Teacher Effectiveness in Clinical Teaching: Structural Equation Modeling

by

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Abstract

Clinical teaching of medical students is vital to prepare them for effective patient management and future practice. In turn, it is important for teachers to recognize the factors that influence learning (i.e., principles) along with the processes that underlie them (i.e., theories). This is expected to promote student learning and facilitate student achievement, future practice and lifelong learning.

This study focuses on the effectiveness of the clinical teacher in a clinical teaching setting, through the statistical and empirical investigation of a model representing the relationship between teacher characteristics, student perceptions and student outcomes. This study was carried out in clinical settings in one medical school in Saudi Arabia.

The study focused on two research questions: First, if there is there a relationship between teacher characteristics (input), student perceptions (process) and student assessment (outcome) factors in clinical teaching. Second, if a latent variable path model can be developed to demonstrate the relationship between teacher characteristic, student perception and student outcome.

This study developed and tested a theory-based model using structural equation modeling. It evaluated clinical teaching by taking into consideration three levels: (1) input factors including teacher characteristics, (2) process factors focusing on student perceptions, and (3) outcome factors addressing student achievement. Data were gathered from clinical teachers as well as medical students.
The results showed a significant relationship between teacher characteristics, student perceptions and student outcomes in clinical teaching. A latent variable path analysis showed a good fit to the data with a comparative fit index of .93, which converged in 7 iterations, with a standardized residual mean error of 0.05 and RMSEA of 0.08, SRMR = 0.05.

To our knowledge this is the first study in the medical education literature that analyzed and demonstrated a perfect fit of the tested three level theoretical model (teacher characteristics, teaching and coaching skills and student outcomes) and empirical data using Structural Equation Modelling. It is proposed that future research studies identify and test additional factors that may influence student outcomes in a clinical setting.
Preface

The purpose of this dissertation was to investigate the correlation between the clinical teacher, student and outcome by using Structural Equation Modeling. This doctoral research should be of interest to medical schools, medical councils and post-graduate training programs. The work included in the dissertation is original, unpublished, and independent work by A.ZAWAWI.
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Dedication

To my respective parents who have given me the drive to tackle any task with enthusiasm and determination.
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<thead>
<tr>
<th>Term &amp; Acronyms</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance; statistical method used to analyze the differences between group means and their associated procedures</td>
</tr>
<tr>
<td>ACGME</td>
<td>Accreditation Council for Graduate Medical Education</td>
</tr>
<tr>
<td>CanMEDS</td>
<td>Canadian Medical Education Directions for Specialists</td>
</tr>
<tr>
<td>CCTEI</td>
<td>Cleveland Clinical Teaching Effectiveness Instrument</td>
</tr>
<tr>
<td>CBD</td>
<td>Case Based Discussion; a structured interview designed to assess professional judgment in clinical cases.</td>
</tr>
<tr>
<td>CFI</td>
<td>Comparative Fit Index</td>
</tr>
<tr>
<td>DOPS</td>
<td>Direct Observation of Procedural Skills; a tool that assesses the procedural skills essential to providing good clinical care, focusing on especially important and technically demanding procedures.</td>
</tr>
<tr>
<td>EQS</td>
<td>Equations, implementing structural equation modeling, Computer Software program</td>
</tr>
<tr>
<td>FA</td>
<td>Factor Analysis; a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors.</td>
</tr>
<tr>
<td>LCME</td>
<td>Liaison Committee on Medical Education</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
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<tr>
<td>LISREL</td>
<td>Linear Structural Relations</td>
</tr>
<tr>
<td>LS</td>
<td>Least Squares</td>
</tr>
<tr>
<td>MCTTQ</td>
<td>Maastricht Clinical Teaching Questionnaire</td>
</tr>
<tr>
<td>ML</td>
<td>Maximum Likelihood</td>
</tr>
<tr>
<td>Mini-CEX</td>
<td>Mini-Clinical Evaluation Exercise; assesses students’ history and physical examination skills.</td>
</tr>
<tr>
<td>OSCE</td>
<td>Objective Structure Clinical Examination</td>
</tr>
<tr>
<td>SEM</td>
<td>Structural Equation Modeling; a statistical methodology that takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon.</td>
</tr>
<tr>
<td>SRMR</td>
<td>Standardized Root Mean-Square Residual</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>RMSEA</td>
<td>Root Mean Square Error of Approximation</td>
</tr>
<tr>
<td>RMR</td>
<td>Root Mean Square Residual</td>
</tr>
<tr>
<td>WBA</td>
<td>Work Based Assessment</td>
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</table>
Epigraph

"Mankind have not been given of knowledge except a little."

Holy Quran
Surah, AlEsraa ayah 85

This ayah indicates that the amount of knowledge we gain in our life is just a small portion of what's out there.
Chapter One: Introduction

This chapter will highlight the research overview of teacher effectiveness in clinical teaching. It will explore the role of the clinical teacher and their effects on the medical students, if any. The researcher will highlight the background of some of the instrument used in the literature to assess clinical teacher effectiveness, as well as to discuss the purpose of the study and research questions. The chapter will conclude with the thesis outline.
1.1 Overview

Clinical teaching is a complex activity that includes all domains of learning, such as knowledge, psychomotor skills, and attitudes. Clinical Teaching in a clinical environment has its own distinct challenges consisting of hospital inpatient, outpatient, and community settings (Ramani & Leinster, 2008). Teaching medical students during their clinical rotations is vital to medical education, and allows students an opportunity to apply their knowledge and understand the environment of their future work (AlHaqwi, Vander, Schmidt, & Magzoub, 2010). In addition to teaching medical students at different stages of their learning, clinical medical teachers face the additional responsibility of having to provide patient care (Irby & Bwoen, 2004; Prideaux et al., 2000).

Clinical teaching can take place in an inpatient or outpatient setting and is based on the premise that students learn best by participating under supervision in the day-to-day care of patients. There are, however, differences between inpatient and outpatient teaching environments, including the type of patient complaints, the clinical setting, the numbers of patients seen, and the continuity of care (Dent, 2005; Laidley & Braddock, 2000; Ramani & Leinster, 2008). Hospital wards today provide fewer opportunities for teaching large numbers of students in patient care settings, as they tend to be more representative of subspecialty conditions or the more critically ill. In hospital, students are not exposed to the full spectrum of prevalent diseases in the community, thus they have less opportunity to learn continuity of patient care (Dent, 2005). In contrast, students learning in outpatient settings are more patient centered with patients presenting with a mix of acute and chronic illnesses, some of which require immediate short and long term management. It can be said that the process of teaching in
outpatient environments is characterized by variability, unpredictability and immediacy of cases (Irby, 1994). The combination of both inpatient and outpatient settings is probably the most effective approach for undergraduate clinical teaching (Murray, Jolly, & Modell, 1997; O'sullivan, Martin, & Murray, 2000).

1.2 Rationale

Most teachers develop their teaching techniques based on a combination of their own experiences as learners, as well as general conceptions of teaching derived from observation. Many clinical faculty start teaching immediately following graduation, thereby receiving little or no explicit training on how to teach, or knowledge on what the processes and theories of teaching are (Irby, 1994; Ramani & Leinster, 2008). Successful teachers may know how to behave in a teaching role but may either be unaware or unable to utilize the basic principles or the theoretical concepts underlying effective teaching methods (McLeod, Meagher, Steinert, Schuwirth, & McLeod, 2004). In fact, few teachers have studied the art and science of medical education (Misch, 2002).

In recent years, there has been an explosion of innovative teaching strategies. As a result, it has been stated that leaders in education need to think more seriously about teacher training and clinical work, in order to develop a framework for excellence in clinical teaching (Hesketh et al., 2001; Ramani & Leinster, 2008). Teachers therefore, should focus more on student’s needs in teaching and should have the knowledge of basic principles and theoretical concepts of teaching and learning (McLeod, et al., 2004). In addition, teachers should understand thoroughly the factors that influence learning (i.e., principles) and the processes that underlie it (i.e., theories) to
promote student learning and facilitate student long-term success (Ormrod, 2004). Importantly, clinical teachers should be familiar with outcome based assessment methods relevant to their own environment, such as the Canadian Medical Education Directions for Speciality (CanMEDS), Accreditation Council for Graduate Medical Education (ACGME), Liaison Committee on Medical Education (LCME), etc. (Ramani & Leinster, 2008).

General Medical Council’s ‘Good Medical Practice’ states: "Teaching, training, appraising and assessing doctors and students is important for the care of patients now and in the future. If physicians are involved in teaching, they must develop the skills, attitudes and practices of a competent teacher" (Steinert, 2009). Although more than 15,000 studies have been published on the topic of teaching effectiveness student ratings have dominated as the primary or sole measure of teaching performance over the last 50 years (Berk, 2009). Therefore in the present study a theory-based instrument was developed and tested with structural equation modeling, in order to explain the correlation between clinical teacher characteristics (considered as input), student perceptions of clinical teaching (considered as process), and student assessments (considered as outcome factors). Data were gathered from both clinical teachers and medical students.

1.3 Background

Student ratings, in general, have dominated as the primary or only measure of teaching performance over the last 50 years (Berk, 2009). There are several evaluation instruments that measure the quality of clinical teaching of medical students in the workplace, but none of them have a specific theoretical base that links the effect of the teacher to the student outcomes (Berk, 2009).
In any assessment of teaching methodology or effectiveness, it is generally accepted that the instrument used for evaluation of clinical teaching should be theory based, reliable and valid. At present, there are several evaluation instruments that measure the quality of clinical teaching for medical students in a clinical setting, either ambulatory or inpatient. The two most cited instruments in the medical education literature are: 1) the Stanford List and 2) the Cleveland Clinical Teaching Effectiveness Instrument (CCTEI) (Copeland & Hewson, 2000; Litzelman, Stratos, Marriott, & Skeff, 1998). The strength of the CCTEI lies in the involvement of the stakeholders in the design process. However, it lacks specific theoretical dimensions that could hamper its effectiveness as well as its claim to be comprehensive. The Stanford List has a clear theoretical basis, but it focuses on a broad collection of teaching activities that makes the instrument less suitable for individual feedback. In contrast, in 2010 Maastricht Clinical Teaching Questionnaire (MCTTQ) published an instrument for clinical teaching evaluation. MCTTQ is theory based, valid and reliable (Stalmeijer, Dolmans, Wolfhagen, Muijtjens, & Scherpier, 2010). Nevertheless, it is limited by the fact that it only focuses on the teaching process from the student’s perspective. Again, this limits its comprehensiveness by excluding other important factors in the clinical teaching process, such as input and outcome factors.

In clinical teaching the educational process may be affected by a variety of factors, the most important being related to the clinical environment, number of patients, number of students, clinical teacher, or a combination of them. Based on the limitations of the available instruments mentioned earlier, this study comprehensively evaluated clinical teaching for input, process and outcome factors, and included both students and teachers in the proposed model. For instance, it was assumed that teachers' educational background significantly influenced their teaching skills...
viewed as an input factor (Hesketh, et al., 2001; Ramani & Leinster, 2008). According to Social Learning Theory, learning is enhanced when students can observe and emulate the thinking and action of expert role models (Bowen & Carline, 1997). In clinical teaching, students can observe clinical teachers and learn from the role models communication, explanation, examination and management skills in the clinical setting. Students can practice what they learn immediately in clinic when they are given the opportunity to communicate, explain and examine the patient under teacher supervision.

In clinical teaching, the teachers should consider Adult Learning Theory, where adults have a specific purpose in mind that encourages them to learn. Clinical teachers should clarify skills in communication depending on where the student is at and what his or her needs are. Generally, students feel more comfortable when they are voluntary participants in their learning. Actively being involved in their learning, having clear goals and objectives, being given feedback to improve their performance, and being given the opportunity for reflection can make learning more meaningful, relevant, and comfortable (Bowen & Carline, 1997; Hewson, 1992; Laidley & Braddock, 2000).

In this research, by using Structural Equation Modeling, we propose that when teaching and coaching skills are used by teachers (as identified in Social and Adult Learning Theory); positive effects on student outcome (i.e., assessment and satisfaction) will be evidenced. In the clinical teaching environment we consider the teacher characteristics as input factors, which affect the process of teaching and the outcome, while we consider the teacher’s teaching and coaching
skills as perceived by student as process factors, and student satisfaction and assessment as outcome factors.

Structural Equation Modeling (SEM) is a powerful technique that can combine complex path models with latent variables (Hox & Bechger, 2001). In more simple terms, SEM consists of a statistical model representing the relationship between relevant latent variables and a measurement model representing the relationship between those latent variables and their manifest or observable indicators (Nachtigall, Kroehne, Funke, & Steyer, 2003). Teaching medical students in a clinical setting is affected by a multitude of factors; however this research focused on the teacher and his/her effect on student outcome.

1.4 Study Purpose

The primary purpose of this study was to explore the relationship between teacher characteristics, student perceptions, and teaching outcomes based on student satisfaction, work-based assessment, and teacher satisfaction. A secondary purpose of this research was to develop a structural equation model of teacher effectiveness in clinical teaching.

A model was developed to test the hypothesis that presumes the importance of a relationship between input (teacher characteristics), process (student perceptions), and outcome (student assessment) factors in clinical teaching.
1.5 Research Questions

The study was focused on two research questions. First, if there is a relationship between teacher characteristics (input), student perceptions (process) and student assessment (outcome) factors in the clinical teaching. Second, if a latent variable path model can be developed to demonstrate the relationship between teacher characteristic, student perception and student outcome.

1.6 Thesis Outline

The present thesis is divided into five chapters. Chapter one provides background information on teacher effectiveness and Structural Equation Modeling, concluding with a statement of the purpose of the study. Chapter two provides a review of the literature relevant to the current study, ending with the research questions that guide this work. Chapter three outlines the research methods utilized to answer the research questions mentioned in chapter two. Chapter four presents the results of the study. Chapter five restates the research results in a discussion form, for the purpose of evaluating the research questions. The final chapter ends with research limitations and recommendations for future research.
Chapter Two: Literature Review

This chapter is a critical review of the literature. The chapter starts with a review of literature on studies dealing with teacher effectiveness, more specifically clinical teaching. The next section includes a review of literature on the evolution of Structural Equation Modeling (SEM) inclusive of recent developments and uses of SEM in medical education, as well as advantages and disadvantage of SEM.
2.1 Teacher Effectiveness

2.1.1: Overview

The earliest research referring to teacher effectiveness occurred in the 1940s and attempted to link teacher characteristics to student learning outcomes. It was not until 1974, that Dunkin and Biddle established a model to test teacher effectiveness focusing on process and product variables (Rink, 2013). Specifically, they identified the constructs of teacher and student characteristics, and studied the relationship between these constructs. After that, studies on the topic of teaching effectiveness were conducted in universities and colleges across the developed world and since then, more than 15,000 papers have been published on the topic (Berk, 2009). Most of the papers analyzed teacher effectiveness in the classroom either by student perceptions or student performance at the end of the year. Student ratings have dominated as the primary or sole measure of teaching effectiveness over the last 50 years (Berk, 2009). In rare cases, programs have analysed changes in student attitude or behaviour (Darling-Hammond, Newton, & Wei, 2010; Irby, 1978; Schmidt & Moust, 1995).

Much of the published works revealed the glaringly obvious and considerable difficulties of assessing teacher effectiveness both in the classroom and clinical environment. This difficulty can be related to the multiplicity of factors affecting the process of learning and teaching, including student attitudes and awareness, the teaching environment, as well as the clinical practice and personal behaviour of the teacher. It was reported that learner outcomes were influenced by number of learners, teacher characteristics, practice, and environmental factors (Srinivasan et al., 2011). Moreover, this was complicated by the interaction between the student and teacher, with practice affecting the clinical teaching environment. The teacher is responsible
for creating an effective learning environment and for applying appropriate learning tools and methods to facilitate student learning (Refer to Figure 1).

One of the goals of medical education is to promote learning by engaging the learner. For instance, the teacher may attempt to engage students in the patient care process by asking simulated questions during clinical teaching, giving feedback, and asking students to reflect, which ultimately is expected to lead to better participation in patient care and improved clinical skills (Srinivasan, et al., 2011).

Figure 1: Interaction between Students, Teachers and Practice
2.1.2 Theoretical Background

The initial research on teacher effectiveness was introduced in the classroom teaching in as early as the 1940s, followed by a lot of research in the same area which tried to elucidate the role of the teacher and the effect on the student performance (Rink, 2013). Since that time, all research has attempted to identify a specific definition of effective teaching (Beran & Violato, 2009). Numerous studies have tried to look at teacher effectiveness from different angles for example: studies that related teacher effectiveness to student learning and student outcomes, while others focused almost exclusively on the instructional process and teaching environment (Stalmeijer, et al., 2010). Defining the effective teacher, effective teaching, and teaching effectiveness can be complex and controversial. It can be affected by more than one factor related either to the teacher, students, and practice. Effective teaching in clinical environment requires criteria for effectiveness. These criteria refer to the objectives of education in general, and of teaching in particular (including teaching skill).

Undoubtedly, clinical teaching has a long term direct and indirect effect on the learner (Connell, 2009). Teacher effectiveness is a complex construct, which is dependent on a large number of variables that have direct and indirect effects on student achievement. Hence, teacher effectiveness is not simply an individual responsibility, but rather a shared responsibility of the entire school or institution and all of its members. Furthermore, narrowly conceptualizing teacher effectiveness cannot appropriately embrace the multitude of complex and causal relationships between the relevant variables.
Irby (1978) reported that the best clinical teachers are described as being enthusiastic, clear, well organized, and adept in interacting with students. However, he did not report on how the above teaching characteristics would affect the learners. Conversely, (Brok, Tartwijk, Wubbels, & Veldman, 2010) reported that the positive effect of teacher–student relationships are revealed in the student’s eventual learning outcome. This contribution explores the relationship between teacher experience and features of teacher–student interactions. Although the differential effectiveness of schools and teachers receives a growing interest, few studies have focused on teacher effectiveness on student learning within the clinical setting.

It is essential that “good” teachers know the adult learning principles and apply them during their teaching (Snell et al., 2000). To understand adult learning, one needs to understand the domains of learning, learning styles, and the process of adult learning. Medical students in the clinical setting are adult learners, who are usually active and self-directed rather than teacher centered. Generally, they appreciate teachers who apply adult learning theory, especially experiential learning. This helps students make decisions that are relevant to patient management in the future. Rolf (2002) reported the importance of how feedback to the learner helps them improve their performance in practice across a range of different teaching methods. It can be said therefore, that teaching in a clinical setting involves more than simply applying the "know how"; rather, it is an intellectual discipline or coherent interdisciplinary field, in it is own right (Connell, 2009).
2.1.3 Teacher Effectiveness

Teacher effectiveness can be defined as “the degree to which an instructor facilitates student achievement” (Beran & Violato, 2009). More generally, teacher influence can be noted in clinical practice, curriculum content and context, educational environment, student learning, and learning outcome (Rink, 2013). Specifically, the teacher plays a crucial role for the student during clinical rotation and should offer opportunities for the students to apply their knowledge within the environment of their future working situation (AlHaqwi, et al., 2010). However, the primary responsibility of clinicians is to provide quality patient care. Therefore, clinical teachers are challenged by the need to teach the student and care for the patient at the same time, explaining or clarifying questions from both (Laidley & Braddock, 2000; Prideaux, et al., 2000). Although good clinical teachers are expected to manage their time between patient care and teaching, Mourad and Redelmeier (2006) found a weak correlation between being a good clinical teacher and delivering effective patient care. Nonetheless, they found that a good professional role model can affect the student’s choice of future career.

Clinical teachers utilise their knowledge to consider case presentations by students. This same knowledge enables them to diagnose patients, provide target instruction, and give feedback. The question is, what do clinical teachers need to know in order to teach effectively? According to Irby (1994), clinical teachers need to be both content experts (which may be the most important part) and context experts. In addition, teachers in a clinical setting need the combination of humanist ideals and teaching skills to generate a "reflective practitioner" (Connell, 2009). A student-teacher interpersonal relationship is one of the factors that affects teaching in general and may affect clinical teaching in particular (Brok, et al., 2010) although in some studies, it does not
show any link to student outcomes (Allen, Witt, & Wheeless, 2006). Other studies however, have shown that a teacher’s personal qualities and clinical knowledge were two of the most important facets of effective teaching (Schmidt & Moust, 1995). Some authors suggest the importance of teacher educational background, especially if they have training on the teaching and learning style, on teaching effectiveness and student achievement (Darling-Hammond, et al., 2010), but they fail to test the effect on the teaching process or link it to student outcomes. However, faculty development and continued professional development have been reported as having a beneficial effect on medical education. Steinert (2006) found that faculty development had a positive effect on student outcome.

Clinical teachers need to be briefed on the curriculum to be taught as well as the teaching method that will facilitate learning, so as to align teacher and student outcomes (Ramani, 2003). Teachers should also be aware and understand clearly the educational objectives for each clinical rotation for different student levels, which will help in standardizing teaching (Kyriakides & Creemers, 2008). For instance, a lack of standardization in teaching and curriculum content of clinical history taking between Teacher A and Teacher B may confuse learners, create inequalities, and make it difficult to ensure the same topics are being taught and assessed appropriately.

In summary, clinical teachers play a major role in both learning outcome, as well as other decisions made by the student, such as future career choice. As a result, teachers need to be content and context experts to fully benefit their learners. To improve clinical teaching,
observation and monitoring of the effectiveness and appropriateness of what teachers do during their clinical teaching, as well as regular teacher development are needed.

2.2 Structural Equation Modeling

2.2.1 Background

Over the past 30 years, the use of Structural Equation Modeling (SEM) has increased in several disciplines such as economics, psychology, education, sociology and medical education research. SEM is a general statistical modeling technique, widely used in behavioural and social sciences, and is a framework that allows researchers to translate theory into testable models (Bollen, 1989). It is also a modern statistical method allowing evaluation of causal hypotheses across a set of inter-correlated non-experimental data (Bentler & Stein, 1992a). Perhaps most importantly, SEM is a powerful technique that can combine complex path models with latent variables (Hox & Bechger, 2001). Arguably, the true power of SEM is demonstrated in latent variable modeling. In more simple terms, SEM consists of a statistical model representing the relationships between relevant latent variables and a measurement model representing the relationship between those latent variables and their manifest or observable indicators (Nachtigall, et al., 2003).

SEM consists of a structural model representing the relationship between the latent variables of interest (e.g., intelligence) and measurement models representing the relationship between the latent variable and their observed indicators (e.g., scores) (Nachtigall, et al., 2003). Chapters 3 and 4 will provide more clarification about SEM and its use in combining complex models.
To discuss the historical background of SEM, the following paragraphs will explain previous but related models and their chronological development starting from regression, factor analysis, path modeling and its relationship to SEM (Refer to Figure 2).

In 1894 mathematician Karl Pearson created a **Regression Model** formula for the correlation coefficient relationship between two variables. Regression analysis provided a test of a theoretical model that became useful for prediction. In 1904, psychologist Charles Spearman used a correlation coefficient to determine which items correlated or went together to create a factor model. Spearman was the first to use the term **Factor Analysis** in identifying a two-factor construct for a theory of intelligence. In 1918, the biometrician, Sewell Wright, developed a third type of model, a **Path Model**, which used correlation coefficients and regression analysis to model more complex relations among variables. It tested theoretical relationships, which historically was termed "causal modeling". Tucker (1955) introduced the new labels of "exploratory" and "confirmatory" factor analysis. The Confirmatory Factor Analysis (CFA) method was more fully developed by Jöreskog in 1960 to test whether a set of data defined a construct or not. The early development of SEM was due to Karl Jöreskog, Ward Keesling and David Wiley (1969,1973) and was first known as the JKW model, but later became known as the Linear Structural Relation Model (LISREL) in 1973. SEM essentially combines path models and confirmatory factor models (P. M. Bentler, 1986; Schumacker & Lomax, 2010; Violato & Hecker, 2007). Its most prominent feature is the capability to deal with latent variables, connected to observed variables by a measurement model (Nachtigall, et al., 2003).
Figure 2: Historical Background of Structural Equation Modeling

- 1896: Karl Pearson - Linear Regression
- 1904: Spearmen - Correlation Coefficient
- 1918: Sewell Wright - Path Model
- 1955: Tucker - Confirmatory & Exploratory Factor Analysis
- 1960: Jöreskog - Structural Equation Model
2.2.2 More Recent Developments

The single most exciting development in SEM during the past quarter century has been the integration of both psychometric factor analysis (FA) and structural (path analysis) models, thus giving rise to the fully achieved development of LISREL (Linear Structural Relations Model). Arguably, this has been the greatest single factor in the spread of SEM techniques throughout the social sciences (Violato & Hecker, 2007). A further development saw the creation of a software package EQS (Equations, implementing Structural Equation Modeling) which was introduced to the field in 1989 by Bollen and is now well known and widely used. Structural equation models are frequently called ‘LISREL’ (Linear Structural Relations Model), a software program by Jöreskog (Schumacker & Lomax, 2010).

Several papers have assessed the growth of SEM and reported increases in journal publishing of SEM articles across the disciplines of psychology, biological sciences and psychometrics (Hershberger, 2003; Tremblay & Gardner, 1996; Violato & Hecker, 2007). Bentler reported as far back as 1992 several examples of SEM in medical research (Bentler & Stein, 1992b). In 1994, an important step forward in the history of SEM occurred when a Structural Equation Modeling Journal began; that journal contributed as much to the development of SEM as all the other journals taken together (Hershberger, 2003).

In 2009, a commentary in the International Journal of Epidemiology urged epidemiologists to use SEM more frequently (Beran & Violato, 2010). More recently, several published papers in medical education used SEM to test their educational theories, while other papers explained SEM and its usage in medical education (Beran & Violato, 2010; Violato & Hecker, 2007).
2.2.3 Basic tenets of SEM

A Structural Equation Model can be best defined as "a class of methodologies that seeks to represent hypotheses about the means, variances and co-variances of observed data in terms of a smaller number of 'structural' parameters defined by a hypothesized underlying model" (Nachtigall, et al., 2003). SEM is a multivariate technique that integrates multiple regression and factor analysis (Martin, 2011). The true power of SEM however, comes from latent variable modeling. SEM uses a model representing the relationship between latent variables of interest, and a measurement model representing the relationship between the latent variable and their manifest or observable indicators (Nachtigall, et al., 2003). (Refer to Figure 3). In developing a SEM, researchers need to follow five steps: 1) model specification, 2) model identification, 3) model estimation, 4) model testing, and 5) model modification (Schumacker & Lomax, 2010). In the methods section (Chapter 3, Page.42), we will explain how we use those steps in developing our model.

SEM is very flexible if clearly understood. It may be the future of medical education research. SEM uses observed and latent variables or defined independent or dependent variables. In contrast, a regression model consists solely of observed variables where a single dependent observed variable is predicted by one or more independently observed variables. In addition, the problem of measurement error in observed variables is not treated in either regression or path models (Schumacker & Lomax, 2010). The advantage of SEM over regular multiple regression analysis is that SEM allows the use of more than one dependent variable, making possible the analysis of causal models with more than one structural path between variables (De Bruin, Schmidt, & Rikers, 2005).
SEM allows researchers to combine a variety of statistical procedures such as multiple regression, factor analysis and multivariate analysis of variance (MANOVA). It can however, appear complicated and difficult to understand, which may explain some confusion between SEM and regression path analysis (Nachtigall, et al., 2003).

Figure 3: Expanded Model of the Regressive Dependencies between Three Latent Variables - A distinction between the Structural Model and Measurement Models (Adapted from (Nachtigall, et al., 2003).
2.2.4 SEM in Medical Education

Although its research tool potential has been recognized, SEM has not been used extensively in medical education research (Violato & Hecker, 2007). Bentler and Stein (1992) stated that "if more biostatisticians were familiar with the technique, SEM could be applied routinely when appropriate." At present, it is difficult to pinpoint when SEM was first introduced to medical education. Two recent published papers offered explanations for how to use five steps in applying SEM in medical education research (Beran & Violato, 2010; Violato & Hecker, 2007). In the Methods of Chapter 3 (p.42) we will explain how we used these steps in developing our model.

SEM appears to be a promising tool for medical education research. As is well known, medical education is grounded in many theories, and SEM can help to test the hypotheses of educational theory in particular, in relation to new teaching and learning practice. Medical education research therefore, can use SEM more often, as it has been extensively tested in psychological research. SEM can provide medical education researchers with an opportunity to link psychological theory in teaching and learning

2.2.5 SEM Advantages and Disadvantages

SEM has become an important and popular analytic method, noticeable in a number of scientific journal articles (Hershberger, 2003; Tremblay & Gardner, 1996). The possibility of modeling complex dependencies and latent variables is regarded as the main advantage for using SEM (Nachtigall, et al., 2003). Equally important to note, SEM helps researchers become more
aware of the need to use multiple observed variables for better understanding of their scientific inquiry. SEM also makes possible the analysis of causal models with more than one structural path between variables (De Bruin, et al., 2005). Furthermore, SEM deals not only with a single simple or multiple regression, but with a system of regression equations. The same variable may represent a predictor in one equation and a criterion in another (Nachtigall, et al., 2003; Schumacker & Lomax, 2010). In addition, SEM allows researchers to test hypotheses based on multiple constructs that may be directly or indirectly related to both linear and nonlinear models (Beran & Violato, 2010). For example, educational data can be analyzed from the collection from more than one level such as teacher, student, and resident. It is possible to use multi-level SEM, which can incorporate other multivariate models. SEM is considered a "meta-multivariate model" (Hershberger, 2003).

SEM can estimate and remove both random and correlated measurement errors, and can also examine mediating processes, giving it an advantage in experimental data over traditional ANOVA or MANCOVA methodologies (Lee, 2011). SEM also gives greater recognition to the validity and reliability of the observed score from measurement instruments. SEM techniques explicitly take measurement errors for each variable into account when statistically analyzing data. They include latent and observed variables as well as measurement errors. SEM can also examine correlated measurement errors to determine to what degree unknown factors influence shared error among variables. In addition, SEM software has a clear mechanism for how to handle missing data such as multi-sampling analysis, Full Information Maximum Likelihood (FIML), Expectation Maximization (EM) and Multiple Imputations (MI) (Tomarken & Waller, 2005). (Refer to the section on managing missing data in Chapter 3, page 47).
SEM is a theory-strong approach, and has the ability to analyze more advanced theoretical models. Neuropsychologists in particular suggested that SEM may bridge the gap between theory and research practice (Bentler & Stein, 1992a). It has become an important tool to test theories with both experimental and non-experimental data (Fan, Thompson, & Wang, 1999).

Finally, there is more than one software program available now for SEM, and all are user friendly. The LISREL program in 1980 was the first SEM software program. However, it has been followed by other programs including AMOS, EQS, Mx, Mplus, Romona and Sepath (Nachtigall, et al., 2003; Schumacker & Lomax, 2010).

The most frequent critique raised against the use of SEM has centered on two issues. Firstly, SEM needs a minimum sample size of 100 to 150 subjects to obtain stable parameter estimates and standard errors. The greater the sample size, the more accurate the result, using a cross validation suggested sample size of 10 to 20 subjects per variable (Schumacker & Lomax, 2010; Yang & Green, 2010). Conversely, too few indicators of the latent construct may lead to under-identification of the model (Bentler & Stein, 1992b). Secondly, SEM can be affected by an unclear theoretical guide, invalid and unreliable data, or poor research planning and over-interpretation of the causal relationship (Beran & Violato, 2010; Martin, 2011). Model identification remains an important and challenging aspect in SEM (Bollen & Davis, 2009). Furthermore, the correlation between variables could be misinterpreted if the model is unspecified due to unexplained or weak theory, an unclear hypothesis, or poor study design (Violato & Hecker, 2007). In this research, we were careful to ensure we had a clear hypothesis.
and study design when writing the SEM equation. Moreover, as explained next in Chapter 3 (p.42), the 5 steps to develop a SEM were followed.

The number of researchers using SEM have increased since 1987 with the advent of user-friendly software programs (Hershberger, 2003; Tremblay & Gardner, 1996). Hershberger (2003) reported that SEM is a case study of how statistical techniques should be developed to meet the demands of substantive research and not the other way around. He believes that the primary reason SEM has become so popular lies in its usefulness to applied research (Hershberger, 2003). Researchers can now obtain more accurate estimates of reliability using SEM by conducting large sample studies with well-constructed scales and critically assessing model fit (Yang & Green, 2010).

In summary SEM can help researchers explore the correlation and covariance in multiple constructs between latent and observed variables, dependant and/or independent variables. In this study, SEM was used to help clarify the correlation between teacher, student and student outcome, as well as take into consideration multivariate, multiple construct and complex relations.
Chapter Three: Research Method

This chapter presents the outline of the research method utilized to answer the research questions mentioned in chapter two. This chapter will discuss the research setting of King Saud bin Abdul-Aziz University for Health Sciences (KSAU-HS), Riyadh, Saudi Arabia, as well as describe the participants of medical students and clinical teachers. In addition, the instrument used for data collection will be presented, as well as the data analysis, and 5 step SEM development process. Moreover, there will be an explanation of how the reader can interpret the EQS output. The chapter will conclude with an explanation of how missing data was managed and ethical considerations of the study.
3.1 Study Context

This study was conducted at King Saud bin Abdul-Aziz University for Health Sciences (KSAU-HS), Riyadh, Saudi Arabia. The medical curriculum in KSAU-HS is designed in a way that the first two and a half years of the curriculum are devoted to the teaching of basic medical sciences. Clinical teaching usually takes place in the following third and fourth year. However, new trends in medical education encourage early exposure of medical students to clinical situations (AlHaqwi, Kuntze, & Van der Molen, 2014). The training of undergraduate medical students during clinical rotations is usually organized by rotating them through the main medical specialties (e.g., Internal Medicine, Surgery, Pediatrics, Obstetrics and Gynecology and Family Medicine). Students are also given the option to spend a certain amount of time in other disciplines as elective courses.

All teachers and students included in the study were in their 4th year of medical school (Phase 3) in the academic year of 2012-2013. Phase 3 is an Integrated Clinical Attachment (ICA); these are rotations spent in the inpatient units and outpatient services of the King Abdul-Aziz Medical, in addition to the core medical and surgical specialties. The clinical rotation is called a Block in KSAU-HS. (Refer to Table 1)

Students in their clinical years are learning full time in a clinical practice setting. During the clinical rotation (block) student’s clinical skills are assessed in two ways: Formative (including a total of 40%, Work Based Assessment) at least four times per rotation, they include: Clinical Based Discussion (CBD), representing 20% of the total score; which is a structured interview designed to assess student’s professional judgment of clinical cases. Direct Observation of
Procedure Skill (DOPS), representing 20% of the total score; focusing on evaluating the procedural skills of trainees by observing them in the workplace setting. **Summative** (including a total of 60%); at the end of each clinical rotation, students sit for the Objective Structured Clinical Exam (OSCE) (representing 30% of the total score) and a written exam (Multiple Choice Questions, representing 30% of the total score). The examination results include formative and summative assessments which are kept in the assessment unit in KSAU-HS.

### 3.2 Participants

Participants in the present study consisted of all undergraduate medical students in the 4th year, phase three of the academic year 2012-2013 (a total of 96 students). Data were collected at the end of each clinical rotation because it was believed that students were better able to give their opinion about the different aspects of the clinical learning environment. They were asked to complete a questionnaire for three of their clinical teachers at the end of each rotation. Every clinical teacher (a total of 129) involved in clinical teaching (inpatient or outpatient), was asked to complete a questionnaire on their educational background and understanding, as well as the use of adult learning theory in their clinical teaching.

Participation was voluntary for both faculty and students. Verbal consent was obtained from the clinical faculty at the beginning of their clinical rotation and they were informed about the objectives and intent of the study. Students participated at the end of each block in the education year 2012/2013, after they were informed about the study objectives and had been given a chance to ask clarification questions to the study researchers. A cover letter was included to inform them about the research aims and objectives. (Refer to Appendix1). All data were kept
confidential, and only used for research purposes. The collected data were saved on a password-protected computer in the Department of Medical Education. Prior to analysis, all participant data were de-identified in order to maintain confidentiality and anonymity, and all computers/USBs were password protected and encrypted. No one other than the primary investigator and student researcher were able to access the data.

Table 1: Distribution of Students and Teachers in all Clinical Rotations (Block)

<table>
<thead>
<tr>
<th>Block</th>
<th>Batch</th>
<th>Duration</th>
<th>Number of students</th>
<th>Number of clinical teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal medicine</td>
<td>7</td>
<td>15 weeks</td>
<td>60</td>
<td>41</td>
</tr>
<tr>
<td>General Surgery</td>
<td>7</td>
<td>15 weeks</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Family medicine</td>
<td>6</td>
<td>10 weeks</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Obstetrics &amp; Gynaecology</td>
<td>6</td>
<td>10 weeks</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>Paediatric</td>
<td>6</td>
<td>10 weeks</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>30 weeks/batch</td>
<td>96</td>
<td>129</td>
</tr>
</tbody>
</table>
3.3. Instrument Development

In order to develop the instruments for the present study, adult learning theory and social learning theories were reviewed. In a clinical setting, since both practical skills and specific knowledge are required, both theories reviewed were considered appropriate in explaining how clinical teaching and learning are facilitated. Students generally have a specific purpose in mind that encourages them to learn during clinical rotation. In an ideal situation, students are voluntary and active participants, are given clear goals and objectives, and provided feedback so as to reflect on their learning.

A checklist was created from the principle of adult and social learning theories in order to develop teacher and student questionnaires. Teachers were asked if they used the specified technique in their teaching and if they believed it was of importance in their clinical teaching. Similarly, students were asked if their teacher applied the identified techniques in their clinical teaching (Please refer to Appendices 2 and 3).

A group of seven experts in clinical teaching and medical education from KSAU-HS and King Abdul-Aziz Medical City were asked to review the questionnaire for validity and feasibility. Subsequently, a focus group was developed. From the discussions which ensued, recommendations were made on how to improve the questionnaire. All recommended changes were then applied to the questionnaire. Additionally, a list of techniques identified as essential for learning to occur was created from a thorough review of the learning theories. Students and teachers were asked to review the questionnaire and a pilot study was then conducted (22 students and 10 teachers). Further final changes were then made to the questionnaire.
The Teacher Questionnaire, which is focused on the teacher’s self-evaluation (Input Factor), contained a total of 21 items. Items included the teacher’s personal background, educational background using principles of adult learning in clinical teaching, including appreciating the importance of adult learning (Please refer to Appendix 2). The Student Questionnaire, which is focused on the student’s perception (Process Factor), contained a total of 16 items. Items reflected student perceptions of their clinical teachers; specifically, whether they believed teachers were applying the principles of adult and social learning in their clinical teaching. Students were asked to give their opinion on each item using a 5 point Likert scale represented as: 1 (Never), 2 (Rarely), 3 (Sometimes), 4 (Most of the Time), and 5 (All of the Time). (Please refer to Appendix 3).

Student outcomes (Outcome Factor) included two sections: (1) Student Satisfaction; questions related to overall satisfaction for teachers. Students were asked to give their opinion on each item using a 5 point Likert Scale. There were also questions for the clinical teachers regarding their level of satisfaction about student learning outcome (1= poor to 5 = excellent), as well as questions for students about their learning satisfaction (1= poor to 5 = excellent); and (2) Student Assessments; by the end of each clinical rotation student clinical assessment grades were collected in both Work-Based Assessment (DOPS, CBD) and Objective Structure Clinical Examination (OSCE).
3.4 Model

A focused group of content experts reviewed the Adult and Social Learning theories and subsequently agreed on concentration areas for the questionnaire. A hypothesis model was developed merging the principles of Adult Learning Theory with Social Learning Theory (Bowen & Carline, 1997; Laidley & Braddock, 2000). This was matched to the hypothesis of teacher effectiveness in clinical teaching, taking into consideration most of the theoretical background was related to classroom teaching. (Refer to Figure 4). The hypothesis model proposed to explore the relationship between teacher teaching skill and coaching skill (according to the adult and social learning theory) with teacher educational background and experience, in addition to the effect on students' outcome.

Based on the limitations of available instruments in the literature (which are either not theory-based or are not student-centred), a model was chosen to evaluate clinical teaching, which comprehensively included teacher characteristics (input), student perceptions (process) and student assessment (outcome) factors. In this, teacher’s educational background was assumed to have a significant influence on teaching skills as input factors (Hesketh, et al., 2001; Ramani & Leinster, 2008). According to Social Learning Theory, learning is enhanced when students can observe and emulate the thinking and action of expert role models (Bowen & Carline, 1997). Moreover, in clinical teaching, the teachers should consider Adult Learning Theory, where the learner has a specific purpose in mind that encourages them to learn.

The notion of the learner are considered voluntary participation, who require meaning and relevance, active involvement in learning, clear goals and objectives, constructive feedback, and
opportunities for reflection should be provided (Bowen & Carline, 1997; Laidley & Braddock, 2000). In this model, we will explore the relationship between learning teaching outcomes (student satisfaction, work based assessment, teacher satisfaction) and the teacher characteristics (input) and student perceptions about the teaching (process) factors. Moreover, in this model, Adult and Social Learning Theory have been included as variables of student perception for their teacher teaching skill (process factor) (Dornan, Boshuizen, King, & Scherpbier, 2007).
Figure 4: Hypothesised Model of Teacher Effectiveness in Clinical Teaching

Variable cannot be obtained in data collection.
3.5 Data Analysis

3.5.1 Research Question One

Is there a relationship between teacher characteristics (input), student perceptions (process) and student assessment (outcome) factors in the clinical teaching/learning environment? The goal of this question is to explore the relationship between input, process, and outcome factors in clinical teaching. Consequently, the following plan for analysis was determined:

(1) Data from both the Teacher and Student Questionnaires were summarized using descriptive statistics (means, standard deviations, and response rates) where appropriate.

(2) Factor analysis was run to explore the relationship between items of the observed variables from students' perceptions (process). (Refer to table 2).

(3) Pearson Product Moment Correlation Coefficients and Analysis of Variance (ANOVA) were computed to explore the relationship between factors. This was done in order to find a model that fit the data, which could also provide the theoretical support as was proposed.

(4) Cronbach’s Alpha for the reliability of each scale was calculated to determine internal consistency.
Table 2: List of Observed Variables

**During clinical teaching your teacher:**

- Asked you questions to clarify your previous knowledge?
- Gave you feedback to improve your performance?
- Asked you to reflect on your learning?
- Encouraged your participation in the session?
- Supervised your examination of patients?
- Specified learning objectives for the clinical session?
- Achieved the learning objectives?
- Encouraged your active participation in the clinical session?
- Responded appropriately to your questions/clarifications?

**Rate your clinical teacher’s:**

- Clinical knowledge.
- Style in clinical teaching.
- Use of different methods of teaching (active learning, passive learning, monologue and dialogue).
- Provision of feedback.
- Respectful attitude toward students.

**Rate your clinical learning:**

- Compared to other teachers; how you would rate your learning from your clinical teacher?
- Has clinical experience prepared you to be confident to deal with similar cases in the future?
3.5.2 Research Question Two

Can a latent variable path model be developed to demonstrate the relationship between teacher characteristics, student perceptions, and student outcomes?

SEM is concerned with testing theoretical models for the structure of functional relationships among multivariate data (Schumacker & Lomax, 2010). SEM provides a framework that helps test the hypothesized underlying structural relationship between the latent variables by integrating three key components: path analysis, factor analysis, and the development of estimation techniques for model fit (Violato & Hecker, 2007). There are two main reasons for using SEM in this study: the first is to understand the pattern of correlation between input, process and output variables; and the second is to explain the variances associated with the proposed model.

To answer the second research question, we used EQS which is a powerful "user friendly " software program for SEM (Waller, 1993). A model was tested comprising all factors and the overall judgment was reached utilizing the linear structural modeling program EQS version 6.2. A random selection (20% to 30%) was taken from the total sample and run several times, with the SEM explaining the relationship between proposed factors. Appendix 4 illustrates the equation used and Command File. From the user’s point of view, EQS is composed of four fundamental variable types: (1) measured variables (v), (2) latent variables or factors (F), (3) measured variable residuals or errors (E), and (4) latent variable residuals or disturbances (D). Users need only identify the V, F, E, and D variables, and their relationship with in a regression
framework. Each variable has its own symbol in Structural Equation Modeling and arrows symbolically represent the impact of one variable on another (Refer to Table 3).

The EQS equation uses the Least Square estimate (LS), which minimizes the sum of the squares of the residual in the model. It examines the pattern of relationships, but does so by determining the optimum solution by minimizing the sum of the squared deviation scores between the hypothesized and observed model (Beran & Violato, 2010).

3.5.2.1 Application of SEM

In developing our model we followed the 5 steps described below

Step 1: Model Specification

The first step in planning for SEM involves identifying the prior hypothesis. In our case, we considered merging core principles of Adult and Social Learning theories as related to factors affecting student perception for the teaching process and the student outcome.

In this step we begin with the focus group, asking them to review the teacher and student questionnaires. The theoretical underpinnings are defined and the research question was developed. A pilot study was conducted on a group of graduate medical students (n = 25) and clinical teachers (n = 10). The focus group met again to review their answers to the questionnaire and some further modifications were recommended. The model was revised accordingly.
Step 2: Model Identification

The research model was then reviewed by a group of experts in medical education and in clinical teaching. For model identification, it is valuable to find unique values for the parameters of the specified model. In this step, the proposed identified model is defined by “things we know” being equal to “things we want to know.” The list of the latent and observed variables are clarified and the factor analysis to identify the factors is run. (Refer to figure 4).

Step 3: Model Estimation

Estimation techniques were developed to determine how our model fit the observed data based on the extent to which the model implied correlation matrix is equivalent to the data derived. Refer to Appendix 4 for the command file for EQS.

Step 4: Model Fit

This step came after running the data in the EQS program, and determined how well the model fit the data. Sample size is one of the important factors affecting the goodness of fit. Given our sample is large enough (867 which is greater than the general guideline of 100), we can expect to obtain a stable estimate of the parameters.

The EQS output will report the fit indexes (refer to appendix 5, 6, and 7). Common fit indexes include the Comparative Fit Index (CFI), Root Mean Square Error of Approximate (RMSEA), and Standardized Root Mean Square Residual (SRMR). To learn more about how these indices are interpreted please refer to the next section (3.5.2.2 on page 44).
Step 5: Model Modification

The final step in SEM involves re-specification of the model on theoretical grounds. EQS was run several times; after each time the model was modified and re-specified according to proposed theoretical relevance. Each time 25% of the data were randomly selected. (Refer to Chapter 4 for the Results; specifically, section 4.5 on page 63).

3.5.2.2 How to Read EQS Output

According to Step 4 in SEM (i.e., model fit), EQS gives the output data to draw the SEM. To clarify, in SEM, “fit” refers to the ability of a model to reproduce the data (usually the variance covariance matrix). There are many fit indices, with most ranging from 0 to 1, with high values indicating a great degree of variance in the data accounted for by the model. The Comparative Fit Index (CFI) is the most commonly used and compares the existing model with a null model. A value CFI > 0.9 is considered representative of a well-fitting model, indicating that 90% or more of the covariance in the data can be reproduced by the hypothesized model (Byrne, 2006; Schumacker & Lomax, 2010).

CFI = \frac{d(\text{null model}) - d(\text{proposed model})}{d(\text{null model})}

The Root Mean Square Residual (RMR) represents the average residual value derived from the fitting of the variance-covariance matrix for the hypothesized model Σ(θ) to the variance – covariance matrix of the sample data (S). However, because these residuals are relative to the size of the observed variances and covariance, they are difficult to interpret (Bentler, 2004; Byrne, 2006).
The **Standardized Root Mean Square Error (SRMR)** represents the average value across all standardized residuals and ranges from 0 to 1, where a well-fitting model is \( \leq 0.05 \). It represents the average discrepancy between observed sample and hypothesized correlation matrices (Byrne, 2006).

**Root Mean Square Error of Approximate (RMSEA)** which is the square root of mean differences between the estimate and the true value. Values less than .05 indicate a good fit, while values higher than .08 represents reasonable error of approximation in the population (Bentler, 2004).

\[
\text{RMSEA} = \sqrt{\frac{X^2 - df}{df (N-1)}}
\]

**Chi-square test** \( (\chi^2) \), which assesses the likelihood that the differences between the population covariance matrix and model implied covariance matrix are zero. **Iteration** is the number of times the program ran the data to fit the model. The best is less than 10 (Byrne, 2006).
Table 3: Symbol Notation for Structural Equation Model

<table>
<thead>
<tr>
<th>Shape /simple</th>
<th>Key meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Circle" /></td>
<td>Circles or ellipses represent unobserved latent variables</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>Squares or rectangles represent observed variables</td>
</tr>
<tr>
<td><img src="image" alt="Single headed arrow" /></td>
<td>Single headed arrows represent the impact of one variable on another</td>
</tr>
<tr>
<td><img src="image" alt="Double headed arrow" /></td>
<td>Double headed arrows represent covariance or correlation between a pair of variables</td>
</tr>
<tr>
<td><img src="image" alt="Measurement error" /></td>
<td>Measurement error associated with an observed variable</td>
</tr>
<tr>
<td><img src="image" alt="Path coefficient" /></td>
<td>Path coefficient for regression of one factor onto another factor</td>
</tr>
<tr>
<td><img src="image" alt="Path coefficient" /></td>
<td>Path coefficient for regression of an observed variable onto an unobserved latent variable (or factor)</td>
</tr>
</tbody>
</table>
3.6 Management of Missing Data

Cases were deleted list wise for any missing data values in variables. That is, not every subject had an actual value for every variable in the dataset, as some values were missing (Schumacker & Lomax, 2010). SEM software has a clear mechanism for how to handle missing data. Since the EQS program was used, list wise deletion of the case was applied and a total of 39 student evaluation forms out of 906 were considered incomplete. There was either data missing on more than 6 items or the student did not sit for the final exam. As a result these forms were excluded, as they made up less than 5% of the total data points.

3.7 Ethical Considerations

This study received ethical approval from the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (RC11/110) and from the University of Calgary`s Conjoint Health Research Ethics Board (CHREB) (E- 24690).

The verbal informed consent provided basic information to the participants of what the research was about and what their participation involved. It clearly stated that participation in this study was completely voluntary and may be withdrawn at any time. The data were placed anonymously in a folder after completion. The researcher in charge of the study had access to the information as a failsafe; however, at no time was any information disclosed to anyone else. All participant data were de-identified in order to maintain confidentiality and anonymity, and all computers were password protected and encrypted.
Chapter Four: Results

This chapter presents the study findings and they are reported in relation to each of the research questions posed. Specifically, the relationship between teacher characteristics (input factor), student perceptions (process factor) and student outcomes (outcome factor) are presented, along with the 3 structural equation models tested.
4.1 Demographic Data

We collected a total of 906 evaluation forms, for 129 clinical teachers and 96 students in different rotations. We requested that each student evaluate 3 clinical teachers during his clinical rotation in Internal Medicine, General Surgery, Family Medicine, Paediatric, and Obstetrics & Gynaecology. The student response rate was 86.78% (Refer to Figure 6), while for teachers it was 10%, even after multiple reminders through emails and telephone. Nonetheless, this was not unexpected or uncharacteristic given the very busy nature of clinical teachers. These professionals have extremely hectic schedules as they face competing demands between their teaching, clinical, and administrative responsibilities. Moreover, it is clear that while all these roles are important, clinicians make patient care their first and foremost priority. In contrast, student response rate was substantially higher than that of teachers, possibly indicating how motivated they are to improve their learning, which they know directly impacts patient care and their professional development.

Using the principle of adult learning and appreciate the importance of learning principle (input factor) teacher satisfaction (output factor) are three variable cannot be obtained because of the low response rate from clinical teachers (10%), (refer to figure 4). Therefore, only teacher characteristics as an input factor including (gender, nationality, background specialty, clinical teaching experience) were acquired from the Clinical Affair Records after obtaining permission from the Dean.
Figure 5: Diagram of Study Participant Enrollment
Given that during the time of data collection the Female College of Medicine was relatively new with no females enrolled; all data for the present study were collected from male medical students. The age of the students ranged between 18 to 27 years, with a mean age of 25 (±1.6 SD). We did not include socio-demographic characteristics in the questionnaire, as it was not related to our research questions.

A total of 116 teachers were evaluated by 96 medical students. Of these teachers, 82 % (n = 95) were male doctors and 18% (n = 20) were female doctors. Similarly, more forms were completed for male doctors (n = 767; 88.5%) compared to female doctors (n = 100; 11.5%). The majority of teachers were Saudi's (84.5%) and their teaching experiences ranged from 5 to 25 years with a mean of 10 years (± 5 SD).

4.2 Descriptive Statistics

A total of 867 forms were analysed. The main score on evaluations for all teachers was 3.9 with a range from 1 to 5 on the 5 point likert scale. The number of evaluation forms received for teachers from students ranged from 1 to 51 forms; for individual teachers, most received from 1 to 10 forms and 13 out of 129 teachers (10%) did not get any evaluations. Therefore, the teachers who did not receive any evaluations were not included in the data analysis. Please refer to Table 4.
Table 4: Frequency of Teacher Evaluation Forms Received from Students

<table>
<thead>
<tr>
<th>Number of Evaluation Forms</th>
<th>Teachers</th>
<th></th>
<th>Number of Forms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>1-10</td>
<td>91</td>
<td>(78.4)</td>
<td>328</td>
<td>(37.8)</td>
</tr>
<tr>
<td>11-20</td>
<td>16</td>
<td>(13.7)</td>
<td>223</td>
<td>(25.7)</td>
</tr>
<tr>
<td>21-30</td>
<td>2</td>
<td>(1.7)</td>
<td>55</td>
<td>(6.3)</td>
</tr>
<tr>
<td>31-40</td>
<td>5</td>
<td>(4.3)</td>
<td>170</td>
<td>(19.6)</td>
</tr>
<tr>
<td>41-50</td>
<td>2</td>
<td>(1.7)</td>
<td>91</td>
<td>(10.4)</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>(100)</td>
<td>867</td>
<td>(100)</td>
</tr>
</tbody>
</table>

4.3 Exploratory Factor Analysis

Factor analysis on the data from the teacher’s evaluation forms yielded a two factor solution explaining 79% of the variance in the dataset. The factors were named according to logic and common sense. Please refer to Table 5, which presents the process factors in the model.

A scree plot was computed, which is a graphical display of the variance of each component in the dataset. This plot is used to determine how many components are calculated using the following formula: $\lambda_i \sum_i = 1 n \lambda_i$ where $\lambda_i$ is the Eigenvalue and $\sum_i = 1 n \lambda_i$ is the sum of all of the eigenvalues (Creswell, 2002). The scree plot shows the variance for the first component and then for the subsequent components. In addition, it shows the additional variance that each component is adding. The scree plot is a useful visual aid for determining an appropriate number of principle components (Creswell, 2002). A scree plot graphs the eigenvalue against the component number. To determine the appropriate number of components, we look for an "elbow" in the scree plot.
The component number is taken to be the point at which the remaining eigenvalues are relatively small and all about the same size (Creswell, 2002).

A critical look at the present study’s scree plot revealed there was a change in variance up to 5 factors. This is illustrated by the arrows in Figure 6. The forced 3 and 4 factor solution did not yield logically coherent variables. As a result, all factors were identified from Factor Analysis from SPSS. These factors are presented in Table 5. Factor one (F1) was labeled as “Teaching Skills” and included variables 1 through 9. Factor two (F2) was labeled “Coaching Skills” and included variables 10 through 16. Factor three (F3) was labeled “Students’ Assessment” and included OSCE, DOPS, and CBD. Factor four (F4) was labeled “Teacher Characteristics” and included variables of teacher gender, nationality, background specialty and years of teaching experience. The final and fifth factor (F5) was labeled “Student Satisfaction” and included variables 15 and 16 which were extracted from the original loadings under “coaching”.
Table 5: Factor Analysis Component Matrix

<table>
<thead>
<tr>
<th>List of the questions given to the student to rate their clinical teaching</th>
<th>Teaching Skill</th>
<th>Coaching Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During clinical teaching your teacher: (Teaching Skill)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Asked you questions to clarify your previous knowledge?</td>
<td>.758</td>
<td>.461</td>
</tr>
<tr>
<td>2. Gave you feedback to improve your performance?</td>
<td>.789</td>
<td>.425</td>
</tr>
<tr>
<td>3. Asked you to reflect on your learning?</td>
<td>.773</td>
<td>.437</td>
</tr>
<tr>
<td>4. Encouraged your participation in the session?</td>
<td>.732</td>
<td>.541</td>
</tr>
<tr>
<td>5. How often you examine the patients under supervision?</td>
<td>.755</td>
<td>.356</td>
</tr>
<tr>
<td>7. Achieved the learning objectives.</td>
<td>.809</td>
<td>.399</td>
</tr>
<tr>
<td>8. Encourage your active participation in the clinical session?</td>
<td>.747</td>
<td>.531</td>
</tr>
<tr>
<td>9. Respond appropriately to your questions/clarifications.</td>
<td>.614</td>
<td>.617</td>
</tr>
<tr>
<td><strong>Rate your clinical teacher (Coaching Skill)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Style in clinical teaching</td>
<td>.452</td>
<td>.804</td>
</tr>
<tr>
<td>12. Use of different method of teaching (active learning, passive learning, monologue and dialogue).</td>
<td>.489</td>
<td>.740</td>
</tr>
<tr>
<td>13. Providing you with feedback.</td>
<td>.545</td>
<td>.698</td>
</tr>
<tr>
<td>14. Respectful attitude toward students.</td>
<td>.363</td>
<td>.807</td>
</tr>
<tr>
<td><strong>Rate your clinical learning: (Overall Satisfaction)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Compared to other teachers how you would rate your learning from your clinical teacher.</td>
<td>.513</td>
<td>.784</td>
</tr>
<tr>
<td>16. Has clinical experience prepared you to be confident to deal with similar cases in the future</td>
<td>.527</td>
<td>.757</td>
</tr>
</tbody>
</table>

*Teaching skill*  
*Coaching skill*
Figure 6: Scree Plot with Possible Factors
4.4. Analysis of Independent and Dependent Variables

4.4.1 Input and Process Factors

The Analysis of Variance (ANOVA) between teacher characteristics (input factor) and student perceptions of teaching (process factor) showed a significant difference between teacher background speciality \((p = .001)\) and nationality \((p = .006)\) with student perception of teaching and coaching skills.

Five major teacher background speciality variables were included in this research. Post hoc Bonferroni analyses showed significant differences between Paediatric and Internal Medicine and General Surgery \((p = .001)\). However, the other specialties did not reveal any significant differences. The majority of clinical teachers included in this research from KSAU-HS were male \((82.1\%)\), but no significant differences were found between male and female teachers in teaching and coaching skills \((p = .568)\). Please refer to Table 6 for the specific results.

Significant differences were also found between teacher nationality \((p = .006)\) on teaching skill, as well as on coaching skill \((p = .011)\). While the majority of clinical teachers working in KSAU-HS were Saudi \((84.5\%)\), the remaining \((15.5\%)\) were mixed from all nationalities.

Teacher years of teaching experience ranged between 5 to 25 years. Nonetheless, there were no significant differences in years of teaching experience found for teaching skill \((p = .074)\) or coaching skill \((p = .143)\). Please refer to Table 6 for the specific results.
4.4.2 Input and Outcome Factors

Analysis of variance for teacher characteristics (input factors) and student assessment (output factors) showed a significant difference between teachers' background speciality and student assessment ($p \leq .0001$) and satisfaction ($p = .001$).

In this research, student clinical assessment included CBD, DOPS (Formative Assessment) and OSCE (Summative Assessment). The Post hoc Bonferroni analyses showed a significant difference between teacher background speciality and CBD ($p \leq .0001$), as well as with DOPS ($p \leq .0001$). Specifically, the significant difference was found between Internal Medicine and Paediatrics. For the OSCE end of the rotation examination, the significant difference was reported between Paediatric and Family Medicine ($p \leq .0001$). As mentioned earlier, male teachers formed the majority and thus there were significant differences in CBD and DOPS ($p \leq .0001$), but no significant difference was found on the OSCE ($p = .515$). In addition, no significant difference was reported regarding the teacher nationality with student assessment. Regarding teacher years of teaching experience, a significant difference with summative assessment was found for both CBD ($p \leq .0001$) and DOPS ($p \leq .0001$). However, for teachers with experience of 16 to 20 years, no significant difference was reported with formative assessment.

Student satisfaction was another factor in outcome factors. Post Hoc Bonferroni analyses revealed a significant difference with teacher background speciality between General Surgery and Paediatrics ($p = .001$). Teacher nationality showed a significant difference ($p = .016$), but
there were no significant differences found between teacher gender and years of experience. Please refer to Table 7.

4.4.3 Process and Outcome

Spearman Correlation was used for the process (ordinal) variables and outcome (continuous) variables. Spearman correlation coefficient is appropriate with nonlinear data and for other types of data measured on an ordinal scale. It is a nonparametric measure of statistical dependence between two variables (Creswell, 2002).

As shown in Table 8, there was no correlation between students' assessment and teaching and coaching skill. Moreover, there was no linear relationship between summative assessments (CBD and DOPS) and the formative assessment (OSCE) with student perception for teacher teaching and coaching skill.

Student satisfaction is the only outcome factor significantly related to teaching and coaching skills. As shown in Table 8, there is a linear relationship between student satisfaction and teaching skill ($r = .773$) ($p \leq .0001$), as well as student satisfaction and coaching skill ($r = .858$) ($p \leq .0001$).
Table 6: Analysis of Variance for Teacher Characteristics (Input Factor) and Student Perceptions (Process Factor)

<table>
<thead>
<tr>
<th>Specialty</th>
<th>N</th>
<th>Teaching Skill</th>
<th></th>
<th>Coaching</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X ±SD</td>
<td></td>
<td>X ±SD</td>
<td></td>
</tr>
<tr>
<td>Family medicine</td>
<td>99</td>
<td>32.3636 ± 8.74404</td>
<td>19.1212 ± 5.21433</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstetrics and gynecology</td>
<td>75</td>
<td>35.7733 ± 10.30032</td>
<td>20.1067 ± 5.92880</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pediatric</td>
<td>81</td>
<td>30.5062 ± 13.08637</td>
<td>18.0494 ± 6.90453</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal medicine</td>
<td>310</td>
<td>34.9613 ± 10.44937</td>
<td>20.3161 ± 5.82846</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General surgery</td>
<td>302</td>
<td>35.3013 ± 10.73597</td>
<td>20.6821 ± 4.79669</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>34.4371 ± 10.72431</td>
<td>20.0773 ± 5.58927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>.001 *</td>
<td></td>
<td>.001*</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>767</td>
<td>34.3625 ± 10.75063</td>
<td>20.0847 ± 5.52581</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>100</td>
<td>35.0100 ± 10.55576</td>
<td>20.0200 ± 6.08356</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>34.4371 ± 10.72431</td>
<td>20.0773 ± 5.58927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td></td>
<td>.568</td>
<td></td>
<td>.913</td>
<td></td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi</td>
<td>805</td>
<td>34.7168 ± 10.69532</td>
<td>20.2112 ± 5.47815</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Saudi</td>
<td>62</td>
<td>30.8065 ± 10.51905</td>
<td>18.3387 ± 6.68236</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>34.4371 ± 10.72431</td>
<td>20.0773 ± 5.58927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td></td>
<td>.006*</td>
<td></td>
<td>.011*</td>
<td></td>
</tr>
<tr>
<td>Experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>573</td>
<td>34.1606 ± 10.86899</td>
<td>19.9668 ± 5.59163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-15</td>
<td>111</td>
<td>33.1892 ± 10.67496</td>
<td>19.4054 ± 6.24991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-20</td>
<td>137</td>
<td>36.4818 ± 9.75064</td>
<td>20.9562 ± 4.55178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-25</td>
<td>46</td>
<td>34.8043 ± 11.31885</td>
<td>20.4565 ± 6.47287</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>34.4371 ± 10.72431</td>
<td>20.0773 ± 5.58927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant</td>
<td></td>
<td>0.074</td>
<td></td>
<td>0.143</td>
<td></td>
</tr>
</tbody>
</table>

* Significant $P < 0.05$. 

55
Table 7: Analysis of Variance for Teacher Characteristics (Input Factors) and Student Outcomes (Outcome Factors)

<table>
<thead>
<tr>
<th>Specialty</th>
<th>CBD</th>
<th>DOPS</th>
<th>OSCE</th>
<th>Student Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>x ±SD</td>
<td>N</td>
<td>x ±SD</td>
</tr>
<tr>
<td>Family medicine</td>
<td>99</td>
<td>1.9861 ±.03974</td>
<td>1.9948 ±.02131</td>
<td>24.5976 ±1.85346</td>
</tr>
<tr>
<td>Obstetrics &amp; gynecology</td>
<td>75</td>
<td>1.9848 ±.04394</td>
<td>1.9976 ±.01184</td>
<td>24.6812 ±3.07105</td>
</tr>
<tr>
<td>Pediatric</td>
<td>81</td>
<td>1.9793 ±.07379</td>
<td>1.9874 ±.05399</td>
<td>26.9130 ±1.63052</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>310</td>
<td>3.8735 ±.19683</td>
<td>3.8785 ±.15912</td>
<td>25.6906 ±2.02563</td>
</tr>
<tr>
<td>Total</td>
<td>864</td>
<td>3.2391 ±.85756</td>
<td>3.2470 ±.85045</td>
<td>25.2125 ±2.51589</td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>.000*</td>
<td></td>
<td>.000*</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>767</td>
<td>3.3862 ±.78479</td>
<td>3.3939 ±.77619</td>
<td>25.2326 ±2.47752</td>
</tr>
<tr>
<td>Female</td>
<td>100</td>
<td>2.1111 ±.46342</td>
<td>2.1200 ±.46363</td>
<td>25.0582 ±2.80161</td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>3.3291 ±.85756</td>
<td>3.2470 ±.85045</td>
<td>25.2125 ±2.51589</td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>3.2391 ±.85756</td>
<td>3.2470 ±.85045</td>
<td>25.2125 ±2.51589</td>
</tr>
<tr>
<td>Significant</td>
<td></td>
<td>.000*</td>
<td></td>
<td>.000*</td>
</tr>
<tr>
<td>Experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>573</td>
<td>3.2962 ±.83929</td>
<td>3.3039 ±.83405</td>
<td>25.3398 ±2.31242</td>
</tr>
<tr>
<td>11-15</td>
<td>111</td>
<td>2.7523 ±.95000</td>
<td>2.7343 ±.88404</td>
<td>24.7988 ±3.22008</td>
</tr>
<tr>
<td>16-20</td>
<td>137</td>
<td>3.6316 ±.54593</td>
<td>3.6491 ±.51798</td>
<td>25.0247 ±2.64904</td>
</tr>
<tr>
<td>21-25</td>
<td>46</td>
<td>2.5335 ±.85773</td>
<td>2.5776 ±.84575</td>
<td>25.1848 ±2.55937</td>
</tr>
<tr>
<td>Total</td>
<td>867</td>
<td>3.2391 ±.85756</td>
<td>3.2470 ±.85045</td>
<td>25.2125 ±2.51589</td>
</tr>
<tr>
<td>Significant</td>
<td></td>
<td>.000*</td>
<td></td>
<td>.000*</td>
</tr>
</tbody>
</table>

*Significant p ≤ .05.
Table 8: Correlation between Student Perception (Process Factors) and Student Outcome (Outcome Factors)

<table>
<thead>
<tr>
<th></th>
<th>Teaching Skill</th>
<th>Coaching Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CBD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.030</td>
<td>.061</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.385</td>
<td>.071</td>
</tr>
<tr>
<td>N</td>
<td>867</td>
<td>867</td>
</tr>
<tr>
<td><strong>DOPS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.024</td>
<td>.065</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.483</td>
<td>.063</td>
</tr>
<tr>
<td>N</td>
<td>867</td>
<td>867</td>
</tr>
<tr>
<td><strong>OSCE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>-.006</td>
<td>-.002</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.866</td>
<td>.957</td>
</tr>
<tr>
<td>N</td>
<td>867</td>
<td>867</td>
</tr>
<tr>
<td><strong>Student Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.773</td>
<td>.858</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000*</td>
<td>.000*</td>
</tr>
<tr>
<td>N</td>
<td>867</td>
<td>867</td>
</tr>
</tbody>
</table>

* Significant $p \leq 0.05$. 
4.5 Structural Equation Models

Based on theoretical considerations and the results of the factor analysis, analysis of variance and correlation analyses determined in steps 4.2 and 4.3, a latent variable path model was developed and tested using EQS 6.2. The model fit was tested via the correlation matrix using Least Square (LS) estimation. As this step was intended to explore the relationships among numerous variables simultaneously, and because these patterns of relationships have not been explored in previous research, the model was specified to develop the best fit. The model was then re-specified until the best fit was obtained. After converging in seven to eight iterations, the model gave a moderate fit. The following paragraphs present a description for each of the three models.

4.5.1 First Model

The first analysis for SEM was done from a 20% random sample of a total of 876 data points. The data were then imported in EQS according to the equation mentioned in the methods section (refer to Appendix 4). The first data used the correlation matrix between process and outcome factors including: teacher's teaching skills (F1), coaching (F2) (Process Factor) and student assessment (F3) (Outcome Factor). (Refer to Appendix 5). The rotation converged in 7 iterations, providing a good fit to the data. The Comparative Fit Index (CFI) = 0.92, Root Mean Square Error of Approximate (RMSEA) = 0.10, Standardized Root Mean Square Residual (SRMR) = 0.05 and $\chi^2$/d.f = 446/146, $P<0.0001$ and Cronbach's Alpha = 0.94.

Figure 7 shows the first model; specifically, it shows the correlation between teaching and coaching skill with student assessment. Of the 3 models, this first one is the most parsimonious,
based on the results from the factor analysis. It includes two predictors (F1 = Teaching Skills and F2 = Coaching Skills) (Process Factor), and one predicted factor (F3 = Student Assessment (OSCE, DPOS, CBD) (Outcome Factor). The correlation between the first factor (Teaching Skill) and second factor (Coaching Skill) was found to be 0.84. In addition the correlation between these two factors and a third factor (Assessment) was 0.12 and 0.01 respectively. Refer to Figure 7.
Figure 7: First Model

Outcome Factor

Process Factor

Outcome Factor

Process Factor

Outcome Factor

Process Factor

Outcome Factor

Process Factor
4.5.2 Second Model

A low response rate from teachers resulted in the researchers seeking approval from the dean’s office to access the teacher data on teacher characteristics (F4) (Input Factor), including the four measured variables of gender, nationality, specialty and years of experience in clinical teaching. Using 25% of the total sample (216 cases out of 867 cases), a second model was applied using the correlation matrix between Input, Process and Outcome Factors teacher characteristics (F4) (Input Factor) teacher’s teaching skills (F1) and coaching (F2) (Process Factors), and student assessment (F3) (Outcome Factor). (Refer to Appendix 6). The second model converged in 8 iterations and provided a good fit to the data Confirmatory Fit Index (CFI) = .92, Root Square Error Of Approximate (RMSEA) = .09, Standardized Root Mean Square Residual (SRMR) = .05, $\chi^2$/d.f = 620/224, $P < 0.0001$, Cronbach's Alpha = 0.91.

Figure 8 shows the correlation between the proposed factors varying between .92 and -.02. The high correlation was found between teacher characteristic (F4) and student assessment (F3), followed by the correlation between teaching and coaching skills (.92). Interestingly, there is an inverse (negative) weak relationship between teaching skills and teacher characteristics (-.02).
Figure 8: Second Model

Outcome Factor

Process Factor

Input Factor

Process Factor

Outcome Factor

Input Factor
4.5.3 Third Model

In this model, variables were manipulated; specifically, two variables from the third factor were extracted by creating a new factor (F5) = Student Satisfaction, which was previously described in the reported Factor Analysis section of 4.3. The data fit was achieved via the correlation matrix between factor predictors, including teacher characteristics (F4) (Input Factor), teacher's teaching skills (F1) and coaching skill (F2) (Process Factor) and student satisfaction (F5) with student assessments (F3) (predicted factor) (Outcome Factor). Please refer to Appendix 7.

In this third model, a high correlation (.97) was found between student satisfaction (F5) and coaching skills (F2), teaching characteristics and student assessment (.96), followed by teaching and coaching skills (.93). On the other hand, the weakest relationships were found between coaching skills and student assessment (.02), teaching skills and student assessment (.05), teacher skills and teacher characteristics (.06), and student assessment and student satisfaction (.08). The model fit was excellent (refer to figure 9), which converged in 7 iterations (Comparative Fit Index (CFI) = .93, Root Mean Square Error of Approximate (RMSEA) = .08, Standardized Root Mean Square Residual (SRMR) = .05, $\chi^2$/d.f= 582/220, P<0.0001, Cronbach's alpha (0.92).
Figure 9: Third Model
4.6 Summary of Results

The results from a three latent variable path analysis, testing the correlation between input, process and outcome factors, are presented in Table 9 which summarizes the fit indices of each of the models.

The third model (refer to Figure 10) was redrawn for better presentation for the correlation than the extracted model from EQS. As shown, it provided the best fit index and correlations among the independent variables, thereby best explaining the proposed theoretical model. It revealed a strong correlation between teaching skills and coaching skills with student satisfaction and teacher characteristics.

Table 9: Summary of Fit Indices for the Three Models

<table>
<thead>
<tr>
<th></th>
<th>First Model</th>
<th>Second Model</th>
<th>Third Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square</td>
<td>446.5</td>
<td>620.8</td>
<td>582.8</td>
</tr>
<tr>
<td>Degree of freedom</td>
<td>149</td>
<td>224</td>
<td>220</td>
</tr>
<tr>
<td>CFI</td>
<td>0.92</td>
<td>0.92</td>
<td>0.93</td>
</tr>
<tr>
<td>RMR</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>SRMR</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.10</td>
<td>.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Cronbach's Alpha</td>
<td>0.94</td>
<td>0.91</td>
<td>0.92</td>
</tr>
<tr>
<td>Reliability coefficient RHO</td>
<td>0.97</td>
<td>0.95</td>
<td>0.96</td>
</tr>
<tr>
<td>Iteration</td>
<td>7</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>
Figure 10: Teacher Effectiveness in Clinical Teaching (Final Model)
Chapter Five: Discussion

Teacher Effectiveness in a Clinical Teaching model (TECT) showed best fit indices of the three tried models. The Confirmatory Fit Index (CFI) ranged between .92 - .93; Standardized Root Mean Square Residual (SRMR) =.05; and Root Mean Square Residual (RMSEA) ranged between .10-.08. To our knowledge, this is the first model to explain the correlation between teacher characteristics and student outcomes mediated by student perceptions. The TECT model showed a strong correlation between teaching skill and student satisfaction, teaching skill and coaching skill, coaching skill and student satisfaction, and teacher characteristic and student assessment.

In this chapter we will discuss each of the research questions, as well as present recommendations, research limitations, the strength of the research, and future research directions. The chapter will close with a final summary and conclusion.
5.1 Discussion of Research Question One

Is there a relationship between teacher characteristics (input), student perceptions (process) and student assessment (outcome) factors in clinical teaching? This question is answered in three parts: (1) input and process factors, (2) input and outcome factors, and (3) process and outcome factors.

5.1.1 Input and Process Factors

Analysis of variance showed a significant difference between teacher’s specialty and students' perceptions of teaching and coaching. The lowest mean for teaching skill was the Pediatrics specialty ($\bar{x} = 30.5$). The Post hoc Bonferroni test showed a significant difference for Obstetrics & Gynecology ($p = .02$), Internal Medicine ($p = .008$), and General Surgery ($p = .003$). Refer to Table 6 for these values. One explanation for these findings could be that there is variation between student learning and teaching experiences in different clinical rotations. In the Pediatrics rotation at KSAU-HS, students spend most of their time learning on the inpatient unit, while in other specialties they are mostly in outpatient clinics. It has been reported before, that students learn more in an outpatient setting where they are exposed to a larger spectrum of clinical encounters (Dent, 2005; Ramani & Leinster, 2008). In addition, students learn more in outpatient environments that provide them the factors of unpredictability and the sense of urgency to manage cases (Irby, 1995).

The mean of student’s perception of teacher coaching skills was also lower in Pediatrics ($\bar{x} = 18.04$) when compared with other specialties. Significant differences were found between Pediatrics and Internal Medicine ($p = .011$), and Pediatrics and General Surgery ($p = .002$). This
could be explained by teacher coaching methods being affected by specialties due to differences in the clinical setting. As mentioned earlier, in KSAU-HS each clinical rotation has a different clinical activity between inpatient and outpatient. In a Pediatric rotation, the student spends more time in the inpatient setting with groups of four to six, while in Internal Medicine, students’ spend more time in outpatient, which gives them an opportunity to receive more direct one on one coaching from preceptors. In General Surgery there are procedural clinics allowing students to have more opportunity to also get direct coaching while performing procedures. Other studies have also suggested that clinical teachers on the inpatient wards have less opportunity to teach because of the presence of larger number of students (Dent, 2005; Laidley & Braddock, 2000). However, another study at KSAU-HS did not show a relationship between class size, teaching specialty and students’ perceptions (AlHaqwi, et al., 2010).

Teacher’s experience in this study ranged from five to twenty-five years. Analysis of variance showed a higher mean for teaching ($\bar{x} = 36.4$) and for coaching ($\bar{x} = 29.2$) for teachers with sixteen to twenty years’ experience compared to others. Refer to Table 5. Please note that this difference was not found to be statistically significant ($p = .07, p = .13$). These results are consistent with a study conducted at Stanford University that reported average teacher effectiveness was higher for teachers who had more than eight years' experience and who had attended faculty development teaching skills programs when compared with teachers who did not attend such programs (Darling-Hammond, et al., 2010). In broad terms, clinical teaching is the skill of combining clinical knowledge with general theories of effective teaching (Irby, 1994). The results of this study are also consistent with Schmidt and Moust (1995) who found
that students reported that teacher's personal qualities and clinical knowledge were the two important factors related to perception of effective teaching.

The assessment of other teacher characteristics showed that Saudi teachers were perceived as better teachers and coaches when compared to non-Saudi teachers. This could be due to the fact that at King Abdul-Aziz Medical City, almost all non-Saudi doctors practice Medicine without the expectation of teaching students. This lack of involvement in medical education may have led to the perception of being less effective when compared with Saudi medical practitioners.

In summary, we found a significant correlation between teacher characteristics and student’s perceptions. This finding matches other studies which have reported that different teaching skills and experiences are important factors that affect students’ perception of learning (Rolf, 2002). Good clinical supervision, organized clinical sessions and the practice of clinical skills were also identified by students as important factors in a previous study from Saudi Arabia (AlHaqwi, et al., 2010).

5.1.2 Input and Outcome Factors

A significant mean difference was found between teacher specialty and student outcome. Analysis of variance reported the highest mean for DOPS and CBD scores in Internal Medicine ($\bar{x} = 3.87$) and General Surgery ($\bar{x} = 3.64$), while the lowest mean was reported in Pediatrics ($\bar{x} = 1.98$). Refer to Table 7. In addition, the Post hoc Bonferroni test showed significant differences between Internal Medicine and Family Medicine ($p = .001$), internal medicine and Obstetrics and Gynecology ($p = .012$), internal medicine and Pediatrics ($p = .001$). The Post hoc
tests revealed significant differences between Pediatrics and Family Medicine ($p \leq .0001$), Pediatrics and Obstetrics & Gynecology ($p \leq .0001$), and Pediatrics and General Surgery ($p \leq .0001$). This may be explained by the alignment between clinical skills taught during the clinical rotation, and WBA in those two blocks. In addition, the duration of clinical rotations (Internal Medicine and General Surgery) was longer by five weeks compared to other clinical rotations (refer to Table 1). Additionally, a significantly higher mean for student satisfaction scores was found in Internal Medicine ($\bar{x} = 7.97$) and General Surgery ($\bar{x} = 8.11$) when compared to all other specialties, but it was the lowest in Pediatrics ($\bar{x} = 6.90$). The Post Hoc test showed significant differences between student satisfaction scores in Pediatrics and Internal Medicine ($p = .007$), as well as Pediatrics and General Surgery ($p = .001$). Student satisfaction may be related to the longer duration of the rotation, which could be taken into consideration during curriculum planning.

In regards to the end of the rotation clinical assessment, the analysis of variance showed a higher mean in students’ OSCE score in Pediatrics ($\bar{x} = 26.9$) when compared to all other specialties. Post hoc tests showed that OSCE scores were statistically significantly different ($p \leq .0001$) between Pediatrics and all other specialties (refer to Table 7). One possible explanation for this finding may be related to the variety of examiners found within the pediatric specialty rotation. Given their heterogeneity, there may be greater variability in how they score the OSCEs. Moreover, the KSAU-HS Assessment Unit (2013) reported a low reliability of the OSCE. The relationship found between teacher background specialty and student outcome (OSCE) was consistent with the findings of Irby (1994) who reported that teacher supervisory and instructional skills are important factors affecting clinical teaching, which enhance students’
learning regardless of the teacher’s background specialty. Moreover, Rink (2013) suggested that clinical educators who want to improve clinical teaching should evaluate the relationship between teaching skills and students' outcomes.

The analysis of variance showed a significant difference between Work Based Assessment and teaching experience in years \( (p \leq .0001) \). The highest mean score of a student assessment was reported for teachers with sixteen to twenty years of teaching experience, \( (\bar{x} = 3.6) \) and the lowest \( (\bar{x} = 2.5) \) was for teachers with twenty-one to twenty five years of experience. One explanation for this may be that senior educators have extremely busy schedules, while those with less than 16 years of experience may be more junior and not as heavily involved in clinical teaching. Post hoc tests showed significant differences between DOPS and CBD scores in all three groups (5-10, 11-15, 16-20) \( (p \leq .0001) \). This suggests that a teacher with less than twenty years of experience could have a significant difference in student outcomes when compared with a teacher with more than twenty years of experience. It could be said that a clinical teacher with medical education training is more expert in outcome based assessment (Ramani & Leinster, 2008). At KSAU-HS, clinical teachers are invited to attend faculty development programs that help them enhance their teaching and assessment skills. These results are consistent with a randomized control trial that compared trained versus non–trained teachers for an emergency medicine rotation and found that student performance was better when they trained with non-trained teachers in some of the OSCE categories. Overall there was no significant difference (Breckoldt, Svensson, lingemann, & Gruber, 2014). It has been reported before that teaching competency is just as important as being a medical content expert (Irby, 1994). This claim was
also substantiated by Schmidt and Moust (1995) who reported a positive correlation between teacher expertise and student academic achievement in PBL sessions.

5.1.3 Process and Outcome Factors

During this research, no significant correlation between student perceptions of their teachers and assessment outcome was found, with the exception of student satisfaction (refer to Table 8). This could explain why students’ positive or negative attitudes towards their clinical teacher had no relationship with their score. This is consistent with previous studies that reported no relationship between student teacher interaction and ultimate outcome (Allen, et al., 2006). Multiple factors have been shown to exert an influence on student’s outcome including: the educational environment, multiple learners, teacher and mentor interaction and learners taking responsibility for their learning (Kyriakides & Creemers, 2008; Srinivasan, et al., 2011). It is important to note that a positive teacher-student relationship may have an influence on students' performance (Brok, et al., 2010). AlHaqwi et al. (2010) found that Saudi students are usually concerned about teaching instruction in the clinical session, supervisory skills and students' own learning skills. Further local studies should evaluate the relationship between teacher and student outcomes. In the United States they create databases linking teachers to students’ test scores, thereby using this data to evaluate effectiveness of teacher education programs and individual teachers (Darling-Hammond, et al., 2010).

An important point of clarification is the reliability of the OSCE. In KSAU-HS, the OSCE forms 30% of the total score. At the end of each block, students are required to complete seven stations of the OSCE (each station is 7 minutes in duration). Reliability of the OSCE was
moderately low, ranging between 0.5 to 0.6, probably due to a smaller number of stations and shorter testing time. According to a recent literature review, assessment of clinical competency should include at least 14 OSCE cases and should achieve a value of > 0.8 of co-efficiency score. (Dornan, Mann, Schachter, & Spencer, 2011). This moderately low reliability could have affected the correlation we found between teacher’s characteristics and student’s outcome.

5.2 Discussion of Research Question Two

Can a latent variable path model be developed to demonstrate the relationship between teacher characteristic, student perception and student outcome?

Three models were tried and re-specified until the best fit was obtained to explain the correlation between teacher characteristics, student perception and outcome. (Refer to Table 9). The third model gave the best fit with a positive correlation. It explained the positive correlation between teacher and student outcome mediated by student perception. (Refer to Figure 10 and Table 10). The third model, which converged in seven iterations, provided a good fit to the data, showing a CFI = .93, indicating that > 90% of the covariance in data was able to reproduce the hypothesized model. SRMR of .05 means that this model explains the correlations to within an average error of .05. The RMSEA of .08 represents reasonable error of approximation in the population. In addition to the above, the reliability (Cronbach’s Alpha) for all three models was excellent and found to be .94, .91, and .92 respectively.

A critical review of the correlation between independent variables found that the third model had the same relationship seen earlier by the analysis of variance, with the strongest correlation
between teaching and coaching skills and student satisfaction, and teacher characteristics with student assessment. In more detail, the final model showed a correlation between teaching process and outcome (satisfaction), where student’s perception about teacher’s teaching and coaching skills correlated with their satisfaction (.90 and .97 respectively). Arguably, preceptors as teachers are role models for learners not only for clinical practice, but also for values, attitudes, and patterns of reasoning and thinking (Bowen & Carline, 1997). The third model under teaching and coaching skills encouraged learners to reflect on their clinical learning, observation, and hands-on training, and may have helped them develop implicit norms, standards and values. Teacher characteristics were highly correlated to student assessment (.96). Interestingly, it was reported as an important factor that affected teaching outcome, suggesting a need for evaluating teacher characteristics regularly, so as to assure high quality of teaching (Darling-Hammond, et al., 2010).

To the best of our knowledge, the use of SEM has not been looked at in the literature of medical education to establish any correlations between clinical teaching and student outcomes. The most cited instrument in medical education literature that measures the quality of clinical teaching for medical students in the workplace is the Maastricht Clinical Teaching Questionnaire (MCTQ). This is a valid and reliable evaluation instrument demonstrating a cognitive apprenticeship concept for clinical teaching during clerkships from a student perspective only (Stalmeijer, et al., 2010). The Cleveland Clinical Teaching Effectiveness Instrument (CCTEI) is also a valid and reliable instrument, especially as an evaluation tool in a wide variety of clinical teaching settings. However, it measures student perceptions only (Copeland & Hewson, 2000). Interestingly, the Stanford List reported that students cannot distinguish between teacher
knowledge and teacher ability in order to promote self-directed learning. Again, this list was dependent on student perception (Litzelman, et al., 1998). None of these instruments correlated the teacher’s characteristics to students' outcomes.

In 2011, Srinivasan wrote: “a teacher’s effectiveness model for developing a better understanding of the skills necessary for success as a medical educator would be an important advancement in medical education, and would lead to an improved quality of teaching and enhanced learning outcomes.” When a model is built on the theoretical principles of Adult Learning Theory, it takes into consideration the principles of how adults learn. It is generally accepted that teaching methods based on learning theory may result in more effective learning (Laidley & Braddock, 2000). Whereas principles of learning inform us of the factors that are important for learning, theories tell us why these factors are important (Ormrod, 2004). The process of teaching broadly reflects the concept of adult learning, explaining the relations between factors affecting student’s learning and outcome. Social Learning Theory describes the process by which medical students become members of the professional community of physicians (Bowen & Carline, 1997). In addition to the above, Adult Learning Theory emphasizes task relevance, the importance of active learner involvement in goal setting, and the use of skills practice as an effective pedagogical technique (Laidley & Braddock, 2000).

The final model for teacher effectiveness in clinical teaching (TECT) provided a clear picture of the correlation between teacher characteristics, students perception and students outcome. SEM allows researchers and specialists to test direct and indirect effects that may be present in different samples and population groups (Brok, et al., 2010). Teacher effectiveness as perceived
by students could help to identify areas of high impact in terms of focusing on knowledge of learning theory, methods of teaching, and teaching using multiple measures. Examining these relationships can help educators develop a knowledge base for continuous improvement. Students as learners are important mediators in the process of clinical teaching and their point of view informs the process of teaching.

5.3 Recommendations

Faculty development remains the cornerstone for cultivating and sharpening teaching skills in order to match the lifelong development of clinical competence with teaching competence. The finding of a lack of relationship between student perceptions and subsequent test performance is intriguing. It suggests the need for continued inquiry to study how students create their own perceptions of teaching effectiveness and the contrast between reality and what is perceived. Moreover, direct observation coupled with teacher shadowing is of paramount importance to determine what clinicians actually do when they are teaching. This approach is more time consuming, but offers direct evidence to teaching practices by individual teachers and/or different disciplines in multiple settings.

It is important to remain cautious in the interpretation of relationships produced by statistical models in spite of the promised complexity and holistic connections. The mere fact remains that valid and reliable conclusions are based on valid and reliable input data and SEM is not an exception to this rule.
5.4 Limitations

It is important to note that there are several limitations to our study. First, we had a very low response rate from clinical teachers who were sent surveys inquiring about a detailed teaching and experience profile. Thus, we had to rely on existing data at the academic office that was limited to few available faculty characteristics. Second, our study did not address or include as an input the factor of social interactions between learners and teachers and the effect of team dynamics on creating perceptions, in addition to the sense of satisfaction with what is being offered. Third, the process component in the SEM model was restricted to students’ perceptions of what constitutes effective teaching. In other words, there was no objective inquiry into the appropriateness of the teaching methods used for learning objectives during any of the teacher/learner encounters. Fourth, the term of effective teaching was a fuzzy impression of what was perceived as effective by students. For this matter, we had to use student performance in the OSCE as output data in the SEM model. On the other hand, we found low reliability of OSCE stations which might have affected the statistical correlations and co-variances of the SEM model.

5.5 Strength of the Study

To our knowledge, this study is the first of its kind in medical education to use Structural Equation Modeling to assess the presence of potential relationships between general teacher characteristics, student perceptions of effectiveness of teaching, and student testing performance.
5.6 Future Research Directions

The results of this study provide a fertile ground for the development of future research questions to be addressed. First, it would be most valuable in the future to assess the relationship between measured time of a teaching session and teaching styles across disciplines in different practice settings. Second, it would be informative to evaluate the effect of different teaching styles on novice versus intermediate versus advanced learners and their test performance. Third, this study opens the door to exploring the effect of team dynamics and social factors between teachers, residents and medical students on perceptions of learning experiences and effectiveness of teaching.

5.7 Conclusion

Evaluation of teaching effectiveness in a clinical setting is complicated by the extensive use of clinical instruction which should include teachers as well as students (Irby, 1978). Good clinical teaching is concerned with providing role models for good practice, making good practice visible and explaining it to trainees (Prideaux, et al., 2000). Observing the effectiveness and appropriateness of what a teacher does during clinical teaching requires close monitoring with multiple measurements, including student teacher feedback, student teacher evaluation, student satisfaction, teacher reflection, peer review and work based assessment.

Educators, in their attempt to identify the impact of reform on student achievement, should take into account the multi-level structure of education (Kyriakides & Creemers, 2008). This not only means that appropriate multi-level statistical modeling approaches should be used to measure the impact of reform on student achievement gains. Rather, it also implies that
evaluators should search for factors operating at different levels, specifically at the school, teacher and student levels, which are likely to influence the effective implementation of reform. It should also be acknowledged that an effective reform policy may not necessarily have direct effects on student achievement, but may have indirect effects (Kyriakides & Creemers, 2008).

Structural Equation Modeling offers a great opportunity for medical education research, helping to link learning theory with medical practice. Importantly, SEM is a powerful technique that can combine complex path models with latent variables to produce a comparative result with clear correlations. It is accepted that faculty development and continuous professional development has an effect on medical education (Steinert et al., 2006). Yvonne Steinert and others found a positive effect of faculty development on student outcome, and they have recommended lifelong learning programs as being better than one-off workshops. As well, Steinert et al. (2006) have argued that a blended learning type has a more positive influence compared to a single method of teaching. However, it can also be said that professional development has merely moderate effects on teacher practice and very small but sometimes significant effects on student achievement, when professional development is mediated by teacher practice (Bowen & Carline, 1997).

Clinical teaching is the heart of teaching medical students, and clinical teachers play a major role in clinical teaching. Yet, it is a challenging task for a medical student and clinical teacher to learn, teach and provide patient care simultaneously. In every medical establishment, higher authorities should invest more in clinical teaching. Clinical teaching is very important and it should be given greater attention in order to improve student outcome.
References


OPEN LETTER TO STUDY PARTICIPANTS
رسالة توضيحية للمشتركين في الدراسة

**TITLE:** Teacher effectiveness in clinical teaching: Structural Equation Modeling

**PRINCIPAL DOCTOR/INVESTIGATOR:** Dr. Alia Zawawi
PhD Student Medical Education

**TELEPHONE #:** Telephone: 2520088 ext: 46585
Bleep: 6097
Mobile: +966505426083

Dear Clinical Teacher and Medical Students

This is the questionnaire of the study title:
Teacher effectiveness in clinical teaching: Structural equation modeling

We will develop a model to prove our hypothesis that presumes relationship between the input, process and outcome factors in clinical teaching along with, the effect of the input factors on the process and outcome factors.

Aim:
- To identify different factors that affects the quality of clinical teaching.
- To develop and assess a latent variable path model that verifies the relationship between competent clinical teacher students outcome.

**Thanks for answering the questionnaire.**

*If you would like to receive an Executive Summary of this study please provide your email and/or contact number.*
**Appendix 2**

Teacher badge number:

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<thead>
<tr>
<th>1-1</th>
<th><strong>Teacher educational background</strong></th>
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<td>2. Board</td>
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</tr>
<tr>
<td>3. Other specify……………………………………………………</td>
<td></td>
</tr>
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1-2) Specialty

| 1. Internal Medicine |
| 2. Family Medicine |
| 3. General surgery |
| 4. Pediatric |
| 5. Obstetrics and gynecology |
| 6. ENT |
| 7. Ophthalmology |
| 8. Dermatology |
| 9. Other specify…………………………………|

1-3) Years since graduation from medical school

…………………. Years

1-4) Years since start teaching

…………………..years

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<tr>
<th>2-1</th>
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<td>2. Diploma</td>
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<td>3. Fellowship</td>
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<tr>
<td>4. Master</td>
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<tr>
<td>5. PhD</td>
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</tr>
</tbody>
</table>
2-2) How many course/workshop/conference in medical education you attend during the last 12 months?

2-3) How often do you read in medical education per month?

2-4) What is your preference for your continued professional development?

1. Online courses
2. Electronic journals
3. Conferences
4. Others, specify

2-5) Are you member in any medical education society?

1. Yes
2. No

If yes specify

2-6) Have you conducted any medical education research?

1. Yes
2. No

If yes, did you publish it?

1. Yes
2. No
3- Please tick your impression about the importance of the following learning principle for the student to practice in clinical teaching.

<table>
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<tr>
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<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>N/A</th>
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<tbody>
<tr>
<td>3-1) students should link previous <strong>knowledge and experience</strong> to the current teaching case or scenario?</td>
<td></td>
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<td>3-2) teachers should give <strong>feedback</strong> to student performance?</td>
<td></td>
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<td>3-3) teachers should ask students <strong>to reflect</strong> on their learning?</td>
<td></td>
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<td>3-4) students should <strong>participate</strong> in the clinical learning?</td>
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<td>3-5) teachers should specify <strong>objectives for</strong> the student from the clinical session?</td>
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<tr>
<td>3-6) students should <strong>be actively involved</strong> in the clinical session?</td>
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</table>

4- Please give a score of the following learning principle you are applying during **clinical teaching**.

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<tr>
<th>During your clinical teaching:</th>
<th>Never</th>
<th>Rarely</th>
<th>Some time</th>
<th>Most of the time</th>
<th>All the time</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1) Do you assess student <strong>previous knowledge and experience</strong> to the teaching case or scenario?</td>
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<tr>
<td>4.2) Do you build or refer to the student’s previous knowledge and experience to the teaching case or scenario?</td>
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<tr>
<td>4.3) Do <strong>you give feedback</strong> to student performance?</td>
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<td>4.4) Do you stop to ask for student clarification?</td>
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<td>4.5) Do you ask the student to repeat what they learn?</td>
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<tr>
<td>4.6) Do you ensure that all students are participating?</td>
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<tr>
<td>4.7) Do you specify <strong>objectives</strong> for the student before the clinical session?</td>
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<tr>
<td>4.8) At the end of your clinical teaching session do you ensure that you have reached your objectives?</td>
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<tr>
<td>4.9) Do you let students participate <strong>actively</strong> in the clinical session including:</td>
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<tr>
<td>a. History taking</td>
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<tr>
<td>b. Clinical examination</td>
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<tr>
<td>c. Listing differential diagnoses</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5- <strong>Teacher satisfaction level</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate your level of satisfaction with your:</td>
</tr>
<tr>
<td>5-1) Clinical teaching</td>
</tr>
<tr>
<td>5-2) Rate your level of satisfaction with students’ participation in clinical session.</td>
</tr>
<tr>
<td>5-3) Rate your level of satisfaction with your students learning from your clinical teaching.</td>
</tr>
<tr>
<td>5-4) Rate your student satisfaction level with your clinical teaching.</td>
</tr>
</tbody>
</table>
Appendix 3

Dear student:

Student ID………………………………………………………………………

Please evaluate your clinical teacher according to the following points:

Name of the clinical teacher …………………………………………………

<table>
<thead>
<tr>
<th>During clinical teaching your teacher:</th>
<th>Never</th>
<th>Rarely</th>
<th>Some time</th>
<th>Most of the time</th>
<th>All the time</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Asked you questions to clarify your previous knowledge?</td>
<td></td>
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<tr>
<td>2- Gave you feedback to improve your performance?</td>
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<tr>
<td>3- Asked you to reflect on your learning?</td>
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<tr>
<td>4- Encouraged your participation in the session?</td>
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<td>5- How often did you examine patients under supervision?</td>
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<td>6- Specified learning objectives for the clinical session?</td>
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<td>7- Achieved the learning objectives?</td>
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<td>8- Encouraged your active participation in the clinical session?</td>
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<td>9- Responded appropriately to your questions/clarifications?</td>
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<tr>
<td>Rate your clinical teacher’s:</td>
<td>Poor</td>
<td>Fair</td>
<td>Not sure</td>
<td>Good</td>
<td>Excellent</td>
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<tr>
<td>1- Clinical knowledge</td>
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<tr>
<td>2- Style in clinical teaching</td>
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<tr>
<td>3- Use of different method of teaching</td>
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<td>(active learning, passive learning, monologue</td>
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<tr>
<td>and dialogue)</td>
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<tr>
<td>4- Providing you with feedback</td>
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<td>5- Respectful attitude toward students.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate your clinical learning:</th>
<th>Poor</th>
<th>Fair</th>
<th>Not sure</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Compared to other teachers how would you</td>
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<tr>
<td>rate your learning from your clinical teacher?</td>
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<td>2- Has clinical experience prepared you to be</td>
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<td>confident in dealing with similar cases in</td>
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<td>the future?</td>
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</tbody>
</table>
Appendix 4

The Command File for EQS.

/TITLE
TEACHER EFFECTIVNESS FIRST SAMPLE 175
/SPECIFICATIONS
VARIABLES = 19; CASES = 175; DA = 'C:\EQS62\examples\firstgp.ess';
METHOD=LS; MATRIX=RAW; ANALYSIS=CORRELATION;

/LABELS
V1=item1; V2=item2; V3=item3; V4=item4; V5=item5; V6=item6; V7=item7; V8=item8;
V9=item9; V10=item10; V11=item11; V12=item12; V13=ITEM13; V14=ITEM14;
V15=ITEM15; V16=ITEM16; V17=CBD; V18=DOPS; V19=OSCE;
F1=TEACHING SKILL; F2=COACHING SKILLS; F3=ASSESS;

/EQUATIONS
V1 = 1F1 + E1;
V2 = *F1 + E2;
V3 = *F1 + E3;
V4 = *F1 + E4;
V5 = *F1 + E5;
V6 = *F1 + E6;
V7 = *F1 + E7;
V8 = *F1 + E8;
V9 = *F1 + E9;
V10 = 1F2 + E10;
V11 = *F2 + E11;
V12 = *F2 + E12;
V13 = *F2 + E13;
V14 = *F2 + E14;
V15 = *F2 + E15;
V16 = *F2 + E16;
V17 = 1F3 + E17;
V18 = *F3 + E18;
V19 = *F3 + E19;

/VARIANCES
F2 = 1*;
F1 = 1*;
F3 = 1*;
E1 = 2*;
E2 = 2*;
E3 = 2*;
E4 = 2*;
E5 = 2*;
E6 = 2*;
E7 = 2*;
E8 = 2*;
E9 = 2*;
E10 = 2*;
E11 = 2*;
E12 = 2*;
E13 = 2*;
E14 = 2*;
E15 = 2*;
E16 = 2*;
E17 = 2*;
E18 = 2*;
E19 = 2*;

E1 TO E19=2*;

/PRINT
FIT = ALL;

/COVARIANCES
F1, F2 = 1*;
F1, F3 = 1*;
F2, F3 = 1*;

/LMTEST
SET=GVF,PEE;

/END

----------------------------------------------------------------------------------------------------------------------------------
Appendix 5

Fit Indices for the First Model.

AVERAGE ABSOLUTE STANDARDIZED RESIDUAL = 0.0399
AVERAGE OFF-DIAGONAL ABSOLUTE STANDARDIZED RESIDUAL = 0.0443
GOODNESS OF FIT SUMMARY FOR METHOD = LS

INDEPENDENCE MODEL CHI-SQUARE = 4200.094 ON 171 DEGREES OF FREEDOM
INDEPENDENCE AIC = 3858.094
INDEPENDENCE CAIC = 3145.916
MODEL AIC = 148.580
MODEL CAIC = -471.973

CHI-SQUARE = 446.580 BASED ON 149 DEGREES OF FREEDOM
PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS 0.00000

FIT INDICES
-----------
BENTLER-BONETT NORMED FIT INDEX = 0.894
BENTLER-BONETT NON-NORMED FIT INDEX = 0.915
COMPARATIVE FIT INDEX (CFI) = 0.926
BOLLEN'S (IFI) FIT INDEX = 0.927
MCDONALD'S (MFI) FIT INDEX = 0.427
JORESKOG-SORBOM'S GFI FIT INDEX = 0.448
JORESKOG-SORBOM'S AGFI FIT INDEX = 0.296
ROOT MEAN-SQUARE RESIDUAL (RMR) = 0.057
STANDARDIZED RMR = 0.057
ROOT MEAN-SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.107
90% CONFIDENCE INTERVAL OF RMSEA (0.095, 0.118)

RELIABILITY COEFFICIENTS
------------------------
CRONBACH'S ALPHA = 0.949
RELIABILITY COEFFICIENT RHO = 0.974
Iteration 7
Appendix 6

Fit Indices for the Second Model.

AVERAGE ABSOLUTE STANDARDIZED RESIDUAL = 0.0385
AVERAGE OFF-DIAGONAL ABSOLUTE STANDARDIZED RESIDUAL = 0.0420

GOODNESS OF FIT SUMMARY FOR METHOD = LS

INDEPENDENCE MODEL CHI-SQUARE = 5190.467 ON 253 DEGREES OF FREEDOM
INDEPENDENCE AIC = 4684.467
INDEPENDENCE CAIC = 3582.251
MODEL AIC = 172.514
MODEL CAIC = -803.362

CHI-SQUARE = 620.514 BASED ON 224 DEGREES OF FREEDOM
PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS 0.00000

FIT INDICES

-----------------------------
BENTLER-BONETT NORMED FIT INDEX = 0.880
BENTLER-BONETT NON-NORMED FIT INDEX = 0.909
COMPARATIVE FIT INDEX (CFI) = 0.920
BOLLEN'S (IFI) FIT INDEX = 0.920
MCDONALD'S (MFI) FIT INDEX = 0.393
JORESKOG-SORBOM'S GFI FIT INDEX = 0.424
JORESKOG-SORBOM'S AGFI FIT INDEX = 0.291
ROOT MEAN-SQUARE RESIDUAL (RMR) = 0.053
STANDARDIZED RMR = 0.053
ROOT MEAN-SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.092
90% CONFIDENCE INTERVAL OF RMSEA (0.083, 0.100)

RELIABILITY COEFFICIENTS

-----------------------------
CRONBACH'S ALPHA = 0.918
RELIABILITY COEFFICIENT RHO = 0.957
Iteration = 8
Appendix 7

Fit indices for The Third Model.

AVERAGE ABSOLUTE STANDARDIZED RESIDUAL = 0.0375
AVERAGE OFF-DIAGONAL ABSOLUTE STANDARDIZED RESIDUAL = 0.0409

GOODNESS OF FIT SUMMARY FOR METHOD = LS

INDEPENDENCE MODEL CHI-SQUARE = 5561.500 ON 253 DEGREES OF FREEDOM
INDEPENDENCE AIC = 5055.500
INDEPENDENCE CAIC = 3948.555
MODEL AIC = 142.873
MODEL CAIC = -819.688

CHI-SQUARE = 582.873 BASED ON 220 DEGREES OF FREEDOM

PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS 0.00000

FIT INDICES

----------
BENTLER-BONETT NORMED FIT INDEX = 0.895
BENTLER-BONETT NON-NORMED FIT INDEX = 0.921
COMPARATIVE FIT INDEX (CFI) = 0.932
BOLLEN'S (IFI) FIT INDEX = 0.932
MCDONALD'S (MFI) FIT INDEX = 0.432
JORESKOG-SORBOM'S GFI FIT INDEX = 0.466
JORESKOG-SORBOM'S AGFI FIT INDEX = 0.330
ROOT MEAN-SQUARE RESIDUAL (RMR) = 0.053
STANDARDIZED RMR = 0.053
ROOT MEAN-SQUARE ERROR OF APPROXIMATION (RMSEA) = 0.088
90% CONFIDENCE INTERVAL OF RMSEA (0.079, 0.096)

RELIABILITY COEFFICIENTS

------------------------
CRONBACH'S ALPHA = 0.922
RELIABILITY COEFFICIENT RHO = 0.960

Iteration = 7