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13. STRUCTURAL EQUATION MODELING APPROACHES IN EDUCATIONAL RESEARCH AND PRACTICE

INTRODUCTION

Over the years, researchers have developed statistical methods to help them investigate and interpret issues of interest in many discipline areas. These methods range from descriptive to inferential to multivariate statistics. As the psychometrics measures in education become more complex, vigorous and robust methods were needed in order to represent research data efficiently. One such method is Structural Equation Modeling (SEM). With the advances in computational methods, statistical power to analyse complex data has been increased in recent years. Many educational researchers started using this technique in their research and the outcomes of the analysis help to identify the factors and interactions between students' characteristics, personal preferences, affective traits, motivational levels, study skills, engagement and various other factors that could help in educational practice (Teo & Khine, 2009). The chapters in this book presents the collective works on concepts, methodologies and ideas for SEM approach to educational research and practice. The anthology of current research described in this book will be a valuable resource for the next generation educational researchers.

   The book is organized into three parts. Part I deals with theoretical foundations on the use of SEM in educational research. In Part II the research papers cover the use of SEM specifically in learning environment research and in Part III, Structural Equation Modeling in educational practice is presented followed by the conclusion.

THEORETICAL FOUNDATIONS

In Chapter 1, Teo from the University of Auckland and his colleagues from National Taichung University provided how Structural Equation Modeling (SEM) can be used as a method for analysing multivariate data both non-experimental and experimental in educational research. They noted that SEM procedures incorporate both unobserved (latent) and observed variables while other multivariate techniques are based on observed measurement only. They continue to identify types of models in SEM and explain in detail each of those models. It was also noted that there are five steps in testing SEM models. These five steps are model specification, identification, estimation, evaluation and modification. The

remaining chapter focused on the test of model fit and model modification. They concluded that the chapter presented non-technical, non-mathematical, and step-by-step introduction to SEM with a focus for educational researchers who possess little or no advanced Mathematical skills and knowledge.

Yo In'nami from Toyohashi University of Technology in Japan introduced the readers to Structural Equation Modeling (SEM) in a user-friendly way and lists some of the developments in the field of SEM applications. The chapter explained the principles, assumptions, strengths, limitations, and applications of SEM for experimental and non-experimental data. It describes five steps for SEM application: (a) model specification, (b) model identification, (c) parameter estimation, (d) model fit, and (e) model respecification. The chapter also provided brief insights into current issues in the field. Knowledge of these issues is vital for those who intend to use SEM. In addition, this chapter also described present and future trends with regard to the development of SEM to better prepare researchers for studying more advanced topics later in their careers.

STRUCTURAL EQUATION MODELING IN LEARNING ENVIRONMENT RESEARCH

Learning environment research, grounded in psychosocial contexts of the classrooms, has been firmly established as a field of study over the past four decades. Educators agree that, although important, academic achievement does not provide a complete picture of the process of education. The quality of the environment in which students learn plays an important role in achieving desired educational outcomes (Fraser, 2001). With the use of survey instruments and interviews with students, teachers and other stakeholders as a lens, educators are able to gain valuable information about the social ecology of the classrooms that could help to improve the instructional approach, classroom management and the learning organisation. Much research has been conducted to identify the factors and interactions between students' characteristics, personal preferences, affective traits, motivational levels, study skills, and various other factors that could help in organising conductive learning environments.

In recent years learning environment researchers used SEM as a tool to determine the effects of the classroom environments and psychological factors such as motivation, self-regulation, and attitudes towards subjects. Part II of this book contains six chapters that focus on the study of learning environments using SEM as an analytical tool. In Chapter 3 Marjan Vrijnsen-de Corte and her colleagues in the Netherlands presented the study on teachers' perceptions of the school as a learning environment for practice-based research. In their study, Structural Equation Modeling (SEM) was used to investigate paths (relations) between respondents' perceptions of the school as learning environment for practice-based research (research structure, research culture, and partnership), motives for performing practice-based research, process variables (planning and performing research, and evaluating and reporting research), and outcome variables (research attitude and efficacy beliefs, and teacher efficacy beliefs).

Chapter 4 by Liu and Fraser presented the development and validation of an English classroom learning environment inventory and its use in China and the associations between students' perceptions of the classroom learning environment and their English-related attitudes and academic achievement were investigated using structural equation modeling. The learning environment inventory measured the scales containing Teacher Support, Task Orientation, Student Cohesiveness, Cooperation and Oragnization. The inventory has 37 items. The attitude towards English was measured by Test if English-Related Attitudes questionnaire that has 8 items. The results from structural equation modeling are that Teacher Support, Task Orientation, Student Cohesiveness and Organisation had positive associations with students' English-related attitudes. The direct association between Task Orientation and attitudes was positive and statically significant, whereas Cooperation had a negative and significant impact on attitudes. The authors suggested that English teachers can make use the newly-developed inventory to assess students' perceptions for the improvements in their classroom environments.

Ennest Afari from the Petroleum Institute in Abu Dhabi presented his findings on the effects of psychosocial learning environment on students' attitudes towards mathematics in Chapter 5. This chapter reports a study that investigated the effects of psychosocial features of learning environment on college students' attitudes towards mathematics in the United Arab Emirates. The learning environment was assessed with two scales (Teacher Support and Involvement) from the What Is Happening In this Class? (WIHIC) questionnaire and one scale (Personal Relevance) from the Constructivist Learning Environment Survey (CLES). Structural equation modeling (SEM) was used to estimate and test the hypothesized relationships of 3 learning environment factors (teacher support, involvement and personal relevance) on enjoyment of mathematics lessons and academic self-efficacy. Results supported the positive effects of 2 learning environment factors (teacher support and personal relevance) on enjoyment of mathematics lessons and academic efficacy.

In Chapter 6, Valayutham, Aldridge and Afari described a comparative Structural Equation Modeling analysis on students' learning environment, motivation and self-regulation. The study aimed to identify salient psychosocial features of the classroom environment that influence students' motivation and self-regulation in science learning, and examine the effect of the motivational constructs of learning goal orientation, science task value and self-efficacy in science learning on students' self-regulation in science classrooms. Finally the study aimed to compare results from variance and covariance-based structural equation modeling (SEM) analysis. The comparative analysis of PLS and AMOS applications indicated that the results were similar for both confirmatory factor analysis and assessment of the research model.

The purpose of Hasan Seker's chapter (Chapter 7) is to show how SEM analysis can benefit learning environment research. His chapter dealt with in/out of school learning environment and SEM analyses of attitudes towards school. In Chapter 8, Lee her colleagues from Hong Kong presented a study that examined the effects of the teaching and learning environment on the development of students' generic

capabilities. In their study the students completed a modified version of the Student Engagement Questionnaire, which measured their perceptions of the development of six capabilities and their ratings of the quality of six aspects of the teaching and learning environment. Structural Equation Modeling was used to test two alternative models on the impacts of the teaching and learning environment upon the development of the six generic capabilities based on samples of undergraduates.

STRUCTURAL EQUATION MODELING IN EDUCATIONAL PRACTICE

Part II of this book contains studies related to the use of SEM in educational practice. The section begins with Liem and Martin's work on the latent variabl modelling in educational psychology. The chapter described the many methodological applications of SEM that are used to answer distinct applied and substantive questions important to understanding and enhancing students' educational development. The chapter also synthesized findings from large-scale SEM studies conducted across elementary school, high school, and university/college. These studies encompass SEM involving, inter alia, longitudinal data, mediation, interactions, multi-group analyses, and multi-level modeling. The authors also presented some ideas for future SEM applications in educational research and practice.

In Chapter 10, John Rugutt from Illinois State University demonstrated the SEM approach to link teaching and learning environment variables to higher order thinking skills. Specifically the author of this study used the structural equation model (SEM) approach to test a model that hypothesized the influence of motivation (MO), teacher student relations (TSR), and self-efficacy (SE) on higher order thinking skills (HOTS). Also, the study used confirmatory factor analysis (CFA) to validate MO, TSR, SE and HOT measures. The study further investigated a SEM model that hypothesized interrelationships among all the study variables.

Binod Sundararajan and his colleagues from Dalhousie University, Halifax, Canada and North Carolina Central University, USA presented a path analysis model to examine the influence of group decision in e-Learning and blended learning environments. SEM was used to determine the effects of different variables such as motivation, respects, ability to make friends, self-perception of group mates and gaining new knowledge. Three hypotheses were tested and the data was analysed using AMOS. The authors concluded that both asynchronous and synchronous communication patterns in E-learning and blended learning environments allow learners to gain respect from group mates which then motivates them to have influence in group decision making processes, make friends, collaborate and have a significant impact on group knowledge gains.

In Chapter 12, Christine DiStefano and her co-researchers from the University of South Carolina and the University of West Georgia presented their finding from the factorial invariance investigation of teacher climate factors across school organizational levels. Six climate dimensions involved in this study were Working

conditions/ leadership (WCL), Home-school relationship (HSR), Instructional focus (IF), Resources (RES), Social-physical environment (SPE), and Safety (SAF). Invariance testing and latent means comparisons were conducted by school organizational level to determine how the model structure, and resulting climate interpretations, may differ for teachers across elementary, middle, and high schools. The authors concluded that the results can be used to assist schools and administrators interested in enhancing school climate.

CONCLUSION

In sum, this book brings a range of international examples and theories to illustrate the applications of SEM in educational research and practice. The challenge for the researchers and educators is how we can make use of these results in practical ways for the improvement of future education and new generation of learners across the world.

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