Chapter 1
Objective Measurement in Psychometric Analysis

Myint Swe Khine

Abstract The Rasch model, a subset of a larger group of models known as item response theory (IRT), is becoming a common way of analyzing psychometric data in educational research. There are many reasons why researchers are adopting this approach. One of the reasons for using Rasch analysis technique is that it is possible to express a person's measures on the same scale, regardless of which survey or test form the respondent completed. This chapter synthesizes the studies reported in this book and describes the potentials of using Rasch model for objective measurement.

Introduction

Psychometric evaluations using Rasch measurement are increasingly prevalent in educational and human sciences research in the past decades. Quantitative researchers use Rasch techniques to guide the development of surveys, questionnaires, rating scales, and tests and analyze the functioning and improve the precision of such instruments. Rasch measurement is known to align with the notion of objective measurement that aims to provide a common metric to express the results (Bond & Fox, 2013). The use of Rasch analysis based on item response theory (IRT) provides a versatile and effective way for examining the psychometric quality of the instruments and tests and allows validation, calibration, and further improvements. Numerous studies have been conducted to discover the properties of various scales used in the fields of psychology, human, and social sciences, and in-depth analyses are reported in the literature (Boone, Staver, & Yale, 2014). The book presents studies related to the use of the Rasch measurement model in validation studies and analysis of psychometric properties of a variety of test instruments, questionnaires, and scales in different languages and diverse contexts. This book is divided into three parts.

M. S. Khine (✉)
Emirates College for Advanced Education, Abu Dhabi, United Arab Emirates
e-mail: Dr.mkhine@gmail.com

Curtin University, Perth, Australia

M. S. Khine (ed.), *Rasch Measurement*,
https://doi.org/10.1007/978-981-15-1800-3_1

While the first part of the book presents theoretical and conceptual frameworks, the second part deals with the use of the Rasch model and analysis in education research. The last part of the book covers validation studies with Rasch analysis in psychometric evaluations of various instruments.

Theoretical and Conceptual Frameworks

Three chapters in Part I of this book serve as a primer on Rasch analysis for researchers and practitioners. In Chap. 2, William Boone presents Rasch basics for the novice. The chapter covers the basics of Rasch theory, an overview of key indices in Rasch analysis, and interpreting those indices, specific techniques, and presentation of results. Boone further explains that Rasch techniques can be used to revise a test, evaluate partial credit tests, and investigate measurement bias. The author also notes that though Rasch analysis can be complex, it allows communicating the research findings more efficiently. DiStefano and Jiang in Chap. 3 provide an introduction to the Rasch rating scale model (RSM) and how to use the methodology in analyzing questionnaires and constructing a psychometrically sound scale. The chapter also presents applied examples to assist researchers in a clear understanding of the Rasch model and decision making. The authors note that RSM is a useful model to examine the characteristics of questionnaire data and scale development. Chong Ho Yu in Chap. 4 explains the concept of objective measurement and the difference between Rasch modeling and item response theory. The major components of Rasch modeling, such as item calibration and ability estimates, item characteristics, item information function, test information function, item-person map, are explained with examples. Moreover, the author also presents the use of different software packages for Rasch modeling, including SAS and Winsteps.

Rasch Model and Analysis in Education Research

The chapters in Part II cover the use of the Rasch model and analysis on education research. This part begins with Chap. 5 by Francisco Ben, who re-examined the utility of the Individualised Classroom Environment Questionnaire (ICEQ) using the Rasch model. The ICEQ is one of the learning environment questionnaires that are designed to measures the psychosocial aspects of classroom climate. The instrument specifically measures aspects of personalization, participation, independence, and differentiation in the classrooms. The study was conducted with 306 high school students in South Australia. The author reports the findings from the evaluation of the ICEQ and the implications for future research and teaching practice.

In Chap. 6, Italo Testa and his team present the findings from the validation study on the university entrance test through Rasch analysis in Italy. The team analyzed the psychometric quality of an 80-item entrance test that was administered to 2435

science and engineering students and another 100-item test administered to 1223 students. The tests were analyzed using Rasch measurement to determine item separation, personal separation, and differential item functioning (DIF). The authors report that the tests do not match the unidimensional requirement and suggest the balancing of difficult items in the tests in a more suitable way.

Chow and Shiu describe the analysis of an elementary economics test to assess university students learning using the Rasch model in Chap. 7. The study took place with 300 first-year students in a university in Hong Kong. The study examines the unidimensionality of the items, personal and item reliabilities, item statistics, personal and item measures, and person-item map of the economics test. The results of the fit statistics in a Rasch analysis reveal the characteristics of the test and information about the level of students' achievement. The chapter concludes with the future use of the assessment information to improve a better understanding of students' mastery of the subject.

In Chap. 8, Huang, Huang, and Oon report the constructs evaluation of 30-item Student Attitudes toward Science (SAS) questionnaire that was administered to 1133 students in Grade 7–11 in China. The aim of the study is to find out whether Rasch analysis can provide psychometric information about the SAS instrument when used with students in China and what the Chinese students' attitudes toward physics and biology are. The study reports, among others, model fit and data reliability, differential item functioning (DIF), and effectiveness of response categories in each of the items. The study found that although Chinese students generally held positive attitudes toward physics and biology, they enjoyed studying physics more than biology but expressed higher confidence with biology.

Chan and Subramanian present their findings from the validation of a science concept instrument with Rasch analysis. The newly developed 22-item instrument was administered to 115 students in 16 Singapore secondary schools. The data were analyzed to explore the differential item functioning with respect to gender and academic tracks, and relationships with prior attainment and science self-efficacy.

Celeste Combrick analyzed the large-scale assessment data on the Progress in International Reading Literacy Study (PIRLS) to assess the measurement invariance in the cross-national achievement of South African participants by applying Rasch partial credit model. The study used 2006 cohort as a reference group and 2016 cohort as a focal group. The objectives of the study are to find out the differential item functioning (DIF) of the common items between cycles of participation and differential bundle functioning (DBF) between cycles of participation, particularly the common linking items and internal measurement invariances. Chapter 10 reports the findings from the study. The author concludes that Rasch models offer sufficient evidence of internal measurement variance and the assessment of the stability of item ordering and functioning.

Validation Studies with Rasch Analysis

The chapters in Part III include validation studies with Rasch analysis. Kreijns and Bilker describe a Rasch analysis approach to the development and validation of a social presence measure in Chap. 11. The researchers constructed a set of 30 items instrument to measure social presence in online educational contexts, in particular, to discover the effects of mediated communication in the social interaction and group dynamics in distributed collaborative learning environments. The questionnaire was administered to 82 students in a university in Germany. A Rasch analysis was conducted to explore the fits of items and persons, unidimensionality, and category probability curve using Winsteps software. The results show two dimensions of the social presence—awareness of others and proximity with others.

In Chap. 12, You and her colleagues report the construct validity of constructed response items to test students in undergraduate introductory biology course in two public universities in the United States. The study involves 437 students who answered the 8-item constructed-response items in the Scientific Literacy in Introductory Biology (SLIB) assessment set. The data were analyzed to evaluate the psychometric properties of polytomous constructed-response items using the partial credit model. The study attempts to find out the unidimentionality of the items, local independence, item and person fits, item and person separation indices and reliabilities, and item difficulty using item-person map. The chapter reports the results and concluded that the development of constructed response items and automatic scoring models will allow faculty to provide an opportunity for students to construct explanations instead of rote learning.

The analysis of the psychometric properties of the social responsibilities goal orientation scale is presented by Bergh in Chap. 13. The study uses data extracted from the Swedish longitudinal Evaluation Through Follow-up (ETF) project. A scale consisting of six polytomous items was administered to the students to measure the students' social responsibility and goal orientation. Rasch analysis is used as a measurement model to investigate the psychometric properties of the instrument and differential item functioning (DIF) by gender. The analysis found that DIF by gender on one item. The study also found the local dependency of the items that indicate the response to one item may be governed by the response to the other item.

In Chap. 14, Nielsen and Santiago explain the graphical log-linear Rasch model (GLLRM) that can be used to test local dependence of the items and differential item functioning (DIF). The data were collected in Australia and Denmark using the perceived stress scale (PSS). The PSS consists of two sub-scales (perceived stress and perceived lack of control), and two versions of the scale (PSS-10 and PSS-14) were used in the studies. The authors report the items they found locally dependent and DIF by gender in both countries.

Conclusion

The chapters in this book cover theoretical and conceptual frameworks for Rasch modeling, analysis of questionnaires and tests, and validation of instruments using Rasch modeling. The authors in this book explain the basics of objective measurement and Rasch modeling and its applications in simple terms. The authors critically examine the effectiveness of various surveys, questionnaires, and tests and provide new and refreshing ideas and recommendations. It is hoped that the book is informative, insightful, and relevant to those who wish to employ and keep up with the latest research in Rasch modeling approach to quantitative education research.

References

Bond, T. G., & Fox, C. M. (2013). *Applying the Rasch model: Fundamental measurement in the human sciences* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Boone, W. J., Staver, J. R., & Yale, M. S. (2014). *Rasch analysis in the human sciences*. Dordrecht: Springer.