# Valid Measurement of Laboratory Learning Experience Quality from the Student Perspective

**Samuel James Priest**
Department of Chemistry, School of Physical Sciences

July 2016


THE UNIVERSITY of ADELAIDE

# Contents

# Abstract

Since the early 2000s, improvement of the student learning experience in university level laboratory activities in Australia has been sought by the Advancing Science by Enhancing Learning in the Laboratory (ASELL) project. The nation-wide project has made use of the ASELL Student Learning Experience (ASLE) survey to gather data and draw conclusions regarding student perspectives of their learning experiences, using trends observed in the data to inform pedagogy. Analyses of rating scale response format items on the ASLE survey have typically involved an integer value scoring system applied to the response categories. The appropriateness of such integer scoring techniques and the subsequent application of parametric statistical methods to ordered categorical data in this way is contested in statistical literature, which raises questions regarding the validity of ASELL project conclusions drawn in the past.

In this thesis, Rasch measurement is applied to a data set of ASLE survey responses, using the true interval scale measures gained to test the validity of the scoring techniques and parametric methods more typically applied to ASLE data. The role of student biases in survey response and 'objectivity' of any measures associated with learning experience quality are explored, yielding quantitative models of the student perception of laboratory learning experiences. The thesis culminates in the use of factor analysis to develop a Linear Logistic Test Model for a data set of over 9000 completed ASLE surveys, explaining the responses received as linear combinations of a small number of major factors in the student laboratory learning experience. The model is used to draw pedagogical conclusions from the ASLE survey data set uninfluenced by limitations of the integer scoring techniques usually applied.

The work has major implications for valid interpretation of ASLE survey data received both in the past and in future, suggesting that whilst integer scoring methods may be amenable to parametric statistics, the conflation of student dependent and student independent factors limits the generality of any conclusions drawn. Student independent measures obtained from Rasch analysis, however, reveal that the perceived relative quality of a laboratory exercise is largely consistent through the student population sampled. The Linear Logistic Test Model generated reveals a wide range of connections between different facets of the laboratory learning experience and this general perceived learning experience quality, informing effective science pedagogy. Pedagogical conclusions include strong connections between group work and understanding of theoretical content, the advantages of data analysis and individual work in development of more technical or practical skills, evidence for the importance of structuring activities appropriate to the ability level of the students, as well as ways to generate student interest and foster perceptions of a positive overall laboratory learning experience. A need for compromise between teaching objectives and learner preferences is highlighted, noting that the "best" way to design a laboratory activity largely depends on the intended purpose of the exercise.

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

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

_____

# Acknowledgements

First and foremost, I wish to thank my supervisors Simon Pyke, Natalie Williamson and John Willison for their continued and valued support throughout my writing of this thesis. I greatly appreciate their willingness to allow me to exercise freedom and creativity in my research, even following paths that are relatively unfamiliar for all concerned, whilst still being able to provide constructive feedback and guidance along the way.

I would also like to thank the many practical demonstrators who have assisted in the distribution of "my horrible surveys" over the course of numerous years, without whom I could never have gathered the wide data set which has been integral to the strength of this work's conclusions. I wish to particularly thank Annelie Karssen, who took over the collection of survey data whilst I was away briefly during 2015. Data gathered during that time has been some of the most useful for my final and most interesting conclusions, and I am grateful for her help. Laboratory technicians Peter Roberts and later Catherine Margach have also been of great help in accommodating my presence in the first year chemistry laboratory, and I am very grateful to them.

Another person deserving of particular thanks is Lyron Winderbaum, who readily offered his assistance in the dreaded art of MATLAB coding when I was in need. Without his help, I'm sure I would never have had it working. Continuing the mathematical theme, I wish to give thanks to Sivakumar Alagumalai, who first introduced me to Rasch analysis and kindly spared his time to provide me some advice in the earliest stages of my research.

I also wish to thank my friends and family for their continual support and kindness throughout my studies. My friends for giving me much needed distractions from my working life as well as sharing my dread of the editing process, and my family for continuing to support and encourage my continued study, even as a few expected deadlines sailed past.

Lastly, I would like to thank all of the first year chemistry students who have passed through the laboratory over the few years I have been present. Without them, my entire project would have been impossible and my working days would never have been so enjoyable.