22	9.38	0.89	0.35

At the age of 21, Bachelor in Elementary or Secondary Education graduate could already start teaching in private schools. By the time, they get their license one year after they could pass the licensure exam for teachers (LET), they could already get the most coveted place in public schools. Table 7.3.2 presents that on average, school principals who participated in the study are about 50 years old (s = 9.30). The table also shows that on average, they have longer experience in teaching (mean = 14.22 years, sd = 9.38) than serving as the school head (mean = 9.07 years, sd = 6.90). The table further presents that the distribution is generally normal.

7.3.2 School-Level Factors

Table 7.3.3 presents that the school-level factors are generally normal as indicated by the values of skewness and kurtosis, which are within the range of values signifying normality. The mean and the variability of the factors are likewise pictured in Figure 7.3.1.

Table 7.3.3
Means, standard deviations, skewness and kurtosis of school Principal-level factors

	n	Mean	sd	Sk	Ku
SCFL_TWM	142	5.57	3.14	-0.19	-0.66
SCFL_REL	142	5.32	3.41	-0.08	-0.86
TAC_LO	144	3.68	1.99	-0.95	0.72
TAC_TP	144	4.80	1.90	-0.41	-0.59
MLSI_SG	145	4.58	1.60	-0.39	-0.90
MLSI_IM	145	4.11	1.56	-0.80	-0.31
MLSI_DS	145	3.77	1.61	-0.30	-0.57
MLSA_A	143	4.22	2.07	-1.39	-0.62
MLSA_B	143	4.16	2.12	-0.44	1.05
CONSTBEL	144	2.57	1.77	-0.62	1.25
DIRINBEL	144	1.84	1.83	0.13	0.59

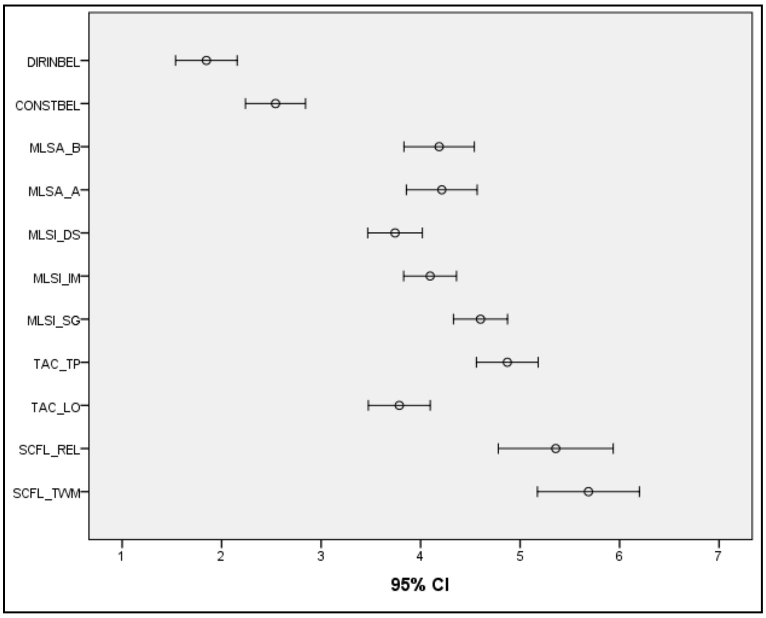


Figure 7.3.1 Error bars of school Principal-level factors

Figure 7.3.1 illustrates that the school principals appeared to have variability in their responses even for the observed variables within the same construct. For instance, the variables TAC_LO and TAC_TP are the observed variables for the construct Teacher Appraisal Criteria (TAC). It can further be grasped from the graph that the responses of the school Principals are seemingly varied and wide spread in the variables school climate for learning in terms of Relationship (SCFL_REL) and school climate for learning in terms of teacher working morale (SCFL_TWM). But school principals tend to be more consistent in their responses about their instructional management or leadership style (MLSI).

7.4 Student Level

7.4.1 Profile Characteristics of Students

The questionnaires were administered to a total of 6,672 elementary and secondary students from both public (government) and private schools in the Southern part of the Philippines, specifically in Region XII.

Table 7.4.1 presents the profile characteristics of the students. Of the 6,672 students, 3,437 or a little over half (51.50%) are Elementary pupils and the remaining 48.50% are Secondary students. There are, however, a big gap in the number of student-respondents in terms of gender. Majority are females which comprise of 60.40% of the total number of students involved, while the remaining 39.60% are males.

Table 7.4.1
Demographic Profile of the students

	Frequency	Percent
School Level		
Elementary	3437	51.50
Secondary	3235	48.50
Gender		
Male	2638	39.60
Female	4032	60.40
Ethnic Group		
Ethnic Group 1	1617	24.40
Ethnic Group 2	1281	19.30
Ethnic Group 3	2219	33.50
Ethnic Group 4	1510	22.80
Parents' Level of Education		
Mother's Highest Level of Education		
Elementary Level	888	13.40
High School Level	2453	36.90
College/Undergraduate Level	2856	43.00
Masters Degree	254	3.80
Doctorate Degree	72	1.10
Others	122	1.80
Father's Highest Level of Education		
Elementary Level	1038	15.70
High School Level	2313	35.10
College/Undergraduate Level	2854	43.30
Masters Degree	195	3.00
Doctorate Degree	52	0.8
Others	141	2.10

Table 7.4.1 (continued)

	Frequency	Percent
Parents' Employment Status		
Mother's Employment Status		
Government Employee	1046	15.80
Private Employee	551	8.30
Self-employed	1046	15.80
Doing housework	3483	52.70
Student	33	0.50
Retired	98	1.50
Unemployed	307	4.60
Others	46	0.70
Father's Employment Status		
Government Employee	1388	21.4
Private Employee	851	13.1
Self-employed	2179	33.6
Doing housework	1000	15.4
Student	36	0.60
Retired	238	3.70
Unemployed	711	11.00
Others	79	1.20
Home Possessions		
Calculator	5884	
Personal Computer	2075	

Ethnic group or affiliation are clustered into four, Ethnic group 3 has the highest number of respondents (2,219) and this includes the Hiligaynon/Ilonggo group. It is followed by Ethnic group 2 with 1,617 students from Maranao/Maguindanao group. Ethnic group 4 is a combination of different ethnic affiliations has 1,510 students. The smallest group (Group 2), the Cebuano group has 1,281 respondents.

For the parents' highest educational level, it can be seen that the number of students with mothers and fathers who have finished the same educational level have seemingly small difference. For instance, there are 2,856 students whose mothers have finished college or undergraduate level and almost the same number of students (2,854) whose fathers have finished college or undergraduate level. This is followed by parents who have finished High School level, 2,453 of the students have indicated that their mothers finished High School, while 2,313 have said their fathers have completed high school. As expected, the number of students whose parents have reached the levels of Master's and Doctorate degrees are the smallest. There are only 254 students whose mothers have reached the masters level, while there are only 195 students with fathers of the same degree. There are also more mothers (72 or 1.10%) who have completed Doctorate degree than their fathers (52 or 0.80%).

In the Philippine culture, it is a common scenario that men are the ones who work for a living, while women are looking after the affairs of the home. There are however some cases where the men are the ones who stay at home. It is therefore not surprising to see that majority (52.70%) of the students have indicated that their mothers are doing housework, while there are also those students (15.4%) whose fathers are the ones who stay at home and do the housework. One reason for this is that the mothers are working abroad or in a foreign land. In today's generation, it is no longer a surprise that women also go out and work to help the family earn a living, either as an employee or doing small business. Hence, the data show that the fathers of 33.60% of the students are self-employed, while only 15.80% of the students have mothers who are also self-employed.

Table 7.4.1 likewise presents that there are more parents who preferred to work in the government than in private institutions. For the mothers, for example, 1,046 are government employees and 551 are private employees. Whereas, the number of students with fathers working in the government and private institutions are 1,388 and 851, respectively. There are quite a number, however, whose parents are unemployed (mother=307, father=711). These are probably the parents who have not finished a course or are not lucky enough to get a good job. The smallest number recorded in the table are those whose parents have gone back to school and are pursuing further studies (mother=33, father=36). Table 7.4.2 shows that, on the average, elementary and secondary students are 12 and 16 years old, respectively. Overall, students are 14 years old.

Table 7.4.2
Mean and standard deviation of students' age and mathematics achievement

		n	Mean	sd
Age	Elementary	3246	12.18	.953
	Secondary	3223	16.22	1.124
	Total	6649	14.14	2.27
Mathematics Achievement		3657	28.43	9.95

7.4.2 Student-level Factors

Table 7.4.3 presents the student-level factors that are considered in the study. The data show that they are generally normally distributed as indicated by their skewness and kurtosis values which are within the threshold values. The 95% confidence interval of the means which are also illustrated using error bar in Figure 7.3.1, indicate that the students' responses are close around the mean signifying more consistency in their answers.

Table 7.4.3
Means, standard deviations, skewness and kurtosis of school Student-level factors

	n	Mean	sd	Sk	Ku
CLM_Pos	6669	1.05	1.44	0.45	1.34
CLM_Neg	6669	0.64	1.68	0.48	1.05
PTA_Pos	6669	1.50	1.60	0.43	0.61
PTA_Neg	6669	0.57	1.95	0.41	0.30
UOM_Pos	6669	1.95	1.70	0.24	-0.73
UOM_Neg	6669	2.11	1.98	-0.04	-0.99
MAS_Pos	6669	0.34	1.52	0.58	2.02
MAS_Neg	6669	0.51	1.72	0.56	1.48
BAM_RelBel	6672	1.32	1.40	0.63	0.69
BAM_InsBel	6672	1.36	1.33	0.90	1.17

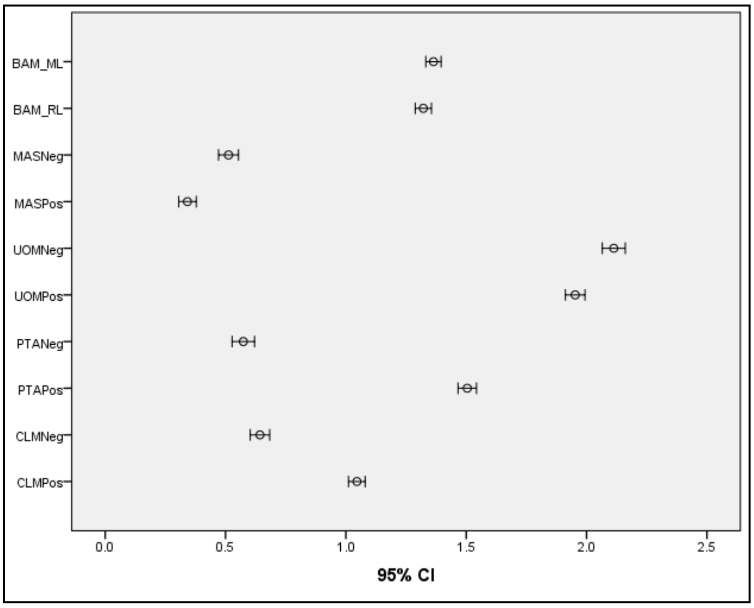


Figure 7.4.1 Error bars of Student-level factors.

7.5 Summary

This chapter highlights the demographic information and general characteristics of the respondents involved. Data are presented either in graphical or in tabular form. The response patterns of the respondents are presented using error bar.

This chapter also presents that the data are generally normally distributed as indicated by the values of skewness and kurtosis. The error bars, likewise indicate that the responses of the students tend to stay close around the mean signifying more consistency in their responses.

The next three chapters present the results for the single-level structural equation modelling for each level.

Chapter 8
Impact of Teacher factors on Classroom Practices: Teacher-level SEM Analysis

---

8.1 Introduction

The present study investigates the factors that may have influenced students' achievement in mathematics. These factors include teacher-level, school-level and student-level factors. This chapter examines the relationship of the latent (unobserved) variable and manifest variates within the single-level model. Three sets of respondents are involved in this study. Hence, three different structural equation models, one for each level (Teacher, School and Students) are examined and results are reported in the sections that follow. It is important to note that the teacher-level model is presented first following the same order as the previous chapters. The results for the school- and student-level are presented in the succeeding chapters.

Structural equation modelling (SEM) is employed to illustrate causal relationships among the variables. This analysis provides a rigorous test of the hypothesised theoretical model (Schumacker & Lomax, 2004). Since the data collected involves multiple scale items, it is best to examine them in a SEM model. Structural equation modelling is preferred over other path analysis approaches because it allows a combination of multiple measures of latent constructs or variables and then to model the causal relationships among these latent constructs. Mplus 7 developed by Muthén and Muthén (1998-2012) is used to perform the SEM analyses.

This chapter likewise seeks to answer the research questions presented in Chapter 1, particularly, the research questions referring to the teacher-level factors:

(2) Teacher-level factors

(a) What teacher individual-level characteristics (gender, age, years of teaching mathematics, level of education, school level, school type) influence teachers' attributes (professional development, teachers' attitudes and beliefs)?

(b) Do individual-level characteristics have influence on classroom practices (teaching and assessment practices)?

(c) How do teacher attributes influence classroom practices?

(d) How do assessment practices influence teaching practices?

In Chapter 6, the items of the variables used in this study were subjected to validation using the Rasch model. After item calibration, weighted likelihood estimates (WLE) are obtained for each scale and subscale. In this way, raw scores are converted into Rasch scale scores or measures, which are used for the succeeding analysis involving structural equation modelling (SEM). Rasch scale scores are formed on an interval scale of measurement and are therefore preferred over raw scores for SEM analysis.

8.1.1 Model Trimming

Model trimming involves removing the variates and variables (MVs and LVs) that do not have significant path coefficients. The significance level of .05 is the basis for trimming down the non-significant paths in the model. Any paths with specific *p* values of greater than .05 are removed and the order of removal starts from the highest *p*-value.

8.2 Variables employed in Teacher-level Structural

8.2.1 Equation Modelling

The teacher single-level model includes the variables that are assumed to influence the teaching and assessment practices, collectively known in this study as 'classroom practices'. These classroom practices are also hypothesised to have inextricable relationships with each other. Other variables hypothesised to influence the classroom practices are presented in Table 8.2.1.

Table 8.2.1
Variables used in the Teacher-level path Analysis

Theoretical Dimensions	Latent variables	Manifest variables	Description
Presage			
Individual Characteristics		Age	Age
		Gender	Gender
		LevEd	Level of Education
		YTM	Years of Teaching Experience
		SchLev	School Level
		SchType	School Type
Process			
Professional Development program (PDP)		FPD	Frequency of attendance to Professional Development Program
	PDP (Professional Development Program attended)	PDP_Math	Professional Development Program-Mathematics
		PDP_Educ	Professional Development Program-Education
Teacher Attitudes towards Mathematics and Teaching (TATMT)		TA_Insec	Teacher attitudes - Insecurity
		TA_Conf	Teacher attitudes - Confidence

Table 8.2.1 (continued)

Theoretical Dimensions	Latent variables	Manifest variables	Description
Mathematics Teaching Efficacy Beliefs (MTEB)	PMTE (Personal Mathematics Teaching Efficacy)	PERSEV	Perseverance
		SPAbil	Self-perceived Ability
	MTOE (Mathematics Teaching Outcome Expectancy)	MTOE_EFC	Teachers Effectiveness
		MTOE_EFT	Teachers Effort
Assessment Process	CAPS (Classroom Assessment Process)	AP	Assessment Planning
		AIP	Assessment Item Preparation
		AAS	Assessment Administration and Scoring
		RSG	Reporting of Scores and Grading
		ADUE	Assessment Data Utilisation and Evaluation
Product			
Classroom Assessment Practice	PCAP (Preferred Classroom Assessment Practice)	AASL	Assessment AS Learning
		AOFL	Assessment OF Learning
		AFORL	Assessment FOR Learning
		ATOL	Assessment TO Learning
Classroom Teaching Practice	TPS (Teaching Practices Scale)	STP	Structured Teaching Practice
		SOTP	Student-oriented Teaching Practice
		EATP	Enhanced-activities Teaching Practice

8.3 Assumptions

Before carrying out the SEM analyses, there are tests conducted to investigate if some assumptions have been met using IBM SPSS 20. Only test for normality and multicollinearity are reported here, however. The data involve the responses from 326 mathematics teachers. There are missing data on some variates and variables. Mplus 7 uses the maximum likelihood (ML) method to deal with missing data.

8.3.1 Test for Normality of Data

It is important to consider whether the data for each of the variables are normally distributed or not before carrying out further the analysis. As presented in Chapter 4, Shapiro_Wilk test was employed. This test also provides skewness and kurtosis values, one of the most commonly used test of normality. The results of the Shapiro_Wilk test reveal a significance value of greater than .05, which suggests that assumption of normality has not been violated. The Quantile-Quantile plot (Q-Q plot) likewise suggests normal distribution.

8.3.2 Test for Multicollinearity of Independent Variables

This analysis involves the correlation between the independent variables and high correlation can occur between these variables. This high correlation is called 'multicollinearity'. Multicollinearity refers to the "extent to which a variable can be explained by another variable in the analysis" (Hair, et al., 2010, p. 2). In other words, two or more variables could be measuring the same thing. Multicollinearity between variables can result in a spurious inflation of regression coefficients (Tabachnick & Fidell, 2013), which consequently lead to an inaccurate interpretation of the results. Hence, it is necessary to first investigate whether serious multicollinearity exists.

One among the many ways to check for multicollinearity is by looking at the Tolerance and variance inflation factor (VIF), which can be obtained by performing regression analysis in IBM SPSS. A tolerance value of less than .10 and a VIF value of above 10 indicates the presence of serious multicollinearity (Pallant, 2011).

The multicollinearity of the independent variables at the teacher level are therefore examined and the results are presented in Table 8.3.1. The results recorded in Table 8.3.1 indicate that none of the variables have less than .10 value of Tolerance and greater than 10 of VIF. Thus, the multicollinearity assumption is not violated. It is therefore safe to proceed to structural equation modelling analysis.

Table 8.3.1
Collinearity Statistics of the Teacher-level Variables

Variables		Collinearity Statistics	
Dependent variable	Independent variable	Tolerance	VIF
TPS	PCAP	0.99	1.01
	INSECURITY	1.00	1.00
	PDP	0.99	1.01
PCAP	SchLev	0.91	1.09
	PMTE	0.86	1.17
	CAPS	0.82	1.22
CAPS	LevEd	0.99	1.01
	MTOE	0.99	1.01
MTOE	SchLev	0.98	1.02
	CONFIDENCE	0.98	1.02
PMTE	SchType	0.94	1.06
	LevEd	0.94	1.06
	CONFIDENCE	1.00	1.00
CONFIDENCE	SchLev	0.97	1.03
	YTM	0.95	1.06
	GENDER	0.95	1.05
	PDP	0.99	1.01
INSECURITY	AGE	0.41	2.45
	YTM	0.40	2.48
	FPD	0.93	1.08

The variates that are referred to as 'manifest' are the individual characteristics (age, gender, level of education, years of teaching mathematics, school level and school type), frequency of attendance to professional development programs, and the two variables or factors of teachers' attitudes towards mathematics and mathematics teaching (confidence and insecurity). Other variables with corresponding observed or manifest variates are treated as latent. This includes the (a) professional development programs, (b) personal mathematics teaching efficacy beliefs and mathematics teaching outcome expectancy, (c) classroom assessment process, (d) preferred classroom assessment practice and (e) teaching practices.

These variables are included in the model that illustrates the hypothesised relationships between the manifest variates and latent variables. The hypothesised model is shown in Figure 8.3.1.

8.4 The Hypothesised Model

The hypothesised model derived from the initial theoretical model is presented in Figure 8.3.1. Circles represent latent variables, and rectangles represent observed or manifest variates. The lines that connect the variables indicate direct or indirect causal effects. The model depicts the relationships between the latent variables (LV) and manifest variates (MV). The MVs with fixed characteristics are not influenced by other MVs and LVs and are placed at the farthest left side of the model. Whereas the outcome variables are placed at the farthest right side. A structural equation model is specified and defined by both the measurement model and the structural model. The measurement models of the latent variables are defined by the results of CFA in Chapter 5, and the raw scores are transformed into Rasch scores using the weighted likelihood estimates (WLE). Hence by simplifying the model into the latent-manifest pattern instead of the hierarchical factor model, the structural model specifies the hypothesised relationships between the MVs and LVs.

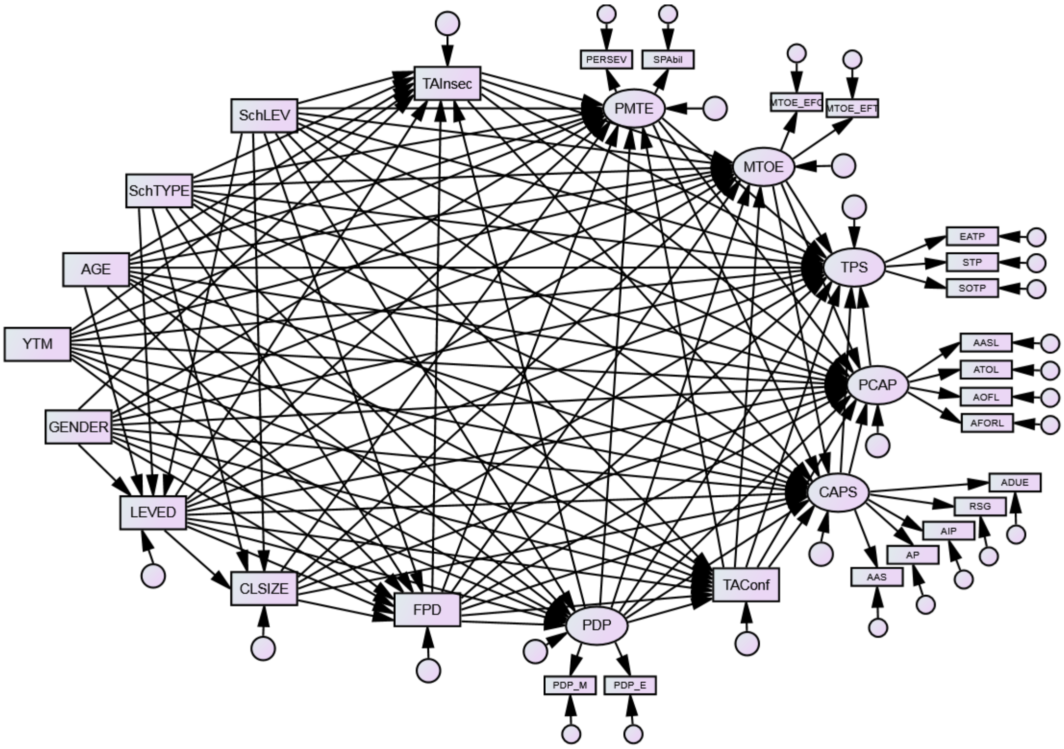


Figure 8.4.1 Hypothesised Teacher-Level Path Model.

The hypothesised model examines the explanatory variables of teaching and assessment practices collectively called 'classroom practices'. Teaching practices is a latent variable with three manifest variates (structured, student-oriented and enhanced activities). Teachers' preference of assessment practices has four indicators: (a) assessment as learning – AASL, (b) assessment to learning- ATOL, (c) assessment for learning – AFORL, and (d) assessment of learning – AOFL). It is hypothesised that teaching and assessment practices are inextricable or inseparable, and that one directly affects the other.

In addition, the hypothesised model shows the causal relationships of the variables involved. It clearly depicts which variables are influencing the other variables in the model.

All path estimates are calculated using Mplus 7. Resulting values reported are the standardised path coefficients (β) to indicate the strength of relationship. The *t*-value is used to indicate the statistical significance of the coefficient. The *t*-value of $-2 \leq t \leq +2$ is significant at .05 level and indicates that the explanatory variable significantly influences the outcome variable.

8.5 Results of Teacher-level Path Analysis

In this study, the measurement models are discussed briefly. Greater emphasis is given to the structural model as it displays the relationships between the MVs and LVs.

8.5.1 Measurement Model results

The measurement model involves confirmatory factor model (see Chapter 5) and it illustrates the relationships between the latent variables and the manifest variates. The magnitudes of relationships between these variables and variates are indicated by the factor loadings. Using the same criteria applied in Chapter 5, a factor loading of .40 and above is considered acceptable. It is important to note, yet again, that albeit hierarchical or second-order factor models are presented as the final CFA models in Chapter 5, transforming the raw scores into Rasch scaled scores reduce the model into first-order factors as pictured in the measurement model.

Teaching practices (TPS) as a construct is reflected by three manifest variates, which include *structured teaching practice* (STP), *student-oriented teaching practice* (SOTP) and *enhanced-activities teaching practice* (EATP). The factor loadings (0.69, 0.89 and 0.85, respectively) of these manifest variates are acceptable indicating that they substantially reflect the construct. The four manifest variates of the *preferred assessment practice* (PCAP) also have acceptable factor loadings (AASL=0.79, ATOL=0.70, AOFL=0.78, AFORL=0.86). Consistently, the five factors (AAS=0.80, AP=0.81, AIP=0.83, RSG=0.60 and ADUE=0.61) of *classroom assessment process* (CAPS) also exhibit good factor loadings. For the latent factors *mathematics teaching outcome expectancy* (MTOE) and *personal mathematics teaching efficacy* (PMTE), the factor loadings of the manifest variates are quite low compared to other manifest variates, they are, however, still within the acceptable range. The two manifest variates of MTOE, '*effectiveness* (EFC)' and '*effort* (EFT)' have loadings of 0.57 and 0.56, respectively. Additionally, PMTE's '*perseverance* (PERSEV)' and '*self-perceived ability* (SPAbil)' have 0.55 and 0.43 factor loading values, respectively. Moreover, one of the two factors of *professional development program* (PDP) obtain the lowest factor loading, but are still deemed acceptable. PDP for Maths (PDP_Math) has a loading of 0.42, while PDP_Educ has a factor loading value of 0.65.

8.5.2 Structural Model Results

The patterns of relationships between the teachers' individual characteristics (gender, age), teachers' experience (level of education, years of teaching mathematics), school characteristics (school type, school level, class size), professional development (frequency of professional development, professional development program), teachers' attitudes (confidence and insecurity), mathematics teaching efficacy beliefs (personal mathematics teaching efficacy and mathematics teaching outcome expectancy) and classroom practices (teaching practices and assessment practices) as outcomes are examined in the analyses that follow.

After employing the model trimming, the final model of the structural equation model is shown in Figure 8.5.1. The final model yielded the following fit indices, χ^2 = 950.252, $p < 0.05$, CFI = 0.88, TLI = 0.86, RMSEA = 0.08, SRMR = 0.09, which indicate that the model fit the data relatively well. Post hoc model modifications were performed in an attempt to develop a better fitting model. On the basis, of theoretical relevance, two residual covariances were estimated (residual covariance between CAPS_RSG and CAPS_ADUE). The model was significantly improved with this modification.

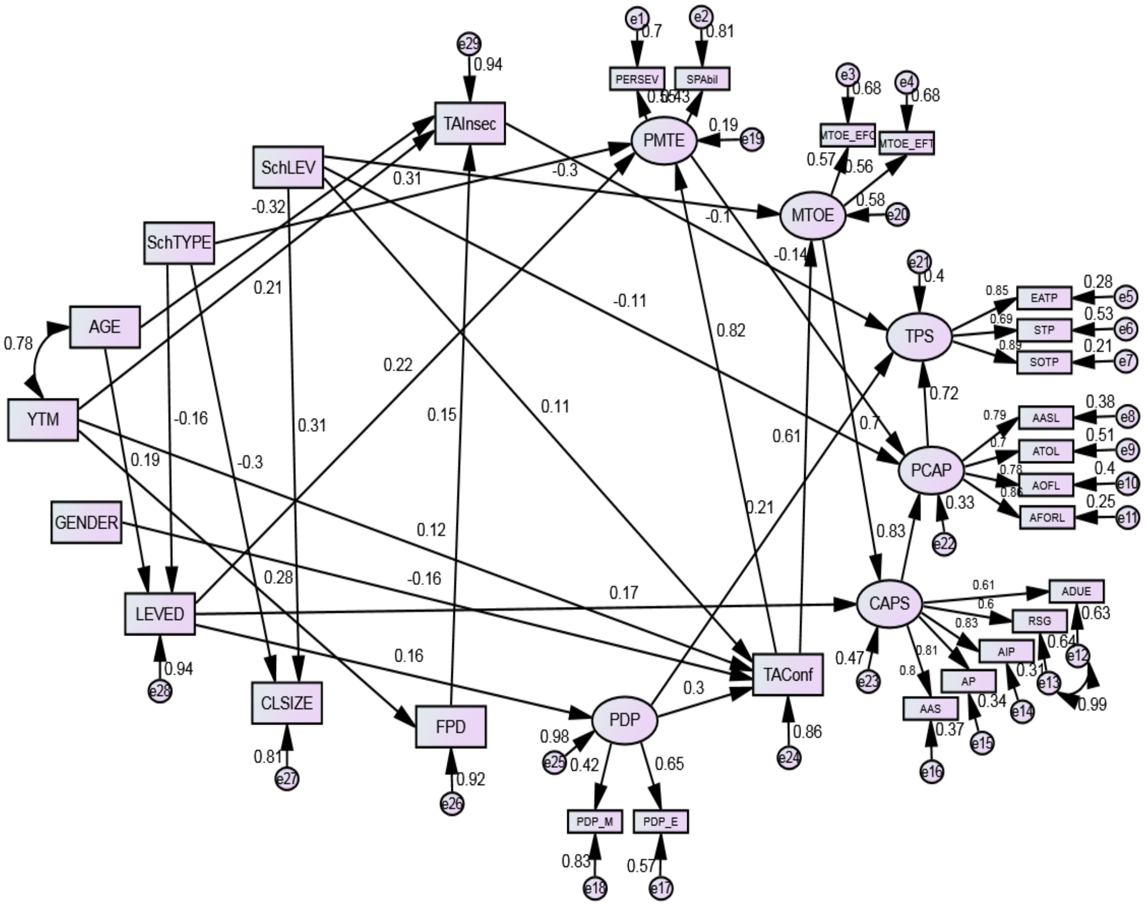


Figure 8.5.1 Final Structural equation Model: Teacher Single-level Model.

In this chapter, the causal relationships between the variables in the structural models are of interest. The structural model results where the direct effects, indirect effects, total effects and the corresponding *p*-value (for significance) for each structural equation model are presented in Table 8.5.1

Model Estimation

The following section presents the estimates of relationships or effects of all the variables and variates involved in the final model. Resulting values reported are the standardised regression coefficients (β) to indicate the strength of relationship or effects and the equivalent *p*-values to indicate statistical significance. If the coefficient is significant, then this indicates that the explanatory variable (X) contributes significantly in estimating the value of the outcome (Y). The results presented are based on the research questions presented in Chapter 1 and are necessarily presented here for review and emphasis.

Table 8.5.1
Summary of direct, indirect and total effects for structural models (N = 326)

Dependent Variable	Independent Variable	Standardised Estimates					
		Direct		Indirect		Total	
		Est.	*p*-value	Est.	*p*-value	Est.	*p*-value
TPS	TA_Insec	-.10	.03			-.10	.03
	PCAP	.72	.00			.72	.00
	CAPS			.60	.00	.60	.00
	MTOE			.42	.00	.42	.00
	PMTE			-.10	.02	-.10	.02
	TA-Conf			.18	.00	.18	.00
	PDP	.21	.00	.05	.00	.26	.00
	FPD			-.02	.10	-.02	.10
	SchLev			-.19	.00	-.19	.00
	SchType			-.05	.00	-.05	.00
	Age			.04	.01	.04	.01
	Gender			-.03	.01	-.03	.01
	YTM			.02	.15	.02	.15
	LevEd			.12	.00	.12	.00
PCAP	CAPS	.83	.00			.83	.00
	PMTE	-.14	.02			-.14	.02
	MTOE			.58	.00	.58	.00
	TA_Conf			.25	.00	.25	.00
	PDP			.07	.00	.07	.00
	YTM			.03	.06	.03	.06
	SchLev	-.11	.02	-.15	.00	-.26	.00
	SchType			-.06	.01	-.06	.01
	Gender			-.04	.01	-.04	.01
	LevEd			.12	.01	.12	.01

Table 8.5.1 (continued)

Dependent Variable	Independent Variable	Standardised Estimates					
		Direct		Indirect		Total	
		Est.	*p*-value	Est.	*p*-value	Est.	*p*-value
CAPS	MTOE	.70	.00			.70	.00
	LevEd	.17	.00			.17	.00
	TA_Conf			.43	.00	.43	.00
	SchLev			-.16	.00	-.16	.00
	Age			.04	.02	.04	.02
	SchType			-.03	.03	-.03	.03
MTOE	TA_Conf	.61	.00			.61	.00
	PDP			.18	.00	.18	.00
	SchLev	-.30	.00	.07	.04	-.23	.00
	YTM			.07	.04	.07	.04
	Gender			-.10	.00	-.10	.00
	LevEd			.03	.07	.03	.07
PMTE	TA_Conf	.82	.00			.82	.00
	SchType	.31	.00	-.04	.04	.27	.00
	LevEd	.22	.00	.04	.06	.26	.00
	PDP			.24	.00	.24	.00
	Age			.05	.02	.05	.02
	SchLev			.09	.04	.09	.04
	YTM			.09	.04	.09	.04
	Gender			-.13	.00	-.13	.00
TA_Conf	PDP	.30	.00			.30	.00
	SchLev	.11	.04			.11	.04
	Gender	-.16	.00			-.16	.00
	YTM	.12	.04			.12	.04
	LevEd			.05	.06	.05	.06
TA_Insec	FPD	.16	.01			.16	.01
	Age	-.15	.01			-.15	.01
	YTM			.05	.02	.05	.02
PDP	LevEd	.15	.04			.15	.04
	Age			.03	.09	.03	.09
	SchType			-.02	.11	-.02	.11
FPD	YTM	.28	.00			.28	.00
LE	SchType	-.16	.01			-.16	.01
	Age	.19	.00			.19	.00

Research question 2a: *What teacher-level characteristics (gender, age, level of education, years of teaching mathematics, school level, school type) influence teachers' attributes (professional development, teachers' attitudes and beliefs)?*

<u>Individual Characteristics and Teachers' Professional Development Program</u>

Examining Direct Effect

Frequency of attendance at professional development programs (FPD) refers to the regularity of teachers' attendance at programs, such as training courses and workshops, within a specified time frame. Only the variable *years of teaching mathematics* (YTM) has a direct effect on FPD with a standardised regression coefficient of β = 0.28, $p < 0.01$. This indicates that those teachers who have had longer experience in teaching mathematics find it necessary to participate more often in the professional development programs available for them. Whereas, teachers' *level of education* (LevEd) influence the kind of *professional development programs* (PDP) they participate in. With a standardised coefficient of β = 0.15, $p < 0.05$, the result shows that the higher the teachers' educational attainment, the more likely they are aware of the kind of training they get, whether mathematics-related or education-related. Gender and age do not show any significant effects with respect to both the frequency and type of professional development program. This indicates that attendance to and preference for certain professional development activities are not dependent on either age and gender.

<u>Individual Characteristics and Teachers' Attitudes</u>

This is carried out in order to answer Research Question (RQ) 2a: *What teacher-level factors influence teachers' attributes?*

This section seeks to answer the question what individual teacher characteristic influence teachers' attitudes. Individual teacher characteristics are gender, age, level of education, years of teaching experience, school level and school type. Teacher attitudes refer to both 'Confidence' and 'Insecurity.'

Direct Effects on Teacher's Attitudes - Confidence (TA_Conf)

Both the *school level* (SchLev, β = 0.11, $p < 0.05$) and *professional development program* (PDP, β = 0.30, $p < 0.01$) have shown positive direct effects on TA_Conf. These results demonstrate that those teachers in the secondary level and have attended professional development activities tend to be more confident in teaching mathematics. In addition, results also indicate a positive relationship between *years of teaching mathematics* (YTM) and confidence in teaching mathematics (TA_Conf) as recorded by the positive regression coefficient ($\beta = 0.12$, $p < 0.05$), while gender has a negative regression coefficient ($\beta = -0.16$, $p < 0.01$). Age does not have any impact on teachers' confidence. The results indicate that teachers with longer mathematics teaching experience have greater confidence with respect to mathematics and teaching mathematics. Whereas with gender, the results indicate that males have greater confidence on the subject and in teaching the subject of mathematics. Although age is highly correlated with years of teaching mathematics, it does not show any relationship with teachers' confidence, which indicates that confidence is not gained from age, but it comes from gaining experience with age.

Indirect Effects on Teacher Attitudes - Confidence (TA_Conf)

Among the four teachers' individual characteristics, teachers' highest *educational level* (LevEd) has an indirect effect on TA_Conf through PDP. The results indicate that attendance at a *professional development program* (PDP) seem to mediate the effect of educational level on TA_Conf. This states that the level of education that the teachers have obtained only has an effect on their confidence towards teaching mathematics when accompanied through their participation in professional development programs. This is especially true for those teachers who do not have mathematics as their field of specialisation, but are assigned to teach mathematics. However, indirect effect coefficient obtained is only $\beta_1 = 0.05$, and not significant, as well ($p > 0.05$). This coefficient likewise does not have practical significance since coefficient that is less than 0.10 indicates low practical significance (Cohen, 1988).

Hence, for purposes of presentation, indirect effects that are below 0.10 are no longer discussed.

Direct Effects on Teacher Attitudes – Insecurity

Age is directly impacting on *Insecurity* (TA_Insec) in teaching mathematics. The age standardised regression coefficient is $\beta = -0.15$, $p < 0.05$, indicating that younger teachers are more insecure in terms of teaching the subject. This is probably caused by lack of experience as younger teachers are those that are new in the field and therefore still lack necessary knowledge and skills which may be obtained through experience. The positive effect of FPD ($\beta = 0.16$, $p < 0.05$) on TA_Insec, however, imply that even if teachers would frequently attend to professional development programs, they would still feel insecure in teaching the subject. These are observed true to those teachers who are not mathematics education graduate but are asked to teach mathematics.

The indirect effect of YTM on TA_Insec via FPD is below 0.10 (indirect effect = 0.05, $p < 0.05$).

<u>Individual characteristics and Teachers Efficacy Beliefs</u>

Teacher efficacy beliefs is another teacher attribute that is considered in this study. This includes the two uncorrelated factors, the *personal mathematics teaching efficacy* (PMTE) and *mathematics teaching outcome expectancy* (MTOE). PMTE and MTOE each have two correlated dimensions, *perseverance* (PERSEV) and *self-perceived ability* (SPAbil) for PMTE and *teacher effectiveness* (EFC) and *teacher effort* (EFT) for MTOE.

Individual characteristics and PMTE

Direct Effects on PMTE

Among the teacher individual characteristics, *level of education* (LevEd) has a direct effect on PMTE with the standardised regression coefficient of $\beta = 0.22$, $p < 0.01$. The results indicate that the higher the level of education the teacher has attained, the more that the teachers persevere and perceive themselves as efficient in teaching mathematics. *School type* (SchType), likewise has direct positive effects ($\beta = 0.31$, $p < 0.01$) on PMTE, suggesting that teachers in the private schools believe that they have the ability to teach mathematics effectively. Being able to believe on one's capability and ability to teach also requires confidence. This is verified by the result as TA_Conf records a quite strong direct positive effect ($\beta = 0.82$, $p < 0.01$) on PMTE. This demonstrate that teachers who are confident in teaching mathematics are more likely to persevere and believe in their own capacity to teach the subject.

Indirect Effects on PMTE

Examination of the indirect effect of teacher's individual characteristic on the *personal mathematics teaching efficacy* (PMTE) beliefs, the results show that teacher's confidence in teaching mathematics TA_Conf mediates the effect of gender on PMTE. The indirect regression coefficient is $\beta_1 = -0.13$, and it is statistically significant. The indirect negative effect indicates that the males exhibit more confidence in teaching mathematics, hence they also display higher PMTE. This likewise implies that as males gain confidence towards the subject, their beliefs that they can deliver the instruction well is also increased. Similarly, TA_Conf has also mediated the effect of PDP on PMTE with a magnitude of $\beta_1 = 0.24$ ($p < 0.00$), signifying that teachers who attend to professional development programs are expected to be more confident in mathematics, which in turn leads to a positive belief about their efficacy in teaching mathematics.

<u>Individual characteristics and MTOE</u>

Direct Effects on MTOE

Teachers may believe that they have given their best effort to help students achieve better. This belief could have been influenced directly or indirectly by a number of factors. Results show that teacher's confidence in mathematics (TA_Conf) directly and positively impacts MTOE to a relatively high extent ($\beta = .61$, $p < .00$). This signifies that teachers who are more confident that they could teach mathematics would most likely believe that they had exerted effort enough to help their students achieve a better outcome. The results further show that teachers in the lower level (Grade 6) believe that the improvement in the performance of their students are due to their effectiveness and the effort they put in to be an effective mathematics teacher (SchLev → MTOE, $\beta = -.30$, $p < .01$).

Indirect Effects on MTOE

Gaining more experience in teaching mathematics through *professional development programs* (PDP), however, has an indirect effect on MTOE via TA_Conf ($\beta_1 = 0.18$, $p < 0.01$). This indicates that teachers' attendance to professional development programs help them gain confidence and their confidence helps them to believe that with their effort and effective teaching, students' learning outcomes are likely to be higher. Moreover, TA_Conf has, in the same way, mediated the effects of gender on MTOE ($\beta_1 = -0.10$, $p < 0.01$), similarly indicating that males who are more confident are likely to believe that students' improved performance is due to their effectiveness as mathematics teacher.

The succeeding presentations are attempts to answer the second research question referring to teacher-level factors: RQ2b: *Do individual teacher characteristics have an influence on classroom practices (teaching and assessment practices)?*

Individual teacher characteristics and Classroom Assessment Process

Classroom Assessment Process (CAPS) starts from assessment planning to assessment data utilisation and evaluation. In this study, five assessment processes are identified: (a) *assessment planning* (AP), (b) *assessment item preparation* (AIP), (c) *assessment administration and scoring* (AAS), (d) *reporting of scores and grading* (RSG), and (e) *assessment data utilisation and evaluation* (ADUE). Quite surprisingly, the results indicate that among the individual teacher characteristics variables, only the teachers' *level of education* (LevEd) is directly influencing CAPS with a standardised regression coefficient of $\beta = 0.17$, $p < 0.01$. This shows that teachers who have attained higher education levels are likely to follow the assessment process quite reasonably. Following the CAPS is a likely assurance of accurate assessment of students' performance.

It can also be gleaned from the results that CAPS is indirectly influenced by SchLev with a magnitude of $\beta_1 = -0.16$, $p < 0.01$. This indirect coefficient is the sum of two indirect path from SchLev to CAPS. However, one longer path yields an indirect path coefficient of less than 0.10 ($\beta_1 = 0.05$, $p = 0.05$) and as stated earlier, it will no longer be presented. The second indirect path of SchLev to CAPS is through MTOE, which yields an indirect coefficient of $\beta_1 = -0.21$, $p < 0.01$, indicating that teachers teaching in the lower level who likely believe of their effectiveness as mathematics teacher are also likely to follow the assessment process.

Individual Teacher characteristics and Preferred Classroom Assessment

Mathematics teachers may adhere to one or more of the four different types of classroom assessment: (a) *assessment as learning* (AASL), (b) *assessment to learning* (ATOL), (c) *assessment of learning* (AOFL), and (d) *assessment for learning* (AFORL). The results show SchLev both directly and indirectly influence teachers' preference of classroom assessment practice (PCAP). The results record a direct effect coefficient of $\beta = -0.11$, $p < 0.05$ on PCAP. The negative coefficient indicates that the teachers from elementary level are using more frequently any of these classroom assessment techniques.

The indirect regression coefficient ($\beta_1 = -0.15$, $p < 0.01$) from SchLev to PCAP is a combined coefficient of three different indirect paths, the highest of which is the path from SchLev to MTOE to CAPS then finally to PCAP. It has already been reported earlier that teachers in the lower level are likely to believe of their effectiveness as mathematics teacher and that this belief leads them to follow the classroom assessment process. These teachers, in turn, are more inclined to adhere to any of the classroom assessment techniques. In addition to SchLev, teachers' level of education (LevEd) is showing an indirect effect on PCAP through four different indirect paths, three of which are, however, not significant. The only significant indirect effect of LevEd on PCAP is through CAPS. Classroom assessment process mediates the effect of LevEd on teachers PCAP with a magnitude of $\beta_1 = .14$, $p < .01$. This indicates that teachers who attain a higher level of education and frequently employ classroom assessment processes are more likely to use any of the four assessment techniques.

Individual Teacher characteristics and Teaching Practices

Teaching Practices (TPS) are defined by the three dimensions, *structured* (STP), *student-oriented* (SOTP), and *enhanced-activities* (EATP). The results in Table 8.5.1 show teachers' individual characteristics which directly and indirectly influence their preferred teaching practice.

Direct Effects on TPS

Only three factors showed to have significant direct effects on teaching practices. With a regression coefficient of $\beta = 0.72$, $p < 0.01$, teachers' preference of assessment practice (PCAP) has indicated a positive direct effects on TPS, which implies that assessment practices should go hand-in-hand with the teaching practice. This result conforms with one of the purposes of assessment, which is to improve instruction (De Luca & Klinger, 2010; Schulman, 1996). The result also indicates that the assessment strategy which the teacher prefers to use will have an impact on his or her teaching practice. For instance, Ginsburg (2009) and Gao (2012) put forward that the use of formative assessment improves teaching strategies. The result also shows that professional development program (PDP) has positive direct effect ($\beta = 0.21$, $p < 0.01$) on teaching practices. This points out that the more the teacher participates or attends professional development programs, the more likely that their teaching practice will improve. This result is consistent with Guskey and Sparks (2004), but contradicts with what Jacob et al. (2017) have found in their study.

Moreover, teachers' feeling of insecurity (TA_Insec) has showed negative direct effect on TPS, which means that the lesser they feel insecure, the more that they are expected to improve their teaching practice.

Indirect Effects on TPS

Several factors have shown to have indirect influence on TPS, among them, years of teaching mathematics (YTM) and frequency of professional development (FPD) are found to be insignificant. Among the teacher-level characteristics, level of education (LevEd) shows positive significant indirect effect ($\beta_1 = 0.10$, $p < 0.01$) on TPS via PDP. School level (SchLev) has influenced TPS indirectly ($\beta_1 = -0.19$, $p < 0.01$) through teachers' preference of classroom assessment practice (PCAP). It can be observed that the indirect effect of both LevEd and SchLev on TPS have been mediated by PCAP. This goes to show that teachers teaching in the elementary school, and those who have acquired higher level of education tend to prefer an effective teaching practice when they likewise have practiced and adhered to appropriate assessment practices.

Teacher Attributes and Assessment Practices

Teacher attributes refer to the professional development programs, teacher attitudes and efficacy beliefs. This section seeks to answer RQ 2c: *How do teacher attributes affect classroom practices?*

Between the two latent variables measuring teachers' efficacy beliefs, PMTE, on one hand, directly affects PCAP. The standardised regression coefficient of $\beta = -0.14$, $p < 0.05$ indicates that teachers' preference for classroom assessment is explained by those teachers with low personal teaching efficacy beliefs. This could probably mean that those who do not believe in their own ability to teach are more likely to resort into using any of the assessment techniques. On the other hand, MTOE both directly influence CAPS ($\beta = 0.70$, $p < 0.01$) and indirectly on PCAP ($\beta_1 = 0.58$, $p < 0.01$) through CAPS. This high indirect coefficient is likely contributed by the fact that these three variables are all gearing towards improving students' performance through effective and appropriate assessment strategies. Correspondingly, MTOE highly explains classroom assessment process (CAPS) in the same way that CAPS also highly explains PCAP ($\beta = 0.83$, $p < 0.01$).

In addition to teacher beliefs, their attitudes towards mathematics have also influenced their assessment practices. Of the two measures of attitudes only TA_Conf have recorded significant indirect effects on both CAPS and PCAP. TA_Conf effect on CAPS is mediated by MTOE ($\beta_1 = 0.43$, $p < 0.01$). While its effect on PCAP is mediated by both MTOE and PMTE showing a total indirect effect of $\beta_1 = 0.25$, $p < 0.01$). This shows that confident teachers only likely to use appropriate assessment strategies when they believe in both their ability and effectiveness to teach.

Teacher attributes and Teaching Practices

It is surprising to know that among the variables which are hypothesised to have direct effects on teaching practices, only the PDP and TA_Insec are showing significant direct effects. While PDP is exhibiting a positive effect on TPS, TA_Insec is showing a negative effect. The positive effect of PDP ($\beta = 0.21$, $p < 0.01$) on TPS indicates that teachers' preference of teaching practice is directly influenced by the kind of professional development activities that the teachers have attended. The type of teaching practice that the teachers employ depends on the type of professional development programs that they choose to attend. Teacher Insecurity has a negative influence on TPS ($\beta = -0.10$, $p < 0.05$) indicating that those who are insecure towards mathematics and teaching mathematics are more likely to use any of the specified classroom teaching practices.

Both measures of self-efficacy beliefs, PMTE and MTOE show indirect effects on TPS. PMTE, on one hand, has an indirect effect on TPS through PCAP. Multiplying the standardised regression coefficients of PMTE to PCAP ($\beta = -0.14$, $p < 0.05$) and that of PCAP to TPS ($\beta = 0.72$, $p < 0.05$) gives an indirect effect of $\beta_1 = -0.10$, $p < 0.05$. This suggests that despite their low belief in their own capacity, teachers still tend to use appropriate assessment strategies and this likewise leads them to using teaching strategies that match with their assessment strategies. MTOE's indirect effect, on the other hand, is larger than that of PMTE. MTOE's influence on TPS is mediated by both CAPS and PCAP with a magnitude of $\beta_1 = 0.42$, $p < 0.01$. It can be observed that all significant indirect effects to TPS are mediated by CAPS and PCAP. This only shows that, in general, beliefs about one's ability and effort exerted lead to the likelihood of assessing students' performance appropriately and those who tend to adhere to a particular assessment strategy are likely to employ a corresponding teaching strategy.

Concurrent with the indirect effects of self-efficacy beliefs is the indirect effect of TA_Conf on TPS ($\beta_1 = 0.18$, $p < 0.01$). The effect is similarly mediated by MTOE, CAPS and PCAP.

<u>Assessment Practices and Teaching Practices</u>

This section addresses the last teacher-related research question is RQ2d: *How do assessment practices affect teaching practices?* This stemmed from the idea that assessment and teaching practices have inextricable relationships, that these two should always match together. It is important to note that three different models have been tried out (one that shows PCAP and TPS have reciprocal (two way) effects, the other that shows one-way effect from TPS to PCAP and the third one is the one-way effect from PCAP to TPS). Among the three, the third model (as shown in Figure 8.4.2.1) came out to have better fit. The other two models also reveal that the effect of TPS on PCAP is smaller as compared to the effect of PCAP on TPS. Specifically, the results show that teachers' preferred assessment practices (PCAP) are highly predictive of their teaching practices ($\beta = 0.72$, $p < 0.01$). This indicates that teachers choose their teaching practices that coincide with their preferred assessment practice.

8.6 Summary

This chapter presents the results of the teacher single-level structural equation modelling analysis. This analysis is carried out to examine the relationships between factors or variables and to investigate further the factors that influence teachers' teaching and assessment practices, collectively known as the classroom practices.

The results of the analysis are discussed and the final structural equation model is presented. The relationships examined seek to answer the research questions presented in Chapter 1.

2a. What individual-level characteristics (gender, age, years of teaching mathematics, school-type and school level) influence teachers' attributes (professional development program, teachers' attitudes and efficacy beliefs)?
2b. Do individual characteristics have influence on classroom practices namely, teaching and assessment practices?
2c. How do teachers' attributes influence classroom practices?
2d. How do assessment practices influence teaching practices?

Only three variables have been found to have direct influence, either positively or negatively, on teachers' teaching practices. These include: Insecurity, which negatively influence teaching practices; professional development program (PDP) and preferred classroom assessment practices (PCAP), both with positive influence on teaching practices. Personal mathematics teaching efficacy (PMTE) and school level (SchLev) both have negative direct effects on the preferred classroom assessment practices (PCAP), while classroom assessment process (CAPS) have positive effect on PCAP. Classroom assessment process (CAPS) is directly and positively influenced by mathematics teaching outcome expectancy (MTOE) and level of education. Mathematics teaching outcome expectancy (MTOE) is negatively influenced by school level (SchLev) and positively by teacher confidence (TA_Conf). Moreover, personal mathematics teaching efficacy (PMTE) is directly and positively influenced by school type (SchType), level of education (LevEd), and teacher confidence (TA_Conf). Teacher confidence are positively influenced by school level (SchLev), years of teaching mathematics (YTM), and professional development program (PDP) and negatively by gender. Age and frequency of professional development (FPD) have, respectively, negative and positive influence on teacher insecurity (TA_Insec). Furthermore, direct positive relationships, except for school type (SchType), are also shown on the following: LevEd on PDP, YTM on FPD and SchType and age on LevEd.

The results of the single-level structural equation modelling analyses are used as a guide for carrying out multilevel analysis using the hierarchical linear modelling (HLM) procedure. This study takes into consideration the hierarchical or nested nature of the data collected for this study. Hierarchical linear modelling and the results obtained using this procedure are discussed in a later chapter after the presentation of the school-level and student-level SEM analyses.

Chapter 9
School-level factors SEM Analysis

9.1 Introduction

This chapter presents the results of the structural equation modelling of the school-level factors. The same procedures and tests were done as that of the teacher-level factors in Chapter 8 using the same software. SEM analysis was performed based on the data from 146 school heads or principals of elementary and secondary public and private schools in Region XII, Philippines.

This chapter attempts to answer the research questions related to the school-level factors:

1. School-level factors

a. What school principal characteristics (age, gender, level of education, years of teaching experience and years as principal) and school characteristics (school level, school type, instruction time, class size) influence school principal attributes (beliefs about the nature of teaching and learning and management/leadership style) and school attributes (school climate and criteria for teacher appraisal)?

b. How do school principal attributes (management or leadership style, beliefs about the nature of mathematics and teaching) influence school attributes (school climate and criteria for teacher appraisal)?

9.2 Variables employed in the School-level Structural

9.2.1 Equation Modelling

The school single-level model includes the variables that were assumed to have influence on the school climate and have impacted on how teachers are appraised. Other variables believed to have contributed to how the school head has managed the affairs of the school, which in turn have impacted the teachers and the students, are presented in Table 9.2.1.

Table 9.2.1
Variables used in the School-level Structural Equation Modelling

Theoretical Dimensions	Latent variables	Manifest variables	Description
Individual Characteristics		Age Gender LevEd YrTch YrPrin	Age Gender Level of Education Years of Teaching Experience Years of experience as Principal
School Characteristics		SchLev SchType InsTime MathTime CLSize	School Level School Type Total Instruction Time Instruction time for Maths Class Size
School Principal Attributes	BANTL (Beliefs about the Nature of Teaching and Learning)	ConstBel DirInBel	Constructivist Belief Direct Instruction Belief
	MLSI (Management/ Leadership Style - Instructional)	MLSI_SG MLSI_IM MLSI_DSI	Manage School Goals Instructional Management Direct Supervision of Instruction
	MLSA (Management/ Leadership Style - Administrative)	MLSA_A MLSA_B	Accountable Management Bureaucratic Management
School Climate	SCFL (School Climate for Learning)	SCFL_TWM SCFL_Rel	Teacher Working Morale Relationships
Teacher Appraisal	TAC (Criteria for Teacher Appraisal)	TAC_LO TAC_TP	Learning Outcome Teaching Practice

Variables that are treated as manifest or observed are the individual characteristics (age, gender, level of education, years of teaching and years as principal), and school characteristics (school type, school level, class size and instruction time). Other variables with corresponding observed variables are treated as latent. These include beliefs in the nature of teaching and learning, management or leadership style, school climate for learning and criteria for teacher appraisal.

9.3 Test for Multicollinearity of Independent Variables

Since again, this analysis involves correlation between variables, it is necessary to first investigate for the existence of multicollinearity as it may tend to inflate the resulting path coefficients (Tabachnick & Fidell, 2013). Using the Tolerance and VIF values as indicators, the results are presented below in Table 9.3.1.

Table 9.3.1
Collinearity Statistics of the School-level Variables

Variables		Collinearity Statistics	
Dependent variable	Independent variable	Tolerance	VIF
TAC	SCFL	0.64	1.57
	MLSI	0.64	1.56
	SchType	0.84	1.20
	LevEd	0.92	1.08
SCFL	MLSI	0.79	1.27
	MLSA	0.77	1.30
	LevEd	0.97	1.03
MLSI	MLSA	0.94	1.06
	CLSize	0.76	1.31
	SchLev	0.73	1.38
	SchType	0.68	1.46
	MathTime	0.96	1.04
MLSA	BANTL	0.99	1.01
	Yrtch	0.91	1.10
	YrPrin	0.92	1.09
	SchLev	0.99	1.01
CLSize	SchLev	0.89	1.12
	SchType	0.89	1.12

Table 9.3.1 shows that none of the variables have less than 0.10 and greater than 10 of Tolerance and VIF values (Pallant, 2011), respectively, then the multicollinearity

assumption has not been violated. Thus, structural equation modelling can be carried out.

9.4 The Hypothesised Model

The hypothesised model is illustrated in Figure 9.4.1. The ellipses represent latent variables, and rectangles represent observed or manifest variables. The lines that connect the variables illustrate direct or indirect effects. The inner or structural model illustrates the hypothesised relationships between the latent variables (LV) and manifest variables (MV).

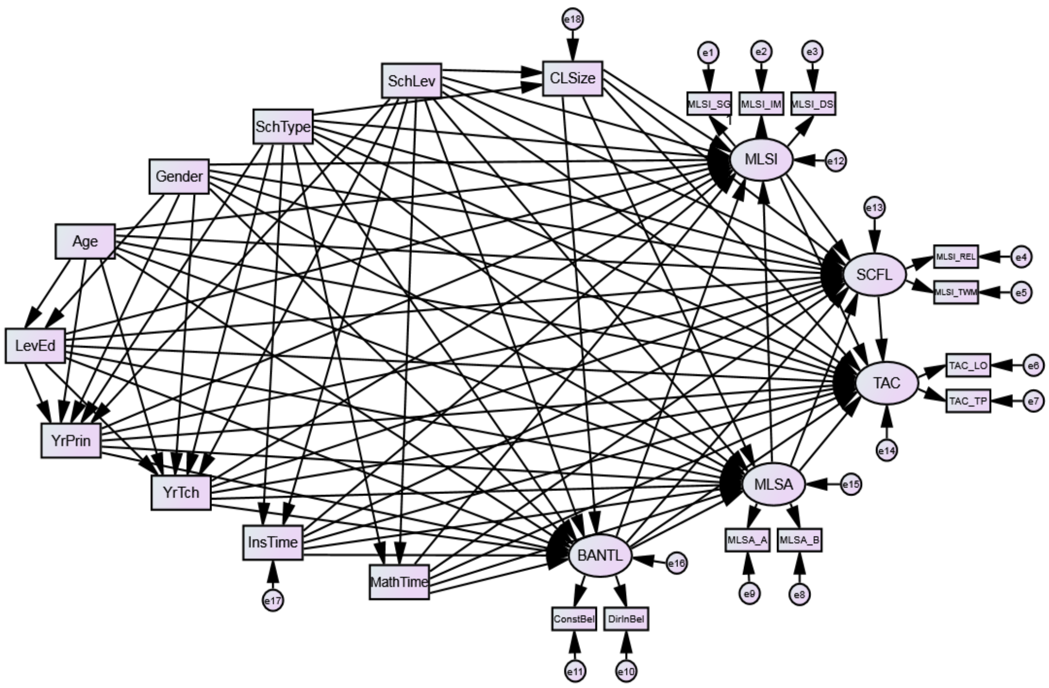


Figure 9.4.1 Hypothesised Principal Single-level Structural Equation Model.

The hypothesised model examined the predictors of school climate for learning and teacher appraisal. School climate for learning, on one hand, was a latent variable with two manifest variables (relationship and teacher working morale). Teacher appraisal criteria, on the other hand, has also two indicators (learning outcome and teaching practice). School principals, as managers of the school, need to establish a good working environment and provide opportunities for teachers in order for them to be motivated at work. They likewise need to establish and maintain good and collaborative relationships with the teachers. Teachers, however, also need to be monitored and evaluated to ensure effective delivery of instruction and assessment. In the model, it is hypothesised that when good relationships are built between the school principal and the teachers, these may influence teacher evaluation criteria.

In addition, school heads may be influenced by their previous experiences, beliefs and the kind of managers or leaders they are advocating. Other school and individual characteristics may also show causal relationships with the other variables as depicted in the hypothesised model.

9.5 Results of School-level SEM Analysis

In the subsequent presentations below, the measurement model and the structural model are discussed. Although more emphasis is given to the structural model as it displays the relationships between the MVs and LVs.

9.5.1 Measurement Model results

The measurement model illustrates the relationships between the latent variables and their respective manifest variables. Using the same criteria as in the previous chapter, a factor loading of .40 and above is considered acceptable.

School climate for learning as a construct is reflected by two manifest variables, *teacher working morale* (TWM) and *relationships* (REL). The factor loadings (0.82 and 0.76, respectively) of these manifest variables are way above the acceptable level indicating that they substantially reflect the construct. The two manifest variables of the *teacher appraisal criteria* (TAC) also yield acceptable factor loadings (TP=0.87, LO=0.79). Consistently, the three factors of *instructional management style* (MLSI) also displays good fit (SG=0.74, IM=0.78 and DSI=0.89). Moreover, the two manifest variables of *administrative management style* (MLSA), *accountable* and *bureaucratic* have loadings of 0.78 and 0.81, respectively. Furthermore, *beliefs about the nature of teaching and learning*'s (BANTL) *constructivist belief* and *direct instruction belief* yield 0.74 and 0.72 factor loading values, respectively. These show that all the manifest variables have adequately reflected their corresponding latent variables.

9.5.2 Structural Model results

After incorporating in the model the school principals' individual characteristics (age, gender, level of education, years of teaching experience and years as principal) and school characteristics (school type, school level, instruction time and class size), the patterns of relationships between and among these manifest variables and latent variables (*beliefs about the nature of teaching and learning* - BANTL, *administrative management style* - MLSA, *instructional management style* - MLSI, *school climate for learning* - SCFL and *teacher appraisal criteria* - TAC) have been examined. The results of which are presented in Figure 9.5.2. It is important to note that the focus of this section is the causal relationships between the variables in the structural models.

The resulting values reported are the standardised regression coefficients (β) which indicates the strength of the relationship. The relationships and regression coefficients that appear in the diagram are all significant at 0.05 level. This means that the predictor contributes significantly in estimating the value of the outcome. The final structural model, shown in Figure 9.5.1, fit the data well with $\chi^2 = 800.121$, $p < 0.05$, CFI = 0.96, TLI = 0.96, RMSEA = 0.04, and SRMR = 0.06.

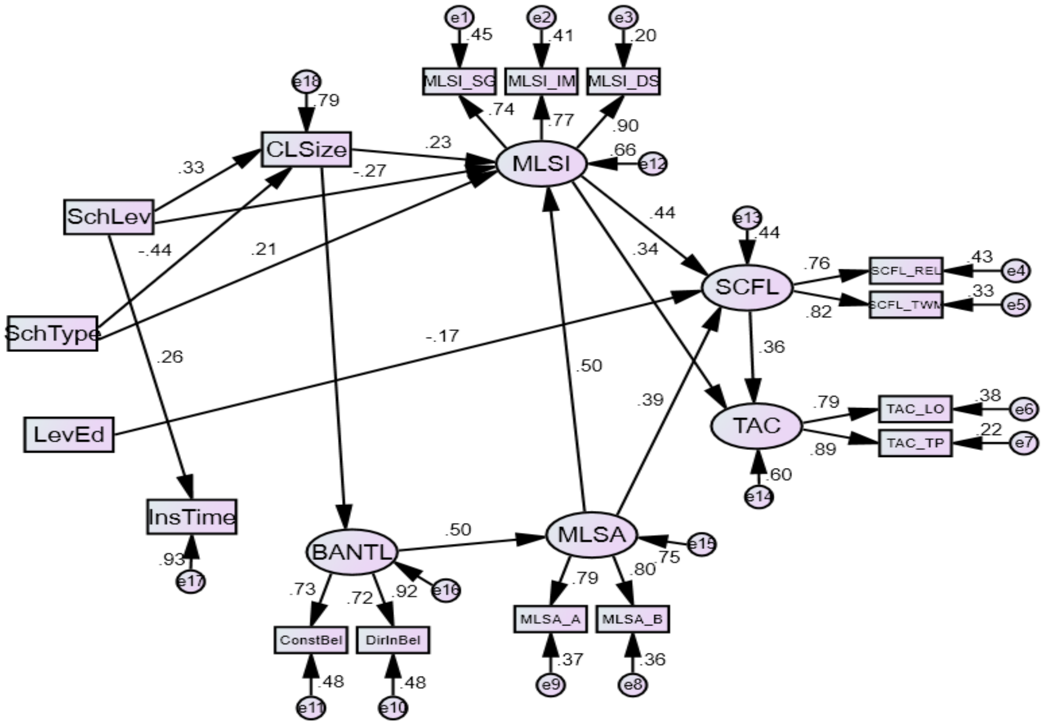


Figure 9.5.1 Final Model of School Single-Level Path.

Model Estimation

To be able to have a better understanding of the diagram, a closer look at the coefficients are presented here. The direct, indirect and total effects and their corresponding *p*-value are presented in Table 9.5.1. The estimates are presented and interpreted based on the research questions presented earlier. For a more concise presentation, indirect effects that are less than 0.10 are no longer discussed.

School Principals' Individual characteristics and School principal attributes

This section presents the answer to research question 1a. Specifically, this looks at the school principal characteristics that have significantly influenced the *beliefs about the nature of teaching and learning* (BANTL), *management/leadership style*, *school climate for learning* (SCFL) and *teacher appraisal criteria* (TAC). School principal characteristics include age, gender, level of education (LevEd), years of teaching experience (YrTch) and years as principal (YrPrin).

Management/leadership styles refer to both the administrative (MLSA) and instructional (MLSI) management style.

Table 9.5.1

Summary of direct, indirect and total effects for structural models

Dependent Variable	Independent Variable	Standardised Estimates					
		Direct		Indirect		Total	
		Est.	*p*-value	Est.	*p*-value	Est.	*p*-value
TAC	SCFL	.36	.01			.36	.01
	MLSI	.34	.01	.16	.03	.50	.00
	MLSA			.39	.00	.39	.09
	BANTL			.19	.00	.19	.00
	CLSize			.17	.00	.17	.00
	LevEd			-.06	.10	-.06	.10
	SchLev			-.08	.10	-.08	.10
	SchType			.03	.55	.03	.55
SCFL	MLSI	.44	.00			.44	.00
	MLSA	.39	.00	.22	.00	.61	.00
	BANTL			.30	.00	.30	.00
	LevEd	-.17	.02			-.17	.02
	CLSize			.19	.00	.19	.00
	SchLev			-.06	.23	-.06	.23
	SchType			.01	.87	.01	.87
MLSI	MLSA	.50	.00			.50	.50
	BANTL			.25	.00	.25	.00
	CLSize	.23	.02			.23	.02
	SchLev	-.27	.00	.10	.02	-.17	.05
	SchType	.21	.03	-.13	.01	.08	.42
MLSA	BANTL	.50	.00			.50	.00
	CLSize			.14	.02	.14	.02
BANTL	CLSize	.28	.01			.28	.01
	SchLev			.09	.03	.09	.03
	SchType			-.13	.02	-.13	.02
CLSize	SchLev	.33	.00			.33	.00
	SchType	-.44	.00			-.44	.00
InsTime	SchLev	.26	.00			.26	.00

Direct and Indirect Effects on Principal's attributes

It is interesting to note that among the five school principal characteristics, none has shown any significant effect on any of the school principal attributes (BANTL, MLSA, MLSI).

Individual characteristics and school attributes

Direct and Indirect Effects on School climate and teacher appraisal

The results show a negative relationship between *level of education* (LevEd) and *school climate for learning* (SCFL) as indicated by its regression coefficient (β = -0.17, $p < 0.05$). Level of education is the only individual school principal characteristics that show direct impact on school climate and indirectly on *teacher appraisal criteria* (TAC). The negative path coefficient, however, indicates that as the school principals' level of education is low, they are more likely to create a better school climate for learning, which in turn increases teacher's working morale and relationships. Before the school principals have reached their position, they were first a teacher and this gives them the understanding on how important it is to boost the morale of the teachers. The principals therefore don't need to have achieved a high level of education in order to figure out what the teacher needs.

School-level characteristics and School principal attributes

This section presents the results on what school-level characteristics directly or indirectly affect the school attributes mentioned earlier. School-level characteristics refer to the school type, school level, instruction time and class size.

Direct Effects on Principal's management/leadership style and Beliefs

Among the school-level characteristics, only the instruction time does not show any effect on school attributes. The three other characteristics are directly impacting the *instructional management style* (MLSI) of the school principal. Both the *class size* (CLSize) and the *school type* (SchType) have positive path coefficients of $\beta = 0.23$, $p < 0.05$ and $\beta = 0.21$, $p < 0.05$, respectively. These indicate that, on one hand, the larger the class size the more likely it is that the school principal is taking his or her role in supervising teachers and improving the curriculum and instruction. For school type, on the other hand, principals in private schools are more expected to carry out its role as an instructional leader. In addition, school level (SchLev) has directly but negatively affecting MLSI with $\beta = -0.27$, $p < 0.05$, indicating that those principals in the elementary level tend to become instructional leaders. Moreover, class size positively and significantly ($\beta = 0.28$, $p < 0.05$) impacts principal's *beliefs on the nature of teaching and learning* (BANTL). This implies that the larger the size of the class, the stronger the belief of the principal is, that teachers should facilitate student inquiry and that quiet classrooms are needed for effective learning. This implies further that the principal's belief, which may in turn influence his or her leadership style, can vary depending on the number of students each classroom has. In the Philippines, for example, public schools normally have larger class sizes compared with private schools, which means that school principals may focus more on finding ways of making learning effective in classrooms having a large class size.

Indirect Effects on Principal's management/leadership style and Beliefs

Other school-level characteristics have likewise indicated an indirect or mediated effect on school principal attributes, such as the management style and the beliefs. For instance, *school level* (SchLev) and *school type* (SchType) have both indirect effects on *instructional management style* (MLSI) and *beliefs on the nature of teaching and learning* (BANTL) through *class size* (CLSize) with calculated indirect path coefficients of $\beta_1 = 0.10$, $p < 0.05$ and $\beta_1 = -0.13$, $p < 0.05$, respectively for MLSI and $\beta_1 = 0.09$, $p < 0.05$ and $\beta_1 = -0.13$, $p < 0.05$, respectively for BANTL. These suggest that the effect of school level and school type on MLSI and BANTL is mediated by class size. These imply that school principals of public high schools may tend to become an instructional leader when class sizes are large. Likewise, school level and school type may influence school principals' beliefs when class sizes are large. Furthermore, class size also illustrates an indirect effect ($\beta_1 = 0.10$, $p < 0.05$) on the administrative management style of the principal through their beliefs on the nature of teaching and learning. This implies that the magnitude of the effect of large class size on school principals' administrative role may be affected by their belief on the nature of teaching and learning.

Direct and Indirect Effects on School climate and teacher appraisal

Interestingly, none of the school-level characteristics have direct impact on the school climate and teacher appraisal criteria. But, three of the school characteristics (class size, school level and school type) have shown indirect effects on both. It is also remarkable to note that the effects of *class size*, *school level*, and *school type*, on both school climate and teacher appraisal are all mediated by instructional management style of the school principal. Though the mediated effects are quite low, this may, however, be enough to explain that the extent of the influence of large class size in elementary private schools may influence school principal's instructional management style, which may in turn influence school climate and teacher appraisal policy.

<u>School principal attributes and School climate and Teacher appraisal</u>

Research question1b, *How do school principal attributes (management/leadership style, beliefs about the nature of mathematics and teaching) influence school climate and criteria for teacher appraisal?* is being addressed in this section.

Direct Effects on School climate and teacher appraisal

School Climate for learning (SCFL) refers to the opportunities provided for teachers to grow professionally and to build relationships with other stakeholders in the school. The structural equation model shows that SCFL are being effected directly by *administrative management style* (MLSA, $\beta = 0.39$, $p < 0.01$) and *instructional management style* (MLSI, $\beta = 0.44$, $p < 0.01$). SCFL likewise directly impacts *teacher appraisal criteria* (TAC) with a path coefficient of $\beta = 0.36$, $p < 0.05$. Only MLSI, however, has a direct effect on TAC with a standardised coefficient of $\beta = 0.34$, $p < 0.05$. This means that whether the principal is an administrative or instructional leader he/she could highly consider providing the teachers a better school environment, where students, teachers, parents and other stakeholders are working harmoniously towards the satisfaction of everyone. And better school climate correlates positively, as well, with the criteria for teacher appraisal.

Indirect Effects on School climate and teacher appraisal

While there are direct paths leading to both SCFL and TAC, there are also variables that partially explain the effect of another variable. For example, MLSI's effect on TAC is partially mediated by SCFL ($\beta_1= 0.16$, $p < 0.05$). Similarly, SCFL has also mediated the effect of MLSA on TAC ($\beta_1= 0.39$, $p < 0.01$). *Beliefs on the nature of* *teaching and learning* (BANTL) has only been mediated by MLSA on SCFL (β_1= 0.30, $p < 0.01$). This means that school principal's leadership style could somehow influence the criteria for teacher appraisal only when school climate has also been established well. Also, school principal's belief on the nature of teaching and learning could only partially influence school climate through administrative management style.

9.6 Summary

This single-level path analysis was carried out to examine the relationships between school-level factors and to investigate further the factors that influence or affect the school climate for learning and teacher appraisal policy.

It can be gleaned that only *school climate for learning* (SCFL, +) and *instructional management style* (MLSI, +) have direct effects on *teacher appraisal criteria* (TAC). Similarly, SCFL have only been directly affected by both MLSI (+) and MLSA (+) and LevEd (-). BANTL have only indirectly effected SCFL through MLSA. For the school-level characteristics, none has directly influenced SCFL and TAC. Their effects on both the SCFL and TAC are partially mediated by MLSI. Only the CLSize (+), SchLev (-) and SchType (-) have direct effects on MLSI. Interestingly, only the LevEd (-) has shown direct effects on SCFL among the school principal's characteristics.

The results of this single-level structural equation model analyses were used as a guide for carrying out multilevel analysis using the hierarchical linear modelling (HLM) technique.

Chapter 10
Factors affecting Mathematics Achievement: Student-level SEM Analysis

10.1 Introduction

This chapter examines the relationships between and among the student-level factors using the structural equation modelling (SEM). Mplus 7 by Muthén and Muthén (1998-2012) is likewise used in the analyses. Just like the previous SEM chapters, the necessary underlying conditions before SEM is carried out have been examined first.

Likewise, this chapter attempts to answer the research questions referring to the student-level factors:

a. What student-level factors (gender, parents' educational level and employment status, ethnic group) influence students' attributes (beliefs about and attitudes towards mathematics)?

b. How do student-level factors and attributes influence mathematics achievement?

10.2 Variables employed in the Teacher-level Structural

10.2.1 Equation Modelling

The student single level model includes the variables that were assumed to have influenced their achievement in mathematics. Student level characteristics and their attitudes and beliefs about mathematics are posited to have relationships with their achievement. Specific names for each of the variables included in the model are presented in Table 10.2.1.

Table 10.2.1
Variables used in the Student-level path Analysis

Theoretical Dimensions	Latent variables	Manifest variables	Description
Presage			
Individual Characteristics		Age	Age
		Gender	Gender
		SchLev	School/grade level
		E	Ethnic group
		MED	Mother's level of education
		FED	Father's level of education
		MJob	Mother's Job
		FJob	Father's Job
Home Possession		WCAL	With Calculator
		WPERCOM	With Personal Computer
		WSTDYDESK	With Study Desk
		WDICT	With Dictionary
		WBOOKS	With Books
		WINTCON	With Internet Connection
		WGAMECONS	With Game Console
		WMOBPHON	With Mobile Phone
Process			
Student Attributes	CLM (Confidence in Learning Mathematics)	Conf	Confident
		NotCon	Not confident
	PTA (Perception on Teachers Attitudes)	PosPTA	Positive perception on teachers attitude
		NegPTA	Negative perception on teachers attitude
	UOM (Usefulness of Mathematics)	Usefl	Mathematics is useful
		NotUse	Mathematics is not useful
	MAS (Mathematics Anxiety)	Ease	Mathematics is easy
		Anx	Anxiety towards mathematics
	BAM (Beliefs about Mathematics)	RelBel	Relational Belief
		InsBel	Instrumental Belief
Product			
Student Achievement	MACH (Achievement in Mathematics)		

The manifest variables or the variates considered in this section are students' individual characteristics (age, gender, grade level, ethnic group, parents highest level of education, parents job and home possessions), student attributes, which include the attitudes towards mathematics (CLM, PTA, UOM, MAS) and beliefs about mathematics (BAM) have corresponding observed variables are treated as latent. Each of the attitude and beliefs latent variables have two equivalent observed variables in which one is an opposing attribute over the other. For instance, confidence in learning mathematics (CLM) has its two indicators as 'confident' and 'not confident.'

10.3 Test for multicollinearity of Independent Variables

Since there are several variables involved in the analyses, it is therefore possible that multicollinearity could exist. Hence, multicollinearity test is first carried out to avoid inaccurate interpretation of the results. The results are shown in Table 10.3.1 and are interpreted based on the Tolerance and VIF values.

Table 10.3.1
Collinearity Statistics of the Teacher-level Variables

Variables		Collinearity Statistics	
Dependent variable	Independent variable	Tolerance	VIF
MACH	CLM	0.63	1.59
	UOM	0.59	1.71
	PTA	0.58	1.73
	BAM	0.76	1.32
MAS	CLM	0.88	1.14
	BAM	0.89	1.13
	Gender	0.99	1.01
	FED	0.85	1.17
UOM	BAM	0.88	1.13
	PTA	0.88	1.14
	Gender	0.98	1.02
	E1	0.99	1.01
PTA	BAM	1.00	1.00
	Age	1.00	1.00
	E1	0.92	1.08
	E2	0.92	1.09

Table 10.3.1 (continued)

Variables		Collinearity Statistics	
Dependent variable	Independent variable	Tolerance	VIF
BAM	Gender	1.00	1.00
	E2	1.00	1.00
	FED	0.87	1.15
	WCAL	0.96	1.04
	WPERCOMP	0.87	1.16
CLM	PTA	0.99	1.01
	SchLev	0.98	1.02
	Gender	0.99	1.01
	WCAL	0.98	1.02

Table 10.3.1 shows that the Tolerance and VIF values have not reached beyond their respective threshold levels (T > .10, VIF < 10) indicating no violation of the multicollinearity assumption. Hence, SEM analysis is permissible.

These variables are placed in the model that illustrates the hypothesised relationships between the manifest and latent variables. The hypothesised model is shown in Figure 10.4.1.

10.4 The Hypothesised Model

The hypothesised model illustrated in Figure 10.4.1 depicts the theoretical relationships between the latent variables (LV) and manifest variables (MV). It shows both the measurement and structural models.

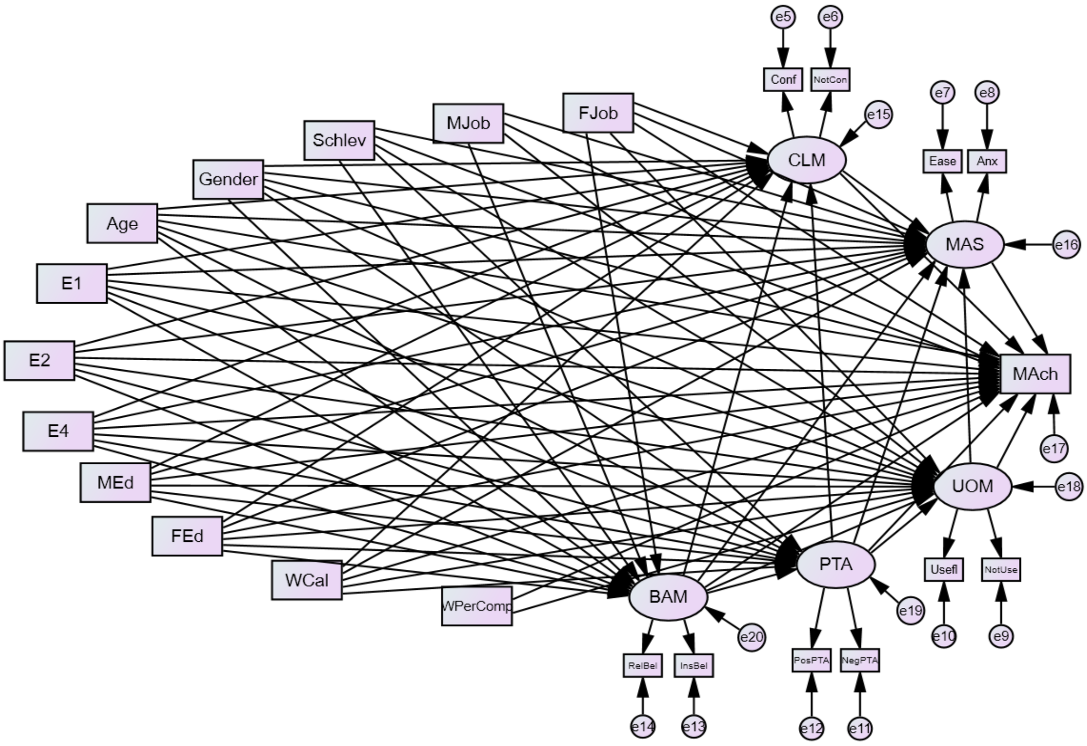


Figure 10.4.1 Hypothesised Student-Level Path Model.

The hypothesised model examined the predictors of students' achievements in mathematics. There are latent variables with two manifest variables each that are part of the model. Confidence in learning mathematics is a latent variable with positive (Conf) and negative (NotCon) confidence as observed variables; students' perception of teacher attitudes also has two indicators, PosPTA and NegPTA; usefulness of mathematics can also be conceived as either positive (Useful) or negative (NotUseful); whereas, students' anxiety towards mathematics also has two indicators (Ease and Anxiety). It is hypothesised that students' individual characteristics, their attitudes towards mathematics and beliefs about mathematics are affecting their achievement in mathematics.

In addition, the hypothesised model shows the causal relationships of the variables involved. It clearly depicts which variables are influencing the other.

After carrying out the analyses using Mplus 7, all estimates obtained are standardised path coefficients (β) which indicate the strength of relationships between the variables involved. The *t*-value is used to indicate the significance of the effect of the predictor variable to the outcome variable at .05 level. The final model is illustrated in Figure 10.5.1

10.5 Results of Student-level Path Analysis

In this section, the measurement models are discussed briefly. More emphasis is given to the structural models as they display the causal relationships.

10.5.1 Measurement Model results

Using the same threshold value, a factor loading of 0.40 and above is considered acceptable. It is important to note, yet again, that raw scores have been transformed into Rasch scores making the measurement model a first-order factor model, instead of its hierarchical CFA model presented in the previous chapter.

The measurement model consists of the models from the four measures of student attitudes and their beliefs about mathematics. Student attitudes are measured by their *confidence in learning mathematics* (CLM), *perception on teacher attitudes* (PTA), perception on the *usefulness of mathematics* (UOM) and *anxiety towards mathematics* (MAS). Each is considered as latent variable with two manifest variables.

For CLM, both indicators *Confident* (Conf) and *Not confident* (NotCon) yield acceptable factor loadings of 0.84 and 0.45, respectively. Perception of teacher attitudes, *positive perception on teacher attitude* (PosPTA) and *negative perception on teachers' attitude* (NegPTA) each obtained factor loadings of 0.79 and 0.25, correspondingly. Additionally, perception on usefulness of mathematics yield a factor loading of 0.91 for *Useful* (Usefl) and 0.54 for *Not Useful* (NotUse). Moreover, mathematics anxiety's indicators record factor loadings of 0.72 for *Ease* and 0.50 for *Anxiety* (Anx). Furthermore, the two indicators of *beliefs about mathematics* (BAM) give factor loadings of 0.58 and 0.86 for *relational belief* (RelBel) and *instrumental belief* (InsBel), respectively.

10.5.2 Structural Models Results

Students' achievement in Mathematics, which is the outcome measure of the student-level factors are obtained from the students' Mathematics score in the National Achievement Test. The patterns of relationships between the students' individual characteristics (gender, age, grade level, ethnic group, parents' education, parents job and possessions at home), students' attributes (attitudes towards mathematics and beliefs about mathematics) and students' achievement in mathematics are examined.

Below are the final path models which resulted after doing model trimming and achieving good model fit.

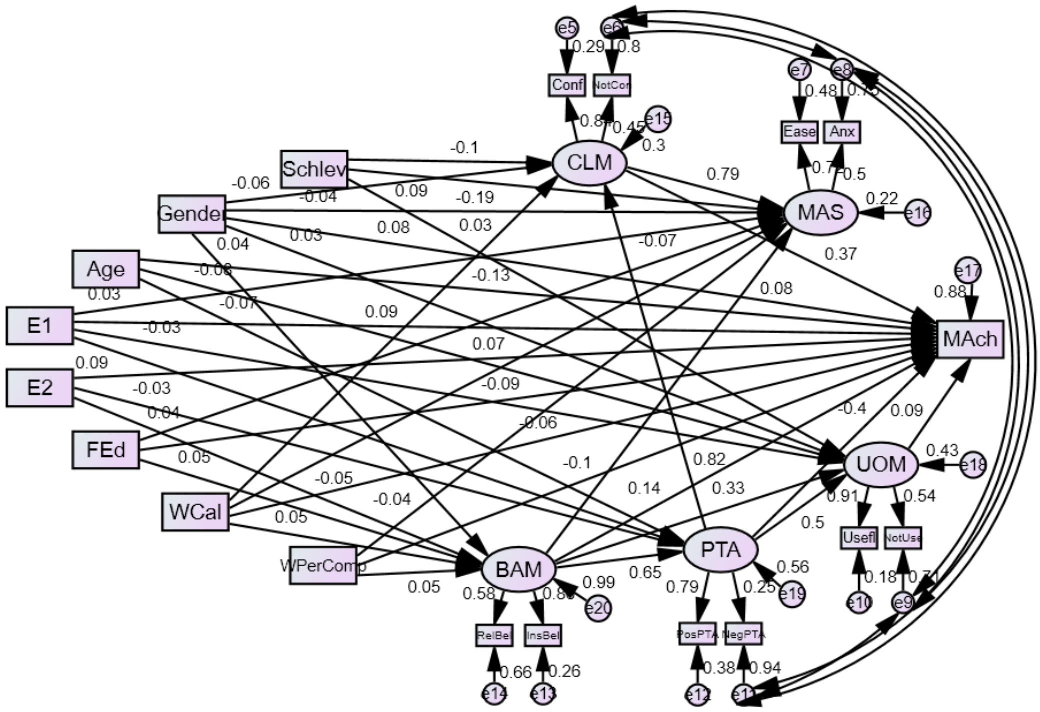


Figure 10.5.1 Final Structural equation Model: Student Single-level Model.

The final structural model fit the data relatively well with $\chi^2 = 1275.895$, $p < 0.05$, CFI = 0.95, TLI = 0.92, RMSEA = 0.05, SRMR = 0.03.

The causal relationships between the variables in the structural models are subsequently discussed using the direct, indirect and total effects results, which are presented in Table 10.5.1. It is important to note that although the direct path coefficients are relatively small, they appear to be significant because of the large sample size. Indirect effects that are below 0.10 are, however, not discussed as they no longer bear practical significance.

Table 10.5.1

Summary of direct, indirect and total effects for inner models

Dependent Variable	Independent Variable	Standardised Estimates					
		Direct		Indirect		Total	
		Est.	*p*-value	Est.	*p*-value	Est.	*p*-value
MAch	UOM	.09	.01			.09	.01
	CLM	.37	.00			.37	.00
	PTA	-.40	.00	.34	.00	-.05	.09
	BAM	.14	.00	-.01	.76	.14	.00
	SchLev			-.03	.00	-.03	.00
	Gender	.08	.00	-.01	.03	.07	.00
	Age	-.13	.00	-.00	.47	-.13	.00
	E1	.09	.00	-.01	.03	.08	.00
	E2	.07	.00	.01	.00	.08	.00
	FED	-.09	.00	.01	.00	-.08	.00
	WCal	-.06	.00	.02	.00	-.05	.00
	WPerComp	-.10	.00	.01	.00	-.09	.00
MAS	CLM	.79	.00			.79	.00
	BAM	.08	.00			.08	.00
	SchLev	-.19	.00	-.08	.00	-.27	.00
	Gender	-.04	.00	-.02	.04	-.07	.00
	Age			-.05	.00	-.05	.00
	E1	.03	.01	.06	.00	.09	.00
	E2			.00	.69	.00	.69
	FED	-.07	.00	.03	.00	-.04	.01
	WCal	-.05	.00	.05	.00	-.00	.89
	WPerComp	-.04	.00	.02	.00	-.01	.33
UOM	PTA	.50	.00				
	BAM	.33	.00	.32	.00	.65	.00
	SchLev	.09	.00				
	Gender	.03	.02	.03	.00	.05	.00
	Age	-.08	.00	-.04	.00	-.11	.00
	E1	-.03	.00	.05	.00	.01	.25
	E2			.02	.16	.02	.16
	FED			.03	.00	.03	.00
	WCal			.03	.00	.03	.00
	WPerComp			.03	.00	.03	.00
CLM	PTA	.82	.00			.82	.00
	BAM			.54	.00	.54	.00
	SchLev	-.10	.00			-.10	.00
	Gender	-.06	.00	.02	.00	-.04	.01
	Age			-.06	.00	-.06	.00
	E1			.08	.00	.08	.00
	E2			.00	.96	.00	.96
	FED			.03	.00	.03	.00
	WCal	.03	.01	.03	.00	.06	.00
	WPerComp			.03	.00	.03	.00

Table 10.5.1 (continued)

Dependent Variable	Independent Variable	Standardised Estimates					
		Direct		Indirect		Total	
		Est.	*p*-value	Est.	*p*-value	Est.	*p*-value
PTA	BAM	.65	.00			.65	.00
	Gender			.03	.00	.03	.00
	Age	-.07	.00				
	E1	.09	.00				
	E2	-.03	.04	.03	.00	.00	.96
	FED			.03	.00	.03	.00
	WCal			.03	.00	.03	.00
	WPerComp			.03	.00	.03	.00
BAM	Gender	.04	.00				
	E2	.04	.00				
	FED	.05	.00				
	WCal	.05	.00				
	WPerComp	.05	.00				

Model Estimation

As mentioned earlier, the values that appear along the path lines, indicating direct effects are standardised significant path coefficients (*β*). The indirect effects are products of the path coefficients between the predictor and mediating variables and between the mediating and outcome variables. The results are presented based on the research questions presented earlier.

<u>Individual characteristics and students' attitudes and beliefs about mathematics</u>

This section presents the students individual characteristics that directly and/or indirectly influence their attitudes and beliefs about mathematics.

Direct Effects on Attitudes and Beliefs about Mathematics

Among the individual level characteristics only the *school level* (SchLev), Gender, Age, *ethnic group 1* (E1), *ethnic group 2* (E2), *father's highest level of education* (FED) are showing direct effects on students' attitudes and beliefs about mathematics. Additionally, only those with calculators (WCAL) and personal computers (WPERCOM) at home have direct effects on attitudes and beliefs, although very small. *School level* (Schlev) has a negative effect on both *mathematics anxiety* (MAS, β = -0.19, $p < 0.01$) and *confidence in learning mathematics* (CLM, β = -0.10, $p < 0.01$) and positive effect on usefulness of mathematics (UOM, β = 0.09, $p < 0.01$). These estimates indicate that students at the elementary level are experiencing anxiety more than the students at the secondary level, this could probably be caused by their prior experience in the mathematics classroom. Elementary pupils are likewise less confident about learning mathematics.

Interestingly, gender has direct effects on all, except the PTA. It is negatively related to both MAS (β = -0.04, $p < 0.01$) and CLM (β = -0.06, $p < 0.01$), indicating that males are more anxious and therefore less confident in learning mathematics. Gender's positive effects on UOM (β = 0.03, $p < 0.05$) and BAM (β = 0.04, $p < 0.05$) suggest that females conceive mathematics as a useful subject compared to the males, hence, females have likewise more positive belief about mathematics.

The effect, however, of age (β = -0.08, $p < 0.05$) on UOM is contradicting to the effect of school level on UOM. School level and age may be strongly correlated, since students at the lower level are most likely to be younger. There are, however, cases when students have delayed their education, thus deviating from the normal or conventional school age. In the previous paragraph, it was reported that secondary students tend to see mathematics useful more than the elementary pupils. However, with age, it shows that the younger the students are, the more that they see mathematics useful to other subjects and in daily lives. These younger students may refer to the elementary pupils. In addition, age also has negative effect on perception of teacher attitudes (PTA, β = -0.07, $p < 0.01$). This could mean that younger students perceived that their teachers have encouraged them to do well in mathematics.

Generally, the students were grouped into four ethnic affiliations (E1, E2, E3, E4) where E3 was made as the dummy variable. It can be gleaned from the model that E1 and E2 have impacted PTA conversely. E1 has positive path coefficient (β = 0.09, $p < 0.01$) towards PTA, which means that students who belong to E1 have positive perception on teacher attitude compared to those who belong to E3. Conversely, E2 records a negative path coefficient (β = -0.03, $p < 0.05$) for PTA, signifying that students in E2 group have a more negative perception on teacher attitude over those in E3 group.

It is also remarkable to note that among the parents-related variables, only the fathers' education level (FED) has significantly connected to *mathematics anxiety* (MAS) and *beliefs about mathematics* (BAM). The results display, on one hand, that students whose fathers' educational level are low tend to be more anxious towards mathematics as indicated by its negative path coefficient of β = -0.07, $p < 0.01$. On the other hand, those students whose fathers have finished higher educational level tend to have positive beliefs about mathematics with β = 0.05, $p < 0.01$. Mathematics has been, for many years, believed to be a male thing, although recent research studies have already shown contradicting results.

Of the students' possessions at home, only owning calculator and personal computer have direct effects on CLM, MAS and BAM. Probably because these things are more likely to be useful in improving performances in mathematics than the other objects such as dictionary, study desks, books and others. Results suggest that students without calculators (β = -0.05, $p < 0.01$) tend to be more anxious about mathematics. However, those who own calculators have confidence in learning mathematics (β = 0.03, $p < 0.05$) and tend to have more positive beliefs about mathematics (β = 0.05, $p < 0.01$). Similarly, owning personal computers at home also has a positive effect on BAM (β = 0.05, $p < 0.01$). But, having no personal computer at home could contribute to student anxiety (β = -0.04, $p < 0.01$).

One indicator of student attitude may also be influenced directly by another indicator. For instance, CLM has positive influence (β = 0.79, $p < 0.01$) on MAS, suggesting that students with confidence in learning mathematics tend to find mathematics easier. Additionally, positive beliefs about mathematics (β = 0.08, $p < 0.01$) likewise make students learn mathematics with ease. *Perception on teacher attitude* has also drawn a positive path (PTA, β = 0.50, $p < 0.01$) towards *usefulness of mathematics* (UOM), the same with *beliefs about mathematics* (BAM, β = 0.33, $p < 0.01$). These results signified that students who perceived that their teachers have shown positive attitudes towards them likewise perceived mathematics as a useful subject. They also tend to perceive mathematics as useful in their daily lives when students have developed positive beliefs about mathematics. Positive perception on teachers attitudes also leads to confidence in learning mathematics as reflected by the positive path coefficient of β = 0.82, $p < 0.01$.

Indirect Effects on Attitudes and Beliefs about Mathematics

Although students’ individual characteristics have shown indirect effects on attitudes and beliefs about mathematics, they are, however, below 0.10. Hence, as mentioned, they are no longer discussed here. The model, however, shows indirect effect of BAM on CLM through PTA. The indirect effect obtained is $\beta_1 = 0.54$, $p < 0.01$, which suggest that when students have positive beliefs about mathematics, this will lead to positive perception on teachers' attitudes towards them and having positive perception about how their teachers are helping them lead to the development of confidence in learning mathematics. While BAM has shown direct effect to UOM, its effect has also been partially mediated by PTA with a coefficient of $\beta_1 = 0.32$, $p < 0.01$, making its total effect on UOM equal to 0.65. Hence, when students believe that learning mathematics could also be fun, this would redound into recognizing the support that teachers give and considering mathematics as a useful subject.

Direct Effects on Mathematics Achievement

Student-level characteristics that have recorded positive effects on mathematics achievement are gender ($\beta = 0.08$, $p < 0.01$), E1 ($\beta = 0.09$, $p < 0.01$) and E2 ($\beta = 0.07$, $p < 0.01$). These indicate that females perform better in mathematics and students from both E1 and E2 achieved higher performance in mathematics compared to those who belong to E3. Conversely, students' characteristics with negative effects on achievement are age ($\beta = -0.13$, $p < 0.01$), fathers' education ($\beta = -0.09$, $p < 0.01$), own a calculator ($\beta = -0.06$, $p < 0.01$) and own personal computer ($\beta = -0.10$, $p < 0.01$). These demonstrate that younger students, students whose fathers have lower level of education, those who do not have a calculator and personal computer tend to perform better in mathematics as compared to their counterpart. One reason could be that when students sit for the exam, they are not required to use a calculator nor with personal computer. Hence, possessing or not these items do not really affect their mathematics performance, except maybe when these are really required, like in higher mathematics.

In addition to the students' characteristics, students' attitudes and beliefs about mathematics have likewise influenced achievement in mathematics (MACH) directly. For instance, CLM affects MACH positively ($\beta = 0.37$, $p < 0.01$) indicating that those who are more confident in learning mathematics tend to achieve better. Beliefs about mathematics (BAM) have also yield a positive path coefficient ($\beta = 0.14$, $p < 0.01$) towards MACH, suggesting that students who believe that mathematics is not purely computation, but also requires exploration perform better. Moreover, the positive path coefficient of UOM ($\beta = 0.09$, $p < 0.05$) to MACH implies that students likewise achieve better when they perceive mathematics as useful in their daily living. Furthermore, PTA, which has a negative path towards MACH ($\beta = -0.40$, $p < 0.01$) suggest that those students who thought they were not given due regard by their teachers in mathematics are likely to do better in mathematics. These are probably those students who, instead of showing discouragement have even strived harder.

Indirect Effects on Mathematics Achievement

Only one indirect effect on MACH are discussed in this section because all the other indirect effects are below 0.10. The model shows that PTA has indirect effect on MACH through CLM. The computed indirect effect is positive with value equal to $\beta_1 = 0.34$, $p < 0.01$. This indicates that the magnitude of the effect of PTA to MACH is mediated by CLM. This implies further that students who perceived that their teachers are helping them understand mathematics better are likely to develop confidence in learning mathematics. This, in turn, lead to a better performance in the achievement test.

10.6 Summary

This chapter has highlighted the variables that have significantly influenced students' mathematics achievement through the single-level structural equation modelling analysis. This has likewise examined the relationships between other student-level factors, looking specifically at the direct and indirect effects.

The final structural equation model has become the basis for seeking answers to the research questions which are particularly addressed in this chapter.

3a: What student-level characteristics (gender, age, grade level, ethnic group, parents educational level and employment status) affect students' attributes (attitudes towards mathematics and beliefs about mathematics)?

3b: How do student-level characteristics and attributes influence mathematics achievement?

It appeared that students' age (-) and gender (+) have significantly influenced their attitudes towards mathematics and achievement in mathematics. However, these results may vary as students get older and have experienced more as they continue to step up the educational ladder. The ethnic groups (+) where the students are affiliated to have also shown significant effects. This is probably indicating that ethnic groups in the Philippines may have actually regarded different subject areas differently. It is also interesting to know that only the father's educational level (-)

has yielded a significant effect on students' achievement. Similarly, students with no calculator and personal computer at home have shown direct paths to achievement.

Among the attitudes towards mathematics, only the mathematics anxiety has not recorded any significant effect on achievement. Confidence in learning mathematics has yielded a positive direct effect, likewise with usefulness of mathematics (+). Perception on teacher attitudes (-) has presented opposite results. Beliefs about mathematics have recorded a positive effect as well.

Similar to the results of the teacher- and school-level, these results of the students single-level path analyses were used as a guide for the hierarchical linear modelling, which will be presented in the subsequent chapter.

Chapter 11
Influence of Teacher-, School- and Student-factors on Students' achievement: Hierarchical Linear Modelling

---

11.1 Introduction

The general objective of this study is to examine the factors that influence students' achievement in mathematics. These factors are from three levels, which are multilevel or hierarchical in nature and where level-1 (student-level) is nested under level-2 (teacher-level) and level-2 nested under level-3 (school-level). As indicated in Chapter 4, the best way to deal with nested data is the use of Hierarchical Linear Modelling (HLM).

In the previous chapters (Chapters 8, 9, 10), individual models of teacher-, school- and student-level factors were analysed using Mplus 7.0 (Muthén & Muthén, 1998-2012). Structural equation modelling (SEM) is carried out to examine the individual level factors for schools, teachers and students. In the educational system, it is given that the structure of the data that will be collected is multilevel or hierarchical in nature. Hence, treating hierarchical data using single-level path analysis or SEM would result in problems with the partitioning of the variance, dependencies in the data and bigger risk in making a Type 1 error (Beaubien, Hamman, Holt, & Boehm-Davis, 2001; Snijders & Bosker, 2012) due to the disaggregation and aggregation of the data. Aggregation means that the variables at the lower level (e.g. students) are moved to a higher level (e.g. teachers). Thus, lower level individual differences are ignored. Disaggregation means moving variables from higher level to a lower level

(Hox, 2010). In this situation, between-group variability is being ignored (Osborne, 2000). Hence, to address these, hierarchical linear modelling (HLM) is employed to analyse the hierarchical or multilevel data. In this way, variables at different levels can be analysed at the same time to investigate the factors that have influence on the outcome variable (i.e., students' mathematics achievement).

This chapter presents the results of the HLM analysis using the multilevel data set. This chapter finishes with a summary.

11.2 Examining Assumptions

11.2.1 *Normality*

The HLM software program (Raudenbush et al., 2004) produces residual files that could be used to check the distributional assumptions of the data before running the final model. In this study, a probability plot (Q-Q) was used to check the assumption of a normal distribution of the dependent variable.

11.2.2 *Missing data*

Missing data are inevitable in social and behavioural sciences research due to a variety of reasons (Tabachnik & Fidell, 2013). Missing data needs to be addressed to avoid analytical challenges such as bias. According to Tabachnik and Fidell (20013), if only five per cent from a large data are missing in random, then the problem is less serious. However, missing data is more complicated in multilevel structure as they may occur in more than one level. For example, in a two-level data, if a unit is missing in level-2 (e.g. teachers) and is excluded in the analysis, all the observations in level-1 (e.g. students) that are nested in level-2 will be excluded for the analysis

(Gibson & Olejnik, 2003). Since, there are only less than five percent of missing data and the sample sizes at all levels are relatively large, missing data are replaced using the mean (Tabachnik & Fidell, 2013).

11.3 Variables Used

Principal component scores of latent variables with two or more manifest variates are calculated using IBM SPSS version 20. Those variables that are already in Rasch forms are maintained for the HLM process. However, to avoid the challenges of handling negative values in the analysis and interpretation of results, Rasch scores are transformed into W scores using the formula, W = 9.1024 * logits + 500 (Woodcock, 1999, p. 111). Consequently, most of the variables used in the analysis are in standardised forms, except for the variables Age, Gender, Level of Education, School level, and School type.

Variables used in the HLM analyses are described in this chapter. Student level or Level-1, Teacher-level or Level-2 and School-level or Level-3 variables are listed in Table 11.3.1. At the highest level (level-3) are school-related variables, such as gender, age, level of education, years of experience, instruction time, school climate, beliefs about the nature of teaching and learning, management or leadership style and criteria for teacher appraisal. At the middle of the hierarchy (level-2), are classroom or teacher-related variables, such as age, gender, level of education, years of experience, class size, professional development programs, teachers' attitudes towards mathematics, classroom assessment process, efficacy beliefs, and teaching practices. Variables at the lowest level (level-1) are the student-level variables. These include gender, age, ethnic group, parents' educational level and employment status, home possessions, beliefs about mathematics and attitudes towards mathematics. The outcome variable, mathematics achievement is measured at level-1. The outcome variable is always located at level-1 or at the lowest level (Castro, 2002). Thus, students (level-1) are nested within classrooms or teachers (level-2) that are situated within schools (level-3).

Table 11.3.1

List of variables used in the Three-level HLM Models

Hierarchical Level	Hierarchical Level	Variables	Description
Level 3	School Level	Gender	Gender
		Age	Age
		LevEd	Level of Education
		SchLev	School Level
		SchType	School Type
		YrPrin	Years as Principal
		YrTch	Years as Teacher
		InsTime	Instruction Time
		MathTime	Instruction time for Maths
		SCFL	School Climate for Learning
		BANTL	Beliefs about the Nature of Teaching and Learning
		MLSI	Management and Leadership Style-Instructional
		MLSA	Management and Leadership Style-Administrative
		TAC	Teacher Appraisal - Criteria
Level 2	Teacher Level	Age	Age
		Gender	Gender
		LevEd	Level of Education
		YTMath	Years Teaching Maths
		CLSize	Class Size
		FPD	Frequency of PD Sessions
		PDP	Professional Development Program
		CNFIDNCE	Teacher Attitude-Confidence
		INSCRITY	Teacher Attitude-Insecurity
		CAPS	Classroom Assessment Process scale
		PMTE	Personal Maths Teaching Efficacy
		MTOE	Maths Teaching Outcome expectancy
		PCAP	Preferred Classroom Assessment Practice
		TPS	Teaching Practices Scale

Table 11.3.1 (continued)

Hierarchical Level	Hierarchical Level	Variables	Description
Level 1	Student Level	Age	Age
		Gender	Gender
		Ethnic 1	Ethnic Group 1
		Ethnic 2	Ethnic Group 2
		Ethnic 4	Ethnic Group 4
		MEd	Mother's highest educational level
		FEd	Father's highest educational level
		MJob	Mother's job
		FJob	Father's job
		WCal	With Calculator
		WPerComp	With Personal Computer
		BAM	Beliefs about Maths
		PTA	Perceived Teacher's Attitudes
		UOM	Usefulness of Maths
		CLM	Confidence in Learning Maths
		MAS	Maths Anxiety
		MAch	Maths Achievement

11.4 Three-Level Model of Mathematics Achievement for students

The selection of variables for the three-level HLM analysis was based on the results of the Mplus analyses. On the bases that other variables that are not significant in the single-level structural equation path model using Mplus may be significant in the HLM analyses, those variables are also investigated. Exploratory analyses are employed to find the possible variables to be included in the model.

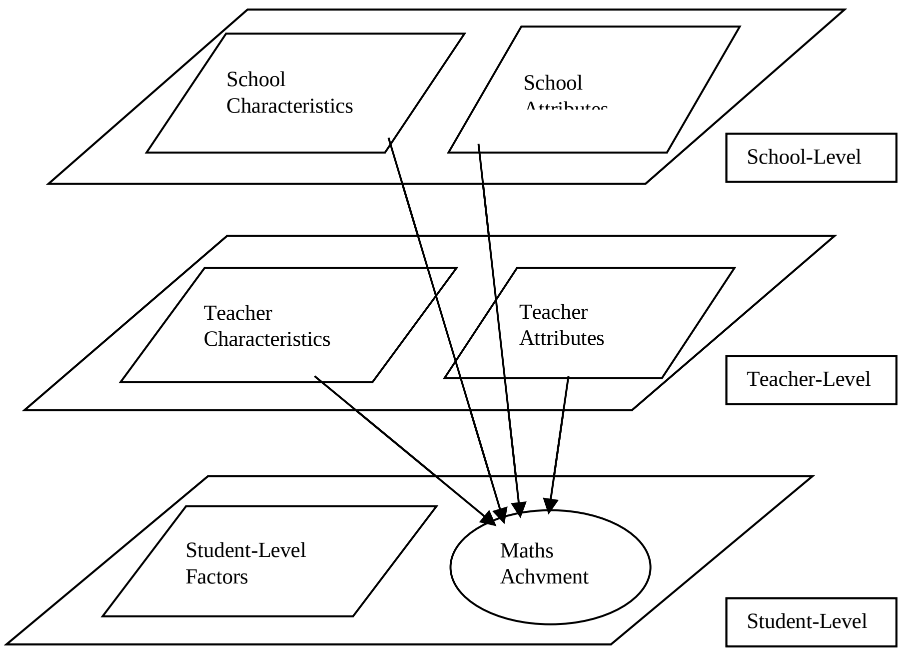


Figure 11.4.1 Three-Level Model of Students’ Mathematics Achievement.

The three-level HLM model analysis was carried out by first running the fully unconditional model (null model) to obtain the estimates of the amount of variance available to be explained in the model (Raudenbush, Bryk, & Congdon, 2004)
An estimate in a fully unconditional model was obtained from a model without entering into the equation any individual level, teacher level and school level variables. That is, predictors of the outcome variable are not yet indicated at any level.

This model represents how much variation in an outcome variable, in this case the mathematics achievement, was allocated across the three different levels, namely student, teacher and school levels. Therefore, the fully unconditional model allowed the partitioning of the variance in the outcome variable at the three levels (Bryk & Raudenbush, 1992). The fully unconditional three-level model is specified by the following equations.

11.4.1 Level-1 Model

The outcome variable (Mathematics achievement) is modelled as a function of school mean plus a random error:

$$Y_{ijk} = \pi_{0jk} + e_{ijk} \quad [11.1]$$

where:

Y_{ijk} is the mathematics achievement of student *i* under teacher *j* in school *k*;

π_{0jk} is the average score of student achievement in school *k*; and

e_{ijk} is a level-1 random effect

In the above equation, the level of mathematics achievement according to student *i* under teacher *j i*n school *k* is considered to be equivalent to the class mean plus a random error.

The indices *i*, *j* and *k* are used to denote student, teacher and school principal where there are

$i = 1,2, \ldots, Njk$	students under teacher *j* in school *k*;
$j = 1,2, \ldots, Jk$	teachers within school *k*; and
$k = 1,2, \ldots, K$	schools

11.4.2 Level-2 Model

The level-1 coefficient $\pi 0jk$, becomes an outcome variable as shown in the equation

$$\pi_{0jk} = \beta_{00k} + r_{0jk} \quad [11.2]$$

where:

π_{0jk} is the average score in the mathematics achievement under teacher *j* and school *k*;

β_{00k} is the average achievement in school *k*; and

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

In the level-2 equation, no predictors are specified that could contribute to explain differences between teachers; and the average mathematics achievement score of students is considered to be equivalent to the average mathematics achievement for that region plus random error.

It is assumed that the random effect associated with teacher *sjk*, r_{0jk}, is normally distributed with the mean of zero and variance τ_π. Within each of the *K* schools, the variability between classrooms is assumed the same.

11.4.3 Level 3 Model

The level-3 model represents the variability between schools. The school mean, β_{00k}, is viewed as varying randomly around a grand mean across all schools:

$$\beta_{00k} = \gamma_{000} + u_{00k} \qquad [11.3]$$

where:

β_{00k} is the average mathematics achievement in school *k*;

γ_{000} is the grand average achievement across schools; and

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

Estimating the null model is a very useful initial step in a hierarchical analysis. It produces a point estimate and confidence interval for the grand mean, γ_{000}. Furthermore, it also provides information about the variability of the outcome variable at each level. The σ^2 parameter represents the student level (level-1) variability, τ_π captures the classroom or teacher level (level-2) variability, and τ_β gives the school level (level-3) variability (Bryk & Raudenbush, 1992). Furthermore, the null model allows the estimation of the proportions of variation that are within classrooms, among classrooms within schools, and among schools. That is,

$\sigma^2 / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance within schools; [11.4]

$\tau_\pi / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among classrooms within schools; and [11.5]

$\tau_\beta / (\sigma^2 + \tau_\pi + \tau_\beta)$ is the proportion of variance among schools [11.6]

Whenever a reliability value falls below 0.05, it is assumed that there is no random effect for that particular coefficient.

The HLM results for the null model are presented in Table 11.4.1. The partition of variance into its three components is shown in Table 11.3.1. Part of the variability at each level can be explained or accounted for by measured variables at each level. Therefore, individual characteristics and perceptions, teacher characteristics, and school characteristics can be utilised as predictors. Furthermore, some of the relationships at the teacher level and school levels may vary randomly among these units. Thus, the next step is to examine the conditional model and to build up the final model.

The hierarchical model that was examined was based on the results of single-level path analysis using MPLUS analysis. There were some limitations of MPLUS as a single-level technique. Therefore, the possibility of the misspecification of a hierarchical model based on those results cannot be ignored. However, little relevant research is available to serve as a sound theoretical and empirical basis for the specification of a hierarchical model. Because of the complexity of the model, MPLUS results were considered to be an appropriate basis for the HLM analyses.

Table 11.4.1

Null Model Results: Three-level Model of Students' mathematics achievement

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		28.32	.65	43.36	92	0.00
Final estimation of level-1 and level-2 variance components:						
Random Effect	Reliability	Standard Deviation	Variance Component	df	Chi-square	P-value
INTRCPT1, R0	.876	3.89	15.12	58	514.33	0.00
Level-1, E		6.64	44.03			
Final estimation of level-3 variance components:						
Random Effect	Reliability	Standard Deviation	Variance Component	df	Chi-square	*P*-value
INTRCPT1/INTRCPT2, U00	.685	5.21	21.17	92	337.45	0.00
Statistics for current covariance components model						
Deviance		24612.62				
Number of estimated parameters		4				

In order to specify the level-1 model, variables that were found to influence the level of mathematics achievement directly at the individual level of analyses as well as within model in the Mplus results were entered into the equation one by one according to the magnitude and statistical significance of path coefficients starting from the strongest path but without the organisational level predictors. Bryk and Raudenbush (1992) suggest that this step is necessary to examine how much of the variance is explained by individual level predictors. Results were then examined and those coefficients that were found not to be significant were removed from the model and the next potential variable was entered into the equation. The input was altered accordingly and the data reanalysed. These steps were repeated step by step until a final level-1 model with only significant effects was obtained. In each run, an exploratory analysis was also performed to check the possibility of each level-2 variable to be included in the model.

The next step was to enter teacher/classroom level variables into the equation. The teacher/classroom level variables were entered one by one according to their t-values shown in the exploratory analysis results. These steps were repeated step by step until a final level-2 model with only significant effects at both levels was obtained.

The last step was to enter school level variables into the equation. As with the teacher/classroom level variables, the school level variables were entered one by one according to their t-values shown in the exploratory analysis results. These steps were repeated until a final model with only significant effects at all three levels was obtained. After adding the significant level-2 and level-3 variables, the final model is specified by the following equations:

Level-1 Model

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}(\text{ETHNIC1}) + \pi_{2jk}(\text{CLM}) + \pi_{3jk}(\text{UOM}) + \pi_{4jk}(\text{BAM}) + e_{ijk} \quad [11.7]$$

Level-2 Model

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(\text{LEVED}) + \beta_{02K}(\text{PDP}) + r_{0jk} \quad [11.8]$$

$$\pi_{1jk} = \beta_{10k} \quad [11.9]$$

$\pi_{2jk} = \beta_{20k} + r_{2jk}$ [11.10]

$\pi_{3jk} = \beta_{30k} + r_{3jk}$ [11.11]

$\pi_{4jk} = \beta_{40k}$ [11.12]

Level-3 Model

$\beta_{00k} = \gamma_{000} + \gamma_{001}(\text{SCHLEV}) + \gamma_{002}(\text{SCHTYPE}) + \gamma_{003}(\text{SCFL}) + \gamma_{004}(\text{BANTL}) + u_{00k}$

[11.13]

$\beta_{01k} = \gamma_{010}$ [11.14]

$\beta_{02k} = \gamma_{020} + u_{02k}$ [11.15]

$\beta_{10k} = \gamma_{100} + u_{10k}$ [11.16]

$\beta_{20k} = \gamma_{200} + u_{20k}$ [11.17]

$\beta_{30k} = \gamma_{300} + u_{30k}$ [11.18]

$\beta_{40k} = \gamma_{400} + u_{40k}$ [11.19]

By substituting level-3 equations (Equations 11) into level-2 equations (Equations 11.), level-2 equations are represented by:

$\pi_{0jk} = \gamma_{000} + \gamma_{001}(\text{SCHLEV}) + \gamma_{002}(\text{SCHTYPE}) + \gamma_{003}(\text{SCFL}) + \gamma_{004}(\text{BANTL})$

$+ \gamma_{010}(\text{LEVED}) + \gamma_{020}(\text{PDP}) + u_{00k} + u_{02k}(\text{PDP}) + r_{0jk}$ [11.20]

$\pi_{1jk} = \gamma_{100} + u_{10k}$ [11.21]

$\pi_{2jk} = \gamma_{200} + u_{20k} + r_{2jk}$ [11.22]

$\pi_{3jk} = \gamma_{300} + u_{30k} + r_{3jk}$ [11.23]

$\pi_{4jk} = \gamma_{400} + u_{40k}$ [11.24]

By substituting level-2 equations into the level-1 equation, the final model is represented by:

$$Y_{ijk} = \gamma_{000} + \gamma_{001}(\text{SCHLEV}) + \gamma_{002}(\text{SCHTYPE}) + \gamma_{003}(\text{SCFL}) + \gamma_{004}(\text{BANTL}) + \gamma_{010}(\text{LEVED}) + \gamma_{020}(\text{PDP}) + \gamma_{100}(\text{ETHNIC1}) + \gamma_{200}(\text{CLM}) + \gamma_{300}(\text{UOM}) + \gamma_{400}(\text{BAM}) + r_{0jk} + r_{2jk}(\text{CLM}) + r_{3jk}(\text{UOM}) + u_{00k} + u_{02k}(\text{PDP}) + u_{10k}(\text{ETHNIC1}) + u_{20k}(\text{CLM}) + u_{30k}(\text{UOM}) + u_{40k}(\text{BAM}) + e_{ijk} \quad [11.25]$$

This equation illustrates that the mathematics achievement level may be viewed as a function of the overall intercept (γ_{000}), 10 main effects and a random error (u_{00k} + u_{10k}(ETHNIC1) + u_{20k}(CLM) + r_{2jk}(CLM) + u_{30k}(UOM) + r_{3jk}(UOM) + u_{40k}(BAM) + r_{0jk} + e_{ijk}). The ten main effects are the direct effects from the level of schooling (SCHLEV, γ_{001}) at level-3, type of school (SCHTYPE, γ_{002}) at level-3, average school climate for learning (SCFL, γ_{003}) at level-3, average beliefs about the nature of teaching and learning (BANTL, γ_{004}) at level-3, average level of education obtained (LEVED, β_{01k}) at level-2, average participation to Professional Development Programs (PDP, β_{02K}) at level-2, and ethnicity (ETHNIC1, π_{1jk}), average confidence in learning mathematics (CLM, π_{2jk}), average perceived usefulness of mathematics (UOM, π_{3jk}) and average beliefs about mathematics (BAM, π_{4jk}).The cross-level interaction effect involves the interaction of school principal's administrative leadership style (MLSA) with teachers' highest level of education (LEVED).

The final results presented in Table 11.4.2 shows that four level-1 variables had an effect on students' achievement, these are ETHNIC1, CLM, UOM and BAM.

Additionally, two variables at level-2 influence students' performance in mathematics, that is, LEVED and PDP. Moreover, four variables at level-3 are likewise showing influence on students' achievement in mathematics. These relationships are depicted in Figure 11.4.2.

Table 11.4.2
Final Model Results: Three-level Model of Students' mathematics achievement

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	29.24	1.19	24.59	88	0.000
SCHLEV, G001	0.23	0.72	0.33	88	0.744
SCHTYPE, G002	-8.22	1.28	-6.44	88	0.000
SCFL, G003	0.13	0.06	2.36	88	0.021
BANTL, G004	-0.10	0.06	-1.77	88	0.079
For LEVED, B01					
INTRCPT3, G010	1.06	0.43	2.48	148	0.015
For PDP, B02					
INTRCPT3, G020	0.11	0.04	2.78	92	0.007
For ETHNIC1 slope, P1					
For INTRCPT2, B10					
INTRCPT3, G100	1.20	0.38	3.11	92	0.003
For CLM slope, P2					
For INTRCPT2, B20					
INTRCPT3, G200	0.07	0.02	3.37	92	0.001
For UOM slope, P3					
For INTRCPT2, B30					
INTRCPT3, G300	0.04	0.02	1.90	92	0.060
For BAM slope, P4					
For INTRCPT2, B40					
INTRCPT3, G400	0.06	0.02	3.53	92	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	.690	3.04	9.22			
CLM slope, R2	.157	0.09	0.01	46	76.39	0.006
UOM slope, R3	.070	0.06	0.00	46	52.37	0.240
Level-1, E		6.46	41.77			

Table 11.4.2 (continued)

Final estimation of level-3 variance components:						
Random Effect	Reliability	Standard Deviation	Variance Component	df	Chi-square	*P*-value
INTRCPT1/INTRCPT2, U00	.489	3.80	14.45	40	144.60	0.000
INTRCPT1/ PDP, U02	.087	0.09	0.01	44	38.36	>.500
ETHNIC1/INTRCPT, U10	.084	0.85	0.73	44	58.80	0.068
CLM/INTRCPT2, U20	.111	0.06	0.00	44	61.57	0.041
UOM/INTRCPT2, U30	.190	0.07	0.01	44	52.73	0.172
BAM/INTRCPT2, U40	.117	0.05	0.00	44	55.66	0.112
Statistics for current covariance components model						
Deviance		24420.72				
Number of estimated parameters		39				

Equation 11.25 as well as Table 11.4.2 show that there is no cross-level interaction effect that relates the three variables to one another. Direct effects from the three-levels are presented in the table.

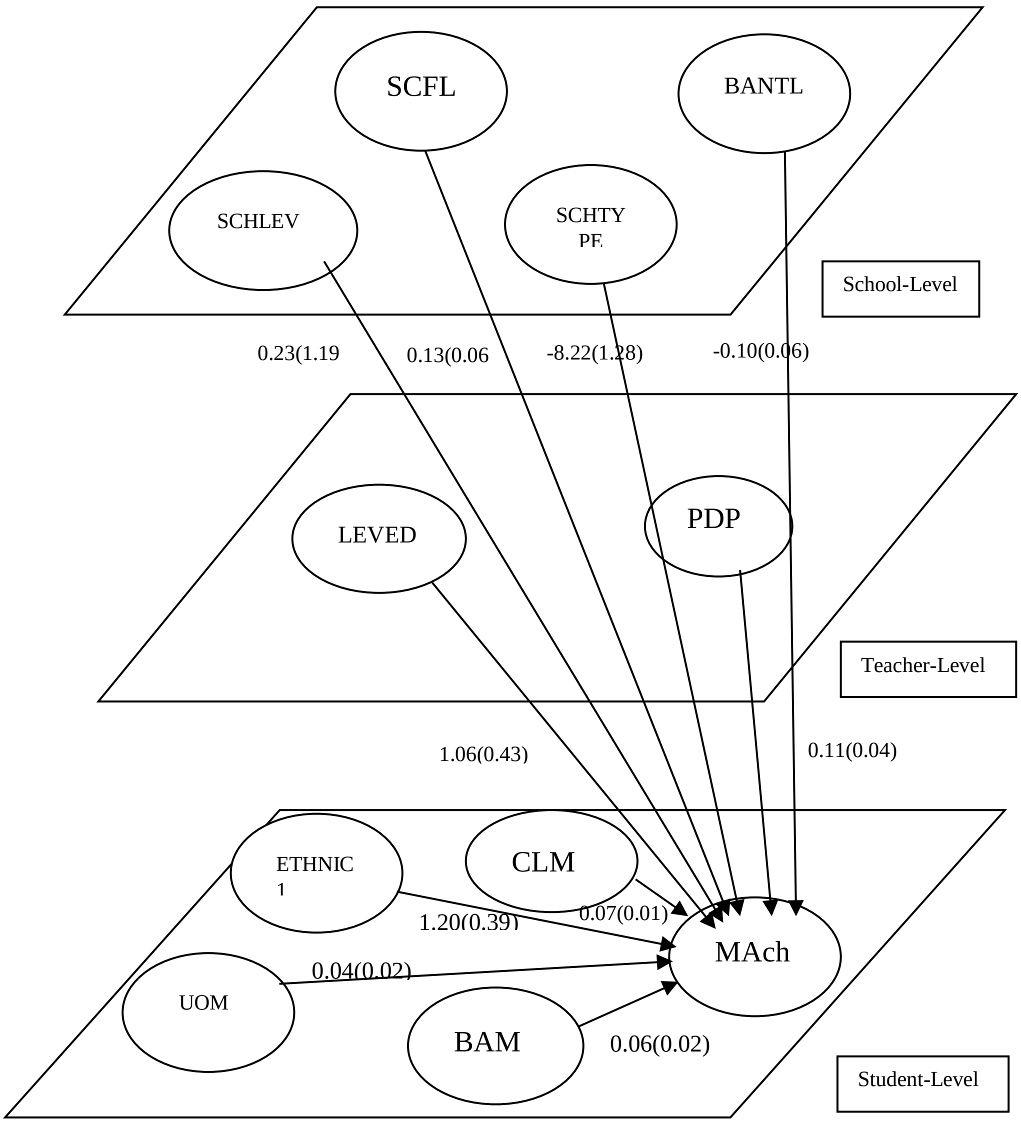


Figure 11.4.2 Three-level Model of students' mathematics Achievement.

This chapter presents the answer to research question number 4 (RQ4), *Which school-, teacher- and student-level factors and attributes have significant influence on students' mathematics achievement*?

To answer RQ4, results from Table 11.4.2 are discussed. This study involves students from two different levels, Grade 6 and Fourth Year high school. The results show that there is no significant difference between the schools in terms of the school level. Controlling for the school level, the results show that the impact of school type (SCHTYPE, -8.22) is significant. With public school coded as 0 and private as 1, this means that students from public schools perform better in the National Achievement Test (NAT). It is not quite surprising since public schools, especially located in the urban areas, are generally competitive with other private and public schools. The result for school climate for learning (SCFL, 0.13, $p < 0.05$) suggests that students perform better when there is a better or positive school climate for learning. This indicates that if teachers are more satisfied and happy with their job, if parents support their children at school and if good relationships are built between and among teachers, parents and students, this will result in better performance in the achievement test. In addition, though, the significance level of school principal's beliefs about the nature of teaching and learning (BANTL, -0.10, $p < 0.10$) is at 0.10 level, it is still retained. The results indicate that the less tightly that beliefs about transmission and constructivist teaching are held by the principal, the more likely that the students perform better in the achievement test in mathematics.

At the teacher-level (level-2), only two variables are significantly influencing students' achievement in mathematics, namely, level of education and participation in professional development programs. The influence of the level of education (LEVED) of teachers on students' achievement is 1.06, $p < 0.05$. This implies that the higher the level of education the teachers completed, the higher the average achievement of the students under him/her. Moreover, teachers' participation to professional development program (PDP, 0.11, $p < 0.05$) also positively influence students' achievement. This implies that students taught by teachers who attend more professional development activities, on average will have higher achievement.

Furthermore, four variables at the student-level (level-1) are directly influencing students' achievement in mathematics. First is their ethnic group (ETHNIC1, 1.20, $p < .05$). Ethnicity has four categories and dummy variables were created. ETHNIC1 is the first group. The group that has the highest number was made as the reference (ETHNIC3). Since the coefficient is positive, this indicates that the reference group (the Ilongggo, Hiligaynon group) perform better than the other Ethnic group. These results may be due to the large number of students in this ethnic group as compared to other ethnic groups. Additionally, two students' attitude variables significantly influence students' achievement (CLM, 0.07, $p < 0.05$; UOM, 0.04, $p < 0.10$), although, one is significant at 0.10 level. Confidence in learning mathematics (CLM) positively influence students' outcome, which means that the students are more likely to obtain better results in the achievement test if they are more confident in learning mathematics. If students perceived mathematics as useful (UOM) in their daily lives, as well as in finding a job in the future, they are more likely to perform better in the test. Lastly, students' beliefs about mathematics (BAM, 0.06, $p < 0.05$) influence significantly students' achievement, as well. The more that the students believe about the relational and instrumental nature of mathematics, the better the performance.

Estimates of the variance in mathematics achievement are obtained from both the fully unconditional model (no predictors specified at any level) and the final model. The estimates are recorded in Table 11.4.4. Variance at each level, as shown in the table, indicates that majority of the variance (51%) was found between the school principals. Approximately one third (31%) of the variance was found between the students and only 18% of the variances occurred between teachers.

Variance explained at each level may reduce or increase once predictors are included in the model. The calculation for the variance that was explained at the final model are presented in Table 11.4.4. It can be seen that most of the variance in the final model can be explained at level-1, student-level (47%), which increased by 16% from the null model. There was also an increase in the variance explained at the teacher-level from 18% to 42%. A significant dropped of the variance explained at the school-level (from 51% to 5%) is also presented in the table. When the variance explained at each level is related to the amount of variance available to be explained at that level, the total amount of variance explained by the model is 25%.

Table 11.4.3
Estimation of Variance Components

Model	Estimation of Variance components		
	between students n=3650	between teachers n=151	between schools n=93
Fully unconditional model	44.03	15.12	27.17
Final model	41.74	8.79	14.33
Variance at each level			
between students	44.03 / (44.03 + 15.12 + 27.17) = 0.51 = 51%		
between teachers	15.12 / (44.03 + 15.12 + 27.17) = 0.18 = 18%		
between schools	27.17 / (44.03 + 15.12 + 27.17) = 0.31 = 31%		
Proportion of variance explained by final model			
between students	(44.03 – 41.74) / 44.03 = 0.05 = 5%		
between teachers	(15.12 – 8.79) / 15.12 = 0.42 = 42%		
between schools	(27.17 – 14.33) / 27.17 = 0.47 = 47%		
Proportion of total available variance explained by final model (0.05 x 0.51) + (0.42 x 0.18) + (0.47 x 0.31) = 0.25 = 25%			

11.5 Summary

This chapter aims to answer research question number 4 (RQ4): *Which school-, teacher- and student-level factors and attributes have significant influence on students' mathematics achievement*? The results presented four school-level variables (SCHLEV, SCHTYPE, SCFL and BANTL) directly influencing students' achievement in mathematics. For the teacher-level factors, only two variables are significantly influencing students' achievement. These are the level of education of teachers and their participation to professional development programs. Student-level variables, which are found to directly influence student's achievement are ETHNIC1, UOM, CLM and BAM. All the other variables do not significantly impact students' achievement.

The next chapter presents the conclusion and the implication of the study. Recommendations for future research are also discussed.

Chapter 12
Discussion

12.1 Introduction

The study aimed to investigate the interplay between the multilevel factors and achievement in mathematics of public and private Elementary and High school students in Region XII, Philippines. Particular interest was directed at determining the classroom practices, referring to teaching and assessment practices, of mathematics teachers. The end goal was to establish the influence of these classroom practices on the achievement of students in mathematics as indicated by the National Achievement Test.

To examine the factors that significantly influence the dependent variables at a single level, Structural Equation Modelling (SEM) was employed. Initially, teacher-level factors were determined by looking into the characteristics and attributes of teachers assumed to pose influence in their teaching and assessment practices in the classroom. A probe on school-level factors was done next, wherein the characteristics and attributes influencing the perception about the school climate and teacher appraisal by the school principals were identified. Finally, student-level factors assumed to have influenced student achievement in mathematics were likewise taken into consideration.

Presentation of the results of the analysis of the interaction among the factor influences utilized a Hierarchical Linear Modelling (HLM) approach. The intention was to build a model that exactly points at how and which of the teacher-, school-and student-level factors greatly influence the achievement of students in mathematics. Aligned with the research questions, major findings are summarised and discussed in the succeeding sections.

12.2 Teacher-level factors

The hypotheses abound the teacher single-level factors opined that the teaching and assessment practices of mathematics teachers, herein collectively known as classroom practices, are influenced by their attitudes and beliefs about mathematics as a subject and in teaching mathematics; in like manner, their participation in professional development programs in the recent years. It was likewise hypothesized that the individual characteristics of the mathematics teachers themselves either directly or indirectly affect their classroom practices. Moreover, it was surmised that there is a seamless connection between a teacher’s teaching and assessment practices in the classroom; suggesting the idea that teaching practices affect assessment practices, in the same manner as assessment practices affect teaching practices.

Due to time constraints and software program limitations, analysis of the recursive model was not possible. Instead, the influence of one over the other was examined separately. Findings revealed that the influence of classroom assessment to teaching practice is stronger than the influence of teaching to assessment practices. This implies that the assessment practice preferred by mathematics teachers significantly influences their teaching practice. This conforms to the assertion of Panizzon and Pegg (2008) that teacher assessment practice is clearly embedded in their teaching practice, in as much as they perceive that their assessment practice is a tool to inform teaching and learning.

The findings further revealed that the greatest direct influence on teaching practice is the *preferred classroom assessment practice* (PCAP). Factors following such are the *professional development programs* (PDP) attended and the level of *Insecurity* in mathematics and teaching mathematics. Mathematics teachers likely align their teaching practices with the assessment practice they prefer. Teaching practices could also be influenced by regular attendance to PDPs and feeling less insecure about mathematics and teaching mathematics. The other factors listed at the teacher-level showed an indirect relationship with teaching practice. These are teacher's self-efficacy beliefs, level of confidence, highest level of education attained and school level.

Two of the main objectives of classroom assessment is to improve students' performance (Panizzon & Pegg, 2008) and teachers' instruction (Schulman, 1996; De Luca & Klinger, 2010). Since classroom and standardised assessments are deeply embedded and given high regard in the Philippines, classroom instruction is influenced by the kind of assessment that students are expected to undertake by the end of each term or schooling. The connection between classroom assessment and teaching practices that surfaced in this study is therefore not surprising. In fact, this supports Stenmark's (1992) and Panizzon and Pegg's (2008) assertion that assessment must be embedded in instruction so that learning will be enhanced. Assessment techniques, called Formative Assessment, applied in the classroom specifically serve this purpose. According to Kyriakides (2008), formative assessment is found to have a strong relationship with teaching effectiveness. Ginsburg (2009) and Gao (2012) also added that results of formative assessment will help teachers improve their teaching strategies.

Teachers should continually seek for improvement in this fast changing world. They should try to keep themselves abreast of the current trends so that they can keep up with the needs of the 21st century learners. One way to improve themselves is through participation in *professional development programs* (PDP), such as, trainings, seminars, workshops and conferences. It is expected, however, that what they have learned or gained from the PDP would be applied in the classroom setting. Only then, can the effectiveness of the PDP be gauged. Because the curriculum likewise continually improves or changes, the Department of Education (DepEd) for basic education and the Commission on Higher Education (CHED) for tertiary education, provide PDP opportunities for teachers each year. Teachers sent on PDPs re-echo or share what they have learned with their colleagues. In this way, no teacher will be left behind in the acquisition of the latest knowledge and skills in teaching.

The findings also showed that PDP significantly influences teaching practices. This is consistent with the study of Garet et al. (2001). Garet et al.'s study, however, specified certain types of PD activities that have significant positive effect on teachers' classroom practice and eventually increased teachers' knowledge and skills. Specified in their study were: a) focus on content knowledge, b) opportunities for active learning and c) coherence with other learning activities. This is likewise consistent with Huffman, Thomas and Lawrenz's (2003) study on the relationship between professional development, teachers' instructional practices and the achievement of students in science and mathematics. Similar to Garet et al., Huffman and colleagues also considered different types of professional development. Among the five types, only two types (examining practice and curriculum development) appeared to have significant relation with science and instructional practice of mathematics teachers. This implies that PDPs could influence the teaching practice when the type or focus of the PDP is related to classroom instruction. Although this study has specified in the survey items on the types of PD activities (mathematics content or education-related) that teachers attended, the measure for PD, however, used the composite scores, that is, whether they had attended or not attended PD programs for the last three years.

The influence of PDP to instructional practice, however, controverts the quasi-experimental study conducted by Jacob, Hill and Corey (2017) wherein it was revealed that the professional development training had no effect on their instructional practice and even on students' outcomes. This is despite the fact that the PD training was geared towards increasing their knowledge on mathematics, helping students understand mathematics and improve their instructional practices. This denotes the inconclusiveness of the effectiveness of PD activities in relation to instructional practices. Several other factors need to be scrutinized to explain what really makes PD programs effective in enhancing classroom instruction and student performance.

The influence of teacher *Confidence* towards teaching mathematics on teaching practice appeared to be indirect, mediated by the *mathematics teaching outcome expectancy* (MTOE), *classroom assessment processes* (CAPS) and *preferred classroom assessment practice* (PCAP). This means that the effect of teachers' confidence has been reduced (Baron & Kenny, 1986) by the mediating variables. It is a common understanding that teaching requires a great degree of courage and confidence in order to efficiently manage pupils and students with various attitudes and learning styles. Teacher confidence could have direct relation with their classroom practice as were the cases in previous studies. For instance, Carpenter and Lubinski (1990) and Wilkins (2008) stress how a teacher attitude towards mathematics could influence his/her preference for instructional strategies.

Furthermore, both *mathematics teaching outcome expectancy* (MTOE) and *personal mathematics teaching efficacy* (PMTE)'s influence on TPS are likewise mediated by PCAP. Again, this shows how mathematics teachers in the Philippines are taking into account their assessment strategies and how these strategies can dictate the way they conduct classroom instruction. This connotes that the teacher's beliefs of their capacity to teach, as well as their ability to help students perform better, could influence their teaching practices, which as discovered, is defined by the preferred assessment strategy. Consistent with this, Eufemia's (2012) study involving 79 teachers from third, fourth and fifth levels likewise reveal that teachers' use of formative assessment is positively associated with their perceived self-efficacy in relation to type of assessment, assessment knowledge and effectiveness of assessment.

It is remarkable that the individual characteristics (i.e., level of education, school level) of any teacher turned out to have an indirect but statistically significant effect on TPS in the aspect of classroom assessment. The effect of *Level of education* (LevEd) has been mediated by CAPS and PCAP, while the effect of *school level* (SchLev) was mediated by the variables MTOE, CAPS and PCAP. This implies that classroom instruction is influenced by the degree of education acquired by the teacher; while in Elementary, through their assessment practices. This confirms the understanding that teaching practices are more dependent on preferred assessment practices; and that teachers taught their students in the way students are to be assessed.

Concerning this, the National Achievement Test (NAT) which is a standardised examination, is conducted in all Philippine schools towards the end of the school year, for selected grade levels. This is crucial especially for government or public schools because the NAT results speak of the school's performance. Better or high performing public schools may get higher funding or subsidies from the national government. Private schools on the other hand do not get any subsidy from the government. Yet, the NAT is likewise vital as a measure of the quality of educational service they offer. This reality probably explains why most paths leading to teaching practices are seen through assessment practices.

The three individual characteristics of teachers, particularly gender, age, years of teaching experience, directly influence teacher attitudes towards mathematics and teaching it. The specified teacher characteristics were also found to indirectly influence efficacy beliefs, professional development and classroom assessment processes. To elaborate, gender directly influence teacher *Confidence*, revealing that male teachers are more attuned to mathematics and are therefore more confident in teaching it. Gender was also noted to pose an indirect influence on teaching efficacy (PMTE) and outcome expectancy (MTOE) through teacher *Confidence*. This indicates that when male teachers are confident in teaching mathematics, then they have high personal teaching efficacy and thus are more persistent in teaching the subject. Likewise, the more confident the male teachers are, the more they exert effort to become effective teachers and the more they believe that they are able to achieve the desired students' outcomes. This result contradicts Levine’s (2013) study involving pre-service teachers enrolled in a one-semester elementary level mathematics education course. In Levine’s study, a course was offered to prepare students to teach mathematics in elementary school. The pre-service students were administered pre- and post-test on confidence in teaching mathematics (CTM) during the first and last day of course, respectively. The pre-test results showed significant gender differences in CTM. The results showed that males have higher CTM at the beginning of the semester than did females. By the end of the semester, both gender showed significant gains in confidence with females demonstrating greater improvement than did males. This was after learning the strategies and developing skills in mathematics instruction. This further implies that females' confidence in teaching mathematics would improve once they engage themselves in trainings that would equip them with skills and strategies in teaching mathematics more effectively. Teaching is traditionally viewed as a female occupation (Apple & Jungck, 1992). It is therefore expected that females would have higher teaching efficacy than males. It is remarkable, however, to find out in the current study that males have higher teaching efficacy as they also have higher confidence in teaching mathematics.

12.3 School-level factors

It was also hypothesised in this study that school-level factors indirectly affect the achievement of students in mathematics. A school principal, who stands as the school head, creates a direct connection to the teachers and indirectly to the students. With effective leadership style, the school principals are able to create a school climate characterized by goal-centeredness and motivational environment, whereby stakeholders have greater access to growth and enhancement opportunities. A type of school climate which, if positively perceived and experienced, will produce better learning outcomes.

The result of the structural equation model shows that both the *administrative leadership style* (MLSA) and *instructional leadership style* (MLSI) are directly affecting *school climate for learning* (SCFL). SCFL likewise directly impacts teacher *appraisal criteria* (TAC). Note, however, that only MLSI, directly affects TAC. This indicates that school principals have direct influence on the school climate (Cotton, 2003; Hallinger, 2003; Hallinger & Heck, 1998). As the school leader, principals are bound to provide teachers opportunities to grow through professional development programs; to create a learning environment that promotes and enhances students learning, and; to provide avenues where parents, teachers, students and other stakeholders could work towards the attainment of a common goal. Whether the principal is an administrative or instructional leader, his/her duties are not limited by being either one of the two. In fact, it is ideal that principal takes both roles as a school head; or focus on either one depending on the need of the school he/she is handling. In general, the duties and responsibilities of a school principal, specifically public school principals, are defined and covered in the mandates issued by the Department of Education (DepEd).

School leaders are also instrumental in providing educational environment that promotes students learning. This study confirmed that both instructional and administrative leadership styles have significantly influenced school climate for learning (Howard, Howell & Brainard, 1987; Hoy & Hoy, 2003; Sebastian and Allensworth, 2012). Of the two, the latter posed stronger influence on school climate. This result is highly probable because the indicators of school climate considered in the current study were more attuned to classroom instruction. This means that the learning progress of students was mirrored through teachers' job satisfaction, opportunities for professional development, teachers and parents support for students' achievement; as well as students' desire to do well in school. This is where the role of the school principals becomes fundamental because they are tasked with maintaining a healthy educational environment and providing a positive school climate that supports both teachers and students in achieving the goals of the educational process (Hallinger & Murphy, 1987).

Results also reveal that there is significant difference in instructional leadership style between the public and private school principals. Findings suggest that principals in private schools could better manage and supervise their instructional goals compared to public school principals; and that the private school principals tend to offer more professional development activities to teachers assessed weak in instruction (OECD, 2009). A likely explanation for this difference is the class size and school population. In general, public schools have bigger class sizes, more number of classes or sections; thus more teachers and classes to supervise. This scenario is inevitable because the mandate to provide education for all inclusively relies heavily on government schools. In comparison, the number of students per class is more regulated in private schools; its number of classes and teachers are thus lesser in private schools. This real scenario flaunts the likelihood that private schools are more manageable than public schools. Private school principals can focus more on instructional goals of the school having lesser number of classes and teachers. Leithwood and his colleagues (2004) examined how leadership influences student learning and indicated that successful leaders respond to the specific demands in the workplace. Accordingly, leaders in smaller schools directly engaged themselves in modelling the desired forms of instruction and in monitoring teaching practices.

Meanwhile, in terms of the administrative leadership style, the study shows that private and public school principals do not differ in terms of how they enforce school policies and procedures. This is contrary to a study conducted by Andersen (2010), which compared the leadership behaviour of public and private managers where leadership style was one of the indicators. In his study, there were significant differences in the behaviour between 459 public and private managers in Sweden, 176 of whom were principals and deputy principals in primary and secondary schools.

While in the aspect of *level of education* (LevEd), a negative relationship was noted between the school principals' level of education and school climate for learning (SCFL). The level of education is the only individual school principal characteristic that showed direct impact on school climate, and indirectly on teacher appraisal criteria (TAC), however, it was not significant.

Interestingly, class size was the only school characteristic which showed indirect effect on both SCFL and TAC. Remarkably, the effects of class size on both school climate and teacher appraisal are all mediated by instructional management style (MLSI) of the school principal. This finding hints that the school principals' instructional management style may be influenced by large class size, which in turn, may also influence the school climate set up and teacher appraisal policy. Moreover, both *class size* (CLSize) and *school type* (SchType) have positive effects on MLSI. This connotes that the larger the class size, the more likely that school principals push their supervisory roles over teachers, the curriculum and instruction. As to school type, private school principals are more likely to be an instructional leader. The study also found out that the level of school (SchLev) has direct but negative influence on MLSI implying that principals in the elementary level are more attuned to being instructional leaders.

Further analysis divulged that class size positively and significantly impacts a principal's beliefs on the nature of teaching and learning (BANTL). This suggests that the larger the class size is, the stronger is the belief of the principal that teachers should facilitate student inquiry, and that a quiet classroom surrounding is needed for effective learning. This implies further that the principal's belief, which may in turn influence their leadership style, may vary depending on the number of students each classroom has. In the Philippines, for example, public schools normally have larger class sizes compared to private schools, which means that school principals may focus more on making ways on how learning can be effective in a classroom with larger class size.

12.4 Student-level factors

At the student-level, the assumption was that students' achievement in mathematics could be influenced not only by teacher-level characteristics and by school-level characteristics, but also by their own individual characteristics and attributes.

Findings disclosed that students' attitudes, beliefs about mathematics, and profile characteristics all influence their achievement in that subject. Student attitudes specifically point at confidence in learning, perception on teacher attitude, usefulness of mathematics and mathematics anxiety; while profile characteristics mentioned in particular are gender, age, ethnicity, home possessions, and the level of education and job status of parents.

In the individual level characteristics, variables that showed direct effects on student attitudes and beliefs about mathematics were the *school level* (SchLev), gender, age, *ethnic group 1* (E1), *ethnic group 2* (E2), and *father's highest level of education* (FED). Additionally, only those *with calculators* (WCAL) and *personal computers* (WPERCOM) at home have direct effects on attitudes and beliefs, although very small, but still significant. School level has negative effect on both mathematics anxiety and confidence in learning mathematics and positive effect on usefulness of mathematics. The estimates indicate that elementary pupils are more anxious about mathematics than are high school students. Elementary pupils were likewise found to be less confident in learning mathematics. This finding probably explains the greater anxiety of elementary pupils in mathematics. In the same manner as the pupils think less of the usefulness of mathematics in real life compared to the high school students' take on the matter. To be specific about it, the study rules that secondary school students are less anxious in learning mathematics and they see its usefulness more than elementary pupils do.

Interestingly, gender posed direct effects to the attitude dimensions, except *perception on teacher attitude* (PTA). Findings point out the negative association of gender to both *mathematics anxiety* (MAS) and *confidence in learning* (CLM). This signifies that males are more anxious than girls; and are therefore less confident in learning mathematics. Even more interesting to note the positive effect of gender to UOM and BAM, which opines that females conceive mathematics as a useful subject more than male students do. In effect, females exhibited more positive beliefs about mathematics compared to the male students. The foregoing findings about the association of gender to mathematics as a subject and learning mathematics somehow repudiates the conventional belief that Mathematics is a male thing. The current study surfaces a negation which cannot simply be refuted because of the statistical evidence herein. This result concurs with the longitudinal study carried out by Hemmings, Grootenboer and Kay (2011), which involved students from independent co-educational secondary school in regional New South Wales. The students were registered in the school as Year 7 during the school year 2004-2005 and were followed through when they reached Year 10, also in the same school. After employing the multivariate analysis of variance (MANOVA), the results show that female students are more likely to sustain positive attitudes toward mathematics.

The effect, however, of age to UOM controverts the effect of school level on UOM. School level and age may be strongly correlated since students at the lower level are most likely younger. There are, however, cases when students have delayed their education, thus deviating from the normal or conventional school age. In the preceding paragraph, it was reported that secondary students tend to see mathematics as more useful than elementary pupils do. However, with age, it shows that the younger the students are, the more highly they see the usefulness of mathematics to other subjects and in real life. Younger students may be inferred as the elementary pupils also. In addition, age showed negative relation to perception on teachers' attitudes. This could be interpreted in a way that the perception or feeling that teachers encourage them to do well in mathematics is more evident in younger aged students than in the older ones.

In terms of ethnicity, the student-respondents were grouped into four ethnic affiliations (E1, E2, E3, and E4) where E3 was taken as the dummy variable. It can be gleaned from the model that E1 and E2 have impacted PTA conversely. E1 has a positive path coefficient towards PTA, which means that students who belong to E1 have positive perception on teachers' attitude compared to those belonging in E3. Conversely, E2 records a negative path coefficient for PTA, signifying that students in E2 group bear greater negative perception on teacher attitude over those in E3 group.

It is also remarkable to note that among the parent -related variables, only the *father's education level* (FED) had significantly connected to *mathematics anxiety* (MAS) and *beliefs about mathematics* (BAM). Findings reveal that students whose fathers' educational level is low tend to be more anxious towards mathematics as indicated by its negative path coefficient. Alternatively, those whose fathers have acquired higher educational level tend to have positive beliefs about mathematics.

With regard to students' possessions at home, those owning calculators and personal computers have shown direct effects on CLM, MAS and BAM. Probably because these things are more likely to be useful in improving performances in mathematics than the other things such as dictionary, study desks, books and others. Conversely, those who do not own calculators and personal computers at home tend to be more anxious about mathematics, probably feeling less equipped in dealing with mathematical problems. Apparently, those owning calculators appear to be more confident in learning mathematics thereby developing a more positive belief about mathematics. The absence of these logistics may tend to cause students' anxiety in mathematics.

In another respect, it is likely that an indicator of a student attitude may also be directly influenced by another indicator. For instance, CLM has positive influence on MAS, suggesting that students with confidence in learning mathematics tend to find mathematics easier. Additionally, positive beliefs about mathematics likewise make students learn mathematics more easily. In like manner, perception on teachers' attitude has also drawn a positive path towards usefulness of mathematics (UOM), the same with beliefs about mathematics. The foregoing results signified that students with positive perceptions on their teachers' attitude towards them, likely distinguish mathematics as a useful subject. Consequently, students with positive beliefs about mathematics as a subject tend to develop an outlook that mathematics is useful in their daily lives. Finally, the resulting positive path coefficient suggests that a positive perception on teachers' attitudes creates confidence in learning mathematics.

Although students' individual characteristics have shown indirect effects on attitudes and beliefs about mathematics, they are, however, below 0.10 and are thus no longer discussed here. The model, however, shows indirect effect of BAM on CLM through PTA. The indirect effect implies that when students have positive beliefs about mathematics, they tend to have positive perception about their teachers' attitudes towards them. Consequently, a positive perception about how their teachers are helping them may lead to the development of confidence in learning mathematics. While BAM has shown direct effect to UOM, its effect was partially mediated by PTA. Together these two made its total effect on UOM. Hence, when students believe that learning mathematics could also be fun, this would redound into recognizing the support that teachers give; and in considering as well mathematics as a useful subject.

Whereas, student-level characteristics that have recorded positive effects on mathematics achievement are gender, E1 and E2. These indicate that females perform better in mathematics and students from both E1 and E2 achieved higher performance in mathematics compared to those in E3. Conversely, students' characteristics which posed negative effects on achievement are age, fathers' education, and possession of a calculator and own personal computer. This purports that younger students, students whose fathers have lower level of education, those who do not have a calculator and personal computer tend to perform better in mathematics as compared to their counterpart. One reason could be that when students sit for the exam, they are not required to use a calculator nor with personal computer. Hence, having these possessions cannot be an assurance of a high performance in mathematics. Likewise, enough to say that having or not having this logistics do not really affect their mathematics performance; except maybe in advanced courses in mathematics where applications require the use of calculators and computers. This does not apply in the study because it covered mathematics in the elementary and secondary levels only.

In addition to profile characteristics, students' attitudes and beliefs about mathematics directly influenced their *achievement in mathematics* (MACH). For instance, CLM affects MACH positively indicating that those who are more confident in learning mathematics tend to achieve better. Beliefs about mathematics (BAM) also generated a positive path coefficient towards MACH, suggesting that students who perform better are those with a belief that mathematics is not purely computation, but also requires exploration. Moreover, the positive path coefficient of UOM to MACH implies that students achieve better when they perceive mathematics as useful in their daily living. Furthermore, PTA, which has a negative path towards MACH suggests that those who thought they were not given due regard by their teachers in mathematics are likely to do better in mathematics. These are probably students who were not discouraged by the seemingly lack of teacher's concern. Instead, they took it as a challenge and strived harder in learning mathematics.

Only two indirect effects to MACH are discussed in this section because all the other indirect effects are below 0.10. The model shows that PTA has indirect effect on MACH through CLM. The computed indirect effect is positive but below the range. This indicates that the magnitude of the effect of PTA to MACH is mediated by CLM. This signifies that students who perceived that their teachers are helping them understand mathematics better are likely to develop confidence in learning mathematics. This, in turn, lead to a better performance in the achievement test.

Furthermore, it is noteworthy that among the attributes of parents, only the father's educational level displayed direct and indirect significant effects on students' achievement in mathematics. This corroborates with prior studies (e.g., Cabrera, Shannon & LeMonda, 2007; Gross, Mettelman, Dye, & Slagle, 2002; Smith, Atkins, & Connell, 2003). While the present study shows the importance of educational level, it also highlights a vicious cycle of academic under-achievement of students with uneducated parents.

Overall, gender, age, ethnic group, fathers' educational attainment and home possessions (calculator and personal computer) directly influence one or more of the students' attributes. Because of the large sample size of students, albeit low indirect path coefficients, they are still regarded as significant at .01 and .05 levels. The results show that males have higher confidence in learning mathematics (CLM); consequently, they also feel at ease about dealing with mathematics (MAS). On the other hand, females have regarded mathematics as useful in their daily lives (UOM) and have higher relational and instrumental beliefs about mathematics (BAM) than males.

Age is also seen as a significant influence to the perception of students about the usefulness of mathematics (UOM), as well as the perceived teachers' attitudes (PTA). Findings highlights that younger students, construed as the elementary pupils, perceive mathematics as useful, compared to how older or high school students thought so. Additionally, the younger students likely bear a stronger perception that their teachers encourage them to do well in mathematics.

Several studies have shown the relationships between ethnicity and attitudes towards mathematics, particularly mathematics anxiety. To mention, in the study of Ma and

Kishor (1997) it was revealed that ethnic affiliation significantly influences students in terms of students' attitudes towards mathematics, which include, mathematics anxiety, perceived usefulness of mathematics, perceived teachers' attitudes and belief about mathematics.

12.5 Three-level hierarchical linear model

To obtain a fuller picture of the relationships between variables, multi-level hierarchical modelling was employed. Putting all the multi-level variables together creates a three-level hierarchical linear model (HLM) which hypothesised the relationships between the variables and how these variables contribute to the achievement of students in mathematics. The interaction of the variables from the school-level (level 3) to the teacher-level (Level 2) and to the student-level (level 1) were also investigated as part of the modelling. This hierarchical linear model summarizes the factors that influence achievement in mathematics.

The final model shows that a considerable level of variance (see Table 11.4.3) in the students' achievement in mathematics was between schools (47%) and an equally considerable amount of variance (42%) was noted between teachers; while the least variance (5%) was between students. These results suggest that differences in students' achievement in mathematics were likely attributable to school-level factors and teacher-level factors, setting aside the students-level factors. This contradicts prior studies like that of Teodorovic (2012) wherein the two-level HLM model illustrated that the differences in the students' achievement in mathematics could be more explained by student-level factors. Similarly, in Chen's (2013) multilevel study about low-achieving mathematics students in Singapore, there were more of student-level factors which could predict the mathematics performance of low-achieving Grade four students compared to school/class-level factors.

Significant relationships and predictors of students' mathematics achievement at all three levels were indicated in the final model. The final model revealed that as far as the school-level variables were concerned, four significant variables that influence students' mathematics achievement were school climate for learning (SCFL), beliefs about the nature of teaching and learning (BANTL), school level (SchLev) and school type (SchType). The results indicate that students perform best when they are provided with an environment that is conducive for learning, when good relationships are built between and among the stakeholders of the school, when teachers' working morale is positive and when parents' support is evident. In addition, results also indicate that students tend to perform better when managed by a school principal who thinks more liberally about how mathematics should be taught by teachers or learnt by students. Moreover, secondary students tend to achieve better than elementary students. While students in public schools appear to have better achievement scores.

School climate has been associated with the achievement of students in several research studies. Its elements may, however, vary from one study to another. Lee and Shute (2010) identified a number of elements for school climate including the teacher efficacy, teacher affiliation, teacher empowerment, principal influence, resource support, school policies and class size. Their study has found a significant relationship between the various elements of school climate and students' academic performance. This is consistent with that of Choi and Chang's (2011) study.

A school principal may formulate a policy regarding classroom instruction and assessment. What a school principal may impose as a policy may be influenced by what he/she believes as the best strategy to teach mathematics and accurately assess students' performance. The policy will then have to be implemented by the teacher. This points out that school principals' beliefs may affect students’ performance indirectly through the teacher. Walker-Glenn's (2010) study involving school principals has, in some point, coincide with the result. Walker-Glenn explored the relationship between school principals' attitudes and beliefs about mathematics and students’ mathematics achievement. The author used mixed method to analyse the data and results of the quantitative analysis showed that there are no direct significant relationships between the school principals' attitudes and beliefs and students' achievement.

The results regarding school type may appear to be surprising as several of the studies conducted involving public and private school students showed that students from private schools achieve better compared to public school students. Fuchs and Wößmann's (2007) study, for instance, revealed that students from private schools have better achievement using data from Programme for International Student Assessment (PISA). This result has also been replicated in other research studies (e.g. Tooley & Dixon, 2006; Ejakait et al., 2011).

Surprisingly, there appears to be no interaction between school -level variables with any of the teachers' characteristics and attributes. This is, however, not the case in the study conducted by TALIS in 2008 (OECD, 2009) which implies a rather contradicting result between secondary and elementary school principals. Since, TALIS involved only secondary schools, and the results show that principals' management style may have less influence on teacher's practices and behaviour, which might not be the case for elementary school principals.

A relevant finding in this study points to the professional development opportunities for teachers, which was found to be significantly associated with students' achievement in mathematics. Teachers get to update themselves by attending seminars, trainings, conferences and workshops. The effect of their attendance at professional development (PD) has been found to be more effective if PDs are related to the field of specialization of the teacher; or related to classroom instruction and assessment. This result is consistent with Jacob, Hill and Corey (2017). They conducted a study to examine the impact of PDs on teachers' knowledge for mathematics learning.

The study also shows that the educational level of teachers and their participation in professional development programs directly influences students' achievement. In the study conducted by Dial (2008), it was reported that the degree level of teachers itself had no effect on student achievement. However, when the degree level interacts with years of experience, a significant effect on students' achievement in mathematics was found. This was not the case, however, in the current study. After model trimming, only the teachers' level of education and participation in PDPs appeared to have significant effects on students' achievement. Congruent with this result, a number of studies (e.g., Betts, Zau & Rice, 2003; Goldhaber& Brewer, 1997, 2000) have revealed that teachers' attainment of advanced degrees could have positive influence on students' performance. Kosgei and colleagues (2013) likewise show that as the level of teachers in Kenya increases, the performance of the students also increase. A likely explanation could be that a more advanced level of education boosts a teacher’s confidence which exudes in the manner by which he/she handles classroom teaching. PDPs in general, regardless of type, mimic the same confidence building effect of higher educational attainment.

The study also highlights the feeling of confidence, by students, in learning as having the strongest influence on their achievement in mathematics. This conforms to a number of prior studies that which reported that student's confidence has the largest association with mathematics achievement (Chen, 2014; Wang et al., 2012).

The main hypothesis of the study says that teaching and classroom practices, termed as classroom practices, directly affect students’ achievement in mathematics. This hypothesis though cannot be accepted because in the study findings, classroom practices are not significant predictors of students’ achievement in mathematics. An outright contradiction to prior studies which propagated the idea that teaching practices (e.g. Brahier, 2005; Hollingsworth, Lokan & McCrae, 2003; Lamb & Fullarton, 2002), as well as assessment practices (e.g. Panizzon & Pegg, 2008; Suurtamm, et al., 2010) contribute significantly to the achievement of students. This could be attributed to the specific strategies employed by the teachers in the classroom and the opportunities provided to the students, which might have served as their tool in developing student understanding (Webster & Fisher, 2003) and enriching learning experiences (Cogan and Schmidt, 1999), thus, improving students' achievement.

The negating results could also be attributed to the quality of teachers (Butty, 2001; Cornell, 1999) or how effective were the strategies delivered in the classroom (Goldhaber, 2002).

12.6 Summary

The achievement of students in mathematics are greatly influenced by their own attributes. In particular, their attitudes towards learning the subject; their appreciation of the practical use of mathematics in their lives, and; their perception toward the motivation, support and effort given by the teacher in getting them to understand the subject. True enough, one's own attitudes and beliefs make a great contribution to one’s performance. This is evidenced by the findings which alludes that among the multilevel factors, it is the student-level factor which posed the greatest influence. While at the teacher level, educational attainment, as well as their attendance or participation in professional development activities positively influence the achievement of student in mathematics.

The results of the study negate the assertion of several authors in their respective prior studies. This investigation finds out that classroom practices, which includes teaching and assessment practices of the teacher, do not significantly affect the progress of students in the mathematics subject. However, the study denotes that building an environment that is conducive to learning is likely defined by the job satisfaction of the teachers and their relationship with the school administrators, parents and other stakeholders. A conducive learning environment also necessitates the support that students get from their parents and teachers. Such kind of conducive environment was noted to be a significant factor contributing to the progress of students in learning mathematics.

The study also found out that the relationship of principal leadership with mathematics instruction and learning are indirect and low. Findings suggests that the mediating school processes described in the framework for essential supports are all important in improving instruction and learning; yet they work and affect in many different ways. Principal leadership is related to the achievement of students, through the learning climate. When considering several mediating factors together, only the school learning climate is associated with the differences in learning gains among schools. Principals in high schools may not have the skills to direct instructional practice in all subjects, but they can create a climate wherein teachers can effectively carry out their teaching roles and duties in the classrooms.

The study findings likewise revealed that the quality of professional development, as well as the professional community and partnerships with parents, are significantly associated with students' achievement. This suggests that principal leadership is crucial in assisting individual teachers to improve their performance. Whereas, the dissociate link between the leadership styles of the principals, and the teaching practices, beliefs and attitudes of the teachers is an interesting finding. It conforms though to prior researches about the impact of the leadership styles of a school head. Finally, results also signify that there is no significant difference in the influence of school principals on the achievement of students in mathematics.

Chapter 13
Conclusion, Implications and Recommendations for Further Research

13.1 Introduction

This study stemmed out of recognition of the importance of teachers and their classroom practices in the teaching and learning process that consequently support students in their achievement in mathematics. This study likewise recognised the role and influence of school-level factors as well as student-level factors. In order to understand what is happening in the elementary and secondary mathematics classroom in Region XII, Philippines, available evidence were reviewed in response to the research questions presented in Chapter 1.

This chapter provides a summary of the research findings and review of the design of the study. Also discussed in this chapter are the implications of the study and limitations. It concludes with recommendations for further research and the contribution of the study to research, methodology and practice.

With the Trends in Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) in the forefront, the use of achievement test results to measure student-, teacher- and school- level variables has been widespread in educational research. Several researches have investigated the variables that influence achievement. The results have been varied, as well as the design of the study and methods of analyses employed.

13.2 The design of the study

This research study aimed at examining the multilevel factors that influence students' achievement in mathematics. Prior to the examination of the influence of a number of factors from three levels on students' achievement, the interrelationships with and influence of other variables at the single level were also investigated. The selection of the factors was based on the objectives of the study and the research questions presented in Chapter 1. These factors were adapted from existing scales and were deemed appropriate in answering the research questions. The scales at the school-level include School Principals' Management and Leadership Styles (Instructional and Administrative), School Climate for Learning, Criteria for Teacher Appraisal and Beliefs about the Nature of Teaching and Learning. These scales were adapted from the Teaching and Learning International Survey (TALIS) 2008 study. At the teacher-level, Teaching Practices Scale (TALIS, 2008), Preferred Classroom Assessment (Gonzales & Callueng, 2014), Classroom Assessment Processes (Gonzales & Fuggan, 2012), Teachers Attitudes towards Mathematics and Mathematics Teaching (Confidence and Insecurity) (White, Perry, Way and Southwell, 2005/2006) and Mathematics Teaching Efficacy Beliefs (PMTE and MTOE) (Enochs, Smith and Huinker, 2000) were used. For students, Attitudes towards Mathematics by Fennema and Sherman (1976), which includes Confidence in Learning Mathematics (CLM), Usefulness of Mathematics (UOM), Perceived Teachers' Attitudes (PTA) and Mathematics Anxiety (MAS) were considered alongside Beliefs about Mathematics Scale (Yackel, 1984). Students' achievement in mathematics are the Mathematics scores of students in the standardised National Achievement Test (NAT) administered every year towards the end of the school year. The scales' validity at the structure level were established using confirmatory factor analysis (CFA) and at the item level using Rasch analysis. Its consistency or reliability were examined using Rasch, as well. Mplus version 7 (Muthén & Muthén, 1998-2012) and Conquest 2.0 (Wu, Adams, Wilson & Haldane, 2007) were used for CFA and Rasch scaling, respectively.

Structural equation modelling (SEM) using Mplus version 7, was employed to examine the causal relationships of the variables at the single level. The data are multilevel in nature and because of the bias caused by the aggregation or disaggregation of the data, hierarchical linear modelling (HLM, version 6.0) was used to answer the main objective of the study, that is examining the factors that influence students' achievement.

In addition to the data obtained from the responses in the scales, the respondents' demographic profiles, such as age, highest educational attainment, qualification and years of experience were likewise obtained.

13.3 Summary of Findings

This section presents the significant findings of the study. A number of factors and their relationships and how they influence students' achievement are discussed. To address research questions 1-3, single-level structural equation modelling analysis was employed, while hierarchical linear modelling was employed to answer questions 4 and 5. The study hypothesised that students' achievement in mathematics is influenced by school-, teacher- and student-level factors as illustrated by the theoretical framework in Chapter 3.

At the Classroom or Teacher level, four questions were advanced:

> RQ1a: What teacher individual-level characteristics (gender, age, years of teaching mathematics, level of education, school level, school type) influence teacher attributes (professional development, teachers' attitudes and beliefs)?

The individual characteristics of teachers', gender, age, years of teaching experience, level of education and school level, directly influence teacher attitudes towards mathematics and teaching, efficacy beliefs, and professional development. Specifically, Gender directly influence teacher *Confidence*. This means that male teachers are more confident in mathematics and teaching mathematics. Aside from its direct influence, gender indirectly influences both *teaching efficacy* (PMTE) and *outcome expectancy* (MTOE) through teacher *Confidence*.

In addition, age significantly directly influences teacher *Insecurity* in mathematics and teaching mathematics. The negative path coefficient indicates that the younger the teacher the more insecure (not confident) they are of mathematics and teaching mathematics. Age is also correlated with experience. Younger teachers normally lack the necessary experience and therefore they are less confident in teaching the subject.

The influence of teachers' years of teaching mathematics experience (YTM) on teacher *Confidence* is positive. This indicates that the longer the teachers teach, the more confident they can become in teaching mathematics.

Level of education (LevEd) significantly influence *professional development* (PDP), *personal mathematics teaching efficacy* (PMTE) and *classroom assessment processes* (CAPS). This indicates that those who attained higher level of education tend to participate more in professional development activities; have higher personal teaching efficacy beliefs; and employs classroom assessment processes.

School level (SchLev) directly and significantly influences teacher *Confidence* and *mathematics teaching outcome expectancy* (MTOE). This implies that teachers in the secondary level are likely to be more confident dealing with and teaching mathematics. However, elementary level teachers are likely to believe more that the effort they exerted and their efficiency contribute to the improvement of students' performance in mathematics.

RQ1b. Do individual-level characteristics have influence on classroom practices (teaching and assessment practices)?

Among the teacher individual characteristics, only level of education (LevEd) influence directly on the *classroom assessment processes* (CAPS) and indirectly on both *preferred classroom practices* (PCAP) and *teaching practices* (TPS). Additionally, *school level* indirectly influences CAPS, PCAP and TPS either through *mathematics teaching outcome expectancy* (MTOE), CAPS or PCAP.

RQ1c. How do teacher attributes affect classroom practices?

Professional development program (PDP), *Confidence*, *Insecurity* and PCAP directly influence *teaching practices* (TPS). On one hand, it implies that teachers employ more frequently effective teaching practices if they participate more frequently in seminars and trainings. On the other hand, teachers with confidence towards mathematics and teaching are more likely to employ effective teaching practices.

Teachers *preferred classroom assessment practices* (PCAP) is directly influenced by *personal mathematics teaching efficacy* (PMTE) and *classroom assessment processes* (CAPS). This indicates that teachers who believe that they can efficiently teach mathematics tend to employ more often their preferred classroom assessment practices. Likewise, teachers who frequently employ classroom assessment processes are more likely to employ more regularly their preferred classroom assessment practice.

Aside from the direct influence of teacher attributes on classroom practices, *mathematics teaching outcome expectancy* (MTOE) also indirectly influence teachers *preferred classroom assessment practices* (PCAP). This points out that if teachers highly believe they can improve students' achievement if they exert more effort to deliver the lessons more effectively, they more likely employ classroom assessment process frequently and thus, influence the use of their preferred classroom assessment.

RQ1d. How do assessment practices affect teaching practices?

It was hypothesised in Chapter 2 that there is a seamless connection between teaching and assessment practices in the classroom. This means that teachers teaching practices influence their assessment practices in as much as their assessment practices influence their teaching practices. Due to time and software limitations, analysis of the recursive model was not made possible. Instead, influence of one over the other is examined separately. It was found out that the influence of classroom assessment on teaching practice is stronger than the influence of teaching to assessment. Hence, this study indicates that teachers preferred assessment practices influence strongly their teaching practices. This suggests that teacher assessment practices are clearly embedded in their teaching practices and that teachers perceived that their assessment practices are tools to inform teaching and learning. For example, if teachers employ assessment as learning (AASL), where students are encouraged to do self-assessment, teachers tend to use student-oriented teaching practice (SOTP).

At the school level, two research questions were advanced in Chapter 1:

> RQ2a: What school principal characteristics (age, gender, level of education, years of teaching experience and years as principal) and school characteristics (school level, school type, instruction time and class size) influence school principal attributes (beliefs about the nature of teaching and learning and management/leadership style) and school attributes (school climate and criteria for teacher appraisal)?

To examine the factors that influence school principal's management/leadership style, school climate and criteria for teacher appraisal, single-level structural equation modelling was carried out. The results show that there is significant difference in the instructional leadership style between the public and private school principals. This suggests that principals in private schools could manage and directly supervise the instructional goals of their schools than those in public schools. This also implies that principals in private schools may offer more professional development activities for teachers who are considered weak in instruction.

In terms of the administrative leadership style, this study shows that principals from both types of schools do not differ in terms of the enforcement of the school policies and procedures.

It was also found that level of education (LevEd) is the only principal-level characteristics that directly but negatively affects *school climate for learning* (SCFL). Among the school-level characteristics, however, class size, school type and school level have shown direct effects on SCFL, *instructional leadership style* (MLSI) and principal's *belief about the nature of teaching and learning* (BANTL).

School leaders are also instrumental in providing educational environment that promotes students learning. Thus, this study investigates how the school principal's leadership style influences school climate for learning.

> RQ2b: How do school principal attributes (management or leadership style, beliefs about the nature of mathematics and teaching) influence school attributes (school climate and criteria for teacher appraisal)?

This study confirms that both *instructional* (MLSI) and *administrative leadership* (MLSA) styles have significantly influenced *school climate for learning* (SCFL). Of the two, the former has stronger influence on school climate. This result is not surprising since the indicators of school climate considered here are more related to instruction, that is, enhancement of students' learning through teachers' job satisfaction, opportunities for professional development, teachers and parents support for students' achievement as well as students' desire to do well in school. In addition, SCFL could influence the criteria to be considered in conducting teacher appraisal.

At the Student level, two questions were considered:

> RQ3a. What student-level factors (gender, age, school level, parents' educational level, employment status, ethnic group, and home possessions) influence students' attributes (beliefs about and attitudes towards mathematics)?

Of the student-level factors, gender, age, ethnic group, fathers' highest educational attainment and home possessions (calculator and personal computer) directly influence one or more of the students' attributes. Because of the large sample size of students, albeit the indirect path coefficients are small, they are still significant at .00 and .05 levels. The results show that while males have higher *confidence in learning mathematics* (CLM), they also feel at ease about dealing with mathematics (MAS). Conversely, females have regarded mathematics as useful in their daily lives (UOM) and have higher relational and instrumental *beliefs about mathematics* (BAM) than males.

Student age is also seen as a significant influence to both *usefulness of mathematics* (UOM) and *perceived teachers' attitudes* (PTA). It is found that younger students (i.e., elementary students) perceived that mathematics is more useful than did the older or high school students. Additionally, it is also the younger students that perceived that their teachers encourage them more to do well in mathematics. The results also show that ethnic groups significantly influence students PTA.

Of the parents' educational attainment, mother's education, on one hand, does not have influence on students' attitudes and beliefs about mathematics. On the other hand, the study indicates that the lower the father's educational level, the higher the students' anxiety level. Also, the higher the father's educational attainment, the higher the students relational and instrumental beliefs about mathematics. It is surprising to know that parents' job or employment status are found to have no influence on students' attitudes towards mathematics and beliefs about mathematics.

The results also reveal that only two home possessions that are deemed to influence students' performance in mathematics, these are calculator and personal computer. The findings show that students with calculator at home are more confident in learning mathematics and at the same time have positive beliefs about mathematics. Conversely, those with no calculators at home are more anxious about mathematics. Similarly, students with no personal computer at home tend to have anxiety towards mathematics, while those with personal computer also have positive beliefs about mathematics.

RQ3b. How do student-level factors and attributes influence mathematics achievement?

The main outcome of this study is the students' achievement in mathematics in the National Achievement Test (NAT). Surprisingly, the results show that girls perform better in the mathematics achievement. In terms of age, younger students have better performance. In terms of ethnicity, the findings indicate that students who belong to Ethnic3 group have higher achievement score in mathematics compared to the other two ethnic groups (E1 and E2).

It is likewise surprising to know that students whose fathers have lower educational attainment achieved better than those whose fathers have higher educational level. It could be that fathers who have lower educational level motivate their children more to do well in school as a result of the misfortune they experienced for not doing well or not finishing school.

Another interesting result shows that students with no calculator and personal computer at home have achieved better in mathematics than those who possessed these things at home. In many cases, teachers do not allow their students to use calculator nor personal computer for computations, especially during exams. Hence, those who do not have calculator and /or personal computer are more adept to solving problems without dependence on these two gadgets.

Research has shown that confidence in learning mathematics influences achievement results positively, indicating that the more confident the students are, the more likely they get higher score in the achievement test. Consequently, students who perceived mathematics as useful in their daily lives and future job, have achieved better than those who perceived that studying mathematics is useless. Moreover, students also achieved better if they have positive beliefs about mathematics.

On the contrary, students who perceived that their teachers have negative attitudes towards them, that is, their teachers do not encourage them to learn, achieved better than those who perceived that their teachers are positive about their performance in mathematics. It is likewise a surprise that mathematics anxiety does not come out as a significant influence to students' achievement in mathematics.

> RQ4. Which school-, teacher- and student-level factors and attributes have significant influence on students' mathematics achievement?

This question is answered through the analysis of hierarchical linear modelling (HLM). Due to the multilevel nature of the data and that one is nested over the other, the data are analysed using hierarchical linear modelling to avoid bias that can be obtained in the aggregation and disaggregation of data. Controlling for school level and school type, the results show that school principals' beliefs of the nature of teaching and learning directly influence students' achievement in mathematics. School climate for learning also indicates direct influence on students' achievement.

The findings of the study is quite a surprise that both teaching and assessment practices (collectively called as classroom practices) do not significantly influence students achievement in mathematics. Several studies conducted have indicated that teaching, as well as assessment practices contribute significantly to students' achievement results.

13.4 Implications of the study

This section considers the implications for teaching and practice, for methodology, theory and policy. A brief discussion of each implication is also presented.

13.4.1 Implications for Policy

The Department of Education (DepEd) could gain a better understanding of what influences student achievement by examining students' experience with Mathematics tasks tested in the National Achievement Test (NAT) and the Mathematics content covered in the curriculum. Valuing academic achievement is perceived as a common trait in schools, but more research is needed to understand the variation among schools with respect to students' exposure to different teaching strategies.

Educational policies should therefore aim to provide professional development programs to increase teachers' knowledge of new pedagogical strategies and tools for teaching. Teachers need guidance and training on how to successfully implement the use of new technologies and other new pedagogical strategies in their classrooms.

Teachers' professional development should lead teachers to reflect on how different teaching practices can enhance learning outcomes and how to use different practices effectively for the benefit of their students as well as to instruct teachers on how to improve their teaching practices. This could be particularly beneficial to teachers working in challenging classrooms, that is, in classes where there are high percentage of low achievers or students with behavioural problems. In addition, professional development opportunities can be used to highlight the types of experiences which develop positive attitudes in students. It is important for practising early years teachers to recognise the vital role that they play in the formation of their students' attitudes, hence ensuring that their interactions and teaching methods employed in their classrooms promote positive attitude development in their students.

Class size is related to the implementation of different active teaching practices, but this information should be used in combinations with other educational-related factors, such as aspects of classroom climate. More information on how class size might be related to the implementation of different active teaching practices may be used as bases for the DepEd to impose policies on class size, especially in public schools, to ensure a healthy learning environment.

This study may also provide insight to the administrators and curriculum developers who would design the teacher education programs or pre-service teacher education program in mathematics. The pre-service teacher education programs should not only focus on the development of content and pedagogical knowledge, but should also emphasise on attitudes. It is important that aspiring teachers will be encouraged to develop positive attitudes towards mathematics who in turn will nurture positive attitudes among the students. Studies conducted by Philippou and Christou (1998), Putney and Cass (1998), Quinn (1997), and Schackow (2005) have noted the positive impact that tertiary experiences had on their attitudes towards mathematics and mathematics teaching.

The implications for educational leaders are strong. One of the most important factors in supporting school improvement is the principal leadership behaviour and the competency to demonstrate the critical responsibilities that will assist teachers and students in their journey to improvement.

13.4.2 Implications for Practice

Identifying factors that influence students' achievement has been the subject of much research. Unfortunately, a number of the factors that were hypothesised to influence students' achievement turned out not to be significant. Nevertheless, multiple implications for the field of practice still unfold from this study. First, Principals continue to play an important role in the instructional process, thus, they must be able to assist teachers in improving their classroom practice to create a positive educational environment for the students. This, in a way, would improve students' learning and achievement. Principals cannot do the job alone, they must therefore involve teachers and students by engaging them in the learning environment, closely monitoring teacher progress, providing professional development opportunities, and by providing support to the less experienced teachers.

By being knowledgeable about the curriculum and instructional strategies, principals are able to assist teachers in the facilitation of instructional practices in the classroom (Leithwood & Riehl, 2003; Waters, Marzano, & McNulty, 2003). Thus, to maintain a healthy learning environment, as an instructional leader, principals need to open opportunities for teachers to grow and to provide the resources, necessary for teachers to appropriately impact student learning (Andrews & Soder, 1987).

Principals make the most meaningful impact on student achievement through fostering a healthy school climate within the educational environment (Gurr, 1997). As important parts of the educational environment, school principals should include teachers and parents in school programs, in enhancing the curriculum and in other relevant school activities. There should always be an open dialogue between and among them in order to promote a healthy environment most suitable for students' learning.

13.4.3 Implications for Theory and Research

This study is able to generate an initial hierarchical linear model of the factors that influence students' achievement in Mathematics. The use of hierarchical linear modelling is, so far, very new in Mathematics education research in the Philippine context. The results, however, are underpinning into a yet more profound structure of the model. Although, the research methods used in this study were not new, they were combined in ways that had not been done previously. In particular, the process of validation of the scales using both the CFA and Rasch model analysis is a new development in the mathematics education research; and the analyses method with the single level's structural equation model and the nested data's hierarchical linear model described the complicated data simply and more comprehensively.

Results of this study indicate that teachers play a significant role in attitude development, and consequently, achievement. Specifically, the study demonstrated that confidence in learning results in higher achievement in mathematics. The study of how attitudes affect achievement could be enhanced by further analysis of mathematics attitudes among high school students.

13.5 Limitations

This section identifies limitations in its design and outcome:

This study may have a very limited generality, but it may point to issues that are important to consider and may turn out to be general. It may make a methodological contribution or may clarify or expand a theory. Sampling method used and sampling size may limit the inferences outside of this research. Hence, extra caution has been taken in making inferences of the results of this study.

For instance, the findings of this study cannot be extrapolated to the whole population of Mathematics teachers and their students in the Philippines in view of the fact that only a selection of schools in Region XII were considered. Therefore, generalizations beyond the schools selected in Region XII should be taken with caution. However, the study can serve as guide to future research in Mathematics Education. Further, only the results in Mathematics area for NAT were utilised in this study as the focus of this research is on Mathematics achievement.
Due to the robust process of validation analyses, the claims hold the value of trustworthiness. However, the generality is low due to the fact that it is a new kind of study. This can be replicated or extended so that generality can be established.

The items used for this study were extracted from survey questionnaires. There is a high risk that their responses are motivated only by socially desirable responses and not accurately depicting their response. There were also no supplementary responses which can be obtained from interviews and observations.

The responses from both the principals and the teachers were based on a singular snapshot of their perceptions and influence at the time the questionnaire was completed. Influence and perceptions may have easily been altered both positively and negatively after the questionnaire was completed and returned. No follow-up contact was entered into the data collection design in order to see if the influence and perceptions recorded on the questionnaire were maintained over a period of time in each respective school site.

The data used as a measure of students' achievement in Mathematics is the individual result in the National Achievement Test (NAT), where Mathematics is one of the subject areas tested. Although, scores for each subject area can be obtained, overall measure of students’ achievement is used to gauge schools' performance in the NAT. This study acknowledges that the coverage for the Mathematics area may not be sufficient to measure students' achievement. Hence, the inference made for the results of this study is limited within its scope.

Since the study utilised large-scale test results as basis of students’ achievement, this study was limited only to Grade Six elementary and Fourth Year high school students in the Philippines, particularly in Region XII. Likewise, the study was limited to mathematics teachers who taught in Grade Six elementary and Fourth Year high school levels.

13.6 Recommendations for Future Research

The following recommendations are presented to improve upon future attempts to replicate or redesign the current study:

For better confirmation and for more comprehensive results, interviews and observations can be included in the data collection design. The use of survey questionnaires alone restricts the respondents' answers and therefore limits the interpretation and discussion of the results.

Although several variables have already been included in this study, these are not exhaustive yet. Many other variables which are found in the literature but are not included in this study. For example, the involvement of parents in school activities and in guiding and supporting their children. From the results in Chapter 10, only a small percentage are accounted for the variance in students' achievement, therefore, there are still other variables not included in the study. Adding more constructs, such as students' motivation, time spent in doing homework may be considered at the student-level. Adding more variables, however, does not automatically result to an increased variance explained, but it would be worth trying.

Whereas this study focused on instructional and administrative leadership, it is recommended that future studies look beyond leadership styles such as transformational, transactional, and distributive leadership. It is important that principals develop leadership style that fits the school's needs. Also, a more thorough investigation of the influence of these leadership styles to students' achievement should be considered.

This study likewise investigates how the leadership style of school principals are influencing school climate for learning. A new study can therefore be conducted which measures how the school principals engage teachers and parents in improving instruction and supporting students learning.

The current study is focused on the classroom practices, referring to both the teaching and assessment practices of mathematics teachers, and examining whether these practices and other teacher characteristics are influencing students' mathematics performance in the National Achievement Test. However, the study shows that classroom practices do not influence students' achievement. It is therefore recommended that the three dimensions of the teaching practices scale (as well as the assessment practices scale) will be treated and accounted for separately rather than an amalgamation of the different dimensions. In this manner, a more specific strategy may come out to be a significant predictor of students' achievement. This may also reveal a better perspective on the influence of classroom practices (teaching and assessment practices) on students' achievement.

Research studies are needed to determine the efficacy of various types of professional development activities, including pre-service and in-service seminars, workshops, and trainings. Studies should include professional development activities that are extended over time and across broad teacher learning communities in order to identify the mechanisms that contribute to the development of teachers' practice and students' performance.

Future research implications arising from this study include investigating further the link between positive attitude and achievement as well as how students can experience a lack of enjoyment while still achieving at a high level. The relationship between attitudes and achievement remains elusive; therefore, it would be beneficial for future investigations to use different measures of attitude and achievement in order to provide a broader base of information from which to draw conclusions.

Some students' attitudes may change by time, therefore, conducting longitudinal studies of student attitudes, especially in areas such as mathematics confidence and anxiety, might provide valuable insight as to how and when critical attitudes toward learning mathematics develop.

While affective factors are found to influence students learning and achievement, it cannot be denied that cognitive factors are also fundamental in determining features of learning. It is therefore recommended that a similar study will be conducted considering cognitive factors or a combination (and therefore comparison) of both affective and cognitive factors.

13.7 Contribution / Unique aspect of the study

This study is first of its kind in the Philippine context. There have been no recent studies carried out in relation to common teaching and assessment practices in the mathematics classroom; and using the mathematics score in the National

Achievement Test. Among the studies that were conducted, several were about specific teaching strategy applied to teaching a particular topic in mathematics. For example, in Ulep's (2006) paper, she presented how mathematics should be taught by presenting different teaching strategies, such as using hands-on activities and group work.

Another significant contribution of this study is it involves several variables from three different levels resulting to a more complex model. This therefore requires the use of a rigorous method employing heavy statistical methods, which again, is a significant development in the mathematics education research in the Philippines. In addition, a large size of data was collected, especially at the student-level, which likewise requires a more rigorous treatment.

Combining Rasch analysis with structural equation modelling (SEM), by using Rasch score in the SEM analysis is another step forward strategy employed in this study. This, however, needs to be treated with caution because not many are employing this strategy.

13.8 Conclusion

The primary objective of this study is to examine the factors that influence students' achievement in mathematics. With the teachers having the direct contact with students, this study focused on the teacher-level factors. While the results are contrary to several studies conducted indicating the influence of teaching and assessment practices on students' achievement, it is inconclusive as the results may be attributed to the complexity of the model and the several variables included. A further investigation of the influence of classroom practices (teaching and assessment practices) should be carried out with consideration to the specific dimensions (indicators) of the teaching and assessment practices, instead of using the composite scores. This is to identify the specific teaching and assessment strategies that strongly (or weakly) influence students' achievement in mathematics.

The results show that school principals have direct and positive influence on school climate for learning. This clearly suggests that principals have greater influence on the school climate, which in turn influence students' achievement. Principals' belief on the nature of teaching and learning likewise significantly influence students' achievement in mathematics, indicating the importance given by principals on teachers' skills and quality of instruction, as well as students' learning. It is imperative that school principals understand what the teachers need to improve instruction and to boost their working morale; and what kind of support the students need to achieve the goals of high achievement results. Thus, providing a positive school climate for learning. Although the results of this study indicate that principals' leadership style does not directly influence students' achievement, the strong influence of their leadership style on school climate cannot be ignored. This also means that principals can have a direct, positive impact on teacher and staff morale. Given that leadership style displayed a positive influence on school climate, it will be advantageous to investigate the principal's influence through each of the constructs of instruction, collaboration, and parental involvement.

The results likewise reveal that students' attitude towards mathematics have direct effect on their achievement. This is therefore one of the areas that the school, specifically the teachers need to maintain and sustain. In order for the students to develop positive attitudes towards learning mathematics, teachers should encourage them to be involved in their learning. The school should give emphasis on the importance of teacher support and encouragement to students to motivate them to learn and achieve their goals.

Finally, the study shows that students' achievement may be directly or indirectly influenced by a multiple number of factors in varying levels and degrees. This implies that school heads, teachers, staff, students and other stakeholders have their own share in providing a healthy learning environment that may enhance students' performance.

References

Abraha, S., Beyene, A., Dubale, T., Fuller, B., Holloway, S., & King, E. (1991). What factors shape girls' school peformance? Evidence from Ethiopia. *International Journal of Educational Development, 11*(2), 107-118.

Adams, T. L., & Hsu, J. W. Y. (1998). Classroom assessment: Teachers’ conceptions and practices in mathematics. *School Science and Mathematics, 98*(4), 174-180.

Adams, R. J., Wilson, M., & Wang, W. C. (1997). The multidimensional random coefficients multinomial logit model. *Applied Psychological Measurement, 21*(1), 1-23.

Aiken, L. R. (1970). Attitudes Toward Mathematics. *Review of Educational Research, 40*(4), 551-596. doi:10.3102/00346543040004551

Aiken, L. R. (1976). Update on attitudes and other affective variables in learning mathematics. *Review of Educational Research, 46*(2), 293-311.

Aiken, L. R. (1979). Attitudes Toward Mathematics and Science in Iranian Middle Schools. *School Science and Mathematics, 79*(3), 229-234. doi:10.1111/j.1949-8594.1979.tb09490.x

Ajzen, I. (1988). *Attitudes, personality, and behavior*. Milton Keynes: Open University Press.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, N.J: Prentice-Hall.

Akinsola, M. (2008). Relationship of some psychological variables in predicting problem solving ability of in-service mathematics teachers. *The Montana Mathematics Enthusiast, 5*(1), 79-100.

Akinsola, M. K., & Olowojaiye, F. B. (2008). Teacher Instructional Methods and Student Attitudes towards Mathematics. *International Electronic Journal of Mathematics Education, 3*(1), 60-73.

Akyüz, G., & Berberoğlu, G. (2010). Teacher and classroom characteristics and their relations to mathematics achievement of the students in the TIMSS. *New Horizons in Education, 58*(1), 77-95.

Ali, R., Hukamdad, D., Akhter, A., & Khan, A. (2010). Effect of Using Problem Solving Method in Teaching Mathematics on the Achievement of Mathematics Students. *Asian Social Science, 6*(2), 67.

Altun, M., & Sezgin-Memnun, D. (2008). Mathematics teacher trainees' skills and opinions on solving non-routine mathematical problems. *Journal of Theory and Practice in Education, 4*(2), 213-238.

Amedahe, F. (2002). Fundamentals of educational research methods. *Mimeograph, UCC, Cape Coast*.

Andersen, J. A. (2010). Public versus private managers: How public and private managers differ in leadership behavior. *Public Administration Review, 70*(1), 131-141

Andrews, R. L., & Soder, R. (1987). Principal leadership and student achievement. *Educational Leadership, 44*(6), 9-11.

Andrich, D. (1978). A rating formulation for ordered response categories. *Psychometrika*, *43*(4), 561-573.

Apple, M., W., & Jungck, S. (1992). You don't have to be a teacher to teach this unit: Teaching, technology and control in the classroom. *Understanding Teacher Development*, 20-42.

Arbuckle, J. L. (2012). IBM SPSS Amos 21. Chicago, IL: Amos Development Corporation.

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*(2), 224.

Australian Institute for Teaching and School Leadership Limited. (2011). *National professional standards for teachers.* http://www.aitsl.edu.au/verve/_resources/AITSL_National_Professional_Standards_for_Teachers.pdf.

Baghaei, P. (2012). The application of multidimensional Rasch models in large scale assessment and validation: An empirica example. *Electronic Journal of Research in Educational Psychology, 10*(1), 233-252.

Ball, D. L. (1990). The Mathematical Understandings That Prospective Teachers Bring to Teacher Education. *The Elementary School Journal, 90*(4), 449-466. doi:10.1086/461626

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Baron, R. M. & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173.

Barr, R., & Dreeben, R. (1983). *How schools work*. Chicago: University of Chicago Press.

Baykul, Y. (1990). To what extent the students' attitudes towards mathematics and science subjects were changed in the Turkish schools in grades five through eleven, the factors which might have some significant relation with the student performance in student selection exam. ÖSYM Yayınları, Ankara, Turkey.

Beaubien, J. M., Hamman, W. R., Holt, R. W., & Boehm-Davis, D. A. (2001). The application of hierarchical linear modeling (HLM) techniques in commercial aviation research. Proceedings of the 11th Annual Symposium on Aviation Psychology, Columbus, OH: The Ohio State University Press.

Beswick, K. (2005). The beliefs/practice connection in broadly defined contexts. *Mathematics Education Research Journal, 17*(2), 39-68.

Betts, J. R., Zau, A., & Rice, L. (2003). *Determinants of student achievement: New evidence from San Diego*. Public Policy Institute of California San Francisco.

Bietenbeck, J.C. (2008). Teaching Practices and Student Achievement: Evidence from TIMSS. Unpublished master thesis, Centro de Estudios Monetarios y Financieros (CEMFI). https://www.cemfi.es/ftp/mt/t1104.pdf

Biggs, J. (1996). Approaches to learning of Asian students: A multiple paradox. *Asian Contributions to Cross-Cultural Psychology, 4*, 180-196.

Bode, R. K., & Wright, B. D. (1999). Rasch measurement in higher education. In *Higher education: Handbook of Theory and Research* (pp. 287-316). Springer, Dordrecht.

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model*. NJ: L: Erlbaum Mahwah.

Boone, W. J., Townsend, J. S. & Staver, J. (2011). Using Rasch theory to guide the practice of survey development and survey data analysis in science education and to inform science reform efforts: An exemplar utilizing STEBI self-efficacy data. *Science Education, 95*(2), 258-280.

Borko, H., Mayfield, V., Marion, S., Flexer, R., & Cumbo, K. (1997). Teachers' developing ideas and practices about mathematics performance assessment: Successes, stumbling blocks, and implications for professional development. *Teaching and teacher education, 13*(3), 259-278.

Brahier, D. J. (2005). *Teaching secondary and middle school mathematics* (2nd ed.). United States of America: Pearson Education Incorporated.

Briggs, D. C. & Wilson, M. (2003). An introduction to multidimensional measurement using Rasch models. *Journal of Applied Measurement*, *4*(1), 87-100.

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms*: Association for Supervision & Curriculum Development.

Brophy, J., & Good, T. (1986). Teacher-effects results. *Handbook of research on teaching,* 328 – 375. New York, Macmillan.

Brown, K. M., Anfara Jr, V. A., & Roney, K. (2004). Student achievement in high performing, suburban middle schools and low performing, urban middle schools: Plausible explanations for the differences. *Education and Urban Society*, *36*(4), 428-456.

Brown, T. A., & Moore, M. T. (2012). Confirmatory factor analysis. In R. H. Hoyle (Ed.), *Handbook of structural equation modeling*, 361-379. New York, NY US: The Guilford Press.

Browne, M. W. & Cudeck, R. (1993). Alternative ways of assessing model fit. In: K. A. Bollen & S. J. Long (Eds). *Testing Structural Equation Models*, Newbury Park/London, 136-162.

Bryk, A., Camburn, E., & Louis, K. S. (1999). Professional community in Chicago elementary schools: Facilitating factors and organizational consequences. *Educational Administration Quarterly, 35*(5), 751-781.

Bryk, A. S., & Raudenbush, S. W. (1992). Hierarchical linear models for social and behavioral research: Applications and data analysis methods. Newbury Park, CA: Sage.

Butty, J.-A. L. M. (2001). Teacher Instruction, Student Attitudes, and Mathematics Performance among 10th and 12th Grade Black and Hispanic Students. *Journal of Negro Education, 70*(1-2), 19-37.

Cabrera, N. J., Shannon, J. D., & Tamis-LeMonda, C. (2007). Fathers' influence on their children's cognitive and emotional development: From toddlers to pre-K. *Applied Development Science, 11*(4), 208-213.

Calingasan, L. (2011). A primer on the new K to 12 Philippine Education curriculum.

Campbell, J. R., Hombo, C. M., & Mazzeo, J. (2000). *NAEP 1999 trends in academic progress: Three decades of student performance*: ERIC

Carpenter, T., & Lubinski, C. (1990). Teachers' attribution and beliefs about girls, boys and mathematics. *Educational Studies in Mathematics, 21*, 55-69.

Cassen, R., & Kingdon, G. (2007). *Tackling low educational achievement*: Joseph Rowntree Foundation.

Castro, S. L. (2002). Data analytic methods for the analysis of multilevel questions: A comparison of intraclass correlation coefficients, rwg (j), hierarchical linear modeling, within-and-between-analysis, and random group resampling. *The Leadership Quarterly, 13*(1), 69-93.

Chen, Q. (2013). *A multilevel analysis of mathematically low-achieving students in Singapore*. Paper presented at the 5th IEA International Research Conference (pp. 26-28).

Chen, Q. (2014). Using TIMSS 2007 data to build mathematics achievement model of fourth graders in Hongkong and Singapore. *International Journal of Science and Mathematics Education,* 12(6), 1519-1545. doi: 10.1007/s10763-013-9505-x.

Chen, C. H., Crockett, M. D., Namikawa, T., Zilimu, J., & Lee, S. H. (2011). Eighth grade mathematics teachers' formative assessment practices in SES-different classrooms: A Taiwan study. *International Journal of Science and Mathematics Education*, 1-27.

Choi, N., & Chang, M. (2011). Interplay among School Climate, Gender, Attitude toward Mathematics, and Mathematics Performance of Middle School Students. *Middle Grades Research Journal, 6*(1), 15-28.

Civelek, M. E. (2018). *Essentials of structural equation modeling*: Lulu. com.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2007). Teacher credentials and student achievement: Longitudinal analysis with student fixed effects. *Economics of Education Review, 26*(6), 673-682.

Cobb-Clark, D. A., & Moschion, J. (2017). Gender gaps in early educational achievement. *Journal of Population Economics, 30*(4), 1093-1134.

Cobb, P., Wood, T., & Yackel, E. (1990). Chapter 9: Classrooms as Learning Environments for Teachers and Researchers. *Journal for Research in Mathematics Education. Monograph, 4*, 125-210.

Cogan, L. S., & Schmidt, W. H. (1999). An examination of instructional practices in six countries. *International comparisons in mathematics education, 11*, 68.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences, 2nd ed. Hillsdale, NJ: Lawrence Earlbaum Associates.

Coleman, J. S., United States., & National Center for Education Statistics. (1966). *Equality of educational opportunity [summary report* (Vol. 2). Washington: U.S. Department of Health, Education, and Welfare, Office of Education.

Cooney, T. J., & Shealy, B. E. (1997). On understanding the structure of teachers' beliefs and their relationship to change. In E. Fennema & B. S. Nelson (Eds.), *The studies in mathematical thinking and learning series. Mathematics teachers in transition*, 87-109. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Cornell, C. (1999). I Hate Math! I Couldn't Learn It, and I Can't Teach It! *Childhood Education, 75*(4), 225-230.

Corcoran, T., & Goertz, M. (1995). Instructional capacity and high performance schools. *Educational Researcher, 24*(9), 27-31.

Cotton, K. (2003). *Principals and student achievement: What the research says*. ASCD.

Creswell, J. (2008). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (3rd ed.). New Jersey: Pearson International Edition.

Crooks, T. J. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research, 58*(4), 438-481.

Curtis, D. D. (2004). Comparing classical and contemporary analyses and Rasch measurement. In S. Alagumalai, D. D. Curtis, & N. Hungi, (Eds.), *Applied Rasch Measurement: A book of Exemplars - Papers in honour of John P. Keeves* (pp. 181-197). The Netherlands: Springer.

Darling-Hammond, L. (2000). Teacher quality and student achievement. *Education Policy Analysis Achives, 8*, 1.

Darmawan, I. (2003). *Implementation of information technology in local government in Bali, Indonesia*. Flinders University.

De Jong, R., Westerhof, K. J. & Kruiter, J. H. (2004). Empirical evidence of a comprehensive model of school effectiveness: A multilevel study in mathematics in the first year of junior general education in the Netherlands. *School Effectiveness and School Improvement*, *15*(1), 3-31.

Dellinger, A.B., Bobbett, J. J., Olivier, D. F., & Ellett, C. D. (2008). Measuring teachers' self-efficacy beliefs: Development and use of the TEBS-Self. *Teaching and Teacher Education*, 24(3), 751-766. doi: https://doi.org/10.1016/j.tate.2007.02.010.

DeLuca, C., & Klinger, D. A. (2010). Assessment literacy development: Identifying gaps in teacher candidates' learning. *Assessment in Education: Principles, Policy & Practice, 17*(4), 419-438.

Department of Education (2010). Briefer on the Enhanced K to 12 Basic Education program. Philippines: Official Gazette. Retrieved: https://mlephil.wordpress.com.

Department of Education (2010). Discussion Paper on the Enhanced K to 12 Basic Education Program.

Department of Education (2011). K to 12 Basic Education Program Primer DepEd Updates

Dial, J. C. (2008). The effect of teacher experience and teacher degree levels on student achievement in mathematics and communication arts (Doctoral dissertation, Baker University).

Diamantopoulos, A., & Siguaw, J. A. (2000). *Introducing LISREL: A guide for the uninitiated*. London: Sage Publications.

Draper, R. J. (2002). School mathematics reform, constructivism, and literacy: A case for literacy instruction in the reform-oriented math classroom. *Journal of Adolescent and Adult Literacy*, *45*(6), 520-529.

Duff, J. (2012). Cooperative learning vs. direct instruction: Using two instructional models to determine their impact on student learning in a middle school math classroom. *Education Senior Action Research Projects*. Paper 5. http://scholar.valpo.edu/sarp/5.

Duncan, P. W., Bode, R. K., Min Lai, S., & Perera, S. (2003). Rasch analysis of a new stroke-specific outcome scale: the stroke impact scale. *Archives of Physical Medicine and Rehabilitation, 84*(7), 950-963. doi:10.1016/S0003-9993(03)00035-2

Dyer, J. E., Lacey, R., & Osborne, E. O. (1996). Attitudes Of University Of Illinois College Of Agriculture Freshmen Toward Agriculture. *Journal of Agricultural Education*, *37*(3), 33-42. doi:10.5032/jae.1996.03033.

Earl, L. (2005). Classroom assessment: Making learning paramount. *Mass Journal*, 5(1), 14-15.

Earl, L., & Katz, S. (2006). Rethinking classroom assessment with purpose in mind. *Winnepeg, Manitoba: Western Northern Canadian Protocol*.

Earnest, J., & Treagust, D.F. (2006). *Education Reform in Societies in Transition: International Perspectives*: Sense Publishers.

Ehrenberg, R. G., Brewer, D. J., Gamoran, A., & Willms, J. D. (2001). Class size and student achievement. *Psychological Science in the Public Interest*, *2*(1), 1-30.

Ejakait, E., Mutisya, M., Ezeh, A., Oketch, M., & Ngware, M. (2011). Factors Associated With Low Achievement Among Students From Nairobi's Urban Informal Neighborhoods. *Urban Education, 46*(5), 1056-1077.

Enemark, P., & Wise, L. (1981). *Supplementary mathematics probe study. Final report* (AIR-892-FR). Retrieved from http://www.eric.ed.gov/PDFS/ED222553.pdf

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics,* 100(4), 194-202.

Ercikan, K., McCreith, T., & Lapointe, V. (2005). Factors associated with mathematics achievement and participation in advanced mathematics courses: An examination of gender differences from an international perspective. *School Science and Mathematics, 105*(1), 5-14.

Ernest, P. (1989). The knowledge, beliefs and attitudes of the mathematics teacher: A model. *Journal of education for teaching, 15*(1), 13-33.

Eufemia, F. (2012). *The relationship between formative assessment and teachers' self-efficacy*. University of Florida.

Evensen, D.H., Hmelo, C.E., & Hmelo-Silver, C.E. (2000). Problem-based learning: A research perspective on learning interactions: Routledge.

Fan, L., & Zhu, Y. (2007). Representation of problem-solving procedures: A comparative look at China, Singapore, and US mathematics textbooks. *Educational Studies in Mathematics, 66*(1), 61-75.

Farrant, J. S. (1994). Principles and Practices of Education. Essex, Longman.

Felder, R. M., & Brent, R. (2007). Cooperative learning. *Active learning: Models from the analytical sciences*. In P. A. Mabrouk (Ed.), ACS Symposium

Series 970, Chapter 4, pp. 34-53. Washington, DC: American Chemical Society.

Fennema, E. (2000). Gender and mathematics: What is known and what do I wish was known. In *Fifth Annual Forum of the National Institute for Science Education* (pp. 22-23).

Fennema, E., & Franke, M. L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 147-164). New York: Macmillan Publishing Company.

Fennema, E., & Sherman, J. (1976). Mathematics attitude scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Catalog of Selected Documents in Psychology*, 6(2), 31.

Field, A. (2009). Discovering statistics using SPSS. London: Sage.

Flanders, J. R. (1987). How Much of the Content in Mathematics Textbooks Is New? *Arithmetic Teacher, 35*, n1.

Floden, R.E. (2001). Research on effects of teaching: A continuing model for research on teaching. *Handbook of research on teaching, 4,* 3-16.

Folk, V. G. & Green, B. F. (1989). Adaptive estimation when the unidimensionality assumption of IRT is violated. *Applied Psychological Measurement, 13*(4), 373-389. Doi: 10.1177/014662168901300404

Freeman, C., O'Malley, K., & Eveleigh, F. (2014). Australian teachers and the learning environment: An analysis of teacher response to TALIS 2013.

Frost, L. A. Hyde, J. S., & Fennema, E. (1994). Gender, mathematics performance, and mathematicss-related attitudes and affect: A meta-analytic synthesis. *International Journal of Educational Research, 21*(4), 373-385.

Fuchs, T., & Wößmann, L. (2007). What accounts for international differences in student performance? A re-examination using PISA data. *Empirical Economics, 32*(2), 433-464. doi:10.1007/s00181-006-0087-0

Gao, M. (2012). Classroom assessments in mathematics: High school students' perceptions. *International Journal of Business and Social Science, 3*(2).

Garet, M.S., Porter, A.C., Desimone, L., Birman, B. F. & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915-945.

Gavora, P. (2010). Slovak pre-service teacher self-efficacy:Theoretical and research considerations. *The New Educational Review*, 21(2), 17-30.

Ghagar, M. N. A., Othman, R., & Mohammadpour, E. (2011). Multilevel analysis of achievement in mathematics of Malaysian and Singaporean students. *Journal of Educational Psychology and Counseling, 2*(11), 285-304.

George, D. & Mallery, M. (2010). SPSS for windows step by step: A simple guide and reference, 17.0 update (10a ed.). Boston: Pearson.

Gibbons, S., Kimmel, H., & O'Shea, M. (1997). Changing teacher behavior through staff development: Implementing the teaching and content standards in science. *School Science and Mathematics, 97*(6), 302-310.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, 76(4), 569.

Gibson, N. M., & Olejnik, S. (2003). Treatment of missing data at the second level of hierarchical linear models. *Educational and Psychological Measurement, 63*(2), 204-238.

Ginsburg, H. P. (2009). The challenge of formative assessment in mathematics education: Children's minds, teachers' minds. *Human Development, 52*(2), 109.

Glickman, C., Gordon, S., & Ross-Gordon, J. (2009). *Supervision and instructional leadership: A developmental approach*. Allyn and Bacon. Boston, MA.

Goldhaber, D. (2002). Mystery of good teaching: the evidence shows that good teachers make a clear difference in student achievement. The problem is that we don't really know what makes a good teacher.(Feature). *Education Next (Feature), 1*, 50-55.

Goldhaber, D. D., & Brewer, D. J. (1997). Why don't schools and teachers seem to matter? Assessing the impact of unobservables on educational productivity. *Journal of Human Resources,* 505-523.

Goldhaber, D. D. & Brewer, D. J. (2000). Does teacher certification matter? High school teacher certification status and student achievement. *Educational Evaluation and Policy Analysis, 22*(2), 129-145.

Goldring, E. B. & Pasternack, R. (1994). Principals' coordinating strategies and school effectiveness. *School Effectiveness and School Improvement, 5*(3), 239-253.

Goldstein, L. S. (1999). The relational zone: The role of caring relationships in the co-construction of mind. *American Educational Research Journal, 36*(3), 647-673.

Gonzales, R. D., & Callueng, C. M. (2014). Classroom assessment practices of Filipino teachers: Measurement and impact of professional development. *Essentials on Counseling and Education: A Festchrift of Prof. Rose Marie*

Salazar-Clemena. Manila: Asian Psychological Services and Assessment (APSA), 220-242.

Gonzales, R. D., & Fuggan, C. G. (2012). Exploring the conceptual and psychometric properties of classroom assessment. *The International Journal of Educational and Psychological Assessment, 9(1)*, 45-60.

Green, K. E., & Frantom, C. G. (2002). Survey development and validation with the Rasch model. In *International Conference on Questionnaire Development, Evaluation, and Testing*. Charleston, SC.

Griffin, C. C., & Jitendra, A. K. (2009). Word problem-solving instruction in inclusive third-grade mathematics classrooms. *The Journal of Educational Research*, *102*(3), 187-202.

Gross, S. J., Mettelman, B. B., Dye, T. D., & Slagle, T. A. (2001). Impact of family structure and stability on academic outcome in preterm children at 10 years of age. *The Journal of Pediatrics, 138*(2), 169-175.

Grouws, D. A., & Cebulla, K. J. (2000). *Improving student achievement in mathematics*: Unesco.

Gulikers, J. T. M., Bastiaens, T. J., Kirschner, P. A., & Kester, L. (2008). Authenticity is in the eye of the beholder: student and teacher perceptions of assessment authenticity. *Journal of Vocational Education and Training, 60*(4), 401-412.

Gurr, D. (1997). Principal leadership: What does it do, what does it look like? In *Australian Principal Centre Research Forum*.

Guskey, T. R. & Sparks, D. (2004). Linking professional development to improvements in student learning. *Research linking teacher preparation and student performance*, 11-21.

Hair, J. F., Anderson, R. E., Tatham, R. L. & Black, W. C. (1998). *Multivariate data analysis (5th ed.)*. Upper Saddle River, NJ: Prentice Hall.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). *Multivariate data analysis*. Pearson Prentice Hall.

Hallinger, P. (2003). Leading educational change: Reflections on the practice of instructional and transformational leadership. *Cambridge Journal of Education, 33*(3), 329-352.

Hallinger, P., & Heck, R. H. (1996). Reassessing the principal's role in school effectiveness: A review of empirical research, 1980-1995. *Educational Administration Quarterly*, 32(1), 5-44.

Hallinger, P., & Heck, R. H. (1998). Exploring the principal's contribution to school effectiveness: 1980-1995. *School Effectiveness and School Improvement, 9*(2), 157-191.

Hallinger, P., & Heck, R. H. (2002). What do you call people with visions? The role of vision, mission and goals in school leadership and improvement. In *Second International Handbook of Educational Leadership and Administration* (pp. 9-40). Springer, Dordrecht.

Hallinger, P., & Murphy, J. F. (1986). The social context of effective schools. *American Journal of Education, 94*(3), 328-355.

Hallinger, P., & Murphy, J. (1987). Assessing and developing principal instructional development. *Educational Leadership, 45*(1), 54-61.

Halmos, P. R. (1980). The heart of mathematics. *The American Mathematical Monthly, 87*(7), 519-524.

Hambleton, R. K., & Jones, R. W. (1993). An NCME instructional module on: Comparison of classical test theory and item response theory and their applications to test development. *Educational Measurement: Issues and Practice, 12*(3), 38-47.

Harlen, W. (2004). *A systematic review of the evidence of reliability and validity of assessment by teachers used for summative purposes*. EPPI- Centre, Social Science Research Unit, Institute of Education, University of London.

Harlen, W. (2007). *Assessment of learning*. London. Sage

Harlen, W. (2008). Trusting teachers' judgment. *Unlocking assessment: Understanding for reflection and application*, 138-153.

Harlen, W., & James, M. (1997). Assessment and learning: Differences and relationships between formative and summative assessment. *Assessment in Education: Principles, Policy & Practice, 4*(3), 365-379.

Harnisch, D. L., Steinkamp, M. W., Tsai, S.-L., & Walberg, H. J. (1986). Cross-national differences in mathematics attitude and achievement among seventeen-year-olds. *International Journal of Educational Development, 6*(4), 233-244. doi:10.1016/0738-0593(86)90027-1

Harris, D., & Sass, T. (2007). Teacher training, teacher quality, and student achievement (working paper No. 3). Washington, DC: National center for analysis of longitudinal data in education research.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education,* 33-46.

Hemmings, B., Grootenboer, P., & Kay, R. (2011). Predicting mathematics achievement: The influence of prior achievement and attitudes. *International Journal of Science and Mathematics Education, 9*(3), 691-705. doi:10.1007/s10763-010-9224-5

Henson, R. K., & Roberts, J. K. (2006). Use of Exploratory Factor Analysis in Published Research:Common Errors and Some Comment on Improved Practice. *Educational and Psychological Measurement, 66*(3), 393-416. doi:10.1177/0013164405282485

Heritage, M., Kim, J., Vendlinski, T., & Herman, J. (2009). From evidence to action: A seamless process in formative assessment? *Educational Measurement: Issues and Practice, 28*(3), 24-31.

Hiebert, J. (1999). Relationships between research and the NCTM standards. *Journal for Research in Mathematics Education, 30(1),* 3-19. doi: 10.2307/749627.

Hollingsworth, H., McCrae, B., Lokan, J., & Australian Council for Educational, R. (2003). *Teaching mathematics in Australia: results from the TIMSS 1999 video study* (Vol. no. 5). Camberwell, Vic: Australian Council for Educational Research.

Lokan, J., McRae, B., & Hollingsworth, H. (2003). Teaching mathematics in Australia: results from the TIMSS 1999 video study. *TIMSS-R Video Study (2003)*, 4. http://research.acer.edu.au/timss_video/4.

House, J. D., & Telese, J. A. (2012). Effects of mathematics lesson activities and computer use on Algebra Achievement of eightgrade students in the United States and Japan: Findings from the TIMSS 2007 Assessment. *International Journal of Instructional Media, 38*(1).

Howard, E., Howell, B., & Brainard, E. (1987). Handbook for conducting school climate improvement projects. Bloomington. Indiana. The Phi Delta Kappa Educational Foundations.

Howitt, D., & Cramer, D. (2000). An introduction to statistics in psychology. Essex. England: Pearson Education Limited.

Hox, J. J. (2010). Multilevel analysis: Techniques and applications 92nd ed.). Routledge.

Hoy, A. W., & Hoy, W. K. (2003). *Instructional leadership: A learning-centered guide*. Boston, MA: Allyn and Bacon.

Hu, L. T., & Bentler, P. M. (1999). Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A multidisciplinary Journal*, 6(1), 1-55.

Huffman, D., Thomas, K., & Lawrenz, F. (2003). Relationship between professional development, teachers' instructional practices, and the achievement of students in Science and Mathematics. *School Science and Mathematics, 103*(8), 378-387.

Husén, T. (1967). *International study of achievement in mathematics: A comparison of twelve countries* (Vols. 1-2). New York: Wiley.

Ignacio, N. G., Nieto, L. J. B., & Barona, E. G. (2006). The affective domain in mathematics learning. *International Electronic Journal of Mathematics Education, 1*(1), 16-31.

Isac, M. M., da Costa, P. D., Araújo, L., Calvo, E.S., & Albergaria-Almeida, P. (2015). Teaching practices in primary and secondary schools in Europe: Insights from large-scale assessments in education. *JRC Scientific and Technical Reports. Luxembourg: Publications Office of the European Union*. doi: 10.383588.

Jacob, R., Hill, H., & Corey, D. (2017). The impact of a professional development program on teachers' mathematical knowledge for teaching, instruction, and student achievement. *Journal of Research on Educational Effectiveness, 10*(2), 379-407.

Jennison, M., & Beswick, K. (2010). Student attitude, student understanding and mathematics anxiety. *Mathematics Education Research Group of Australasia*. July 2010, 280-288.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*: Interaction Book Company.

Johnson, J. P., Livingston, M., Schwartz, R. A., & Slate, J. R. (2000). What makes a good elementary school? A critical examination. *The Journal of Educational Research, 93*(6), 339-348.

Johnson, B., Stevens, J. J., & Zvoch, K. (2007). Teachers' perceptions of school climate: A validity study of scores from the Revised School Level Environment Questionnaire. *Educational and Psychological Measurement, 67*(5), 833-844.

Kanyongo, G. Y., & Ayieko, R. (2017). Hierarchical linear modelling of sixth-grade students' socio-economic status and school factors on mathematics achievement: Case studies of Kenya and Zimbabwe. *African Journal of Research in Mathematics, Science and Technology Education, 21*(2), 187-199.

Kaplan, L. S., Owings, W. A., & Nummery, J. (2005). Principal quality: A Virginia study connecting interstate school leaders licensure consortium standards with student achievement. *NASSP Bulletin, 89*(643), 28-44.

Karp, K.S. (1991). Elementary school teachers' attitudes toward mathematics: The impact on students' autonomous learning skills. *School Science and Mathematics, 91(6)*, 265-270.

Kelloway, E. K. (1998). *Using LISREL for structural equation modeling: A researcher's guide*: Sage.

Ker, H. W. (2016). The impacts of student-, teacher- and school-level factors on mathematics achievement: An exploratory comparative investigation of Singaporean students and the USA students. *Educational Psychology, 36*(2), 254-276. doi: 10.1080/01443410.2015.1026801.

Klieme, E., Pauli, C., & Reusser, K. (2009). The Pythagoras study: Investigating effects of teaching and learning in Swiss and German mathematics classrooms. *The power of video studies in investigating teaching and learning in the classroom*, 137-160.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: The Guilford Press.

Kline, R. B. (2005). *Principles and practice of structural equation modeling (2nd ed.).* New York: The Guilford Press.

Konstantopoulos, S. (2011). How consistent are class size effects? *Evaluation Review, 35*(1), 71-92.

Kosgei, A. Mise, J. K., Odera, O., & Ayugi, M. E. (2013). Influence of teacher characteristics on students' academic achievement among secondary schools. *Journal of Education and Practice, 4*(3), 76-82.

Kozina, A., Rožman, M., Perše, T. V., & Leban, T. R. (2008). The school climate as a predictor of the achievement in TIMSS Advanced study: A students', teachers' and principals' perspective. *IEA IRC, Gothenbrg, Sweden: IEA, Amsterdam*.

Kruse, S. D., Louis, K. S., & Bryk, A. S. (1995). An emerging framework for analyzing school based professional community. In K. S. Louis & S. D. Kruse (Eds.), *Professionalism and community: Perspectives on reforming urban schools* (pp. 23-42). Thousand Oaks, CA: Corwin Press, Inc.

Kulm, G., Morris, K., & Grier, L. (1999). *Middle grade mathematics textbooks: a benchmarks-based evaluation*: Washington, DC: American Association for the Advancement of Science.

Kwon, O. N., Park, J. S., & Park, J. H. (2006). Cultivating divergent thinking in mathematics through an open-ended approach. *Asia Pacific Education Review, 7*(1), 51-61.

Kyriacou, C. (1997). *Effective teaching in schools: Theory and practice (3rd Edn.).* Cheltenham, United Kingdom: Nelson Thornes Ltd.

Kyriakides, L. (2008). Testing the validity of the comprehensive model of educational effectiveness: A step towards the development of a dynamic model of effectiveness. *School Effectiveness and School Improvement, 19*(4), 429-446.

Lamb, S., & Fullarton, S. (2002). Classroom and School Factors Affecting Mathematics Achievement: A Comparative Study of Australia and the United States Using TIMSS. *Australian Journal of Education, 46*(2), 154-171.

Leder, G., & Forgasz, H. J. (2002). Measuring mathematical beliefs and their impact on the learning of mathematics: A new approach. In G. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hidden variable in mathematics education?* (Vol. 31, pp. 95-113). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Leder, G. C., Pehkonen, E., & Törner, G. (2002). Setting the scene. In *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 1-10). Springer, Dordrecht.

Lee, J., & Shute, V. J. (2010). Personal and Social-Contextual Factors in K-12 Academic Performance: An Integrative Perspective on Student Learning.

Educational Psychologist, 45(3), 185-202. doi:10.1080/00461520.2010.493471

Lehr, C. A. (2004). Positive school climate: Information for educators. *National Association of School Psychologists*. Bethesda, MD, 160-168.

Leikin, R., & Zaslavsky, O. (1997). Facilitating student interactions in mathematics in a cooperative learning setting. *Journal for Research in Mathematics Education*, 331-354.

Leithwood, K. A., & Riehl, C. (2003). *What we know about successful school leadership*. Philadelphia, PA: Laboratory for Student Success, Temple University.

Leithwood, K., Seashore-Louis, K., Anderson, S., & Wahlstrom, K. (2004). *How leadership influences student learning*. New York: Wallace Foundation.

Leuchter, M., Pauli, C., Reusser, K., & Lipowsky, F. (2006). Lesson-related beliefs and situational beliefs in teaching staff. *Journal of Educational Science, 9(4),* 562-579.

Levine, G. (2013). Closing the gender gap: Increasing confidence for teaching mathematics. *NERA Conference Proceedings 2013*. Paper 7.

Linacre, J. M. (2002). Optimizing rating scale category effectiveness. *Journal of Applied Measurement, 3*(1), 85-106.

Lipowsky, F., Rakoczy, K., Pauli, C., Drollinger-Vetter, B., Klieme, E., & Reusser, K., (2009). Quality of geometry instruction and its short-term impact on students' understanding of the Pythagorean Theorem. *Learning and Instruction, 19(6),* 527-537.

Little, J. W. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record, 105*(6), 913-945.

Little, R. J., & Rubin, D. B. (2002). Bayes and multiple imputation. *Statistical analysis with missing data*, 200-220.

Liu, O. L. (2009). An investigation of factors affecting gender differences in standardized math performance: Results from US and Hong Kong 15 year olds. *International Journal of Testing*, *9*(3), 215-237.

Liu, X., & Boone, W. J. (2006). *Applications of Rasch measurement in science education*. JAM Press.

Loucks-Horsley, S., Hewson, P., Love, N., & Stiles, K. (1998). Designing professional development for teachers of mathematics and science. Thousand Oaks, CA: Corwin Press.

Luppescu, S., & Ehrlich, S. B. (2012). *UChicago Consortium Rasch measurement model primer*. Chicago, IL: University of Chicago Consortium on Chicago School Research.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, 520-540.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education, 28*(1), 26-47.

Marshall, S. P. (1989). Affect in schema knowledge: Source and impact. In *Affect and mathematical problem solving* (pp. 49-58). Springer, New York, NY.

Marzano, R. J., Waters, T., & McNulty, B. A. (2005). *School leadership that works: From research to results*: ASCD.

Mayer, R.E. (2004). Should there be a three-strikes rule against pure discovery learning? *American Psychologist, 59(1),* 14.

McEvoy, A., & Welker, R. (2000). Antisocial behavior, academic failure, and school climate: A critical review. *Journal of Emotional and Behavioral Disorders, 8*(3), 130-140.

McIntosh, M. E. (1997). Formative assessment in mathematics. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 71(2), 92-96. doi: 10.1080/ 00098659709599333.

McKinney, S., & Frazier, W. (2008). Embracing the Principles and Standards for School Mathematics: An Inquiry into the Pedagogical and Instructional Practices of Mathematics Teachers in High-Poverty Middle Schools. *The Clearing House*, *81*(5), 201-210.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. *Handbook of Research on Mathematics Teaching and learning*, 575-596.

Meelissen, M., & Luyten, H. (2008). The Dutch gender gap in mathematics: Small for achievement, substantial for beliefs and attitudes. *Studies in Educational Evaluation, 34*(2), 82-93.

Messick, S. (1990). Validity of test interpretation and use. *ETS Research Report Series, 1990*(1), 1487-1495. doi:10.1002/j.2333-8504.1990.tb01343.x

Miller, W.C. (1981). Staff morale, school climate and educational productivity. *Educational Leadership, 38*(6), 483-86.

Miskel, C., & Ogawa, R. (1988). Work motivation, job satisfaction, and climate. *Handbook of Research on Educational Administration*, 279-304.

Mullis, I. V., Martin, M. O., Gonzales, E. J., & CHrostowski, S. J. (2004). *TIMSS 2003 International Mathematics Report: Findings from IEA's Trends in*

International Mathematics and Science Study at the Fourth and Eighth Grades: ERIC.

Mullis, I. V., Martin, M. O., Ruddock, G. J., O'Sullivan, C. Y., & Preuschoff, C. (2009). *TIMSS 2011 Assessment Frameworks*. International Association for the Evaluation of Educational Achievement. Herengracht 487, Amsterdam, 1017 BT, The Netherlands.

Musial, D., Nieminen, G., Thomas, J., & Burke, K. (2009). *Foundations of meaningful educational assessment*. New York: McGraw-Hill.

Muthén, L., & Muthén, B. (1998-2012). *Mplus user's guide (7th ed.)*. Los Angeles: Author.

National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics*.

National Council of Teachers of Mathematics (2010). *Principles and standards for school mathematics* (Vol. 1).

National Research Council. (1999). *Improving student learning: A strategic plan for education research and its utilization*. National Academies Press.

Neale, D. C. (1969). The role of attitudes in learning mathematics. *The Arithmetic Teacher, 16*(8), 631-640.

Neumann, I., Neumann, K., & Nehm, R. (2011). Evaluating Instrument Quality in Science Education: Rasch-based analyses of a nature of Science test. *International Journal of Science Education, 33*(10), 1373-1405. doi: 10.1080/09500693.2010.511297.

Newbill, P. L. (2005). *Instructional strategies to improve women's attitudes toward science*. Virginia Tech.

Niaz Asadullah, M., Chaudhury, N., & Dar, A. (2007). Student achievement conditioned upon school selection: Religious and secular secondary school quality in Bangladesh. *Economics of Education Review, 26*(6), 648-659.

Nisbet, S. (1991). A new instrument to measure pre-service primary teachers' attitudes to teaching mathematics. *Mathematics Education Research Journal*, 3(2), 34-56.

Nisbet, S., & Warren, E. (2000). Primary school teachers' beliefs relating to mathematics, teaching and assessing mathematics and factors that influence these beliefs. *Mathematics Teacher Education and Development, 2*, 34-47.

Ogwuche, J. P. D., & Kurumeh, M. (2011). Effect of two problem-solving models on Junior Secondary school students' achievement in Algebra. *Journal of Basic and Applied Scientific Research*. www.textroad.com.

OECD. Publishing, & Organisation for Economic Co-operation and Development Staff (2009). *Creating effective teaching and learning environments: First results from TALIS*. Organisation for Economic Co-operation and Development.

Organisation for Economic Co-operation and Development. (2010). *TALIS 2008 Technical Report*. OECD Pub.

Osborne, J. W. (2000). The advantages of hierarchical linear modeling: ERIC Clearinghouse on Assessment and Evaluation, University of Maryland.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307-332.

Pallant, J. (2011). SPSS Survival Manual 4th edition: A step by step guide to data analysis using SPSS version 18. *Maidenhead, Berkshire: Open University Press. Retrieved on from http://www. allenandunwin. com/spss*.

Panizzon, D., & Pegg, J. (2008). Assessment practices: Empowering mathematics and science teachers in rural secondary schools to enhance student learning. *International Journal of Science and Mathematics Education, 6(2),* 417-436.

Pfannkuch, M. (2001). Assessment of school mathematics: Teachers' perceptions and practices. *Mathematics Education Research Journal, 13*(3), 185-203.

Peker, M. (2009). The effects of an instruction using problem solving strategies in Mathematics on the teaching anxiety level of the pre-service primary school teachers. *The New Educational Review, 19*(3-4), 95-114.

Perveen, K. (2010). Effect of the problem-solving approach on academic achievement of students in mathematics at the secondary level. *Contemporary Issues in Education Research (CIER), 3*(3), 9-14.

Philippou, G., & Christou, C. (1998). The effects of a preparatory mathematics program in changing perspective teachers' attitudes towards mathematics. *Educational Studies in Mathematics, 35*(2), 189-206.

Philippou, G., & Christou, C. (2002). A story of the mathematics teaching efficacy beliefs of primary teachers. In G. Leder, E. Pehkonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (Vol. 31, pp. 211-231). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Pong, S. I., & Pallas, A. (2001). Class size and eighth-grade math achievement in the United States and abroad. *Educational Evaluation and Policy Analysis, 23*(3), 251-273.

Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education, 58*(1), 449-458.

Putney, D., & Cass, M. (1998). Preservice teacher attitudes toward mathematics: Improvement through a manipulative approach. *College Student Journal, 32*, 626-632.

Quinn, R. J. (1997). Effects of mathematics methods courses on the mathematical attitudes and content knowledge of preservice teachers. *The Journal of Educational Research, 91*(2), 108-114.

Raudenbush, S. W., Bryk, A. S., Cheong, Y. F. & Congdon, R. T. (2004). HLM6: *Hierarchical Linear and Nonlinear Modeling*. Chicago: Scientific Software International.

Rech, J., Hartzell, J., & Stephens, L. (1993). Comparisons of Mathematical Competencies and Attitudes of Elementary Education Majors with Established Norms of a General College Population. *School Science and Mathematics, 93*(3), 141-144. doi:10.1111/j.1949-8594.1993.tb12212.x

Relich, J., & Way, J. (1992). *Pre-service primary teachers' attitudes to teaching mathematics: A reappraisal of a recently developed instrument*. Paper presented at the Fifteenth Annual Conference of the Mathematics Association of Australasia: Conference Proceedings. Richmond, NSW.

Relich, J., Way, J., & Martin, A. (1994). Attitudes to teaching mathematics: Further development of a measurement instrument. *Mathematics Education Research Journal, 6*(1), 56-69.

Resnick, L. B. (2010). Nested learning systems for the thinking curriculum. *Educational Resarcher*, 39(3), 183-197. doi: 10.2307/27764582

Reynolds, D. S., York, U., & Buffalo, S. (1996). *Alternative assessment in science: A teacher's guide*: University of the State of New York, State Education Department.

Rice, J. K. (2010). The impact of teacher experience: Examining the evidence and policy implications. Brief No. 11. *National Center for Analysis of Longitudinal Data in Education Research*.

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551.

Rickard, A. (2009). Evolution of a Teacher's Problem Solving Instruction: A Case Study of Aligning Teaching Pratice with Reform in Middle School Mathematics. Department of Mathematical Sciences and School of Education, University of Alaska Fairbanks. *Colección Digital Eudoxus, 1*(3).

Robitaille, D. F., & Travers, K. J. (1992). International studies of achievement in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 687-709). New York: Macmillan Publishing Company.

Rokeach, M. (1972). *Beliefs, attitudes and values: A theory of organization and change by Milton Rokeach*: Jossey-Bass.

Ross, J. A., & Gray, P. (2006). School leadership and student achievement: The mediating effects of teacher beliefs. *Canadian Journal of Education/Revue canadienne de l'education,* 798-822.

Rothman, S., & McMillan, J. (2004). Positive school climate helps students achieve positive results. *Research Developments, 11*(11), 3.

Sanchez, M., & Brisk, M. (2004). Teacher's assessment practices and understandings in a bilingual program. *NABE Journal of Research and Practice, 2(1),* 193-208.

Schackow, J. B. (2005). Examining the attitudes toward mathematics of preservice elementary school teachers enrolled in an introductory mathematics methods course and the experiences that have influenced the development of these attitudes. *Graduate Theses and Dissertations*. https://scholarcommons.usf.edu/etd/853

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. *Handbook of research on mathematics teaching and learning*, 334-370.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research, 99*(6), 323-338.

Schulman, L. (1996). New Assessment Practices in Mathematics. *Journal of Education*, 178(1), 61-71.

Schumacker, R. E. and Lomax, R. G. (2004). *A Beginner's Guide to Structural Equation Modelling (2nd edn)*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schumacker, R. E. and Lomax, R. G. (2010). *A Beginner's Guide to Structural Equation Modelling (3rd Edition)*. New York: Taylor & Francis Group.

Schütz, G. (2006). School size and student achievement in TIMSS 2003. *Lessons learned: What international assessments tell us about mathematics achievement*, 175-205.

Sebastian, J., & Allensworth, E. (2012). The influence of principal leadership on classroom instruction and student learning: A study of mediated pathways to learning. *Educational Administration Quarterly*, *48*(4), 626-663.

Secada, W. G. (1992). Race, ethnicity, social class, language, and achievement in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 623-660). New York: Macmillan Publishing Company.

Silver, E.A. (1992). Chapter 6 Assessment and mathematics education reform in the united states. International Journal of Educational Research, 17(5), 489-502. doi: https://doi.org/10.1016/S0883-0355(05)80007-2.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching*, 77(1), 20-26.

Smith, E. P., Atkins, J., & Connell, C. M. (2003). Family, school, and community factors and relationships to racial-ethnic attitudes and academic achievement. *American Journal of Community Psychology, 32*(1-2), 159-173.

Smith, M. L., & Glass, G. V. (1980). Meta-analysis of research on class size and its relationship to attitudes and instruction. *American Educational Research Journal, 17*(4), 419-433.

Smylie, M. A., Allensworth, E., Greenberg, R. C., Harris, R., & Luppescu, S. (2001). Teacher professional development in Chicago: Supporting effective practice. Chicago: Consortium on Chicago School Research at the University of Chicago.

Snijders, T.A.B and Bosker, R.J. (2012). Multilevel analysis: An introduction to basic and advanced multilevel modelling (2nd ed). Sage.

Stapleton, C. D. (1997). Basic Concepts and Procedures of Confirmatory Factor Analysis. Paper presented at the Annual Meeting of the Southwest Educational Research Association. Austin, TX.

Steinkamp, M. W. (1982). Sex-related differences in attitude toward science: A quantitative sysnthesis of Research. Paper presented at the *Annual Meeting of the American Educational Research Association* (New York, NY, March 18-23, 1982).

Stenmark, J. K. (1992). *Mathematics assessment: Myths, models, good questions, and practical suggestions*. Reston, VA:NCTM.

Stevens, J. P. (2009). Applied multivariate statistics for the social sciences (5th ed.). New York: Routledge.

Stevens, R. J., & Slavin, R. E. (1995). The cooperative elementary school: Effects on students' achievement, attitudes, and social relations. *American Educational Research Journal, 32*(2), 321-351.

Stiggins, R. J. (1988). Revitalizing classroom assessment: The highest instructional priority. *The Phi Delta Kappan, 69*(5), 363-368.

Stiggins, R. J. (1999). Assessment, student confidence, and school success. *The Phi Delta Kappan, 81*(3), 191-198.

Sullivan, A. (2009). Academic self-concept, gender and single-sex schooling. *British Educational Research Journal, 35*(2), 259-288.

Sullivan, P., & Mousley, J. (1994). Quality mathematics teaching: Describng some key components. *Mathematics Education Research Journal*, 6(1), 4-22.

Sullivan, P., & Mousley, J. (2001). Thinking teaching: Seeing mathematics teachers as active decision makers. *In Making sense of mathematics teacher education* (pp. 147-163). Springer, Dordrecht.

Sutton, J., & Krueger, A. (2002). *EDThoughts: What We Know about Mathematics Teaching and Learning*. ERIC.

Suurtamm, C., Koch, M., & Arden, A. (2010). Teachers' assessment practices in mathematics: classrooms in the context of reform. *Assessment in Education: Principles, Policy & Practice, 17*(4), 399-417.

Szetela, W., & Nicol, C. (1992). Evaluating Problem Solving in Mathematics. *Educational Leadership, 49*(8), 42-45.

Tabachnick, B. G., and Fidell, L. S. (1996). *Using multivariate statistics* (3rd edn). Harper Collins. New York.

Tabachnick, B. G., and Fidell, L. S. (2013). *Using multivariate statistics* (6th edn). Boston, MA: Allyn & Bacon.

Taylor, P. C., Fraser, B. J., & Fisher, D. L. (1997). Monitoring constructivist classroom learning environments. *International journal of educational research, 27*(4), 293-302.

Teodorović, J. (2011). Classroom and school factors related to student achievement: What works for students? *School Effectiveness and School Improvement, 22*(2), 215-236.

Teodorović, J. (2012). Student background factors influencing student achievement in Serbia. *Educational Studies, 38*(1), 89-110.

Thurstone, L. L. (1928). Attitudes Can Be Measured. *American Journal of Sociology, 33*(4), 529-554. doi:10.1086/214483

Tooley, J., & Dixon, P. (2006). 'De facto' privatisation of education and the poor: Implications of a study from sub-Saharan Africa and India. *Compare, 36*(4), 443-462.

Torrance, H., & Pryor, J. (1998). *Investigating Formative Assessment: Teaching, Learning and Assessment in the Classroom*: ERIC.

Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*(2), 202-248.

Tsui, M. (2007). Gender and mathematics achievement in Chin and the United States. *Gender Issues, 24*(3), 1-11.

Turner, J. C., Midgley, C., Meyer, D. K., Gheen, M., Anderman, E. M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. *Journal of Educational Psychology*, 94(1), 88.

Ulep, S. A. (2006). Good mathematics teaching practices - in the making: A Philippine experience. *The National Institute for Science and Mathematics Education, in the Tsukuba Journal of Educational Study in Mathematics*, 25, 219-227.

UNESCO, I. (2010). World data on education, 2010/11. *UNESCO International Bureau of Education*. Retrieved March 14, 2013.

Utsumi, M. C., & Mendes, C. R. (2000). Researching the Attitudes Towards Mathematics in Basic Education. *Educational Psychology, 20*(2), 237-243. doi:10.1080/713663712

Visser, M., Juan, A., & Feza, N. (2015). Home and school resources as predictors of mathematics performance in South Africa. *South African Journal of Education, 35*(1).

Walker-Glenn, M. L. (2010). *Leadership for School Numeracy: How School Leaders' Knowledge and Attitudes Impact Student Mathematics Achievement*. Miami University.

Walker, J. T., & Lofton, S. P. (2003). Effect of a problem based learning curriculum on students' perceptions of self directed learning. *Issues in Educational Research, 13*(2), 71-100.

Wang, Y. L., Frechtling, J. A. & Sanders, W. L. (1999). *Exploring linkages between professional development and student learning: A pilot study*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal.

Wang, Z., Osterlind, S. J., & Bergin, D. A. (2012). Building mathematics achievement models in four countries using TIMSS 2003. *International Journal of Science and Mathematics Education, 10*(5), 1215-1242.

Warm, T. A. (1989). Weighted likelihood estimation of ability in item response theory. *Psychometrika, 54*(3), 427-450. doi:10.1007/bf02294627

Waters, T., Marzano, R. J., & McNulty, B. (2003). Balanced leadership: What 30 years of research tells us about the effect of leadership on student achievement. A Working Paper.

Watt, H. M. (2005). Attitudes to the use of alternative assessment methods in mathematics: A study with secondary mathematics teachers in Sydney, Australia. *Educational Studies in Mathematics*, *58*(1), 21-44.

Webb, J. (1989). *The crisis in South African mathematics*.

Webster, B. J., & Fisher, D. L. (2003). School-level environment and student outcomes in mathematics. *Learning Environments Research, 6*(3), 309-326.

Weiner, B. (1972). Attribution theory, achievement motivation, and the educational process. *Review of Educational Research, 42(2)*, 203-215. doi: 10.3102/00346543042002203.

Wenglinsky, H. (2002). The Link between Teacher Classroom Practices and Student Academic Performance. *Education policy analysis archives, 10*(12).

Weston, R., & Gore Jr, P. A. (2006). A brief guide to structural equation modeling. *The Counseling Psychologist, 34*(5), 719-751.

White, A. L., Perry, B., Way, J., & Southwell, B. (2005/2006). Mathematical attitudes, beliefs and achievement in primary pre-service mathematics teacher education. *Mathematics teacher education and development, 7*, 33-52.

Wiliam, D. (2001). An overview of the relationship between assessment and the curriculum. *Curriculum and assessment,* 165-182.

Wilkins, J. L. M. (2008). The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices. *Journal of Mathematics Teacher Education, 11*(2), 139-164. doi:10.1007/s10857-007-9068-2

Williams, B., Onsman, A., & Brown, T. (2010). Exploratory factor analysis: A five-step guide for novices. *Australasian Journal of Paramedicine*, 8(3).

Witziers, B., Bosker, R. J., & Krüger, M. L. (2003). Educational leadership and student achievement: The elusive search for an association. *Educational Administration Quarterly, 39*(3), 398-425.

Wößmann, L., & West, M. (2006). Class-size effects in school systems around the world: Evidence from between-grade variation in TIMSS. *European Economic Review, 50*(3), 695-736.

Woodcock, R. W. (1999). What can Rasch-based scores convey about a person's test performance. *The new rules of measurement; What evey psychologist and educator should know*, 105. Psychology Press.

Wright, B. D., & Linacre, J. M. (1994). Reasonable mean-square fit values. *Rasch Measurement Transactions,* 8, 370-371

Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis*: Mesa Press.

Wright, B. D., & Stone, M. (1999). Measurement essentials. *Wilmington. Wide Range Inc,* 221.

Wu, M. L., Adams, R., Wilson, M. R., & Haldane, S. A. (2007). ACER ConQuest: Generalized item response modeling software (version 2). *Camberwell, Australia: ACER Press, an imprint of Australian Council for Educational Research Ltd*.

Yackel, E. (1984). Mathematical beliefs system survey. *Purdue University, West Lafayette, IN. Appendices*.

Yasar, M. (2016). High school students' attitudes towards mathematics. *Eurasia Journal of Mathematics, Science & Technology Education, 12*(4).

Yavuz, M. (2009). Factors that affect mathematics-science (MS) scores in the secondary education institution exam: An application of structural equation modeling. *Educational Sciences: Theory and Practice, 9*(3), 1557-1572.

Youngs, P., & King, M. B. (2002). Principal leadership for professional development to build school capacity. *Educational Administration Quarterly, 38*(5), 643-670.

Yu, C.Y. & Muthén, B. (2001). Evaluation of model fit indices for latent variable models with categorical and continuous outcomes. Technical report. Muthén & Muthén, Los Angeles, CA. (http://www.StatModel.com).

Yun, S., Miller, P. C., Baek, Y., Jung, J., & Ko, M. (2008). Improving recall and transfer skills through vocabulary building in web-based second language learning: An examination by item and feedback type. *Educational Technology & Society, 11*(4), 158-172.

Zan, R., & Di Martino, P. (2007). Attitude toward mathematics: Overcoming the positive/negative dichotomy. *The Montana Mathematics Enthusiast, 3*, 157-168.

.

Appendices

Appendix A. Teacher Questionnaire

THE UNIVERSITY of ADELAIDE

Classroom Practices in Mathematics: Effects on Primary and Secondary Students Achievement in Region XII, Philippines

Teacher Questionnaire

I. Information about this Questionnaire

This questionnaire is designed for mathematics teachers who are teaching in Grade 6 (elementary school) and Fourth Year levels (secondary school). It contains items that ask for general/background information about the teacher-participant, their attitudes towards mathematics and teaching mathematics, self-efficacy beliefs about mathematics, their preferred teaching and assessment practices, their knowledge of assessment in mathematics and their perceptions of mathematics and assessment. Teacher's responses to this questionnaire are significant in helping describe teachers' teaching and assessment practices and how these affect/influence student's achievement in mathematics. The results of this study will inform policy makers to come up with guiding principles that can possibly contribute to the improvement of mathematics education in the country.

It is important therefore that you respond to each item to the best of your knowledge so that the information you provide will reflect your situation as accurately as possible.

It will take roughly **30 minutes** to complete this questionnaire.

II. General Instructions to Teacher Participant

1. Find a place and time in your school when you will be able to complete this questionnaire without being interrupted. You are given as much time as you need to complete this questionnaire. It would be advisable that you complete this questionnaire in one sitting even if you decide to bring this home.
2. Please read each item carefully and respond as accurately and as honestly as you can. Specific instructions in answering the items are given in every section of the questionnaire and are typed in italics. If you make a mistake in responding to items which have the given options, simply mark X on your previous choice and check another box corresponding to your new answer. If you make an error in answering questions that require writing of number, words and/or sentences, simply cross out your previous response and write the new answer next to it. **Please don't leave any item unanswered.**
3. The questionnaire should be returned to the survey questionnaire administrator or to the researcher at the end of the school day or as soon as it has been completed.
4. When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach me by phone: +63 947 7978602

Thank you very much for taking time to complete this questionnaire.

TEACHER QUESTIONNAIRE

I. A. BACKGROUND INFORMATION

Please tick ☐ the appropriate box to indicate your answer.

Name: ______________________________ Code no: ________

Name of School: ______________________________

1. Type of School: ☐₀ Public ☐₁ Private
2. Gender: ☐₀ Male ☐₁ Female
3. Ethnic Group: ☐₁ B'laan/T'boli/Tiruray ☐₄ Cebuano ☐₇ Tagalog
   ☐₂ Bagobo/Manobo ☐₅ Hiligaynon/Ilonggo ☐₈ Pangasinan
   ☐₃ Maranao/Maguindanao ☐₆ Ilocano ☐₉ Others, specify ______________
4. Age: __________
5. What is the highest level of formal education that you have completed? Please specify your Field of Specialization.

   ☐₁ Bachelors Degree, please specify ______________________________
   ☐₂ Bachelors Degree with Master's units ______________________________
   ☐₃ Masters Degree, please specify ______________________________
   ☐₄ Masters Degree, with Doctorate units ______________________________
   ☐₅ Doctorate, please specify ______________________________
   ☐₆ Others, please specify ______________________________

6. How long have you been working as a teacher? __________ (in years)
7. How long have you been teaching mathematics? __________ (in years)
8. In what grade/year level are you teaching at present?

   ☐₀ Primary, specify __________ ☐₁ Secondary, specify __________

9. How many minutes per week do you teach mathematics? __________
10. On the average, how many students are there in your class? __________

I. B. PROFESSIONAL DEVELOPMENT

Professional development is defined here as activities that develop an individual's skills, knowledge, expertise and other characteristics as a teacher.

Please exclude the initial teacher training/education provided by the school.

11. How often do you attend professional development sessions? *Please tick ☐ only one choice*

   ☐₁ Once in every 6 months ☐₃ Once in 2 years
   ☐₂ Once a year ☐₄ Others, specify __________

12. What professional development programs have you participated in for the last 3 years?

Please tick ☐ as many as you can.

- ☐ Trainings/workshops related to mathematics (or other education-related topics)
- ☐ Trainings/workshops on knowledge and understanding of mathematics content
- ☐ Trainings/workshops on knowledge and understanding of instructional/teaching practices in mathematics
- ☐ Trainings/workshops on mathematics curriculum
- ☐ Trainings/workshops on content and performance standards in mathematics
- ☐ Trainings/workshops on mathematics assessment practices
- ☐ Education conferences or seminars (where teachers and/or researchers present their research results and discuss educational problems)
- ☐ Participation in a network of teachers formed specifically for the professional development of teachers
- ☐ Individual or collaborative research on a topic of interest to you professionally
- ☐ Mentoring and/or peer observation and coaching, as part of a formal school arrangement
- ☐ Qualification programmes (e.g. a degree program)
- ☐ Others, please specify ____

II. TEACHING PRACTICES

A. How often do each of the following activities happen in the class?

Please tick ☐ the response that indicates how often you do the following activities throughout the school year.

1 = Never or hardly ever
2 = In about one quarter (25%) of the lesson
3 = In about one-half (50%) of the lesson
4 = In about three-quarters (75%) of the lesson
5 = In almost every lesson

	1	2	3	4	5
1. I present new topics to the class (lecture-style Presentation).	☐	☐	☐	☐	☐
2. I explicitly/clearly state learning goals.	☐	☐	☐	☐	☐
3. I review with the students the homework they have prepared.	☐	☐	☐	☐	☐
4. I require my students work in small groups to come up with a joint solution to a problem or task.	☐	☐	☐	☐	☐
5. I give different work to the students that have difficulties in learning and/or to the fast learners.	☐	☐	☐	☐	☐
6. I ask my students to suggest or to help plan classroom activities or topics.	☐	☐	☐	☐	☐
7. I ask my students to remember every step in a procedure.	☐	☐	☐	☐	☐
8. I present a short summary of the previous lesson at the beginning of the class.	☐	☐	☐	☐	☐
9. I check my students' exercise books.	☐	☐	☐	☐	☐
10. I require my students to work on projects that need to be completed in at least one week.	☐	☐	☐	☐	☐

1 = Never or hardly ever	3 = In about one-half (50%) of the lesson	5 = In almost every lesson
2 = In about one quarter (25%) of the lesson	4 = In about three-quarters (75%) of the lesson	

	1	2	3	4	5
11. I work with individual students.	☐	☐	☐	☐	☐
12. I ask my students to evaluate and reflect upon their work.	☐	☐	☐	☐	☐
13. I check, by asking questions, whether or not the subject matter has been understood.	☐	☐	☐	☐	☐
14. I require my students to make a product that will be useful to society.	☐	☐	☐	☐	☐
15. I administer a test or quiz to assess student learning.	☐	☐	☐	☐	☐
16. I ask my students to solve word problems in which they are expected to explain their thinking or reasoning.	☐	☐	☐	☐	☐
17. I ask my students to work individually with the textbook or worksheets to practice newly taught subject matter.	☐	☐	☐	☐	☐
18. I design a class activity that require students to present and argue for a particular point of view.	☐	☐	☐	☐	☐

B. Teaching strategies

1 = Never or hardly ever	3 = In about one-half of the lesson	5 = In almost every lesson
2 = In about one quarter (25%) of the lesson	4 = In about three-quarters (75%) of the lesson	

19. I use the following teaching practices:

	1	2	3	4	5
a. Lecture/Teacher-directed instruction	☐	☐	☐	☐	☐
b. Memorization of algorithms, procedures and rules/Drill and practice	☐	☐	☐	☐	☐
c. Hands-on learning activities/ Use of manipulatives/Demonstrations and modeling	☐	☐	☐	☐	☐
d. Games, puzzles and riddles	☐	☐	☐	☐	☐
e. Problem-based learning/Connect mathematics to real-world experiences	☐	☐	☐	☐	☐
f. Cooperative learning groups	☐	☐	☐	☐	☐
g. Strict curriculum-based guidance	☐	☐	☐	☐	☐
h. Multi media (e.g., watching videos)	☐	☐	☐	☐	☐
i. Others, please specify	☐	☐	☐	☐	☐

____

III. ASSESSMENT PRACTICES

A. PURPOSE OF ASSESSMENT

Please read each statement starting with "IN MY TEACHING PRACTICE I USE ASSESSMENT TO" and then check the appropriate frequency level that best matches your typical assessment practice.

VR	- Very rarely or Never	**O**	- Occasionally	**A**	- Always
R	- Rarely	**VF**	- Very Frequently		

IN MY TEACHING PRACTICE, I DO CLASSROOM ASSESSMENT TO:	VR (1)	R (2)	O (3)	VF (4)	A (5)
1. Guide students to set their goals and monitor their own learning progress.	☐	☐	☐	☐	☐
2. Demonstrate to students how to do self-assessment.	☐	☐	☐	☐	☐
3. Determine how students can learn on their own in class.	☐	☐	☐	☐	☐
4. Assist students to identify means of getting personal feedback and monitoring their own learning process.	☐	☐	☐	☐	☐
5. Help students develop clear criteria of a good learning practice.	☐	☐	☐	☐	☐
6. Set the criteria for students to assess their own performance in class.	☐	☐	☐	☐	☐
7. Measure extent of learning at the end of a lesson or subject.	☐	☐	☐	☐	☐
8. Evaluate the level of competence of students at the end of an instructional program.	☐	☐	☐	☐	☐
9. Determine the degree of accomplishment of a desired learning outcome at the end of a lesson.	☐	☐	☐	☐	☐
10. Make the final decision about the level of learning that students achieved at the end of a lesson or subject.	☐	☐	☐	☐	☐
11. Rank students based on their class performance to inform other school officials.	☐	☐	☐	☐	☐
12. Provide information to parents about the performance of their children in school.	☐	☐	☐	☐	☐
13. Examine how one student performs compared to others in my class.	☐	☐	☐	☐	☐
14. Supply information to other teachers, schools, employers regarding students' performance in class.	☐	☐	☐	☐	☐
15. Help students improve their learning process and class performance.	☐	☐	☐	☐	☐
16. Assist students to determine their learning strengths and weaknesses in class.	☐	☐	☐	☐	☐
17. Identify better learning opportunities for students in class.	☐	☐	☐	☐	☐
18. Periodically collect learning data from students to improve instructional process.	☐	☐	☐	☐	☐
19. I ask questions or tasks that allow me to know whether students:					
a. Can recall or remember what is taught in class	☐	☐	☐	☐	☐
b. Explain ideas and concepts	☐	☐	☐	☐	☐
c. Use learned information or concepts in a new way	☐	☐	☐	☐	☐
d. Analyze a situation or condition	☐	☐	☐	☐	☐
e. Justify a stand or decision	☐	☐	☐	☐	☐
f. Create a new product or point of view or idea	☐	☐	☐	☐	☐

B. CLASSROOM ASSESSMENT

VR	- Very rarely or Never	O	- Occasionally	A	- Always
R	- Rarely	VF	- Very Frequently		

	VR (1)	R (2)	O (3)	VF (4)	A (5)
1. I prepare at least 3 learning objectives.	☐	☐	☐	☐	☐
2. I refer to the curriculum when I organize my learning objectives.	☐	☐	☐	☐	☐
3. I follow taxonomy in preparing learning objectives.	☐	☐	☐	☐	☐
4. I prepare a test plan according to the learning of my lessons.	☐	☐	☐	☐	☐
5. I ensure that every topic I cover in class is included in the assessment plan.	☐	☐	☐	☐	☐
6. I relate to the instructional process with the assessment process.	☐	☐	☐	☐	☐
7. I try to include a variety of questions to measure different levels of cognitive skills.	☐	☐	☐	☐	☐
8. I ensure that appropriate assessment strategies are employed.	☐	☐	☐	☐	☐
9. I prepare table of specifications (TOS).	☐	☐	☐	☐	☐
10. I write clear learning objectives so that students are aware of what is to be assessed.	☐	☐	☐	☐	☐
11. I use textbooks as references when I write test items.	☐	☐	☐	☐	☐
12. I include a variety of questions in a single test.	☐	☐	☐	☐	☐
13. I make sure I give clear instructions for every type of question I include in a test.	☐	☐	☐	☐	☐
14. I arrange test questions from easy to difficult.	☐	☐	☐	☐	☐
15. I ensure that questions and options are on the same page.	☐	☐	☐	☐	☐
16. I avoid including items that suggest racial, ethnic or gender biases.	☐	☐	☐	☐	☐
17. I try to prepare questions that minimize guessing.	☐	☐	☐	☐	☐
18. I explain the basis of scoring problem solving items to students.	☐	☐	☐	☐	☐
19. I include on the same page the diagrams or maps needed in a particular question.	☐	☐	☐	☐	☐
20. I proofread all test questions and instructions before printing them.	☐	☐	☐	☐	☐
21. I ensure that the classroom is conducive for testing activities.	☐	☐	☐	☐	☐
22. I see to it that cheating is not encouraged in the classroom.	☐	☐	☐	☐	☐
23. I prepare scoring criteria or rubrics before I start marking test papers.	☐	☐	☐	☐	☐
24. I score test papers at random.	☐	☐	☐	☐	☐
25. I ensure that I have enough test materials before I administer a test.	☐	☐	☐	☐	☐
26. I follow scoring criteria strictly when marking test papers.	☐	☐	☐	☐	☐
27. I make sure I have enough time to score test papers.	☐	☐	☐	☐	☐
28. I provide feedback to students after every test.	☐	☐	☐	☐	☐
29. I give a grade equivalent to the total score in a test.	☐	☐	☐	☐	☐
30. I explain to the students how scores are derived.	☐	☐	☐	☐	☐
31. I share test results to other teachers and school director if necessary.	☐	☐	☐	☐	☐

VR	- Very rarely or Never	O	- Occasionally	A	- Always
R	- Rarely	VF	- Very Frequently		

	VR (1)	R (2)	O (3)	VF (4)	A (5)
32. I make sure parents are informed of the test results of their children.	☐	☐	☐	☐	☐
33. I determine the difficulty level of each test item after a test.	☐	☐	☐	☐	☐
34. I conduct item analysis to know whether items can discriminate students' abilities.	☐	☐	☐	☐	☐
35. I make simple item banking for every subject.	☐	☐	☐	☐	☐
36. I post the names of students who performed well in a test to encourage them.	☐	☐	☐	☐	☐
37. I return all marked test papers to students on time.	☐	☐	☐	☐	☐

C. ASSESSMENT STRATEGIES

VR	- Very rarely or Never	O	- Occasionally	A	- Always
R	- Rarely	VF	- Very Frequently		

1. I use the following assessment strategies:

	VR (1)	R (2)	O (3)	VF (4)	A (5)
a. Multiple Choice	☐	☐	☐	☐	☐
b. True-False or Right-Wrong	☐	☐	☐	☐	☐
c. Matching-types	☐	☐	☐	☐	☐
d. Fill-in the blanks or short constructed response	☐	☐	☐	☐	☐
e. Word Problems	☐	☐	☐	☐	☐
f. Performance assessment	☐	☐	☐	☐	☐
g. Portfolio assessment	☐	☐	☐	☐	☐
h. Graded recitation	☐	☐	☐	☐	☐
i. Observations	☐	☐	☐	☐	☐
j. Term Papers or Projects	☐	☐	☐	☐	☐
k. Class presentations	☐	☐	☐	☐	☐
l. Interviews and conferences	☐	☐	☐	☐	☐
m. Student reflection / journal writing/Students self-assessment	☐	☐	☐	☐	☐
n. Assignments	☐	☐	☐	☐	☐
o. Others, please specify	☐	☐	☐	☐	☐

____

IV. TEACHERS ATTITUDES TOWARDS MATHEMATICS AND MATHEMATICS TEACHING

For each item, tick ☐ the response that indicates how you feel about the item as indicated below.

NA = Not Applicable to me	**MF** = Mostly False,	**MT** = Mostly True
F = False	**MFTT** = More False Than True	**T** = True
DF = Definitely False	**MTTF** = More True Than False	**DT** = Definitely True

	NA (0)	DF (1)	F (2)	MF (3)	MFTT (4)	MTTF (5)	MT (6)	T (7)	DT (8)
1. Generally I feel secure about the idea of teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. I find many mathematical problems interesting and challenging.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Mathematics makes me feel inadequate as a mathematics teacher.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. I'm not the type of person who could teach mathematics very well.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. I have always done well in mathematics classes.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. I do not enjoy teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
7. I am quite good at mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
8. I have generally done better in mathematics courses than other courses.	☐	☐	☐	☐	☐	☐	☐	☐	☐
9. I'm not sure about what to do when I'm teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
10. Time passes quickly when I'm teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
11. I have hesitated to take courses that involve mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
12. I would get confused if I came across a hard problem while teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Teaching mathematics doesn't scare me at all.	☐	☐	☐	☐	☐	☐	☐	☐	☐
14. At school, my friends always come to me for help in mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
15. I am confident of the methods of teaching mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
16. I have trouble understanding anything that is based upon mathematics.	☐	☐	☐	☐	☐	☐	☐	☐	☐
17. It wouldn't bother me to teach a lot of mathematics at school.	☐	☐	☐	☐	☐	☐	☐	☐	☐

V. MATHEMATICS TEACHING SELF-EFFICACY BELIEFS

Please indicate the degree to which you agree or disagree with each statement below by ticking ☐ the appropriate boxes to the right of each statement.

	Strongly Disagree (1)	Disagree (2)	Uncertain (3)	Agree (4)	Strongly Agree (5)
1. When a student does better than usual in mathematics, it is often because the teacher exert a little extra effort.	☐	☐	☐	☐	☐
2. I am continually finding better ways to teach mathematics.	☐	☐	☐	☐	☐
3. When the mathematics grades of students improve, it is often due to their teachers' more effective teaching approach.	☐	☐	☐	☐	☐
4. I know the steps to teach mathematics concepts effectively.	☐	☐	☐	☐	☐
5. I am not very effective in monitoring mathematics activities.	☐	☐	☐	☐	☐
6. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	☐	☐	☐	☐	☐
7. I generally teach mathematics ineffectively.	☐	☐	☐	☐	☐
8. The inadequacy of a student's mathematics background can be overcome by good teaching.	☐	☐	☐	☐	☐
9. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	☐	☐	☐	☐	☐
10. I understand mathematics concepts well enough to be effective in teaching elementary/secondary school mathematics.	☐	☐	☐	☐	☐
11. The teacher is generally responsible for the achievement of students in mathematics.	☐	☐	☐	☐	☐
12. Students' achievement in mathematics is directly related to their teachers' effectiveness in mathematics teaching.	☐	☐	☐	☐	☐
13. A child's interest in mathematics at school is probably due to the performance of the child's teacher.	☐	☐	☐	☐	☐
14. I find it difficult to use manipulatives to explain to students why mathematics works.	☐	☐	☐	☐	☐
15. I am able to answer students' mathematics questions.	☐	☐	☐	☐	☐
16. I wonder if I have the necessary skills to teach mathematics.	☐	☐	☐	☐	☐
17. Given a choice, I would not invite the principal or other administrator (e.g. program/department coordinator, district supervisors) to evaluate my mathematics teaching.	☐	☐	☐	☐	☐
18. I am usually at a loss as to how to help student understand a mathematics concept better.	☐	☐	☐	☐	☐
19. I usually welcome student questions when teaching mathematics.	☐	☐	☐	☐	☐
20. I do not know how to motivate students in learning mathematics.	☐	☐	☐	☐	☐

VI. PERCEPTIONS OF ASSESSMENT

Please briefly answer the question below.

What are your perceptions of assessment in mathematics in terms of its importance to students' learning/achievement?

____

____

____

____

____

VII. PROBLEMS ENCOUNTERED

What problems did you encounter in using any of the assessment strategies listed in III.C above?

____

____

____

____

____

Please make sure that you answer all items.

This is the end of the questionnaire.

Thank you very much for your cooperation!

Please write your name and contact details below:

Name: ____

Preferred contact number and time: ________________________________

Appendix B. Principal Questionnaire

THE UNIVERSITY of ADELAIDE

Classroom Practices in Mathematics: Effects on Primary and Secondary Students Achievement in Region XII, Philippines

Principal Questionnaire

I. Information about this Questionnaire

This questionnaire is designed for Principals in the Elementary (Primary) and High Schools (Secondary). It contains items that ask for general/background information about the principal-participant, general information about the school, basic information about the mathematics curriculum, school and national policies and the school climate in general. Principal's responses to this questionnaire are significant in helping describe school-level factors that may have impact on teachers' teaching and assessment practices and how these factors directly or indirectly influence student's achievement in mathematics. The results of this study will inform policy makers to come up with guiding principles that can possibly contribute to the improvement of mathematics education in the country.

It is important therefore that you respond to each item to the best of your knowledge so that the information you provide will reflect your situation as accurately as possible.

It will take roughly **30 minutes** to complete this questionnaire.

II. General Instructions to Principal Participant

1. Find a place and time in your school when you will be able to complete this questionnaire without being interrupted. You are given as much time as you need to complete this questionnaire. It would be advisable that you complete this questionnaire in one sitting even if you decide to bring this home.

2. Please read each item carefully and respond as accurately as you can. Specific instructions in answering the items are given in every section of the questionnaire and are typed in italics. If you make a mistake in responding to items which have the given options, simply mark X on your previous choice and check another box corresponding to your new answer. If you make an error in answering questions that require writing of numbers, words and/or sentences, simply cross out your previous response and write the new answer next to it. **Please don't leave any item unanswered.**

3. The questionnaire should be returned to the survey questionnaire administrator or to the researcher at the end of the school day or as soon as it has been completed.

4. Should there be any doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach me by phone: +63 947 7978602

Thank you very much for taking time to complete this questionnaire.

PRINCIPAL QUESTIONNAIRE

I. BACKGROUND INFORMATION

Name: ______________________________ Email: ______________________
Name of School: ______________________ Phone: ______________________
Address of School: ______________________

1. Gender: ☐0 M ☐1 F

2. Age: ________

3. What is the highest level of formal education you have completed?

Please tick ☐ *one choice*

☐1 Bachelor's degree
☐2 Bachelor's degree with Master's units
☐3 Master's degree
☐4 Master's degree with Doctorate units
☐5 Doctorate degree
☐6 Post Doctorate
☐7 Others, specify ______________________

4. How many years have you been working as a principal? ________

5. How many years have you been working as a principal at your present school? ________

6. How many years did you spend as a subject/class teacher before you became a principal? ________

II. SCHOOL BACKGROUND INFORMATION

7. Is this school a public or private school?

Please tick ☐ *one choice*

☐0 A public school → Please go to question 9.

☐1 A private school → Please go to question 8.

8. Thinking about the funding of this school in a typical year, which of the following applies?

Please tick ☐ *one choice in each row.*

50% or more of the schools' funding comes from	Yes (1)	No (2)
a.) Government	☐	☐
b.) NGO	☐	☐
c.) Private Individuals	☐	☐
d.) Others, please specify ______________________	☐	☐

9. What is the current school enrolment (number of students of all grades in this school)? ________

10. What is the total enrolment in Grade Six / Fourth Year? ________

11. What is the average number of Grade Six pupils / Fourth year students in each class? ________

12. What is the total instructional time in a typical full day (excluding recess, lunch breaks and after school activities) ________

13. How much time (in minutes) per day is allocated for mathematics? ________

14. How much consideration is given to the following factors when students are considered for admission to this school?

Please tick ☐ one choice in each row

	Not Considered (1)	Considered (2)	Priority (3)	High Priority (4)
a. Residence in a particular area	☐	☐	☐	☐
b. Students' academic record (including placement tests)	☐	☐	☐	☐
c. Recommendations of feeder schools	☐	☐	☐	☐
d. Parents' endorsement of the instructional or religious philosophy of the school	☐	☐	☐	☐
e. Students' need or desire for a special programme (e.g. Advance Math, SPED)	☐	☐	☐	☐
f. Attendance of other family members at the school (past or present)	☐	☐	☐	☐

III. SCHOOL MANAGEMENT

15. Below you can find statements about your management of this school. Please indicate the frequency of these activities and behaviours in this school during the current school year.

Please tick ☐ one choice in each row

	Never (1)	Seldom (2)	Quite often (3)	Very often (4)
a. I make sure that the professional development activities of teachers are in accordance with the teaching goals of the school.	☐	☐	☐	☐
b. I ensure that teachers work according to the school's educational goals.	☐	☐	☐	☐
c. I observe instructions in classrooms.	☐	☐	☐	☐
d. I use student performance results to develop the school's educational goals.	☐	☐	☐	☐
e. I give teachers suggestions as to how they can improve their teaching.	☐	☐	☐	☐
f. I monitor students' work.	☐	☐	☐	☐
g. When a teacher has problems in his/her classroom, I take the initiative to discuss matters.	☐	☐	☐	☐
h. I inform teachers about possibilities for updating their knowledge and skills.	☐	☐	☐	☐
i. I check to see whether classroom activities are in line with our educational goals.	☐	☐	☐	☐
j. I take exam results into account in decisions regarding curriculum development.	☐	☐	☐	☐
k. I ensure that there is clarity concerning the responsibility for coordinating the curriculum.	☐	☐	☐	☐
l. When a teacher brings up a classroom problem, I assist him/her in looking for solutions.	☐	☐	☐	☐
m. I pay attention to disruptive behaviour in classrooms.	☐	☐	☐	☐
n. I take over lessons from teachers who are unexpectedly absent.	☐	☐	☐	☐

19. How strongly do you agree or disagree with these statements as applied to this school, your job, and the teachers at this school?

Please tick ☐ one choice in each row.

	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)
a. An important part of my job is to ensure that the instructional approaches recommended are explained to the new teachers, and that more experienced teachers are using these approaches.	☐	☐	☐	☐
b. The use of test scores of students to evaluate a teacher's performance devalues the teacher's professional judgment.	☐	☐	☐	☐
c. Giving teachers freedom to choose their own instructional techniques can lead to poor teaching.	☐	☐	☐	☐
d. A main aspect of my job is to ensure that the teaching skills of the staff are always improved.	☐	☐	☐	☐
e. An important part of my job is to ensure that teachers are held accountable for the attainment of the school's goals.	☐	☐	☐	☐
f. An important part of my job is to present new ideas to the parents in a convincing way.	☐	☐	☐	☐
g. I influence decisions about this school taken at a higher administrative level.	☐	☐	☐	☐
h. I see to it that students, teachers and staff stick to the rules of the school.	☐	☐	☐	☐
i. I check for mistakes and errors in administrative procedures and reports.	☐	☐	☐	☐
j. An important part of my job is to resolve problems with the timetable and/or lesson planning.	☐	☐	☐	☐
k. An important part of my job is to create an orderly atmosphere in the school.	☐	☐	☐	☐
l. I have no way of knowing whether teachers perform well or badly in their teaching duties.	☐	☐	☐	☐
m. In this school, we work on the achievement of the school development plan.	☐	☐	☐	☐
n. I define goals to be accomplished by the staff of this school.	☐	☐	☐	☐
o. I stimulate a task-oriented atmosphere in this school.	☐	☐	☐	☐

20. How often is the work of teachers in this school appraised by either you, other colleagues in the school, or an external individual or body (e.g. accreditation)?

	Never (1)	Less than once every 2 years (2)	Once every 2 years (3)	Once per year (4)	Twice or more per year (5)
a. You (the principal)	☐	☐	☐	☐	☐
b. Other teachers or members of the School management team	☐	☐	☐	☐	☐
c. External individual or body (e.g. external inspector)	☐	☐	☐	☐	☐

If you answered 'Never' to all of the above (a, b, and c) → Please go to question 25.

21. To what extent do the following aspects considered in teacher appraisal?

Please tick ☐ one choice in each row.

1 = I do not know if it was considered
2 = Not considered at all
3 = Considered with low importance
4 = Considered with moderate importance
5 = Considered with high importance

	(1)	(2)	(3)	(4)	(5)
a. Student test scores	☐	☐	☐	☐	☐
b. Retention and pass rates of students	☐	☐	☐	☐	☐
c. Other student learning outcomes	☐	☐	☐	☐	☐
d. Student feedback on the teaching they receive	☐	☐	☐	☐	☐
e. Feedback from parents	☐	☐	☐	☐	☐
f. How well the teacher works with you, the principal, and their colleagues	☐	☐	☐	☐	☐
g. Direct appraisal of classroom teaching	☐	☐	☐	☐	☐
h. Innovative teaching practices	☐	☐	☐	☐	☐
i. Relations between the teacher and students	☐	☐	☐	☐	☐
j. Professional development undertaken by the teacher	☐	☐	☐	☐	☐
k. Teacher's classroom management	☐	☐	☐	☐	☐
l. Teacher's knowledge and understanding of their main subject field(s)	☐	☐	☐	☐	☐
m. Teacher's knowledge and understanding of instructional practices (knowledge mediation) in their main subject field(s)	☐	☐	☐	☐	☐
n. Teaching of students with special learning needs	☐	☐	☐	☐	☐
o. Student discipline and behaviour in the teacher's classes	☐	☐	☐	☐	☐
p. Teaching in a multicultural setting	☐	☐	☐	☐	☐
q. Extra-curricular activities with students (e.g. school plays and performances, sporting activities	☐	☐	☐	☐	☐

22. When teachers' work is appraised in this school, can these appraisals directly lead to any of the following for the teacher?

Please tick ☐ one choice in each row.

	Can result from an appraisal of teachers' work (1)	Can not result from an appraisal of teachers' work (2)
a. A change in salary	☐	☐
b. A financial bonus or another kind of monetary reward	☐	☐
c. A change in the likelihood of career advancement	☐	☐
d. Opportunities for professional development activities	☐	☐
e. Changes in teachers' work responsibilities that make their job more attractive	☐	☐
f. A development or training plan to improve their teaching	☐	☐

23. We would like to ask your opinion on the objectives of the appraisal of teachers' work at this school. Could you please rate the importance of each of the following objectives in the appraisal of teachers' work?

Please tick ☐ one choice in each row.

	No importance (1)	Low importance (2)	Moderate importance (3)	High importance (4)
a. To determine the career advancement of individual teachers	☐	☐	☐	☐
b. To inform an administrative level above the school (school board, municipality, school district, school inspectorate)	☐	☐	☐	☐
c. To evaluate the performance of the whole school	☐	☐	☐	☐
d. To evaluate the teaching performance in a particular subject	☐	☐	☐	☐
e. To address a crisis or problem in the school	☐	☐	☐	☐
f. To identify the professional development needs of teachers	☐	☐	☐	☐
g. To take decisions about remuneration and bonuses of teachers	☐	☐	☐	☐
h. To take decisions about school improvement	☐	☐	☐	☐

24. Please indicate the frequency with which each of the following occurs if an appraisal of teachers' work identifies weaknesses or you consider a teacher to be underperforming in their teaching duties.

Please tick ☐ one choice in each row.

	Never	Sometimes (2)	Most of the time (3)	Always (4)
a. I ensure that the outcome is reported to the teacher.	☐	☐	☐	☐
b. I ensure measures to remedy the weaknesses in teaching are discussed with the teacher.	☐	☐	☐	☐
c. I establish a development or training plan for the teacher to address the weaknesses in their teaching.	☐	☐	☐	☐
d. I impose material sanctions on the teacher (e.g. reduced annual increases in pay).	☐	☐	☐	☐
e. I, or others in the school, report the underperformance to the district or division office.	☐	☐	☐	☐
f. I ensure the teacher has more frequent appraisals of their work.	☐	☐	☐	☐
g. Others, please specify below	☐	☐	☐	☐

____

25. How would you characterize each of the following within your school?

Please tick ☐ one choice in each row

	Very low (1)	Low (2)	Medium (3)	High (4)	Very high (5)
a. Teachers' job satisfaction	☐	☐	☐	☐	☐
b. Techers' opportunities for professional development	☐	☐	☐	☐	☐
c. Teachers' understanding of the schools' curricular goals	☐	☐	☐	☐	☐
d. Teachers' degree of success in implementing the schools' curriculum	☐	☐	☐	☐	☐

	Very low (1)	Low (2)	Medium (3)	High (4)	Very high (5)
e. Teachers' expectations for student achievement	☐	☐	☐	☐	☐
f. Parental support for student achievement	☐	☐	☐	☐	☐
g. Parental involvement in school activities	☐	☐	☐	☐	☐
h. Students' regard for school property	☐	☐	☐	☐	☐
i. Students' desire to do well in school	☐	☐	☐	☐	☐

Grade Six / Fourth Year High School teachers in your school

26. In your school, are any of the following used to evaluate the practice of Grade Six / Fourth Year High School mathematics teachers?

	Yes (1)	No (2)
a. Observations by the principal or senior staff	☐	☐
b. Observations by inspectors or other persons external to the school	☐	☐
c. Student achievement	☐	☐
d. Teacher peer review	☐	☐

IV. SCHOOL RESOURCES

27. Is this school's capacity to provide instruction hindered by any of the following?

Please tick ☐ one choice in each row.

	Not at all (1)	Very little (2)	To some extent (3)	A lot (4)
a. A lack of qualified teachers	☐	☐	☐	☐
b. A lack of laboratory technicians	☐	☐	☐	☐
c. A lack of instructional support personnel	☐	☐	☐	☐
d. A lack of other support personnel (e.g. IT, utility)	☐	☐	☐	☐
e. Shortage or inadequacy of instructional materials (e.g. textbooks)	☐	☐	☐	☐
f. Shortage or inadequacy of computers for instruction	☐	☐	☐	☐
g. Shortage or inadequacy of other equipment (e.g. computer units)	☐	☐	☐	☐
h. Shortage or inadequacy of library materials	☐	☐	☐	☐
i. Others (please specify below)	☐	☐	☐	☐

____

28. In this school, to what extent is the learning of students hindered by the following behaviors?

Please tick ☐ one choice in each row.

By students in this school:	Not at all (1)	Very little (2)	To some extent (3)	A lot (4)
a. Late arrival at school	☐	☐	☐	☐
b. Absenteeism (i.e. unjustified absences)	☐	☐	☐	☐

	Not at all (1)	Very little (2)	To some extent (3)	A lot (4)
c. Classroom disturbance	☐	☐	☐	☐
d. Cheating	☐	☐	☐	☐
e. Profanity/Swearing	☐	☐	☐	☐
f. Vandalism	☐	☐	☐	☐
g. Theft	☐	☐	☐	☐
h. Intimidation or verbal abuse of other students (or other forms of bullying)	☐	☐	☐	☐
i. Physical injury to other students	☐	☐	☐	☐
j. Intimidation or verbal abuse of teachers or staff	☐	☐	☐	☐
k. Use/possession of drugs and/or alcohol	☐	☐	☐	☐
By teachers in this school:				
l. Arriving late at school	☐	☐	☐	☐
m. Absenteeism	☐	☐	☐	☐
n. Lack of pedagogical preparation	☐	☐	☐	☐

29. Regarding this school, who has a considerable responsibility for the following tasks?

A 'considerable responsibility' is one where an active role is played in decision making.

Please tick ☐ *as many as appropriate in each row.*

	Principal	Teachers	School governing board	Regional or local education authority	National education authority
a. Selecting teachers for hire	☐	☐	☐	☐	☐
b. Firing teachers	☐	☐	☐	☐	☐
c. Establishing teachers' starting salaries	☐	☐	☐	☐	☐
d. Determining teachers' salary increases	☐	☐	☐	☐	☐
e. Formulating the school budget	☐	☐	☐	☐	☐
f. Deciding on budget allocations within the school	☐	☐	☐	☐	☐
g. Establishing student disciplinary policies	☐	☐	☐	☐	☐
h. Establishing student assessment policies	☐	☐	☐	☐	☐
i. Approving students for admission to the school	☐	☐	☐	☐	☐
j. Choosing which textbooks are used	☐	☐	☐	☐	☐
k. Determining subject content	☐	☐	☐	☐	☐
l. Deciding which subject areas are to be taught	☐	☐	☐	☐	☐
m. Allocating funds for teachers' professional development	☐	☐	☐	☐	☐

30. How strongly do you agree or disagree with each of the following statements about teaching and learning in general?

Please tick ☐ one choice in each row.

	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)
a. Effective/good teachers demonstrate the correct way to solve a problem.	☐	☐	☐	☐
b. "Poor performance" means a performance that lies below the previous achievement level of the student.	☐	☐	☐	☐
c. It is better when the teacher – not the student – decides what activities are to be done in the classroom.	☐	☐	☐	☐
d. One of the role of teachers is to facilitate students' own inquiry.	☐	☐	☐	☐
e. Teachers know a lot more than students; they shouldn't let students develop answers that may be incorrect when they can just explain the answers directly.	☐	☐	☐	☐
f. Students learn best by finding solutions to problems on their own.	☐	☐	☐	☐
g. Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.	☐	☐	☐	☐
h. How much students learn depends on how much background knowledge they have – that is why teaching facts are so necessary.	☐	☐	☐	☐
i. Students should be allowed to think of solutions to practical problems themselves before the teacher shows them how they are solved.	☐	☐	☐	☐
j. "Good performance" means a performance that lies above the previous previous achievement level of the student.	☐	☐	☐	☐
k. A quiet classroom is generally needed for effective learning.	☐	☐	☐	☐
l. Thinking and reasoning processes are more important than teaching specific curriculum content.	☐	☐	☐	☐

31. When a teacher begins teaching at this school, does he/she undertake a formal induction process?

Please tick ☐ one choice.

☐1 Yes, for all teachers who are new to this school

☐2 Yes, but only for teachers for whom this is their first teaching job

☐3 No, there is no induction process for teachers who are new to this school

→ If 'No' go to question 33.

32. If "Yes" in the previous question, who organizes the induction process?

Please tick ☐ one choice.

☐1 The school alone

☐2 The school together with agencies or institutions outside of the school

☐3 Outside agencies or institutions alone / DepEd

33. When a teacher begins teaching at this school, is there a programme or policy by which he/she works with an experienced teacher or teachers who act as their mentor?

Please tick ☐ one choice.

☐1 Yes, for all teachers who are new to this school

☐2 Yes, but only for teachers for whom this is their first teaching job

☐3 No, there is no mentoring programme or policy in this school

→ If 'No' go to question 35.

34. If 'Yes' in the previous question, is the mentor teacher's main subject area(s) usually the same as that of the new teacher?

Yes ☐1 No ☐2

35. How would you rate the importance of mentoring new teachers in helping them to improve their instructional effectiveness?

Please tick ☐ one choice.

Not important at all	Of low importance	Of moderate importance	Of high importance
☐1	☐2	☐3	☐4

V. CURRICULUM

A. NATIONAL CURRICULUM:

IMPORTANT: Throughout this questionnaire, the term "national curriculum" is intended to include any centrally-supported curriculum. The curriculum needs not be mandated but it should be strongly recommended or at least widely used. This curriculum may not necessarily be articulated in a formal document, or different aspects of the curriculum may appear in different documents.

36. In what year was the current intended mathematics curriculum for Grade Six / Fourth Year High School introduced?

____

37. Is this intended mathematics curriculum that includes Grade Six / Fourth Year High School currently being revised?

Yes ☐1 No ☐2

38. Are any of the following methods used to help implement the national mathematics curriculum at Grade Six/Fourth Year?

	Yes (1)	No (2)
a. Mandated or recommended textbook(s)	☐	☐
b. Instructional or pedagogical guide	☐	☐
c. DepEd's memoranda or guidelines	☐	☐
d. Curriculum evaluation during or after implementation	☐	☐
e. Specifically developed or recommended instructional activities	☐	☐
f. National assessments based on student samples	☐	☐
g. A system of school inspection or audit	☐	☐
h. Others Please specify: ______________________________	☐	☐

Comments: ____
____
____
____
____

39. Does the national curriculum specify the amount of instructional time that should be devoted to mathematics?

	Yes (1)	No (2)
a.) At Grade 6	☐	☐
b.) Fourth Year High School	☐	☐

If Yes, what percentage of total instructional time is supposed to be devoted to mathematics? ________

B. PEDAGOGICAL APPROACH

40. Which best describes how the national mathematics curriculum at Grade 6/Fourth Year High School addresses the issue of students with different levels of ability?

Tick ☐ one choice only.

a.) The same curriculum is prescribed for all students ☐

b.) The same curriculum is prescribed for students of different ability levels, but at different levels of difficulty ☐

c.) Different curricula are prescribed for students of different ability levels ☐

Comments: ____
____
____
____
____

41. How much emphasis does the National Mathematics curriculum at Grade Six/Fourth Year place on the following?

	None (1)	Very little (2)	Some (3)	A lot (4)
a. Mastering basic skills	☐	☐	☐	☐
b. Understanding mathematical concepts and principles	☐	☐	☐	☐
c. Applying mathematics in real-life contexts	☐	☐	☐	☐
d. Communicating mathematically	☐	☐	☐	☐
e. Reasoning mathematically	☐	☐	☐	☐
f. Incorporating the experiences of different ethnic/cultural groups	☐	☐	☐	☐
g. Integrating mathematics with other subjects	☐	☐	☐	☐
h. Deriving formal proofs	☐	☐	☐	☐

Comments: ____
____
____
____
____

C. ASSESSMENT

42. Does the National government or DepEd specify the assessment strategies to be used by mathematics teachers?

	Yes (1)	No (2)
a.) At Grade 6	☐	☐
b.) Fourth Year High School	☐	☐

If Yes, what specific assessment strategies or approaches are supposed to be used in mathematics? _______________

43. How much emphasis does the National Mathematics curriculum at Grade Six/Fourth Year place on the following assessment practices?

VR - Very rarely or Never **O - Occasionally** **A - Always**
R - Rarely **VF – Very Frequently**

	VR (1)	R (2)	O (3)	VF (4)	A (5)
a. Formative Assessment	☐	☐	☐	☐	☐
b. Summative Assessment	☐	☐	☐	☐	☐
c. Multiple Choice	☐	☐	☐	☐	☐
d. True-False or Right-Wrong	☐	☐	☐	☐	☐
e. Matching-types	☐	☐	☐	☐	☐
f. Fill-in the blanks or short constructed response	☐	☐	☐	☐	☐
g. Essay	☐	☐	☐	☐	☐
h. Performance assessment	☐	☐	☐	☐	☐
i. Portfolio assessment	☐	☐	☐	☐	☐
j. Graded recitation	☐	☐	☐	☐	☐
k. Observations	☐	☐	☐	☐	☐
l. Term Papers or Projects	☐	☐	☐	☐	☐
m. Class presentations	☐	☐	☐	☐	☐
n. Interviews and conferences	☐	☐	☐	☐	☐
o. Student reflection / journal writing/Students self-assessment	☐	☐	☐	☐	☐
p. Assignments	☐	☐	☐	☐	☐
q. Others, please specify	☐	☐	☐	☐	☐

____

This is the end of the questionnaire.

Thank you very much for your cooperation!

Appendix C. Student Questionnaire

THE UNIVERSITY of ADELAIDE

Classroom Practices in Mathematics: Effects on Primary and Secondary Students Achievement in Region XII, Philippines

Student Questionnaire

I. Information about this Questionnaire

This questionnaire is designed for Grade 6 (elementary) and Fourth Year High School (secondary) students. It contains items that ask for general/background information about the student-participant, their attitudes towards mathematics, beliefs about mathematics, and their perceptions of mathematics. Students' responses to this questionnaire are significant in helping describe how students' attributes influence teachers' teaching and assessment practices and how these practices affect/influence student's achievement in mathematics. The results of this study will inform policy makers to come up with guiding principles that can possibly contribute to the improvement of mathematics education in the country.

It would be of great help if you could respond/answer all the items in the questionnaire.

It will take roughly **30 minutes** to complete this questionnaire.

II. General Instructions to Student Participant

1. With the guidance of your teacher and/or researcher, please complete this questionnaire within the specified time frame. It would be advisable that you complete this questionnaire in one sitting.

2. Please read each item carefully and respond as accurately as you can. Specific instructions in answering the items are given in every section of the questionnaire and are typed in italics. If you make a mistake in responding to items which have the given options, simply mark X (☐) on your previous choice and check another box corresponding to your new answer. If you make an error in answering questions that require writing of number, words and/or sentences, simply cross out your previous response and write the new answer next to it. **Please don't leave any item unanswered.**

3. The questionnaire should be returned to the survey questionnaire administrator or to the researcher as soon as it has been completed.

4. When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach me by phone: +63 947 7978602

Thank you very much for taking time to complete this questionnaire.

STUDENT QUESTIONNAIRE

I. BACKGROUND INFORMATION

Please carefully answer the following questions. Please check each box ☐ that corresponds to your response.

Name: ______________________________ Teacher's code no.: __________

1. Gender: ☐ 0 M ☐ 1 F
2. Age: ____________
3. Grade/Year level: ____________
4. Ethnic Group: ☐ 1 B'laan/T'boli/Tiruray ☐ 4 Cebuano ☐ 7 Tagalog
   ☐ 2 Bagobo/Manobo ☐ 5 Hiligaynon ☐ 8 Pangasinan
   ☐ 3 Maranao/Maguindanao ☐ 6 Ilocano ☐ 9 Others, specify __________
5. What is the highest level of education of your parents?

   a.) Mother

   ☐ 1 Elementary education

   ☐ 2 High School education

   ☐ 3 University / College undergraduate education

   ☐ 4 Graduate education ☐ Masters

   ☐ PhD / EdD

   ☐ 5 Others, please specify ________________

   b.) Father

   ☐ 1 Elementary education

   ☐ 2 High School education

   ☐ 3 University / College undergraduate education

   ☐ 4 Graduate education ☐ Masters

   ☐ PhD / EdD

   ☐ 5 Others, please specify ________________________

6. What is the current employment status of your parents?

   a.) Mother

   ☐ 1 Employed (tick one choice below)

   ☐ Government employee ☐ Private employee ☐ Self-employed

   ☐ 2 Doing housework at home

   ☐ 3 Student

   ☐ 4 Retired

   ☐ 5 Unemployed

b.) Father

☐ 1 Employed (tick one choice below)

☐ Government employee ☐ Private employee ☐ Self-employed

☐ 2 Doing housework at home

☐ 3 Student

☐ 4 Retired

☐ 5 Unemployed

7. Do you have any of these things at home?

	YES 1	NO 2
a. Calculator	☐	☐
b. Personal Computer	☐	☐
c. Study desk or table for your use	☐	☐
d. Dictionary	☐	☐
e. Books	☐	☐
f. Internet connection	☐	☐
g. Gaming consoles (Playstation, Xbox, PSP, Wii, DS, etc.)	☐	☐
h. Mobile phone (including smart phones)	☐	☐

II. ATTITUDES TOWARDS MATHEMATICS

Tick ☐ the appropriate response in each of the following statements.

SD	D	N	A	SA
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

A. Confidence in Learning Mathematics Scale

	SD 1	D 2	N 3	A 4	SA 5
1. Generally I am confident when I am in a mathematics class.	☐	☐	☐	☐	☐
2. I am sure I could do advanced work in mathematics.	☐	☐	☐	☐	☐
3. I am sure that I can learn mathematics.	☐	☐	☐	☐	☐
4. I think I could handle more difficult mathematics.	☐	☐	☐	☐	☐
5. I can get good grades in mathematics.	☐	☐	☐	☐	☐
6. I have a lot of self-confidence when it comes to mathematics.	☐	☐	☐	☐	☐
7. I am not good in mathematics.	☐	☐	☐	☐	☐
8. I don't think I could do advanced mathematics.	☐	☐	☐	☐	☐
9. I am not the type to do well in mathematics.	☐	☐	☐	☐	☐
10. Even though I study hard, mathematics seems difficult for me.	☐	☐	☐	☐	☐
11. I have the tendency to fail mathematics.	☐	☐	☐	☐	☐

B. Teachers Attitudes Scale

SD	D	N	A	SA
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

	SD 1	D 2	N 3	A 4	SA 5
1. My teachers have encouraged me to study more mathematics.	☐	☐	☐	☐	☐
2. My teachers think I'm the kind of person who could do well in mathematics.	☐	☐	☐	☐	☐
3. Mathematics teachers have made me feel I have the ability to go on in mathematics.	☐	☐	☐	☐	☐
4. My mathematics teachers would encourage me to take all the mathematics I can.	☐	☐	☐	☐	☐
5. My mathematics teachers have been interested in my progress in mathematics.	☐	☐	☐	☐	☐
6. When it comes to anything serious I have felt ignored when talking to mathematics teachers.	☐	☐	☐	☐	☐
7. I have found it hard to win the respect of mathematics teachers.	☐	☐	☐	☐	☐
8. Getting a mathematics teacher to take me seriously has usually been a problem.	☐	☐	☐	☐	☐

C. Usefulness of Mathematics Scale

	SD 1	D 2	N 3	A 4	SA 5
1. I study mathematics because I know how useful it is.	☐	☐	☐	☐	☐
2. Knowing mathematics will help me earn a living.	☐	☐	☐	☐	☐
3. Mathematics is a worthwhile and necessary subject.	☐	☐	☐	☐	☐
4. I will use mathematics in many ways.	☐	☐	☐	☐	☐
5. Mathematics will not be important to me in my life's work.	☐	☐	☐	☐	☐
6. Mathematics will be of no relevance to my life.	☐	☐	☐	☐	☐
7. I see mathematics as a subject I will rarely use in my daily life	☐	☐	☐	☐	☐
8. Studying mathematics is a waste of time.	☐	☐	☐	☐	☐
9. It is not important for me to do well in mathematics in Elementary or High School.	☐	☐	☐	☐	☐
10. I expect to have little use from mathematics when I get out of school.	☐	☐	☐	☐	☐

D. Mathematics Anxiety Scale

	SD 1	D 2	N 3	A 4	SA 5
1. Mathematics doesn't scare me at all.	☐	☐	☐	☐	☐
2. It wouldn't bother me at all to take more mathematics subjects.	☐	☐	☐	☐	☐
3. I haven't usually worried about being able to solve mathematics problems.	☐	☐	☐	☐	☐
4. I have almost never felt nervous during a mathematics test or exam.	☐	☐	☐	☐	☐

SD	D	N	A	SA
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

	SD 1	D 2	N 3	A 4	SA 5
5. I usually have been at ease during mathematics tests.	☐	☐	☐	☐	☐
6. I usually have been at ease in mathematics classes.	☐	☐	☐	☐	☐
7. Mathematics usually makes me feel uncomfortable.	☐	☐	☐	☐	☐
8. Mathematics usually makes me feel impatient.	☐	☐	☐	☐	☐
9. I start to worry when I think of trying to solve mathematics problems.	☐	☐	☐	☐	☐
10. I am unable to think clearly when working out/solving mathematics.	☐	☐	☐	☐	☐
11. A mathematics test would scare me.	☐	☐	☐	☐	☐
12. Mathematics makes me feel confused.	☐	☐	☐	☐	☐

III. BELIEFS ABOUT MATHEMATICS

For each item, please tick ☐ the response that indicates how you feel about the item as indicated below.

SD	D	U	A	SA
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

	SD 1	D 2	U 3	A 4	SA 5
1. Doing mathematics consists mainly of using rules.	☐	☐	☐	☐	☐
2. Learning mathematics mainly involves memorizing procedures and formulas.	☐	☐	☐	☐	☐
3. Mathematics involves relating many different ideas.	☐	☐	☐	☐	☐
4. Getting the right answer is the most important part of mathematics.	☐	☐	☐	☐	☐
5. In mathematics, it is impossible to solve a problem without looking at the examples.	☐	☐	☐	☐	☐
6. One reason learning mathematics is so much work is that you need to learn a different method for each new type of problems.	☐	☐	☐	☐	☐
7. Getting good grades in mathematics is more of a motivation than is the satisfaction of learning the mathematics content.	☐	☐	☐	☐	☐
8. When I learn something new in mathematics I often continue exploring and developing it on my own.	☐	☐	☐	☐	☐
9. I usually try to understand the reasoning behind all of the rules I use in mathematics.	☐	☐	☐	☐	☐
10. Being able to successfully use a rule or formula in mathematics is more important to me than understanding why and how it works.	☐	☐	☐	☐	☐
11. A common difficulty in taking quizzes and exams in mathematics is that if you forget relevant formulas and rules you are lost.	☐	☐	☐	☐	☐
12. It is difficult to talk about mathematical ideas because all you can really do is explain how to solve/deal with specific problems.	☐	☐	☐	☐	☐

SD	D	U	A	SA
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

	SD 1	D 2	U 3	A 4	SA 5
13. Solving mathematics problems frequently involves exploration.	☐	☐	☐	☐	☐
14. Most mathematics problems are best solved by using a previously learned solution for that type of problem.	☐	☐	☐	☐	☐
15. I forget most of the mathematics I learn in a course soon after the course is over.	☐	☐	☐	☐	☐
16. Mathematics consists of many unrelated topics.	☐	☐	☐	☐	☐
17. Mathematics is a rigid subject.	☐	☐	☐	☐	☐
18. I get frustrated if I don't understand what I am studying in mathematics.	☐	☐	☐	☐	☐
19. The most important part of mathematics is computation/solving.	☐	☐	☐	☐	☐

IV. STUDENT'S PERCEPTIONS OF MATHEMATICS

What are your perceptions of Mathematics in terms of its importance to society or real life and connection to other subject areas?

____
____
____
____
____

This is the end of the questionnaire.

Thank you very much for your cooperation!

Name ____

Grade/Year level: ___________________________________

School: ____

Preferred contact number and time (within this week only) ________________________________

Appendix D. Ethics Approval

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY

BEVERLEY DOBBS
EXECUTIVE OFFICER
LOW RISK HUMAN RESEARCH ETHICS REVIEW GROUP (FACULTY OF HUMANITIES AND SOCIAL SCIENCES AND FACULTY OF THE PROFESSIONS)
THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA

TELEPHONE +61 8 8313 4725
FACSIMILE +61 8 8313 7325
email: beverley.dobbs@adelaide.edu.au

27 November 2012

Dr I Darmawan
School of Education

Dear Dr Darmawan

ETHICS APPROVAL No: **HP-2012-099**
PROJECT TITLE: **Classroom practices in mathematics: Effects on primary and secondary students achievement in Region X11, Phillippines**

I write to advise that the Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions) has approved the above project. The ethics expiry date for this project is **30 Nov 2015**.

Ethics approval is granted for three years subject to satisfactory annual progress and completion reporting. The form titled *Project Status Report* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. On expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

ASSOCIATE PROFESSOR RACHEL A. ANKENY
Convenor
Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
OFFICE OF RESEARCH ETHICS, COMPLIANCE AND INTEGRITY

BEVERLEY DOBBS
EXECUTIVE OFFICER
LOW RISK HUMAN RESEARCH ETHICS REVIEW GROUP (FACULTY OF HUMANITIES AND SOCIAL SCIENCES AND FACULTY OF THE PROFESSIONS)
THE UNIVERSITY OF ADELAIDE
SA 5005
AUSTRALIA

TELEPHONE +61 8 8313 4725
FACSIMILE +61 8 8313 7325
email: beverley.dobbs@adelaide.edu.au

Applicant:	Dr I Darmawan
School:	Education
Application/RM No:	14278
Project Title:	**Classroom practices in mathematics: Effects on primary and secondary students achievement in Region X11, Phillippines**

Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

ETHICS APPROVAL No: HP-2012-099

APPROVED for the period until: 30 Nov 2015

This study is to be conducted by Michelle Rivera Lacia, PhD Candidate.

ASSOCIATE PROFESSOR RACHEL A. ANKENY
Convenor
Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

Appendix E. Approval Region XII

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF EDUCATION
REGION XII
Regional Administrative Center, Carpenter Hill, City of Koronadal
Fax number: 083-2288825

DepED
DEPARTMENT OF EDUCATION

October 24, 2012

Ms. Michelle Lacia
University of Adelaide,
South Australia

Dear Ms. Lacia:

This is to acknowledge receipt of your request for permission to conduct your research to the schools in Region XII in connection with your scholarship study at the University of Adelaide, South Australia.

This Office sees no objection in your request therefore you are hereby permitted to gather data and conduct interviews and observations in the different schools in the region.

Furthermore, as per your request, we are providing you with the shortlist of central schools, IU's and nationalized high schools within the region for your reference.

Thank you very much.

Very truly yours,

MA. ROSA C. GUTIERREZ, CESO VI
OIC-Regional Director

Appendix F. SDS Kidapawan City

THE UNIVERSITY of ADELAIDE

School of Education

Level 6, 10 Pulteney St., Adelaide SA 5005; Tel: +61 8 8313 0694, Fax: +61 8 8313 3604

February 5, 2013

ERNESTO C. ARIAGA, CESO VI
Schools Division Superintendent
Kidapawan City

Dear Sir Ariaga:

Greetings of Peace.

I am Michelle Rivera Lacia, a faculty member of Notre Dame University in Cotabato City. I am currently a Higher Degree by Research (HDR – leading to PhD) student at the University of Adelaide, South Australia under the AusAID-Australian Development Scholarship.

I have completed my research proposal presentation with a working title of "*Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippines*". This proposed research will investigate the current teaching and assessment practices (collectively known as classroom practices) of the Grade Six and Fourth Year High School Mathematics teachers and its likely effect on students' mathematics achievement (NAT math score) in public and private schools in Region XII. It specifically aims to examine other underlying factors that directly or indirectly affect students' performance. Teachers' attitudes towards mathematics and mathematics teaching, mathematics self-efficacy beliefs, content knowledge, pedagogical content knowledge, knowledge and perception of assessment as well as students' attitudes towards and beliefs about mathematics will be examined as possible factors that could influence teachers' classroom practices. This further seeks to address the dearth of research that looks at both the teaching and assessment practices of mathematics teachers in the country. The results are expected to provide significant information which can be used as bases in designing professional development programs for teachers, to enhance pre-service teacher programs and to support the government's goal of improving mathematics education not only in Region XII but in the entire country, as well.

In relation to this, I am humbly asking for a ***letter of permission*** from your good office to conduct the above mentioned study in Kidapawan City Division schools. This will involve collection of necessary data using survey questionnaires (for principals, math teachers and students), interview (for teachers and students), classroom observation and National Achievement (NAT) Mathematics scores of Grade Six and Fourth Year High School students who will be included in the study.

I am hoping for your favorable response to this request. I would like to extend my heartfelt appreciation and gratitude for any support you could provide. This would likewise offer me the opportunity to be part of the remarkable efforts in building and improving the capacity of our teachers and the quality of learning that our students deserve to get. I would make certain that your office will be furnished with the ***report of the results*** of this study soon after carrying out all the necessary analyses of the collected data.

Thank you very much.

Respectfully yours,

MICHELLE RIVERA LACIA

Mobile Phone: 0947 7978602
Email: michelle.lacia@adelaide.edu.au
michellelacia2000@yahoo.ca

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF EDUCATION
REGION XII
CITY SCHOOLS DIVISION OF KIDAPAWAN
JP LAUREL CORNER QUIRINO STREET,
KIDAPAWAN CITY

1st Endorsement
February 05, 2013

Respectfully returned to **Ms. Michelle Rivera Lacia,** college instructor of Notre Dame University, Cotabato City currently studying at the University of Adelaide, South Australia under the AusAID-Australian Development Scholarship program approving the herein letter request for permission to conduct her study entitled **"Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippnes"** and gather data from selected School Heads, Grade 6 Teachers and 4th Year Mathematics Teachers and selected Grade 6 and 4th Year students of public and private schools of Kidapawan City as stated herein for use in her study on the following conditions:

a. The conduct of the study shall not encroach the official time of the School Heads, Teachers, Grade 6 and 4th year students;
b. prior arrangement to the school head shall be made so that the official function of the teachers involved in the study will not be disturbed;
c. no school/government supplies and equipments/funds shall be utilized; and
d. copy of abstract/thesis and findings shall be provided this office upon completion of the study.

ERNESTO C. ARIAGA, JR.
Asst. Schools Division Superintendent
Officer In-Charge

Appendix G. SDS Koronadal City

THE UNIVERSITY of ADELAIDE

School of Education

Level 6, 10 Pulteney St., Adelaide SA 5005; Tel: +61 8 8313 0694, Fax: +61 8 8313 3604

1 February 2013

OMAR A. OBAS, CESO VI
Asst. Schools Division Superintendent
Officer-In-Charge
DepEd, Koronadal City Division
Koronadal City

DEPED KORONADAL CITY DIVISION
RECEIVED
Date: 2/1/13 Time:
Ctrl.No. Initial:

Dear Sir Obas:

Greetings of Peace.

I am Michelle Rivera Lacia, a faculty member of Notre Dame University in Cotabato City. I am currently a Higher Degree by Research (HDR – leading to PhD) student at the University of Adelaide, South Australia under the AusAID-Australian Development Scholarship.

I have completed my research proposal presentation with a working title of ***"Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippines"***. This proposed research will investigate the current teaching and assessment practices (collectively known as classroom practices) of the Grade Six and Fourth Year High School Mathematics teachers and its likely effect on students' mathematics achievement (NAT math score) in public and private schools in Region XII. It specifically aims to examine other underlying factors that directly or indirectly affect students' performance. Teachers' attitudes towards mathematics and mathematics teaching, mathematics self-efficacy beliefs, content knowledge, pedagogical content knowledge, knowledge and perception of assessment as well as students' attitudes towards and beliefs about mathematics will be examined as possible factors that could influence teachers' classroom practices. This further seeks to address the dearth of research that looks at both the teaching and assessment practices of mathematics teachers in the country. The results are expected to provide significant information which can be used as bases in designing professional development programs for teachers, to enhance pre-service teacher programs and to support the government's goal of improving mathematics education not only in Region XII but in the entire country, as well.

In relation to this, I am humbly asking for a ***letter of permission*** from your good office to conduct the above mentioned study in Koronadal City Division Schools. This will involve collection of necessary data using survey questionnaires (for principals, math teachers and students), interview (for teachers and students), classroom observation and National

Achievement Test (NAT) Mathematics scores of Grade Six and Fourth Year High School Students who will be included in the study.

I am hoping for your favorable response to this request. I would like to extend my heartfelt appreciation and gratitude for any support you could provide. This would likewise offer me the opportunity to be part of the remarkable efforts in building and improving the capacity of our teachers and the quality of learning that our students deserve to get. I would make certain that your office will be furnished with the ***report of the results*** of this study soon after carrying out all the necessary analyses of the collected data.

Respectfully yours,

MICHELLE RIVERA LACIA

Phone No.: 0947 7978 602
Email: michelle.lacia@adelaide.edu.au
michellelacia2000@yahoo.ca

Republika ng Pilipinas
Kagawaran ng Edukasyon
Rehiyon XII
SANGAY NG PAARALANG LUNGSOD
Lungsod ng Koronadal

February 1, 2013

TO: The School Head/Administrators
Both Public and Private Schools
This Division

Herewith is a letter from MICHELLE RIVERA LACIA, a faculty member of Notre Dame University, Cotabato City and a student of School of Education. The University of Adelaide, Australia re: asking this office to allow her conduct survey using questionnaires for her research proposal entitled "Classroom Practices in Mathematics: Effects on Primary and Secondary Student's Achievement in Region XII, Philippines", with information that this office interposes no objection however it is believed that determination of your availability to accommodate her is well within your competence to decide.

For information, guidance and compliance.

OMAR A. OBAS, CESO VI
Asst. Schools Division Superintendent
Officer-In-Charge

Appendix H. SDS South Cotabato

THE UNIVERSITY of ADELAIDE

School of Education

Level 6, 10 Pulteney St., Adelaide SA 5005; Tel: +61 8 8313 0694, Fax: +61 8 8313 3604

February 11, 2013

Department of Education
Division of South Cotabato
Received: MONIRON T. SAMBUTUAN
Date : FEB 14 2013
Time : 1:30
No. : 17

DR. RAPHAEL C. FONTANILLA, CESO VI
Schools Division Superintendent
South Cotabato

Dear Dr. Fontanilla:

Greetings of Peace.

I am Michelle Rivera Lacia, a faculty member of Notre Dame University in Cotabato City. I am currently a Higher Degree by Research (HDR – leading to PhD) student at the University of Adelaide, South Australia under the AusAID-Australian Development Scholarship.

I have completed my research proposal presentation with a working title of *"Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippines"*. This proposed research will investigate the current teaching and assessment practices (collectively known as classroom practices) of the Grade Six and Fourth Year High School Mathematics teachers and its likely effect on students' mathematics achievement (NAT math score) in public and private schools in Region XII. It specifically aims to examine other underlying factors that directly or indirectly affect students' performance. Teachers' attitudes towards mathematics and mathematics teaching, mathematics self-efficacy beliefs, content knowledge, pedagogical content knowledge, knowledge and perception of assessment as well as students' attitudes towards and beliefs about mathematics will be examined as possible factors that could influence teachers' classroom practices. This further seeks to address the dearth of research that looks at both the teaching and assessment practices of mathematics teachers in the country. The results are expected to provide significant information which can be used as bases in designing professional development programs for teachers, to enhance pre-service teacher programs and to support the government's goal of improving mathematics education not only in Region XII but in the entire country, as well.

In relation to this, I am humbly asking for a ***letter of permission*** from your good office to conduct the above mentioned study in South Cotabato Division schools. This will involve collection of necessary data using survey questionnaires (for principals, math teachers and students), interview (for teachers and students), classroom observation and National Achievement (NAT) Mathematics scores of Grade Six and Fourth Year High School students who will be included in the study.

I am hoping for your favorable response to this request. I would like to extend my heartfelt appreciation and gratitude for any support you could provide. This would likewise offer me the opportunity to be part of the remarkable efforts in building and improving the capacity of our teachers and the quality of learning that our students deserve to get. I would make certain that your office will be furnished with the ***report of the results*** of this study soon after carrying out all the necessary analyses of the collected data.

Thank you very much.

Respectfully yours,

MICHELLE RIVERA LACIA

Mobile Phone: 0947 7978602
Email: michelle.lacia@adelaide.edu.au
michellelacia2000@yahoo.ca

NOTED:

Appendix I. SDS Sultan Kudarat

THE UNIVERSITY of ADELAIDE

School of Education

Level 6, 10 Pulteney St., Adelaide SA 5005; Tel: +61 8 8313 0694, Fax: +61 8 8313 3604

February 15, 2013

KAHAR M. MACASAYON, PhD, CEO VI
SCHOOLS DIVISION SUPERINTENDENT
SULTAN KUDARAT

Dear DR. MACASAYON::

Greetings of Peace.

I am Michelle Rivera Lacia, a faculty member of Notre Dame University in Cotabato City. I am currently a Higher Degree by Research (HDR – leading to PhD) student at the University of Adelaide, South Australia under the AusAID-Australian Development Scholarship.

I have completed my research proposal presentation with a working title of *"Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippines"*. This proposed research will investigate the current teaching and assessment practices (collectively known as classroom practices) of the Grade Six and Fourth Year High School Mathematics teachers and its likely effect on students' mathematics achievement (NAT math score) in public and private schools in Region XII. It specifically aims to examine other underlying factors that directly or indirectly affect students' performance. Teachers' attitudes towards mathematics and mathematics teaching, mathematics self-efficacy beliefs, content knowledge, pedagogical content knowledge, knowledge and perception of assessment as well as students' attitudes towards and beliefs about mathematics will be examined as possible factors that could influence teachers' classroom practices. This further seeks to address the dearth of research that looks at both the teaching and assessment practices of mathematics teachers in the country. The results are expected to provide significant information which can be used as bases in designing professional development programs for teachers, to enhance pre-service teacher programs and to support the government's goal of improving mathematics education not only in Region XII but in the entire country, as well.

In relation to this, I am humbly asking for a ***letter of permission*** from your good office to conduct the above mentioned study in SULTAN KUDARAT Division schools. This will involve collection of necessary data using survey questionnaires (for principals, math teachers and students), interview (for teachers and students), classroom observation and

National Achievement (NAT) Mathematics scores of Grade Six and Fourth Year High School students who will be included in the study.

I am hoping for your favorable response to this request. I would like to extend my heartfelt appreciation and gratitude for any support you could provide. This would likewise offer me the opportunity to be part of the remarkable efforts in building and improving the capacity of our teachers and the quality of learning that our students deserve to get. I would make certain that your office will be furnished with the ***report of the results*** of this study soon after carrying out all the necessary analyses of the collected data.

Thank you very much.

Respectfully yours,

MICHELLE RIVERA LACIA

Mobile Phone: 0947 7978602
Email: michelle.lacia@adelaide.edu.au
michellelacia2000@yahoo.ca

APPROVED

SARAH H. MALASAYON, Ph.D. CESO VI,
OIC - Schools Division Superintendent

by:

LEONARDO M. BALALA
Asst. Schools Division Superintendent
2/15/13

Appendix J. Request Letter - NETRC

THE UNIVERSITY of ADELAIDE

School of Education

Level 6, 10 Pulteney St., Adelaide SA 5005; Tel: +61 8 8313 0694, Fax: +61 8 8313 3604

30 June 2015

DR. NELIA V. BENITO, CESO IV
Director III, National Education Testing and Research Center
DepEd Complex, Meralco Ave., Pasig City 1600
Philippines

Dear Dr. Benito:

I am Michelle Rivera-Lacia, a faculty member of Notre Dame University in Cotabato City. I am currently a PhD in Mathematics Education candidate in the University of Adelaide, South Australia under the Australia Awards Scholarship program.

I am now working on my research entitled "*Classroom Practices in Mathematics: Effects on Primary and Secondary Students' Achievement in Region XII, Philippines*". This investigates the current teaching and assessment practices (collectively known as classroom practices) of the Grade Six and Fourth Year High School Mathematics teachers and their likely effect on students' mathematics achievement (NAT and NCAE math score) in both public and private schools in Region XII. It specifically aims to examine other underlying factors that could affect students' performance which include teachers' attitudes towards mathematics and mathematics teaching, mathematics self-efficacy beliefs, knowledge and perception of assessment as well as students' attitudes towards and beliefs about mathematics. The results are expected to provide significant information which can be used as bases in designing professional development programs for teachers, enhance pre-service teacher programs and support the government's goal of improving mathematics education not only in Region XII but in the entire country, as well.

Before I collected my data on January to March 2013, I sought permission from DepEd National and Region XII offices, from which I was granted permission (please see attached) to pursue my data collection. I was also granted permission by the Division Superintendents. I visited around 180 schools in different school divisions (excluding Sarangani province and General Santos City-included only 1 school) in Region XII. I used survey questionnaires for school Principals, Mathematics teachers and Grade 6 and Fourth Year High school students. I likewise conducted an interview to both teachers and students. In addition to the data that I have already collected, I will also need the NAT and/or NCAE results of Grade 6 and Fourth Year High school students who were involved in my study as measures of students' achievement. From the very start, Division Superintendents, school principals, mathematics teachers and students are aware that NAT and NCAE will also be obtained and be part of my study. I am now on my final year and working on my data analyses and thesis writing. I will not be able to move forward and complete my analyses without the remaining data I need for my study.

In this connection, I am humbly requesting from your office the **NAT and NCAE 2012-2013 Individual Results of Grade Six pupils and Fourth Year High school students with students' names (if available) and reference numbers** from both private and public elementary and secondary schools in Region XII. Please see attached the list of schools that participated in my study for your reference.

Having been a teacher for more than 10 years, I fully understand that students' data should be kept with utmost confidentiality. In the same way that students NAT/NCAE results should also be treated the same. I have no intention to divulge the identity of my respondents (school principals, teachers and students), nor the names of the schools and divisions in any of my reports. It is likewise a strict requirement by the Research Ethics committee of the University of Adelaide (please see attached the Ethics approval). The only thing I needed their names for is for me to match my data with their scores, since I only got the students' names with me. If I will not get the matched data, then, that will totally distort my research findings which could lead to the examiners failing my research.

For this purpose, I was granted permission by my Principal Supervisor, Head of School of Education and my scholarship program to fly back to the Philippines and personally visit your office to collect the data and sign any pertinent documents on August 3-4, 2015.

I am hoping for your favorable response to this request. I would like to extend my heartfelt gratitude for any support you could provide for the completion of my research.

Thank you very much.

Respectfully yours,

MICHELLE RIVERA LACIA
School of Education
Faculty of Arts
The University of Adelaide
Adelaide, AUSTRALIA 5005

Noted by:

DR. I GUSTI DARMAWAN
Principal Supervisor
Senior Lecturer, School of Education
Faculty of Arts
The University of Adelaide
Adelaide, AUSTRALIA 5005