The Impact of International Assessments on Mathematics Teacher Development in the Kingdom of Saudi Arabia (KSA).

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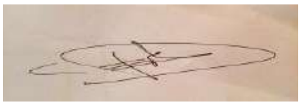
Signed: 

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Abbreviations

DCU	Dublin City University
TIMSS	Trend in mathematics and science study
IEA	The International Association for the Evaluation of Educational Achievement
KSA	Kingdom of Saudi Arabia
MoE	Ministry of Education (Saudi Arabia)
SDG	Sustainable Development Goal
ISCED	International Standard Classification for Education
MASD	Math Ability Score Difference
NCES	National Centre for Education Statistics
ICT	Information and Communication Technology
MDS	Multidimensional Scaling
OECD	Organisation for Economic Co-operation and Development
PIRLS	Progress in International assessment in Reading Literacy Study
PISA	Program for International Student
STEM	Science, Technology, Engineering and Mathematics
UNESCO	United National Education, scientific and Cultural Organization

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Title: The Impact of International Assessments on Mathematics Teacher Development in the Kingdom of Saudi Arabia (KSA).

Mjaed Alatawi

Abstract

Background: Within the Kingdom of Saudi Arabia there is the belief that its education system is structured to prepare its students to meet the demanding requirements of the 21st century. However, the country has been recording low average scale scores in the recent Trends in International Mathematics and Science Study (TIMSS) assessments.

Even with the progress that the Ministry of Education has made in Saudi Arabia over the years, international mathematics assessment scores have been a regular disappointment. For example, the recent TIMSS scores published in 2015 categories Saudi Arabia among the five countries with lower average achievement in Mathematics around the world. These results also reveal that Saudi Arabia has an average scale score of 383 while the international average is 500. This study is an attempt to suggest causative factors giving rise to this poor performance.

Method: The study followed a quantitative approach employing data acquisition questionnaires in a relatively large sample of teachers (n=326). The instrument used for data collection in the study was a survey constructed using a redesigned TIMSS survey for 2015 and following a pilot study. The survey collected information such as the academic and professional background of the teachers: instructional practices; classroom resources; and attitudes towards teaching. The variables were compared using correlation in mathematics teachers of 4th-grade student. The resultant correlations were used to inform the construction of the relevant model for Structural Equation Modelling using Smartpls™. The study sample consisted of the 326 Mathematics teachers for fourth grade.

Results: The findings show that student achievement is affected by a complex set of causative factors such as: teacher confidence, teacher satisfaction, teaching methods and classroom experience. The findings were reliable on the whole, as most of the path coefficients had a p-value less than .05(i.e., statistically significant), and with respect to the goodness of fit of the model, there was a large fit.

Conclusions: Strong relationships between the complex set of causative factors call for additional development of assessment practices in mathematics education in KSA. In this study, the associations were confirmed via Smartpls™ and outcomes discovered that there was a significant and positive relationship among some variables such as teacher interaction, confidence, satisfaction, teacher emphasis on academic success, leadership support and classroom experience. Therefore, in order to improve TIMSS scores, progress and development in leadership, assessment and strategies in supporting teachers are recommended.

Keywords: International assessments; TIMSS; mathematics teacher development. Teacher emphasis on academic success.

Chapter 1 Introduction

1.1 Background to the Study

Saudi Arabia has one of the most dedicated educational policies across the world. Primarily, the objectives of this policy are to ensure that education is more efficient and meets the religious, social, and economic needs of the country (KSA Ministry of Education, 2017). To achieve these objectives, the Saudi government has established various agencies responsible for the planning, administration, and implementation of the education policy. The agencies are governed by the Ministry of Education, which is responsible for setting the overall standards of learning throughout the country (KSA Ministry of Education, 2017). Despite these outstanding efforts, most learners in Saudi Arabia are believed to score standardly below the international average.

Previous scholarly studies have attributed the standard performance in Saudi Arabia to the low scores in the mathematics subject (Al-Twaijry, 2010; Youssef, Pourghasemi, and Pourtahi et al., 2016). Mostly, that is because mathematics learning is allocated a lower amount of time compared to other subjects, such as Islamic and Arabic studies. According to Alamer (2014), approximately 57% of the hours in Saudi primary schools are dedicated to Islamic and Arabic studies, while only 22% of the hours are used for a combination of mathematics and science learning. Similarly, intermediate schools allocate approximately 43% of the hours for Islamic and Arabic studies for every grade, and only 40% for a combination of mathematics, science, English, and computer science (Alamer, 2014). This trend is also consistent in Saudi secondary schools, wherein the first year of study, students spend 31% of the hours studying Islamic and Arabic studies, and 37% of the time studying a combination of mathematics, science, and computer science (Alamer, 2014). That tendency is also consistent in the second and third years of secondary school learning and reveals the less priority that the mathematics subject receives.

Despite the deficiencies in the time allocated for mathematics learning, the teaching process is always laborious and accompanied by numerous assessments. Mostly, the authorised mathematics curriculum is related to that published by McGraw Hill (Sedgwick, 2001). In other words, the syllabus focuses on achieving balanced learning and relies mostly on vertical interdependence to help students of all grades develop cognitive understanding, as well as the relevant mathematical skills. To be precise, the mathematics prospectus focuses on examining concepts and developing cognitive skills; helps students develop skills of mastering mathematical concepts and guides the learners in logically applying mathematics to solve the problems experienced in daily life (Sedgwick, 2001). Additionally, most of the schools in Saudi Arabia have established mathematics laboratories, visual aids, as well as computer laboratories used to enhance mathematics learning (Culej, 2015). Supplementary materials used for teaching include geometric figures, illustrated textbooks, teaching aids, guidebooks, flashcards, teacher's manuals, as well as computer software specifically developed for teachers. The observations by Alamer (2014) concerning the mathematics curriculum in Saudi Arabia indicate that adequate measures have been put in place to ensure mathematics learning is successful. Khormi and Woolner (2019) clarified on the measures put in place by demonstrating MoE's decision to establish the mathematics curriculum based on international experiences. Because of this approach, decision-makers selected the McGraw-Hill Education company and its SA representative Al-Obekan Education company to take the responsibility of developing the mathematics curriculum (Khormi & Woolner, 2019). In line with this directive, McGraw-Hill and Al-Obekan has had the responsibility of bringing together the McGraw-Hill Educational Series for Mathematics.

Even with the progress that the Ministry of Education has made in Saudi Arabia over the years, international mathematics assessment scores have been a regular disappointment. For example, the recent Trends in International Mathematics and Science Study (TIMSS) scores published in 2015 categorise Saudi Arabia among the five countries with lower average achievement in Mathematics around the world (TIMSS, 2015). The other three countries in this category include Morocco, South Africa and Kuwait. These results also reveal that Saudi Arabia has an average scale score of 383 (4.1) compared to Singapore (the country with the best scores), which has an average scale score of 618 (3.8) (TIMSS, 2015). Compared to the 2011 TIMSS assessment scores, it is evident that mathematics scores in Saudi Arabia decreased from 410 (5.3) in 2011 to 383 (4.1) in 2015, while those of Singapore improved from 606 (3.2) in 2011 to 618 (3.8) in 2015 (TIMSS, 2015). The decrease in the mathematics scores within a four-year period in Saudi Arabia raises many serious concerns about the impact of international assessments on the development of teachers and the resulting student performance. Owing to that shocking drift in mathematics performance, this study sought to examine mathematics assessment in Saudi Arabia and whether international frameworks, such as TIMSS, have an impact on teacher development in the Kingdom.

1.1.1 International Association for the Evaluation of Educational Achievement (IEA)

The International Association for the Evaluation of Educational Achievement (IEA) is responsible for carrying out international comparative studies. The institution was founded in the 1950s and assesses educational achievement based on the background of the learners, teachers, classroom, and other variables within the school (Education State University, 2021). The IEA can best be described as a collaborative initiative between research institutes primarily focused on conducting academic research (IEA, 2021). In the recent times, the institution focuses more on the interests of policymakers and most of its member countries are represented by the Ministry of Education.

In the recent past, the IEA has carried out numerous survey studies of basic school subjects. Most of the studies are driven by the curriculum and measure educational outcomes by analysing the official curricula of the partaking countries (IEA, 2021). The studies examine school and classroom process variables and those associated with the background of the teacher and the student. Examples include the studies of mathematics and science, reading literacy, along with English and French as foreign languages. Sometimes, the IEA also carries out studies that are not based on the curriculum, for instance Pre-Primary Project and the Computers in Education study (IEA, 2021). In a standard IEA study, the researchers collect data in the third or fourth grade, seventh or eighth grade, and the last year of schooling. While some studies include both of the mentioned categories, other do not include all the three identified populations. The most popular study conducted by the IEA is the Third International Mathematics and Science Study (TIMSS) (IEA, 2021). This study is designed to examine mathematics and science achievement in the context of national curricula, instructional practices, along with the social and learning environment of the learners. Since the late 1990s, the IEA started a cycle of studies that would allow nations to gain a longitudinal international comparative perspective (IEA, 2021). An example is the TIMSS, now referred to as the Trends in Mathematics and Science Study. TIMSS is now conducted in alternating years, as discussed in the succeeding sub-section.

1.1.2 Trends in International Mathematics and Science Study (TIMSS)

The Trends in International Mathematics and Science Study (TIMSS) offers reliable and well-timed tend data on the achievement of mathematics and science among learners. TIMSS data is recognised by UNESCO as a strong evidence base for researchers, educators, and policymakers interested in tracking progress towards the achievement of Sustainable Development Goal (SDG) 4 (IEA, n.d.; TIMSS & PIRLS, 2019). This SDG focuses on ensuring that all people obtain quality education. IEA has collected TIMSS data from students in the 4th and 8th grade each 4 years since 1995. The fourth grade is the grade that denotes four years of schooling upon counting from the first year of ISCED Level 1. The eighth grade, on the other hand, stands for eight years of schooling upon counting from the first year of ISCED Level 1 (IEA, n.d.). At times, TIMSS measures student achievement in the final year of secondary school. These assessments provide a trustworthy account of how students in these grades perform in mathematics and science. The United States has been taking part in every administration of TIMSS (IEA, n.d.). Nations that take part in multiple TIMSS cycles can follow up on the trends in student achievement, while examining changes that have happened in the curriculum, instruction, and other facets of education that impact learning.

As mentioned earlier, TIMSS is carried out every four years and follows a quasi-longitudinal design. The cohort examined in the fourth grade are usually evaluated four years later while in their eighth grade (IEA, n.d.). By assessing fourth-grade students, the test gets to uncover early warnings for potential reforms in the curriculum. The fourth-grade test also allows the effectiveness of the proposed reforms to be scrutinized four years later once the students are in their eighth grade (IEA, n.d.). Students meeting the minimum proficiency level set by TIMSS can add and subtract whole numbers, can multiply by a single-digit number, and have some understanding of simple fractions, measurements, and geometric shapes.

The main organising concept of TIMSS assessments is the national curricula. Each assessment depends on detailed frameworks that are established in partnership with the participating nations (IEA, n.d.). The frameworks outline the pertinent knowledge and skills of students at the fourth and eighth grades. National Research Coordinators facilitate the process of developing the assessment questions and questionnaires (IEA, n.d.). These professionals also help administer the assessment, report the outcome, and make meaning out of the findings in the context of their nation.

Apart from assessing mathematics and science achievement, the TIMSS also collects a lot of data on the contextual factors that are associated with student learning and achievement

(IEA, n.d.). These factors may be present at home or at school. Contextual factors may include information on the organisation of the education system to encourage learning, the home environment and whether it supports learning, the school climate and resources, along with the process through which instruction happens in the classrooms (IEA, n.d.). In line with this information, TIMSS circulates an encyclopaedia with detailed information about the educational context in every country and how it can facilitate mathematics and science learning.

TIMSS 2019 marked the seventh such assessment, marking 24 years of trends. This assessment also marked the transition to eAssessment, where participating nations could administer TIMSS 2019 in either electronic or paper format (IEA, n.d.; TIMSS & PIRLS, 2019). That means that from now henceforth, participating countries must use an innovative computerized version of TIMSS to examine complex areas within the framework used to teach mathematics and science. eTIMSS can best be described as an engaging and interactive form of assessment that incorporates the content of the paper-and-pencil edition of TIMSS (IEA, n.d.). This new program also includes problem solving and inquiry activities meant to stimulate and motivate the learners. IEA will administer the next cycle of the TIMSS in 2023.

The design of TIMSS is suitable for various countries. It accommodates nations along the distribution of performance, ranging from high to medium to low. The assessment incorporates an element mostly designed to measure achievement of populations that are still nurturing numeracy skills at the fourth grade (IEA, n.d.). TIMSS provides a benchmarking option where entities outside the set criteria can be included in the assessment. This technically means that countries can have TIMSS administered to students in other grades.

1.1.3 Programme for International Student Assessment PISA

PISA is an international study that was launched by the OECD in 1997 and carried out for the first time in 2000 and today covers over 80 countries. Every 3 years, the PISA survey provides comparative data on the performance of 15-year-olds in the fields of reading, math and science. In addition, each cycle examines its own innovative area such as collaborative problem solving (PISA 2015) and global competence (PISA 2018). Since their introduction, the results have shaped discussions on education policy on a national and global level.

Student performance (PISA 2018) Saudi Arabia

The test was carried out for the first time in Saudi Arabia in 2018. The result: 15-year-olds scored 399 points for reading literacy, the main topic of PISA 2018, compared to an average of 487 points in the OECD countries. On average, 15-year-olds get 373 points in math, compared to an average of 489 points across OECD countries. Boys' performance in math is among the lowest among PISA-participating countries and economies. In Saudi Arabia, the 15-year-old average achievement in science is 386 points, compared to an average of 489 points in OECD countries. (PISA, 2018)

1.2 Aim

The Kingdom of Saudi Arabia believes that its education system is structured to prepare their students to meet the demanding requirements of the 21st century. However, the country has been recording low average scale scores in the recent TIMSS assessments, with a comparatively high margin between the kingdom and Singapore which has the best education policy with outstanding TIMSS scores across the world (TIMSS, 2015). Hence, this study seeks to examine the impact of international assessments on mathematics teacher development in KSA.

1.3 Objectives

To achieve the aim of this study, the researcher sought to achieve the following research objectives:

1. Investigate the factors contributing to low TIMSS scores in mathematics in KSA.
2. Examine how TIMSS scores can be used to enhance teaching recommendations in the mathematics subject in KSA.
3. Identify the strategies used to teach mathematics in KSA and compare them to the established standards in the Singaporean Education System.

1.4 Research question

The key research question in this research study was:

- Is there a link between international assessment scores and mathematics development practices in KSA?

1.5 Significance of the Study

The study is significant to the education sector in Saudi Arabia, as well as in other countries with low TIMSS scores. Mostly, the study will educate stakeholders in the education system in Saudi Arabia concerning the meaning of TIMSS scores on student achievement. According to Rodriguez (2004), the TIMSS score of a country can provide an unparalleled amount of information concerning the teaching practices, the characteristics of schools, educational policies, and attitudes of students towards mathematics learning. Besides, these scores may also provide the KSA education sector with information about the factors that contribute to academic fortes and weaknesses in mathematics learning. Additionally, this study seeks to serve as an encouragement to the Ministry of Education in KSA that there is considerable room for improvement. That can be achieved by examining other successful countries, such as Singapore and developing equal teaching strategies designed for the KSA learner.

1.6 Motivation

People have always wondered whether assessment frameworks have an impact on the performance of students and teachers in the mathematics subject. Even though researchers have attempted to examine this correlation, such as in the studies by McDonald and Boud (2003), very few have focused on the significance of TIMSS scores on the performance of participating countries. Besides, examining mathematics performance in KSA has proved to be a challenging aspect in many aspects because of the blatant prioritisation of Islamic and Arabic studies over other subjects. Even so, this paper attempts to explore the difficult path of examining mathematics teacher development in KSA using TIMSS scores. The results of the study bring us closer to finding solutions to the operational challenge of poor mathematics performance in Saudi Arabia.

Chapter 2 Literature review

2.1 Introduction

The aim of this literature review was to examine some of the factors that influence student achievement as presented by the TIMSS authors (Mullis, Martin, Foy, Kelly, & Fishbein, 2020). Key factors identified and discussed in this paper include teacher professional development, the size of the class, teacher satisfaction, use of technology, type of assessment, teacher burnout, use of non-specialist teachers, use of computers, and administration of homework. These factors are extensively discussed below.

2.2 International Assessment Frameworks

One of the fundamental goals of education globally is to prepare students to excel in the mathematics and science disciplines (National Academy of Sciences et al., 1996). Largely, that is because these disciplines prepare students to succeed in future career initiatives and in their eventual daily life (Bishop et al., 2006; Furner & Kumar, 2007; Mullis & Martin, 2014). For an individual to effectively participate in societal activities, they must have a basic understanding of mathematics and science principles, which by extension guide them in making informed decisions about their health, finance, public policies, and other issues that affect their economy and environment (Bishop et al., 2006; Mullis & Martins, 2014). Due to the significance of these disciplines, various international assessment frameworks have been developed to guide countries on how to improve their teaching practices and the learning curriculum. Some of the popular international assessment frameworks include the IEA's Trends in International Mathematics and Science Study (TIMSS) (Mullis et al., 2005; Mullis & Martins, 2014), and the OECD Programme for International Student Assessment (PISA) (Mullis & Martins, 2014; OECD, n.d.). Overall, the TIMSS framework measures progress in educational achievement in mathematics and science at the 4^{th} and 8^{th} grades, while the PISA framework involves conducting a comprehensive and rigorous international assessment of the knowledge and skills acquired by the students during the learning period (Mullis & Martins, 2014). Due to the focus of the current study, the literature review shall examine the TIMSS framework in depth.

TIMSS assessments are sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and are managed by the National Centre for Education Statistics (NCES). The first TIMSS data was collected in 1995, and the procedures have since been conducted during every four years (Bennett & Davier, 2017; Liu, 2010). However, advanced data on the TIMSS assessment has been collected internationally during three occasions, in 1995, 2008, and 2015 (IEA, 2018). The procedures used in the assessment follow a quasi-longitudinal design, where the cohort consisting of 4^{th} grade students is examined four years later at the 8^{th} grade (IEA, 2018). Examining students at the 4^{th} grade is significant because early warning signs can be identified, leading to the implementation of necessary curriculum reforms focused on improving the quality of learning among the students (IEA, 2018). The progress achieved after the implementation of the necessary curriculum reforms can then be measured when the student is in their 8^{th} grade (IEA, 2018). The curriculum used in TIMSS assessments investigates how individual countries provide educational opportunities in mathematics and science to their students. The curriculum also measures the factors related to how the students use the opportunities provided to them (IEA, 2018). The assessment involves the cooperation of students, their teachers, and the school administration. Recent TIMSS data was collected in 2015 and featured assessment information about students in the 4^{th}, 8^{th}, and 12^{th} grade. Over 60 countries, including the United Arab Emirates participated in the assessment (IEA, 2018). Some of the countries that have consistently reported high TIMSS scores and represent successful examples of education reforms include Singapore, Canada, Australia, Finland, Ireland, and the Republic of Korea (IEA, 2018). In the Middle East, the experiences of Jordan since the 1980s provides a suitable perspective of education reforms in a developing country (IEA, 2018).

The curriculum model used in TIMSS assessments consists of three aspects, which include the intended curriculum, the implemented curriculum, and the achieved curriculum (Hastedt, 2016; Reddy et al., 2006) (see figure 2.1). The intended curriculum represents the concepts of mathematics and science, which the society anticipates the students to learn as well as aspects organisation of the education system to encourage learning (Hastedt, 2016; Reddy et al., 2006). The implemented curriculum aspect of the assessment represents the information that is taught in the classrooms to students, the features of the teachers, and how they handle the delivery process (Hastedt, 2016; Mullis & Martins, 2014; Reddy et al., 2006). Finally, the achieved curriculum aspect examines what the students have gathered from the learning process, and their thoughts about the mathematics and science subjects.

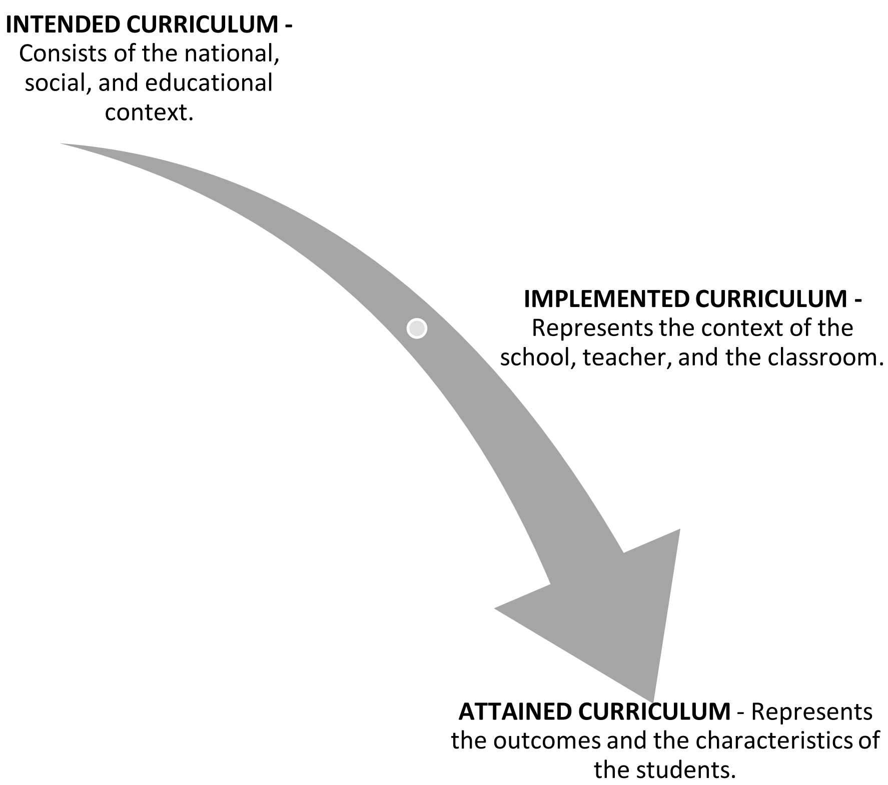

Figure 2-1 TIMSS Curriculum Model

2.3 TIMSS and Quality Education

There is some growing research evidence to suggest that schools can improve the learning of mathematics among their students using internationally recognised assessment frameworks, such as TIMSS. Some of these studies, including Darling-Hammond (2000) and Brophy (2001) maintain that a huge part of the difference in the learning of mathematics must be attributed to teachers. Specifically, the study by Darling-Hammond (2000) uses evidence from 50 state policies to examine the correlation between the quality of the teacher and student achievement. The qualitative and quantitative findings of their study reveal that investment in policies that focus on improving the quality of teaching contribute immensely towards the improvement in student performance. Darling-Hammond (2000) also recommends that education initiatives targeted at enhancing the performance of students in certain subjects must consider placing more emphasis on the preparation and certification of its teachers. Similarly, Brophy (2001) notes in his booklet how effective teachers help their students to show better educational gains compared to less effective teachers. Brophy (2001) argues that “Besides presenting information and modelling application of skills, effective teachers structure a great deal of content-based discourse Effective teachers routinely monitor their students’ progress in this fashion, using both formal tests or performance evaluations and informal assessments of students' contributions to lessons and work on assignments," (p. 29). To some extent, these studies reinforce the significance of using TIMSS to enhance the quality of teaching that the teachers provide to their students to enhance the quality of education.

Other sets of studies have focused on the unequal nature of effectiveness among teachers and the different variables involved. Most of these studies identify the key variables as the academic and professional background of the teacher, as well as their classroom practices. Some of the research studies that have examined the correlation between the effectiveness of teachers and the academic achievement of teachers include Goe (2007) and Goe & Stickler (2008). The research synthesis by Goe (2007) covers the key question on the components of teacher quality and identifies key teacher quality variables that have been reported in previous studies. Some of these variables identified by the researcher include teacher effectiveness, experience, education, evaluation scores, instructional practices, instructional quality, and attitude. Similarly, Goe and Stickler (2008) reveal in their publication that there are contradictions from previous research concerning what constitutes effectiveness among teachers and the resulting achievement among students. These authors propose 4 strategies, which they believe must be key concerns in TIMSS assessments. The proposed characteristics include the qualification of teachers, practices, characteristics, and effectiveness. By extension, Al Shannag et al., (2013) note that these variables are of high concern in Saudi Arabia as they are in Singapore, considering that they can affect the process of recruiting and retaining teachers.

The argument concerning the role of teacher qualification, practices, effectiveness, and characteristics in TIMSS assessments has been examined by many other scholars. Some of these scholars include Aaronson, Barrow, & Sanders (2003) and Nye, Konstantopoulos & Hedges (2004). The working paper by Aaronson et al., (2003) examines the correlation between teacher variables and student achievement among Chicago high school students. Through this dataset, the authors estimate the significance of teachers on the achievement of students in the mathematics subject. Their empirical findings indicate that linking a student to a teacher that is ranked two standard deviations higher in terms of quality played a significant role in adding an estimated 0.3 to 0.5 on the mathematics grades. Such an improvement can be equated to between 25 and 45% of scores on an average year. Equally, the study by Nye et al., (2004) estimates teacher effects to determine whether they affect student learning achievements. The empirical findings of the study indicate a larger impact of teacher effects on the achievement of mathematics skills compared to other disciplines, such as reading.

Besides, the researchers also find a substantial correlation between the experience of teachers and achievement among students, more so among 3rd-grade mathematics students. Together, these studies highlight the significance of the variables proposed by Goe (2007) and Goe and Stickler (2008) in enhancing student achievement, more so in the mathematics subjects.

Some studies on TIMSS have also attempted to compare the most established education systems and those that are shaping up for success soon. One key example of such a study is by Marsh, Abduljabbar, Parker, Morin, Abdelfattah, & Nagengast (2014). Specifically, these authors compare the TIMSS responses of students in the U.S and the Saudi Arabian education system. The researchers use TIMSS 2007 data for 8th grade students to examine the psychometric properties of maths self-concept, achievement, positive affect, as well as coursework aspirations. The researchers describe the TIMSS assessments as the principal basis for conducting international comparisons and benchmarking in the mathematics and science subjects. Another study that takes a comparative approach is by Dodeen, Abdelfattah, Shumrani and Hilal (2012), where the authors compare the qualifications, practices, and perceptions of mathematics teachers in Saudi and Taiwanese schools. The data used in the study consisted of TIMSS 2007 responses collected from 8th Grade students. The findings of the study revealed key differences in the preparation process adopted by teachers taking on certain topics of the mathematics subject. Besides, the study also found out that some of the qualifications and practices of teachers were associated with their scores (Dodeen et al., 2012). These observations from research reveal that one of the key roles of international assessment frameworks, such as the TIMSS is to identify topics that have been taught to students, the assessment tools used during the teaching process, and the relevance of the questions used to examine the understanding of students.

Some researchers view the use of TIMSS assessments as a holistic strategy to implementing education reforms. For instance, Maroun, Samman, Moujaes, and Abouchakra (2008) conduct a case study of Saudi Arabia and the broader GCC region with the focus of examining how education reforms can be made successful. The researchers maintain that a one-size-fits-all education program does not exist. Even so, they observe that there is some common link among some of the countries, such as Finland and Canada, that have performed consistently well over the years (Maroun et al., 2008). The common aspect about some of these successful education systems is their use of a holistic approach that is supported by effective implementation strategies. A holistic strategy approach respects and works with the meaning structures of every person. Teachers begin a topic with what the student already knows or understands from their world view. That means that the teacher starts with what has meaning to the students rather than what the curriculum feels should be meaningful to them (Birsa, 2018). The researchers note that "Such an approach helps provide a prudent guide to focal areas of strategy that are likely to lead to enduring results. By studying what other countries have done, we can propose an analogous way forward for other countries – for example Saudi Arabia," (p.24). In other words, Maroun et al. (2008) argue that the use of the TIMSS assessments provides the education system in Saudi Arabia with the chance to learn from their shortcomings and identify the factors that have contributed to success in other education systems.

Some researchers hold the view that there is a correlation between student achievement and their self-perception, especially in the mathematics subject. Such an argument has been examined empirically in numerous studies, such as Shen & Tam (2008). In their study, Shen and Tam use three waves of TIMSS data to investigate the connection between the mathematics and science achievement and self-perception among students in their 8th grade. In a country set-up, the researchers find that there is a positive correlation between the achievement of students and how much they like mathematics, their self-perceived ability in the subject, as well as their supposed easiness of the subject (Shen & Tam, 2008). However, when comparing TIMSS scores from different countries, Shen and Tam (2008) find a negative relationship between self-perception and achievement in the mathematics and science subjects. The negative relationship obtained reported from comparing TIMSS scores of different countries could possibly illustrate the differences in academic standards in different countries (Shen & Tam, 2008). Additionally, these findings also elevate the role of TIMSS scores as that of providing low-performing countries with low academic standards to learn from high-performing countries with superior academic standards.

2.4 Professional development

Previous research showed a lot of interest in how teacher professional development translates into better student outcomes. The goal of teacher professional development should be to promote or change the behavior of the teacher and eventually impact student learning. In their study, Lumpe, Czernik, Haney, and Beltyukova (2012) investigated the relationship between the participation of teachers in professional development programs and student achievement. The study findings showed that participation in professional development predicted student achievement in science (Lumpe et al., 2012). Another study by Bruce, Esmonde, Ross, Dookie, and Beatty (2010) scrutinized the correlation between classroom-embedded teacher professional learning and student achievement. The outcome of the study revealed high teacher efficacy and student achievement after the implementation of the professional learning program. A more recent study by Althauser (2015) focused on the impact of job-embedded professional development on the performance of students in mathematics. Job-embedded professional development (JEPD) describes teacher learning established in daily teaching practice. JEPD is meant to develop the content-specific instructional practices of teachers with the intention of boosting student learning (Althauser, 2015; Croft et al., 2010). The approach is primarily school, or classroom based and is incorporated into the workday. Teachers assess and find solutions for real and immediate problems of practice as part of a cycle of continuous improvement (Althauser, 2015; Croft et al., 2010). The results showed that continued professional development may lead to better student achievement in mathematics (Althauser, 2015). Basically, these studies imply that any form of teacher professional development can benefit students by improving their performance in mathematics.

Despite the positive correlation noted in past research, several questions regarding the effect of teacher professional development on the achievement of learners remain to be addressed. Dash, de Kramer, O'Dwyer, Masters, and Russell (2012) focused on an online program for teacher professional development and its impact on student achievement among fifth grade mathematics students. The online professional development program used in the study enhanced the skills of the teachers in dealing with fractions, measurement, and algebraic thinking (Dash et al., 2012). The teachers took part in more than 70 hours of training. The findings showed that teachers who were in the experimental group had better knowledge in knowledge and practices. However, the positive changes in the outcome of the teachers did not cause any expressive change in the mathematics achievement of the students (Dash et al., 2012). These findings imply that professional development programs can be a useful strategy to enhance the content knowledge and practice of mathematics teachers. However, the impact of these programs on the academic achievement of learners needs further investigation.

There is a correlation between professional development and an increase in student achievement. Professional development contributes to better instruction and improves student learning by connecting to the curriculum materials that teachers use. Besides, professional development promotes assessment and accountability measures that facilitate student success.

2.5 Class size

When it comes to the topic of class size, many scholars agree, and have agreed for a long time, that it is a key determinant of various aspects of student outcomes (Bourke, 1986;

Hoxby, 2000; Okpala et al.,2000). The impacts of class size may range from variation in test scores to differing wider life outcomes. Amid reforms (Bourke, 1986; Hoxby, 2000) suggesting that class size does not matter, Schanzenbach (2014) conducted a study to examine whether this aspect is important. The findings presented in her report support the prevailing belief that students learn more and teachers become more effective when in small-sized classes. Schanzenbach (2014) further noted that small-sized classes were highly effective at increasing the levels of achievement among low-income and minority learners. Indications on what constitutes a small class are relative, and Schanzenbach (2014) quotes the STAR experiment, which suggests the threshold of between 15 and 20 learners per mathematics class. Similar observations were made in the study by De Paola, Ponzo, and Scoppa (2013). The researchers explored the effect of class size on the achievement of learners at a medium-sized Italian public learning institution. The authors assigned the teachers and the learners to classes of assorted sizes in a random manner. The researchers controlled for various individual characteristics and found that larger classes had a significant negative impact on the performance of students in mathematics (De Paola et al., 2013). The impact was much larger for students with a lesser ability, but negligible for learners with a higher ability. When compared to other subjects, class size did not seem to have an impact on the ability of students to acquire language skills (De Paola et al., 2013). From a distinct perspective, Weiss, Carolan and Baker-Smith (2010) evaluated the assumption on the relationship between the size of a high school and achievement in mathematics. Their multilevel regression analysis showed that high schools that were moderately sized had the best outcome in student engagement. In sum, these studies tend to suggest that smaller mathematics classes contribute to much better student performance compared to larger ones. Many researchers have argued otherwise too.

Class size does have an effect on student performance. It is possible that student achievement may slightly decline as the size of the class increases. Students in smaller classes are likely to learn and interact more with the teachers compared to larger classes.

2.6 Teacher satisfaction

Teacher satisfaction closely relates to measures of the school environment (Fulton & Britton, 2011). Many teachers are likely to be satisfied when there is safety in a school, security policies and practices are enough, and when the severity of different problems is low (Fulton & Britton, 2011). As evident in past scholarly work, these conditions are likely to lead to better student achievement in mathematics. An independent evaluation initiated in a report by Fulton and Britton (2011), the authors evaluated the satisfaction of STEM teachers. The outcome indicated remarkably high levels of satisfaction, which improved their knowledge of STEM content (Fulton & Britton, 2011). Consequently, an increase in student achievement was also noted in the report. Another study by Kraft, Marinell, and Yee (2016) noted that low levels of teacher satisfaction contributed to teacher turnover, which eventually affected student achievement. Factors associated with teacher satisfaction, as noted in the study include better school leadership, improvement in academic expectations, better relationships among teachers, and an adequate level of safety in school (Kraft et al., 2016). These factors corresponded with better gains in student achievement. In the same manner, a study by Johnson, Kraft, and Papay (2011) investigated the impact of professional satisfaction on student achievement. The researchers conducted a survey of working conditions in schools in the state of Massachusetts. Johnson et al. (2011) noted that most of the teachers were more satisfied and planned to stay longer in schools that had a positive work context. Such a positive work environment appeared to contribute to better student outcomes, especially in mathematics and English language. From these studies, it is evident that working conditions influence teacher satisfaction, which predicts the school-level value-added scores in mostly mathematics and English to a lesser degree.

Job satisfaction among teachers contributes to the well-being and achievement of their students. To be an effective teacher, one needs to be passionate about their profession. Happy teachers devote more time to their students and give the best they can to facilitate better student achievement. There is also a connection between job satisfaction and teacher burnout. Teachers with higher levels of emotional exhaustion have a higher chance of experiencing burnout.

2.7 Use of technology

The impact of using computers to teach mathematics has been of great interest to past researchers (Estapa & Nadolny, 2015). The prevailing assumption is that the use of such technology can enhance student performance and achievement. One study by Shirvani (2010) investigated the use of computer technology on learners performing poorly in mathematics. The researchers used a sample of first-year high school students. The outcome of the study showed that poorly performing learners in mathematics who had access to computer technology performed better than those who did not use such technology (Shirvani, 2010). Besides, students that used computer technology also developed improved attitudes towards mathematics (Shirvani, 2010). Augmented reality was used in a study by Estapa and Nadolny (2015) to investigate student achievement and motivation in the mathematics subject. The study was quasi-experimental in nature, with 61 high school students who participated in a dimensional analysis mathematics activity (Estapa & Nadolny, 2015). The findings supported the claim that the use of technology increased student achievement and enhanced the motivation to learn mathematics. Despite these findings, the study by Estapa and Nadolny (2015) is limited in the sense that it only focuses on one mathematical activity – dimensional analysis. Another quasi-experimental study was carried out by Eyyam and Yaratan (2014), and the researchers examined the attitude of students towards the use of technology in class and whether these digital devices improved the academic achievement of the learners. The mathematics posttest results showed that the learners who were taught using technology had exceedingly high achievement compared to those instructed without technology. The outcome also showed that the learners had a positive attitude towards the use of technology in a mathematics class. Together, these findings imply that the use of technology in the classroom had a positive effect on the success of students and improved their attitude towards mathematics lessons.

Past research evidence implies that the use of higher technology in the classroom does not necessarily lead to better student performance in mathematics and science (Galvis & McLean, 2021). However, classrooms with higher access and use of technology stand a better chance of engaging in online teaching, which reduces possible losses (Aypay et al., 2007; Jacobs et al., 2007). This is mostly connected with TIMSS in various ways. The 2019 Trends in International Mathematics and Science Study (TIMSS) data showed that most countries with outstanding performance in mathematics and science assessment still have room to integrate technology within the classroom (Galvis & McLean, 2021). TIMSS allows researchers to look at student and teacher familiarity with computer use in the classroom (Aypay et al., 2007; Jacobs et al., 2007). Besides, TIMSS examines professional development in integrating technology into teaching.

I believe that technology affects student achievement. Specifically, the use of technology can increase student achievement when used appropriately. Students can increase their mathematics scores by using a technology-based mathematics curriculum compared to a traditional curriculum.

2.8 Type of assessment

Past studies (Cheah, 2010; Herr & Tippens, 2013) tend to suggest that the type of assessment used in a mathematics classroom can influence student achievement. Assessment can either be continuous or summative. Continuous assessment refers to where the teacher puts the evaluation throughout the course, while summative is conducted at the end of the term or course. Related work (Cheah, 2010; Herr & Tippens, 2013) has examined the impact of these types of assessment on student achievement. In the study by Cheah (2010), the researcher examined assessment practices in primary mathematics classrooms in Malaysia. While all forms of assessment are effective, Cheah (2010) recommend the use of continuous assessment since it allows learners to engage in remedial and enrichment activities that in the end enhance the performance of the learners. Stated otherwise, continuous assessment allows the teachers to evaluate the communication and critical thinking skills of the learners and strategize best on how to improve their performance. Herr and Tippens (2013) also examined the significance of continuous assessments on student performance. The findings of the study indicate that continuous assessments allow teachers to determine the level of student understanding so that the teaching process can be tweaked suitably to meet real-time needs. A different study by Brookhart (2013) evaluated the significance of continuous and summative assessments in the USA. The findings tend to suggest that summative assessments, such as standardized tests, contribute to better student performance compared to continuous assessments, which often involve teacher judgement measures (Brookhart, 2013). From these studies, it is not clear which type of assessment is best in enhancing student performance. However, what is clear from the research is that assessments tend to have an impact on the achievement of the learners.

The role of assessment is to collect relevant information about the performance or progress of a student, determine their interests, and make judgments concerning their learning process. The type of assessment used can identify the strengths, weaknesses, knowledge, and skills of a student. Teachers can use the outcome of such assessments to determine areas that need improvement.

2.9 Teacher Burnout

A series of recent studies (Herman, Hickmon-Rosa, & Reinke, 2018; McLean & Connor, 2015; Klusmann, Richter, & Ludtke, 2016) have indicated that teachers can experience burnout when they engage in more work than teaching. Certainly, such an experience can affect the teacher as well as the performance of the learners. Herman et al. (2018) analyzed profiles of teachers to determine the impact of stress, burnout, as well as self-efficacy on the outcomes of the learners. A total of 121 teachers and 1,817 students from nine elementary schools located in a Midwestern school district participated in the study (Herman et al., 2018). Based on the study findings, teachers that experienced high stress, burnout, and low coping mechanisms were associated with low student outcomes. Quite the reverse, teachers with low stress, low burnout, and high coping mechanisms were associated with outstanding student outcomes (Herman et al., 2018). Another study related to this was conducted by McLean and Connor

(2015), and the researchers analyzed the impact of depressive symptoms among third-grade teachers on student achievement. The scores in mathematics of learners who began the year with substandard skills and were taught by teachers with more depressive symptoms experienced smaller gains. The case was different for learners who were taught by teachers who had fewer depressive symptoms. What this means is that the quality of the classroom learning environment facilitated the relationship between depressive symptoms and the achievement of learners. Klusmann, Richter, and Ludtke (2016) also examined these constructs by focusing on the impact of emotional exhaustion on student achievement. The authors considered emotional exhaustion to include symptoms of stress and burnout. The sample used in the sample was made up of 1,102 German elementary school teachers as well as students. The researchers controlled for the gender, years of experience, and the composition of the class, among other factors. The findings showed that there was a significantly negative correlation between emotional exhaustion and student's achievement in mathematics. When put together, these studies tend to highlight the significance of teachers' well-being for student achievement.

As I see it, teacher burnout can potentially lead to worse academic achievement. Besides, teachers experiencing this state are less likely to motivate their students. However, there is a need for more robust studies in this area to ascertain the exact effects that teacher burnout can have on the students they teach.

2.10 Non-specialist Teachers

On many occasions, there are instances where a non-specialist teacher teaches the mathematics subject. This population has drawn an emerging interest among scholars in the field of education. The study by Kutaka, Smith, Albano, Edwards, and Ren et al. (2017) compared specialists to non-specialist teachers based on professional development. The study findings showed that on average, specialist teachers from *Primarily Math* had a Math Ability Score Difference (MASD) change score that was 1.85 units higher compared to non-specialist teachers in the comparison group (Kutaka et al., 2017). In another study by Crisan and Rodd (2017), the authors examined the identity of non-specialist teachers. In their discussion, the authors noted that most non-specialist teachers to be good at teaching mathematics despite the performance of their learners being poor. A recent study by Canales and Maldonado (2018) examined the impact of teacher quality on the achievement of learners in Chile. The authors used pseudo-longitudinal data for 2011 derived from the Education Quality Measurement System (Canales & Maldonado, 2018). The authors found that the quality of teachers facilitated students' learning in mathematics and language. Besides, teaching experience had a noticeable non-linear impact on the mathematics test scores (Canales & Maldonado, 2018). Through these observations, the findings tend to suggest that the use of non-specialist teachers can impede student achievement.

The quality of teachers has a much stronger relationship to student achievement. When non-specialist teachers are used in the classroom, this can affect student achievement. I also believe that the impact of non-specialist teachers is progressively stronger at higher grades, showing a cumulative impact on students' achievement.

2.11 Using computers in the classroom.

The use of technology in the mathematics classroom has also challenged the way teachers organize student learning and achievement. As a result, previous studies have examined whether the use of computers in the classroom impacts student learning. For instance, Drijvers, Doorman, Boon, Reed, and Gravemeijer (2010) examined the types of orchestrations that teachers develop when using technology and how they impact student performance. The data used featured 38 lessons on videotapes taught by three teachers (Drijvers et al., 2010). The study findings proved the existence of a positive relationship between the use of computers in the mathematics classroom and student achievement (Drijvers et al., 2010). Another study by Pilli and Aksu (2013) focused on the *Frizbi Mathematics 4* educational software which was administered on 4th grade students. The investigational group was taught using the educational software, while the control group was taught using a talk. The outcome of a series of ANOVAs based on repeated measures indicated major differences between the two groups. Evidence from the study shows that the use of computers for learning and teaching mathematics at the primary school level resulted in better achievement, retention, and attitude among the learners. Kay and Kletskin (2012) evaluated the use of video podcasts to provide mathematics instruction in higher education. The authors examined 59 problem-based video podcasts that encompassed five different areas in mathematics. Most of the students used the video podcasts regularly and found them easy to use. The students also found the videos to be effective tools for learning and resulted in a gain in knowledge in pre-calculus concepts. These studies tend to suggest that the use of computers in the classroom benefits student's learning and achievement.

The use of computers in the classroom has also generated mixed results. Carr (2012) focused on the use of iPads and game-based learning on mathematics instruction. The authors conducted pretest and posttests on 104 students from fifth grade. They administered the pretest before the iPad intervention and the posttest after the intervention (Carr, 2012). One-way repeated-measures analysis of variance revealed no significant changes from pretest to posttest (Carr, 2012). In the same way, Skryabin, Zhang, Liu, and Zhang (2015) investigated the influence of ICT on the achievement of students in reading, science, and mathematics. The authors used data from international databases, such as TIMSS 2011, PISA 2012, and PIRLS 2011. The authors found that ICT influenced academic performance in a positive manner. However, they noted that the influence was mixed across various student groups and subjects depending on what the technology was being used for.

I agree with past research that the use of computers in class can reinforce student achievement. However, it is also important to note that the incorporation of technology in class can be detrimental. It could encourage students to procrastinate and could eventually reduce the efficiency of the time spend in class.

2.12 Homework

A few authors (Pelletier & Normore, 2013; Fernandez-Alonso, Suarez-Alvarez, & Muniz, 2015) have also recognized the significance of homework in promoting student learning and achievement. One study by Pelletier and Normore (2013) analyzed the prognostic power of homework assignments on the achievement of students in mathematics. Evidence in the study showed that the performance of students in the homework could be used to predict the academic success of students in mathematics (Pelletier & Normore, 2013). In another study by Fernandez-Alonso et al. (2015), the authors examined the personal factors that influence homework performance among adolescents. The authors noted a positive correlation between adolescents who completed homework and their learning outcomes (Fernandez-Alonso et al., 2015). However, this relationship was heavily mediated by previous knowledge in the examined concepts. In other words, the findings support the viewpoint that the completion of homework had a positive impact on student academic achievement.

Other studies went an extra mile of comparing the type of homework and its effect on the achievement of learners. In the study by Hauk, Powers, and Segalla (2015), the authors compared web-based to paper-and-pencil homework. The authors found no significant differences in the performance or achievement gain in algebra in the experiment and control group (Hauk et al., 2015). What these findings mean is that how the homework is administered does not necessarily influence student achievement. Similarly, Lenz (2010) examined the impact of web-based homework system on the outcomes of first-year mathematics students. Unlike the findings in the study by Hauk et al. (2015), these authors found that the use of web-based homework increased the chances of students attempting and receiving higher homework grades. However, the findings supported the observations made by Hauk et al. (2015), indicating no noticeable differences between the exam grades of learners in using web-based in comparison to those using the paper-based platform. Roschelle, Feng, Murphy, and Mason (2016) used a dataset consisting of 2,850 seventh-grade mathematics learners to examine the impact of online mathematics homework. The results demonstrated that an online intervention enhanced student scores compared to a traditional approach (Roschelle et al., 2016). However, this impact was mostly visible among learners with low previous mathematics achievement. From these studies, there is no significant difference in student achievement among students who complete their homework online and those who complete it traditionally.

I agree with the reviewed studies that homework can contribute to greater academic achievement. It does this by enhancing the students' memory and thinking skills. I also think that doing homework helps students learn how to manage their time.

2.13 Teacher confidence

Teacher confidence has the most significant impact on student achievement. A teacher with the right level of confidence is likely to push learners, attempt alternative methods, or confront difficulties. Previous research provides an understanding of the significance of teacher confidence for teaching and teacher development. In one study, the authors examined the role of confidence in learning to teach in higher education (Sadler, 2013). The associated feelings of confidence with content knowledge and teacher skills. Sadler (2013) also categorized experience as the primary factor in teachers' development of self-confidence. Self-confidence appeared to improve as the teachers changed their teaching approach. For instance, speaking more slowly and enhancing the transparency of the lesson appeared to improve self-confidence (Hativa, 2000). In another study of academics' perceptions of their growth and development, ÅKerlind (2003) identified that teacher confidence, comfort, and the ease of teaching contributed to development. One of the study participants discussed teacher growth and professional development: "There's still a lot of growth in teaching that I can make. I want to be so comfortable with teaching that I can walk out there with hardly any preparation and deliver a wonderful lecture" (ÅKerlind, 2003). Indeed, the findings from these studies show that confidence is a key dimension for teacher professional development regardless of the conception and approach to teaching taken by an individual.

A study by Norton (2017) examined the confidence of trainee primary school teachers and its impact on their mathematical content knowledge and confidence to teach certain concepts. The researcher got data from a cohort of 210 trainee teachers. From the study findings, confidence to do and teach mathematics was reasonably correlated with student competence. The confidence of the trainee teachers varied based on the specific mathematics tasks they were working on. The findings of this study agree with existing educational research literature showing that prospective teachers need to understand the mathematics they are expected to teach deeply, and high levels of self-efficacy and confidence should accompany this knowledge (Bernard et al., 2019; Bernard & Senjayawati, 2019).

Over time, extensive literature has also developed concerning the role of teacher anxiety on student achievement. Teachers who lack confidence are often described as being anxious. In Peker (2009), the study addresses the anxiety affiliated with teaching mathematics among pre-service teachers. Mathematics teaching anxiety can be described as the feelings of tension and anxiety that manifest during the teaching of concepts, theories, and formulas, or during problem solving. Teachers who lack confidence to teach can easily say to themselves, "*I can't teach this concept*, or *I have never been good at mathematics teaching*, or *I just can't teach this problem solving*," (Peker, 2009). Some symptoms of mathematics teaching anxiety may include extreme nervousness, negative self-talk, difficulties in concentration, and sweaty palms—to name a few. The teacher cannot teach as expected since they are convinced they cannot be successful in teaching (Peker, 2009). Such characteristics can contribute to mathematics failure among some students.

A teacher's belief in their teaching ability can affect how they consider, approach, and teach their students. A confident teacher most often has a positive impact on their students' attitude, achievement, emotional, and effective growth. Among other things, we can make an argument that it is essential or beneficial for teachers to be comfortable in their role for the sake of their students.

2.14 Teacher interaction

A proliferation of research suggests that teachers' interaction can motivate students to learn (D. P. Martin & Rimm-Kaufman, 2015; Rimm-Kaufman et al., 2015). Creating classroom environments that encourage positive and healthy interactions can motivate learners to channel their energies and desires to reach their academic goals. Rimm-Kaufman et al. (2015) investigated the concomitant quality of teacher-student interaction using a sample of 5th graders in mathematics classrooms. The multilevel models used in the study revealed that the quality of teacher-student interaction was linked to student-reported engagement. That means that students in classrooms with teachers who are warm, caring, and responsive reported working hard, enjoyed learning about math, and shared ideas and materials with other learners in their classroom. The study findings also revealed that learners in classrooms with teachers who used proactive methods to behavior management, facilitated smooth transitions between activities, and made learning goals clear before learning reported feeling significant cognitive, emotional, and social engagement in their maths learning outcomes (Rimm-Kaufman et al., 2015). These results underscore the significance of developing emotionally supportive interactions between teachers and students in fifth grade, among other levels of learning.

A similar study by Martin and Rimm-Kaufman (2015) explored whether teacher-student interaction quality influenced emotional and social engagement among fifth-grade mathematics learners. The study sample featured 73 teachers and 387 Fifth graders. The level of teacher-student interaction was measured based on emotional, organizational, and instructional support. Teachers offer emotional support by being sensitive, warm, responsive, and aware of the needs and interests of their students (D. P. Martin & Rimm-Kaufman, 2015). Besides, they can offer organizational support by establishing non-chaotic classroom environments based on clear expectations and productive learning (D. P. Martin & Rimm-Kaufman, 2015). Last, teachers can offer instructional support by providing clear feedback to learners, establishing opportunities for conceptual thinking, and developing new vocabulary (D. P. Martin & Rimm-Kaufman, 2015). Based on these tenets, students who considered their classroom environments as being more caring and well-structured were more likely to report a high level of engagement in school, which led to higher rates of attendance and better test scores (D. P. Martin & Rimm-Kaufman, 2015). These findings are further supported by Klem and Connell (2004) and Ruzek et al. (2015).

Even though research links teacher-student interactions with student outcomes, there are a few major shortcomings of existing work. Most of the teacher-student interaction research focuses on various content domains, and only a few authors focus on the math domain, specifically (D. P. Martin & Rimm-Kaufman, 2015). The experiences of learners differ depending on the academic subject. Students who experience a powerful level of engagement in mathematics may not feel equivalently engaged in English or Science. Marks (2000) illustrates these findings in an earlier study that showed that learners found the teacher interaction to be stronger in a mathematics class compared to social studies.

Teacher-student interaction is important in learning mathematics for various reasons. Teachers who develop a positive interaction with their learners establish classroom environments that are more helpful to learning and meet their emotional, developmental, and educational needs. The countless interactions that happen daily between the teacher and student need to make the latter feel comfortable and manage their behavior as well.

2.15 Teacher emphasis on academic success

Teacher emphasis on academic success refers to the beliefs of teachers about academic success and their focus on academic tasks. This construct includes setting high but achievable goals and insisting on diligent work (Hoy et al., 2008; Smith & Sean Kearney, 2013). The theme is also demonstrated through peer respect for hardworking students and the desire by the whole school community to achieve academically (Hoy et al., 2008). Teacher emphasis on academic success has been a major predictor of student achievement in standardized tests.

Past research emphasizes the significance of academic success since it directly influences positive outcomes of the students upon graduation (Badri, 2019; Scherer & Nilsen, 2016; Tavsancil & Yalcin, 2015; Yalcin et al., 2017). Students who perform well or those who get to high levels of education have a better chance of being employed and receiving higher salaries compared to those with no academic success (Badri, 2019). Because of this, past studies suggest that academic optimism makes a major contribution to student achievement, more so in mathematics and science. Academic optimism may reflect parents, teachers, and student's priority and drive for academic success. Specifically, teacher emphasis on academic success has often been examined from the academic optimism point of view. For instance, Scherer and Nilsen (2016) analyzed the role of instructional quality as a possible mediator between the climate in school and student motivation. The authors focused on three aspects that contribute to the climate in school; emphasis on academic success, order, and safety in schools (Scherer & Nilsen, 2016). They also focused on three aspects that highlight achievement motivation: self-concept, extrinsic value, and intrinsic value. In the study findings, the authors reported a significant positive correlation between the quality of instructions and achievement motivation at the mathematics classroom level (Scherer & Nilsen, 2016). These results point towards a substantial positive effect of pedagogical content knowledge on students' learning gains in the mathematics subject. Pedagogical content knowledge refers to a type of knowledge that is distinctive to teachers, and is dependent on the way teachers relate their pedagogical knowledge (what they know concerning teaching) to their subject matter knowledge (what they know concerning what they teach) (Cochran, n.d.; Loughran et al., 2012; Pompea & Walker, 2017). Pedagogical content knowledge comprises the combination or the blend of teachers' pedagogical knowledge and their subject matter knowledge. As a form of knowledge, pedagogical content knowledge is responsible for making science and mathematics teacher instead of scientists.

Another recent study questioned whether teachers' academic optimism matters in improving mathematics results (Straková et al., 2018). In their study, the authors combined three aspects of a teacher's professional creed, including trust, self-efficacy, and academic emphasis. Straková et al. (2018) explored the collective and individual functioning of these measures in the Czech environment and studied its impact on student outcomes. Pilot data was drawn from 39 schools, 325 teachers, and 1,316 Grade 9 students. Data was also obtained from the Czech Longitudinal Study in Education (CLoSE) covering 163 schools, 1,469 teachers, as well as 4,798 students (Straková et al., 2018). After carrying out a two-level structural equation modelling, it was clear that there was a significant impact of a school's academic optimism on the achievement of learners (Straková et al., 2018). The authors controlled for previous achievement and socioeconomic status at the student and school level.

Better yet, Beard et al. (2010) examined the academic optimism of individual teachers. The authors hypothesized that the teacher sense of academic optimism amounted to individual teachers' beliefs that they can teach effectively. Teachers who are optimistic academically raise students who can learn and parents who support them so they can press hard for learning. Beard et al. (2010) grounded the concept of teacher emphasis on academic achievement in the social cognitive and self-efficacy theories along with the social capital theory. The authors observed that collective academic optimism has been linked to academic performance at the school level (Beard et al., 2010). Individually, quality teachers ensure that students are actively engaged in useful and appropriate learning activities to ensure the students' time in school is spent well. Academic learning time is significant since the time spend successfully on academic tasks could have a positive relationship with student learning (Beard et al., 2010). Hence, teachers' sense of academic emphasis, at times referred to academic press can help engage learners inappropriate, academic tasks.

In one recent study, school emphasis on academic success was found to have the most significant effect on the mathematics success of fourth- and eighth-grade students (Yalcin et al., 2017). The effect size of this variable revealed that an increase of one standard deviation would occasion an increase of .38 and .65 standard deviation in the mean mathematics achievement of fourth- and eighth-grade students, respectively (Yalcin et al., 2017). Other factors found to have a significant impact on teacher's emphasis on academic success include confidence in teaching mathematics, the working conditions of the teachers, and instruction to engage the students in learning. The impact of school emphasis on academic achievement was mostly influenced by the teachers ability to help the students develop positive attitudes concerning school (Yalcin et al., 2017). Such emphasis also raises student's awareness about their aims and academic life.

Recently, another study tried to determine the link between school features and students' mathematics success in the Trends in International Mathematics-Science Study (TIMSS). The authors used TIMSS that was administered to 8th grade students earlier in 2011 (Tavsancil & Yalcin, 2015). The study was carried out using a correlational approach, and the relationship between mathematics success and variables at student and school levels were examined using a two-level hierarchical-linear model. The findings of the study revealed differences between the students' mathematics scores at various schools (Tavsancil & Yalcin, 2015). The most significant finding was related to teacher emphasis on academic success. The findings demonstrated that teacher emphasis on academic success was positively correlated with students' mathematics achievement (Tavsancil & Yalcin, 2015). Based on these findings, it is necessary to investigate the role of school's emphasis on academic success in relation to the mathematics performance of the learners.

In my view, teacher emphasis on academic success promotes student learning, in part, by encouraging student academic optimism. Learners who believe that an academic outcome is within their reach will effectively handle negative experience since they are convinced that the outcome is still attainable. Quite the reverse, learners with a realistic appraisal of their academic competencies may calculate their odds for success and easily fall victim to setbacks or discouragement, abandoning academic challenges that could easily be within their reach.

2.16 Leadership support

Leadership support is reportedly required to enhance the mathematics outcomes of students. This also means that the role of leaders is changing from simply managing schools to more responsibilities for supporting instructional reforms in every content area. Past research shows that leaders play a central role in supporting teachers develop high-quality instructional practices (Coburn, 2003). Besides, instructional leadership has been recognized as a primary strategy in successful education reform. Various conjectures are present in the literature concerning how leaders can support mathematics teachers by facilitating instructional improvement and encouraging certain instructional practices (Coburn, 2003).

One study examined aspects of leadership that can help improve mathematics outcomes in low socio-economic status schools and school networks (Vale et al., 2010). The authors evaluated 43 schools in two networks of schools in rural Victoria. The study found evidence to support the significance of leadership approaches together with distributed leadership practice (Vale et al., 2010). Based on the study findings, school leaders can establish network and school structures along with relationships at different levels to allow and support ongoing improvements in teachers' pedagogical content knowledge and teaching practice. These initiatives can help build the leadership capacity of teachers in their schools (Vale et al., 2010). Leaders with effective knowledge on mathematics teaching can also mentor teachers in their schools and support the practices of professional learning teams within their schools.

Another study also presented a framework of how to support principals as instructional leaders in the mathematics subject (Abdullah et al., 2018; Boston et al., 2017; McNeill et al., 2018; Qadach et al., 2020). The researchers used design research to engage principals in professional development. Besides, they assessed the ability of the principals to identify aspects of high-quality mathematical tasks and instruction through classroom video analyses and pre-post task sort analyses (Boston et al., 2017). The studies found major differences between the principals' ability to identify high-quality mathematics tasks and instruction. They also found differences in the principles' ability to identify students' thinking and teachers' actions. Additional data used by the researchers also identified changes in the feedback of principals to mathematics teachers (Abdullah et al., 2018; McNeill et al., 2018; Qadach et al., 2020). Based on these findings, the researchers hypothesize the conditions needed to support principals as instructional leaders in certain content areas.

Leadership support has also been examined from a systematic review perspective. The authors resorted to analyzing the link between pedagogical leadership and mathematics achievement (García-Martínez et al., 2018). The systematic review was inspired by the fact that many studies have been developed on pedagogical leadership and its role in educational improvement. However, only a few of these studies have focused solely on the mathematics subject (García-Martínez et al., 2018). The authors, therefore, highlighted the significance of school leadership and mathematics education and provided empirical evidence on the positive relationship between these two elements. One advantage of this study is that the authors followed guidelines instituted in the PRISMA declaration to guarantee its systematicity (García-Martínez et al., 2018). The PRISMA declaration is a guide consisting of 27 items, used for reporting systematic reviews. It is a road map that helps researchers best describe what was done and what was found (Sarkis-Onofre et al., 2021). The findings of the study revealed a positive link between leadership and teacher professionalism, teaching and learning, and student performance.

Personally, I believe that the actions of leaders and those of teachers are important in teaching mathematics effectively. Leaders can support teachers in developing knowledge that meets the students' needs. Besides, leaders of mathematics should go beyond the formal positions of school principles.

2.17 Teaching practice

Good teaching practice has a major impact on student learning. In most cases, teachers attempt to meet the principles of good practice to provide their students with the best learning experience (Aglazor, 2017). Some earlier and recent studies found that teacher-directed practices contributed to greater student math achievement (Baker et al., 2002; Rittle-Johnson, 2006). Baker et al. (2002) synthesized research on the effects of interventions meant to enhance mathematics achievement among students considered being low achieving or at risk for failure. The outcome of the study revealed that different interventions contributed to improvements in the mathematics achievement of learners experiencing difficulty. The study identified some explicit teacher-led and contextualized teacher-facilitated approaches that contribute to student learning. One of the teaching practices involves direct instruction, which entails teaching rules, principles, concepts, and problem-solving strategies unequivocally. Teachers who engage in direct teaching provide various examples of the principle or concept. Teaching practice that involved explicit instruction had a positive and moderately strong effect on the mathematics achievement of students considered to be at risk. Another teaching practice discussed by Baker et al. (2002) entails the use of contextualized instruction. A feature of this approach is for some or all of the instruction to stress real-world applications and focus on understanding the basic concepts of authentic problems. A teaching approach that emphasizes concept development is critical to mathematics success and leads to a deeper understanding of mathematics and computational proficiency (Baker et al., 2002). In summary, the study furthers an understanding of how teaching practice focused on concept development compares to other approaches fundamental in ensuring students' success in the mathematics subject.

Another past study focused on the effect of direct instruction in promoting transfer of knowledge (Rittle-Johnson, 2006). The study sample comprised third- through fifth-grade children aged between 8 and 11 years. The students learned about mathematical equivalence under varying conditions (Rittle-Johnson, 2006). Teaching practice involving the use of self-explanation and instruction helped the students learn and remember correct procedures.

Besides, self-explanation encouraged transfer of knowledge regardless of the conditions of instruction (Rittle-Johnson, 2006).

Some researchers have explored teaching practice from a student-centered perspective (Corkin et al., 2019). At its core, student-centered teaching enables an active learning environment that allows students to interact with each other and link new ideas with existing knowledge. Methods of pedagogy aligned with student-centered teaching encourage student understanding and rigor in mathematics content (Corkin et al., 2019). A student-centered approach facilitated better understanding and performance in mathematics.

As clear above, many studies have examined the relationship between different teaching practices and student achievement. However, uncertainty remains over the practices that teachers should use. Teaching practice could either be teacher-directed or student-centered (Clements et al., 2013). Teacher-directed instruction primarily involves the teacher communicating the mathematics to the learners directly, and most of the interactions about the lesson are between the teacher and the student (Clements et al., 2013). Quite the reverse, student-centered instruction mostly involves the students doing the teaching of mathematics, and most of the interactions happen between and among the students (Clements et al., 2013). Some studies suggested that teacher-directed practices resulted in greater student math achievement (Baker et al., 2002; Rittle-Johnson, 2006), while others found that student-centered approaches were more effective (Corkin et al., 2019). The differences in the outcome of these studies could be because of key differences across the studies, including differences in the particular teacher-directed and student-centered practices evaluated.

Teaching practice characteristics matter in ensuring student achievement in mathematics. In my view, teaching practice is the most significant school-related factor influencing student achievement. The approach to pedagogy seems to contribute to teacher effectiveness at all grade levels, especially when supported by suitable content.

2.18 Teaching activities

Teaching activities are critical for improving student learning in the mathematics subject. In essence, the achievement of students is related to the resources available for teaching. Teaching activities facilitate the learning of abstract concepts and ideas and deters rote learning (Akiba & Liang, 2016). For instance, Akiba and Liang (2016) reviewed six types of teacher professional learning activities and their impact on student achievement. The authors used longitudinal survey data got from 467 middle school mathematics teachers in 91 schools. The data was merged with that of 11,192 middle school students' mathematics scores collected from a standardized assessment in Missouri (Akiba & Liang, 2016). An analysis of the data revealed that teacher-centered collaborative activities designed to teach mathematics were more effective in improving student mathematics achievement. Examples of such activities included teacher collaboration and informal communication (Akiba & Liang, 2016). Teacher—driven research activities presented through professional conferences were also found to be linked with student achievement and growth in mathematics (Akiba & Liang, 2016). From this study, schools should invest their professional development funds and resources in supporting teacher-centered collaborative and research-based learning activities to improve student learning.

Recently, teaching activities have grown to incorporate computer-based tools and resources. It has been claimed that these digital resources replicate the functionality of traditional tools with increased efficiency (Pepin et al., 2017). These tools also make it possible for learners to interact in various forms based on instantaneous feedback resulting from their actions (Pepin et al., 2017). This is echoed in a study that sought to examine the use of computer-based tools and resources to support the teaching and learning of mathematics (Ruthven & Hennessy, 2002). Data was collected through group interviews with mathematics departments in seven secondary schools. The authors form a pedagogical model capable of guiding the use of technology in the classroom (Ruthven & Hennessy, 2002). However, another recent study showed concern over the quality of technological resources used by mathematics teachers (Trgalová & Jahn, 2013). The increasing number of teaching resources available over the internet makes their quality more pressing. Teachers experience difficulties choosing from those that would be suitable for their educational goal and context. Because of these challenges, (Trgalová & Jahn, 2013) recommend developing skills to evaluate teaching activities to find out their potential impact on student achievement. The findings of these studies suggest digital resources used in teaching are likely to influence instructional activity and interaction between teachers and students.

A report published by the International Bureau of Education sought to examine ways to improve student achievement in mathematics (Grouws & Cebulla, n.d.). According to the report, the strongest possibility of enhancing student learning emerged where schools implemented various changes in the teaching and learning activities shaping the daily life of the student. For instance, schools concerned with improving the scientific problem-solving skills of their students can introduce teacher training programs in three domains: application of a learning cycle domain, utilization of computer simulations, and application of systemic methods to solving problems (Grouws & Cebulla, n.d.). Planning for the training of these changes would be no small mission, but would hold a great promise for enhancing student problem-solving (Grouws & Cebulla, n.d.). As teachers seek to enhance their teaching effectiveness by changing their instructional activities, they should consider the teaching context and give special consideration to the students they teach.

Teaching activities are valuable as supporting tools in the learning of mathematics. They give students the flexibility to access files and materials informally without the supervision of an instructor. Teachers need to know about curriculum activities in mathematics which allow students to explore ideas, acquire and integrate information, and frame and solve problems. Indeed, teaching activities can help structure interactions among students, facilitate collaboration with other teachers, and help shape sympathetic experiences at school and at home.

2.19 Conclusion

The purpose of this literature review was to discuss the view of authors concerning some of the teacher - factors that influence student achievement as understood by the authors of TIMSS (Mullis et al., 2020). It is clear from the literature review that any form of teacher professional development can benefit students by improving their performance in mathematics. Some studies showed that professional development programs can be a useful strategy to enhance the content knowledge and practice of mathematics teachers, while others provided evidence that smaller mathematics classes contribute to much better student performance compared to larger ones.

It was also evident from the literature review that working conditions influence teacher satisfaction, which influences the performance of students in mathematics. Other findings from the review are as follows: the use of technology in the classroom had a positive effect on the success of students and improved their attitude towards mathematics lessons. It was not clear which type of assessment was best in enhancing student performance. There was a significantly negative correlation between emotional exhaustion among teachers and student's achievement in mathematics. The use of non-specialist teachers was shown to impede student achievement. The use of computers in the classroom benefited student's learning and achievement, while completion of homework had a positive impact on student academic achievement.

Chapter 3 Comparison of Saudi Arabia & Singapore

3.1 Introduction

Mathematics has been part of the education system in the Kingdom of Saudi Arabia since the early Qur'anic Schools that taught learners how to recite the Qur'an and a few arithmetic skills. The first education system was later developed in 1952, making mathematics a mandatory subject in all the phases of education (Alsharif, 2011). Since then, policymakers in Saudi Arabia have launched national initiatives targeting mathematics education to improve its teaching and learning. Most of these initiatives were inspired by the findings of various studies and reports highlighting the significance of improving the quality of teaching and learning in schools (Alsharif, 2011). Besides, the low performance in international exams, such as Trends in International Mathematics and Science Study (TIMSS) by Saudi students has consistently contributed to a rethink about mathematics learning and teaching methods in schools (*TIMSS 2003 Technical Report*, 2004; *TIMSS 2007 Technical Report*, 2008). This literature review examines some of the strategies used to teach mathematics in KSA and compares them to the established standards in the Singaporean education system. The paper is organized as follows. The first section discusses the strategies used to teach mathematics in KSA. The second section compares the strategies in KSA with the established standards in the Singaporean Education System. Singapore was selected for comparison due to the high performance of students in the country on international assessments. The curriculum, teachers, learners, and the learning environment are believed to contribute towards Singapore's best performance in international benchmark studies, such as PISA and TIMSS (Lindorff et al., 2019). The last section compares mathematics success in KSA and Singapore.

3.2 Strategies Used to Teach Mathematics in KSA

The teaching of mathematics in Saudi Arabia is mostly dependent on lecture-style transmission and memorization. These teaching styles emphasize the role of the educator, where the teacher delivers information, explains content, and asks the learners comprehension questions (Alhaidari, 2006; Almulla, 2016; Alshehri, 2014). Teachers present mathematical concepts in a direct manner without connecting to other concepts or illustrating how such concepts really work (Alhaidari, 2006). With this strategy, students become aware of how to imitate but do not understand the reasoning behind it. In the classroom, the learners mostly work independently and competitively in order to earn rewards (Alhaidari, 2006; Almulla, 2016). However, many recent research studies have argued that these types of teaching methods and theories are no longer adequate to prepare learners to encounter the challenges and the changes of an international society (Alhaidari, 2006). The traditional method is not conducive to shaping mathematical thinking to handle varying challenges using different methods in changing contexts.

A recent study by Alzahrani (2017a) used a case study class from a secondary school in Saudi Arabia to evaluate strategies used to teach mathematics. The author collected data and compared traditional methods of teaching to metacognitive mathematics instruction in KSA. The findings of the study show an inclination to rely on linking a presented solution to the ones encountered earlier (Alzahrani, 2017b). Because of this approach, students seem to lack focus when required to engage in thought monitoring or adjustment and prefer to link current to past solutions. The connection created by the learners cannot be described as reflective or metacognitive. Instead, it can be viewed as an aspect of rote learning and imitation (Abir, 2013; Alzahrani, 2017b). Teachers focus more on the steps needed to solve problems directly instead of the thought methods involved in that process. While describing this teaching strategy, Abir (2013, p.17) observed that "Possibly more serious is the poor quality of the Saudi educational system itself. Two major reasons for this are the low standard of foreign teachers and the Egyptian model followed by Saudis: this is based on rote-learning, recitation, and 'cramming'." Due to this approach, the relationship between the teacher and the student is neither participatory nor constructive but one where monitoring error is a normal process. The teacher serves as the central point of the learning process, but his role in the mathematics class does not extend beyond the delivery of information (Alzahrani, 2017b). Academic content is lacking in mathematics classes, and teaching and learning are merely focused on passing exams instead of encouraging learners to develop deep understanding (Alhareth & Dighrir, 2014). Consequently, this approach to teaching mathematics hinders the manifestation of metacognition.

During the teaching process, teachers depend heavily on the provided resources to plan their lessons, more so textbooks. This is an important reason why the intended curriculum does not widely reflect in the implemented curriculum (Albedaiwi, 2014; OECD iLibrary, 2021). Even though textbooks are a critical teaching resource in a majority of education systems, a distinguishing factor in Saudi Arabia is the extent to which the teachers rely on them to structure their lessons (Albedaiwi, 2014). Mathematics teaching instructions regularly follow the textbook from cover to cover, and teachers exercise little or no discretion concerning the learning material that needs to be repeated or adjusted in response to the needs of the learners.

There are many factors that explain the heavy reliance of teachers on textbooks. One of them is the very weak pedagogical knowledge and skills of most teachers and the limited understanding of the general learning standards and objectives that must be achieved (Albedaiwi, 2014; OECD iLibrary, 2021). Teacher dependence on mathematics and other subjects' textbooks is further reinforced by supervisors' reliance on the textbook and lesson unit outcomes to assess teacher compliance and students learning. A policy developed by the MoE expects teachers to adhere to the units in the prescribed mathematics textbooks exactly as arranged, even in circumstances where such an approach could have a negative impact on the students (Albedaiwi, 2014). The MoE argues that textbooks provide some sort of security to learner. That means that in a standard mathematics class in a public school in KSA, teachers use textbooks as the only teaching source. It is forbidden to change, alter, add, edit, or join any other textbook apart from the one provided by the Ministry of Education (Albedaiwi, 2014; OECD iLibrary, 2021). It is often difficult for teachers to provide supplementary materials to learners since they are obliged to follow the textbook closely. What is more, mathematics and other subjects' teachers are required to follow the timeframe provided by the MoE and appended to the teacher coursework planning (Albedaiwi, 2014). Hence, teachers have no room to integrate additional content in the teaching process in Saudi Arabia.

Textbooks in Saudi Arabia have three components. The first is the teacher's guide with steps and recommendations that teachers should follow to help them with the application of teaching methods (Albedaiwi, 2014). The second component is the student's book which has the actual lessons and the materials that the learners need to grasp. The last component is the student workbook, which learners use to complete part of their homework (Albedaiwi, 2014). The implication of the MoE policy concerning the use of textbooks in general is that this practice leads to ignorance among learners. Besides, most teachers are unable to recognize personal weakness and abilities in learning the mathematics subject.

Besides, the traditional methods fail to teach learners the skills necessary for the contemporary labour market (Alhaidari, 2006; Almulla, 2016). Due to these inadequacies, educators in Saudi Arabia have been promoting new ideas and concepts in the field of education affiliated with knowledge and key skills students need to learn (Almulla, 2016). Recommendations resulting from the 2007 TIMSS report indicated that students in Saudi Arabia must develop the strategic competence and adaptive reasoning to allow them to handle non-routine mathematics problems, such as those examined on the TIMSS tests (Alsaeed, 2012). Another recommendation from the report is that students need to experience problem-solving skills in mathematics which can be applied to new situations and problems. Additionally, teachers must be able to help learners take part in various mathematical processes

(Alsaeed, 2012). Teaching strategies should be adapted to help learners engage in mathematical activities that would help them work through and adapt to new mathematical situations.

Despite these efforts to improve teaching and learning, classroom practices in Saudi Arabia are still very traditional. For the new ideas to take root, the kingdom has consistently been re-evaluating its teacher training and education programs (OECD iLibrary, 2021). Saudi Arabia's curriculum has constantly been renewed and additional training initiatives incorporated to support teacher's adoption of modern pedagogies (OECD iLibrary, 2021). Most of these initiatives have been accompanied by the development of new materials and provision of appropriate support that is useful in helping teachers in the Kingdom take up the new teaching methods. A decent example is the Math and Science Blended Professional Development Programme that encourages teachers to provide student-centred instruction (OECD iLibrary, 2021). Another example is the use of peer tutoring to teach mathematics in KSA. This instructional approach allows students to help each other during learning activities (Alegre et al., 2019). A professional researcher or practitioner supervises students as they learn from and with each other in a structured manner (Topping et al., 2013). This technique is believed to foster collaboration from a broad perspective and is seen as unconventional to basic unidirectional teaching. Besides, many past studies highlight the academic benefits of peer tutoring in mathematics (Abed & Shackelford, 2020; Ke & Grabowski, 2007). However, these new practices are yet to be embraced fully in the teaching of mathematics in Saudi Arabia.

In a recent study by Alhareth and Dighrir (2014), the researchers observed the occasional use of cooperative learning strategies while teaching mathematics in KSA. In cooperative learning, learners work together in small heterogeneous groups to complete common goals. Teachers divide students into groups consisting of 2-5 members and provide them with instructions and precise guidelines on the goals that should be achieved (Alhareth & Dighrir, 2014). The cooperative learning strategy has been found to increase the achievement and productivity of learners compared to competitive and individual work. The students act as sources of learning from each other, and the performance of an individual member relies heavily on the other members of the group (Johnson & Johnson, 1992). Cooperative learning has proven useful in situations where a class has many students, making it difficult for the teacher to address student problems on a personal level (Alhareth & Dighrir, 2014). Teachers overcome this challenge by identifying where most students have common challenges and deal with them through discussions in the classroom. Teachers also encourage learners to discuss freely amongst themselves and consult whenever necessary (Alhareth & Dighrir, 2014).

Mathematics teachers also apply this principle at the intermediary level to encourage active participation (Alhareth & Dighrir, 2014). Gaining mathematical knowledge and skills at the intermediary level entails repetitive trials and feedbacks to guarantee continuous learning.

Studies have also simulated the potential benefits of shifting from the traditional to metacognition teaching strategies in mathematics classrooms in Saudi Arabia (Alzahrani, 2017b; Desoete & De Craene, 2019; N. H. Lee et al., 2019; Susilo et al., 2019). Alzahrani (2017a) tested the possibility of such a modern teaching strategy by implementing the IMPROVE programme among secondary school students in Saudi Arabia. The primary components of the IMPROVE programme were based on strategy acquisition, metacognitive processes, and feedback-corrective enrichment for lower as well as higher cognitive procedures (Alzahrani, 2017a; Desoete & De Craene, 2019; N. H. Lee et al., 2019). Some of the skills that could be relevant in implementing such a strategy in Saudi Arabia include discipline to timing, management of activities, group distribution, mathematics problem solving, presentation of concepts, and correction of errors made by learners (Alzahrani, 2017a). Such an approach can also allow teachers to excel at communicating with students concerning class issues and maintaining a unique level of openness to their suggestions. In sum, the study findings showed that cooperative learning could be crucial in creating a suitable environment for learning through metacognition (Alzahrani, 2017a; Desoete & De Craene, 2019; N. H. Lee et al., 2019; Susilo et al., 2019). This approach would enhance the student's ability to monitor and evaluate each other's method of thinking at close proximities in the mathematics classroom.

Despite the efforts put in place to modernize the teaching strategies in Saudi Arabia, there is consensus that these strategies have not yet resulted in significant change in instructional practices in many of the classrooms (OECD iLibrary, 2021). Recent research shows that in most schools, teaching and learning of mathematics and other subjects is still focused on remembering facts to pass tests instead of developing deep learning. The primary characteristic of pedagogy entails teacher-led lectures with learners taking notes (OECD iLibrary, 2021). The teaching approach does not systematically encourage learners to be critical neither does it promote reflection.

3.3 Comparison with Established Standards in the Singaporean Education System

Singapore is a comparatively young nation that enforced mandatory education for children of primary school age in 2000. Since the implementation of a novel education system in the country, English has been the medium of instruction and mathematics has over time been taught in English (Ho, 2008; P. Y. Lee, 2008). Mathematics has been taught in Singapore for only sixty years, a time during which its curriculum has undergone a lot of development and changes. The country's leadership has been at the forefront in controlling mathematics education, regarding what, why, who, whom, and how to teach (Ho, 2008; P. Y. Lee, 2008). Established standards in the Singaporean education system have also been influenced by the experience of teachers, the social context of debates concerning the content and style of the curriculum, and the expectations of parents and employers (Ho, 2008; P. Y. Lee, 2008). Due to these factors, mathematics teaching in Singapore stands out as a threshold for other countries to compare. What follows is a comparison of the strategies used to teach mathematics in KSA with the established standards in the Singaporean education system.

Similar to Saudi Arabia, the approach to teaching primary mathematics in Singapore is determined using a textbook. However, the textbooks in Singapore are designed to build a deep understanding of mathematical concepts (Ginsburg et al., 2005). The contents of the books often feature multistep problems and concrete illustrations that show how abstract mathematical concepts can be used to solve problems from varying perspectives (Fan et al., 2018). The traditional KSA mathematics textbooks seldom get beyond definitions and formulas. The contents of these books only focus on developing student's mechanical ability to apply the taught mathematical concepts (OECD iLibrary, 2021). A clear-cut difference exists in how Singapore and traditional KSA textbooks prepare mathematical concepts. The textbooks in Singapore consist of a lot of mathematical problems, yet the traditional texts in KSA rarely go beyond teaching students the mechanics of mathematics and place a lot of emphasis on the application of definitions and formulas to regular problems (Alabdulaziz & Higgins, 2021; Fan et al., 2018). Texts in Saudi Arabia seem to mostly show learners that mathematics concepts have representations in the real world. As such, the illustrations virtually play no significant role in helping learners understand how to use mathematics to handle real-world issues (OECD iLibrary, 2021). Quite the reverse, the mathematics textbooks in Singapore have a lot of concrete illustrations. The texts are designed to help the many students who experience difficulties grasping abstract mathematical concepts to benefit from visual representations of mathematical ideas (Madani & Forawi, 2019). Hence, the illustrations in Singapore mathematics texts show learners how to graphically decompose, represent, as well as solve difficult multistep problems.

Apart from textbooks, teachers in Singapore use the internet as a rich source for mathematics lessons. On regular occasions, teachers use suitable webpages and applets to demonstrate proofs to their learners (Kaur, 2004; Tay et al., 2012). They may use such a technology to demonstrate concepts such as Pythagoras Theorem or to visualize displacement and velocity graphs. Besides, some mathematics teachers in Singapore also use more advanced tools, such as Computer Algebra Systems to facilitate the teaching process (Kaur, 2004; Tay et al., 2012). Most of the schools have also started using Learning Management Systems for Mathematics, which allow the engagement of learners in online mathematics learning (Kaur, 2004). This trend in Singapore is unlike in KSA where teachers must strictly follow the textbooks recommended by the MoE while teaching. Deviations and use of additional resources such as the internet is currently not allowed in KSA.

The Singaporean system places a lot of emphasis on the mastery of instruction (Fong & Kaur, 2015; Lindorff et al., 2019). Stated otherwise, the mathematics teaching strategy in Singapore focuses on making sure each student develops an understanding of certain concepts before moving to the next, in contrast to prioritizing content coverage (which basically characterizes the curricula in KSA) (Fong & Kaur, 2015; Lindorff et al., 2019). The approach used in Singapore is based on the *Model of School Learning* which conceptualizes aptitude based on the time taken and needed to learn, thereby categorizing students as either "fast" or "slow" learners (Fong & Kaur, 2015; Lindorff et al., 2019). The intent of mathematics instruction in Singapore is to encourage the acquisition of knowledge in a wide range of topics and to encourage the development of thinking and reasoning skills (Fong & Kaur, 2015). Thus, teachers ensure that their teaching approach in mathematics reflects the goals of instruction set by the curriculum – measure the proficiency of students in solving mathematics problems, reason mathematically, and communicate arithmetically.

The mastery approach used to teach mathematics in Singapore vary somewhat but share certain characteristics. The whole class moves at a generally similar pace through a mathematics curriculum that is not too content heavy (Boyd & Ash, 2018b). Most lessons start with a whole class engagement with a contextualized problem. Learners engage in the use of collaborative work, which often includes the use of concrete materials, manipulatives, as well as dialogue around potential solutions (Boyd & Ash, 2018b). The approach tends to avoid in-class grouping and differentiation by task, both of which have been used widely in Saudi Arabia. Tasks carried out in the classrooms are determined cautiously, and there is an emphasis on mathematical variation and connections (Boyd & Ash, 2018b). This strategy is based on early thinking on mastery learning which assumes that almost all students can learn most of what they are taught when exposed to certain instructional conditions (Boyd & Ash, 2018b).

That means that teachers in Singapore ensure that all learners progress in their knowledge and understanding by establishing the appropriate conditions for learning.

Established standards in the Singaporean education system are also centred on problem-solving and developing the classroom environment to promote collaborative talk, often referred to as cooperative learning. This strategy aligns with a heterogeneous grouping of learners to provide an opportunity for peer support (Boyd & Ash, 2018a). A focus on verbal reasoning and classroom dialogue is one of the approaches used to develop the classroom environment in Singapore. The teachers promote the development of confidence and skills by talking about mathematics problems. The emphasis on dialogue shows that the teachers are creating a different learning environment in their mathematics lessons (Boyd & Ash, 2018a). Teachers are at liberty to use different approaches to put the children into pairs during the lessons. Some teachers use randomly select 'talking partners' and change them constantly, while others group the learners in pairs intentionally to have different previous attainment in mathematics. Teachers can also pair learners depending on how well they cooperate together (Boyd & Ash, 2018a). Additionally, zoning could be used to have clusters of learners in certain areas of the classroom where one child in each pair has special learning needs or is regarded to have a particularly high level of previous attainment.

Unlike the rote-learning approach utilized in mathematics classrooms in Saudi Arabia, the Singaporean Education system heavily relies on a framework – concepts, metacognition, attitudes, skills, and processes (Gopinathan, 1999; Kaur, 2004; S.-S. Lee et al., 2016). Concepts are the basic knowledge required to solve mathematical problems, such as numerical, algebraic, geometrical, and statistical concepts. Skills denote the topic-related manipulative skills that learners are expected to use when solving problems (Kaur, 2004). Examples of relevant skills encouraged by teachers in Singapore include estimation and approximation, communication, arithmetic manipulation, use of mathematical tools, and handling of data, among others (Gopinathan, 1999; S.-S. Lee et al., 2016). The teaching of mathematics is also dependent on processes, which are the thinking skills and heuristics. Learners engage in activities that allow them to classify, compare, and identify attributes and components. Besides, they get to use diagrams and models, check out for patterns, work backwards, make suppositions, and simplify and solve part of the problem (Kaur, 2009; Menon, 2000). The Singaporean education system also focuses on developing the affective components of mathematics learning among the learners. Students get to enjoy doing mathematics, show confidence in using mathematics, persevere while working on mathematics problems, and appreciate the beauty and power of mathematics (Kaur, 2004). Teachers also focus on establishing metacognition skills, which require the learners to control their thinking processes while solving problems. To facilitate the achievement of metacognition skills, student must constantly and consciously monitor the strategies and thinking processes used to carry out mathematical tasks (Kaur, 2004, 2009; Menon, 2000). Besides, they must consider seeking alternative approaches of carrying out a task or be interested in checking the suitability and reasonableness of answers to mathematical problems. Figure 3.1 shows an illustration of the primary components of the mathematics framework used in Singapore.

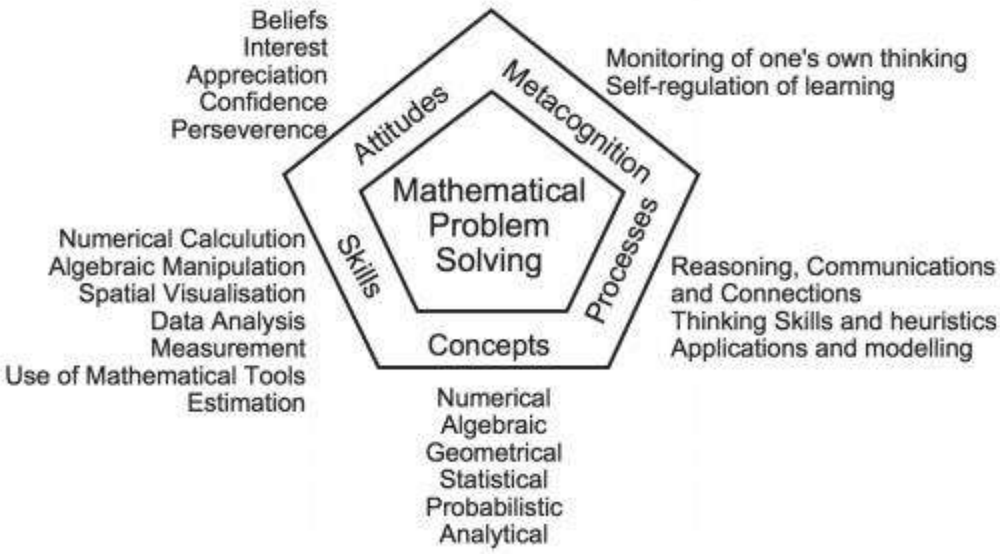

Figure 3-1 The Singapore Mathematics Framework (Ginsburg et al., 2005)

The components of the mathematics teaching framework in Singapore are logical and uniform and develop topics in-depth at every grade (Ginsburg et al., 2005). The KSA system, on the contrary, has no official national framework. Singapore’s framework for teaching mathematics establishes a balanced set of mathematical priorities that emphasize on the development of computational skills together with more conceptual and strategic thinking processes (Ginsburg et al., 2005). It encapsulates very few topics in-depth that are carefully sequences based on grade. The system of teaching mathematics is also designed in a spiral manner, where topics taught at one grade are covered once more at an advanced level in the later grades (Ginsburg et al., 2005). Teachers expect learners to master previous content related to a topic, rather than repeat it.

The Singaporean education system understands that some learners may encounter difficulties in mathematics and provides them with an alternative framework to follow. In KSA, such provisions do not exist. The alternative mathematics framework in Singapore covers all the mathematics topics included as part of the regular framework (Ginsburg et al., 2005). However, it does so at a much-reduced pace and with a lot of repetition to ensure the learners grasp the required concepts. This system also provides slower students with additional help from teachers that undergo exclusive training (Ginsburg et al., 2005). In KSA, slower mathematics students do not enjoy such a benefit. Besides, the traditional system in place rarely tracks learners that grasp mathematical concepts at a slower pace. Consequently, learners are rarely taught all the needed mathematics materials in the KSA mathematics teaching approach. Where students need additional help, they often receive it from teacher's aides with no college degrees or appropriate experience.

3.4 Mathematics Success – KSA vs. Singapore

Owing to the differences in the strategies used to teach mathematics, it is imperative to compare the subject's success in KSA and Singapore. Singapore's learners have consistently performed outstandingly in all mathematics areas, scoring at or near the top in all TIMSS mathematics content areas – fractions and number sense; measurement; data representation, analysis, and probability; algebra; and geometry. A comparison of students' achievement at 4th Grade in 2007 ranked Singapore 2nd with an average score of 599. Saudi Arabia did not participate in the ranking during this year. In 2019, Singapore ranked 1st with an average score of 625, while KSA ranked 53rd with an average score of 398. The implication of this is that KSA students scored significantly lower in all the content areas (table 3.1).

Table 3-1 TIMSS Comparison Between Singapore and Saudi Arabia

Year	2007		2011		2015		2019	
Intranational Average score	500		500		500		500	
Number of Country	59		50		49		58	
Grade	Grade 4		Grade 4		Grade 4		Grade 4	
	Rank	**Average Score**	**Rank**	**Average Score**	**Rank**	**Average Score**	**Rank**	**Average Score**
Singapore	2	599	1	606	1	618	1	625
Saudi Arabia	Did not participate	Did not participate	45	410	46	383	53	398

3.5 Conclusion

The mathematics teaching strategies used in Saudi Arabia mostly rely on lecture style transmission and memorization. The recommended teaching approach supports the role of the educator, and the teacher is expected to deliver information, explain content, and ask learners comprehension questions. Quite the reverse, Singapore's mathematics teaching approach offers a highly logical approach to setting priority and content areas across different grades. Singapore's approach to teaching balances the conceptual, computational, as well as strategic problem-solving skills. Teachers precisely specify mathematical topics and outcomes, and content is organized across grades in a spiral approach that limits repetition of topics. Compared with the traditional approach used in Saudi Arabia, Singapore's special emphasis on multistep word problems is consistent with its desire to promote conceptual understanding among its learners. Besides, Singapore also provides a special framework for slow learners that is supported by policies that allow these students to receive help from expert teachers. The established standards of teaching in the Singaporean education system could prove useful in implementing future reforms in Saudi Arabia. The Ministry of Education in KSA should, therefore, consider strengthening features of its mathematics system to closely resemble the integrated national mathematics teaching system in Singapore.

Chapter 4 Pilot Study

4.1 INTRODUCTION

The Arab region has been in the spotlight for coming out near the bottom in international comparisons of student's abilities in mathematics and science. Saudi Arabia, among related nations, has often been ranked in the bottom one-third for many years (Bollag, 2019). This is so despite the country having an education system designed to prepare students to meet the demanding requirements of the 21st century.

The results augur poorly for the prospects of developing a strongly educated citizenry, inured to thinking critically to improve the economy and solidify civil society and democratic governance within the region. Because of these poor mathematics scores, a study was conceived to identify the impact of international assessments on mathematics teacher development in the Kingdom of Saudi Arabia (KSA).

The pilot study of the current research was the first step in understanding why the Kingdom of Saudi Arabia recorded poor results in TIMSS tests from 2003 to 2015. However, it was also the last step of the first groups of steps of preparing for this study. This chapter covers the aim of the pilot study in general – what the researcher anticipates from the pilot study. This is followed by a discussion of how the pilot study was applied in the current research. The chapter will also discuss the outcomes of the pilot study briefly, since they have a direct impact on the actual study. For starters, the study defines a pilot study and states its value after the introduction to clarify why it is needed in the research process.

Based on the above aim, the specific objectives of the pilot phase of the study were as follows:

1. To gain an in-depth understanding of the factors contributing to low TIMSS scores in mathematics in KSA.
2. To use the collected information to examine how TIMSS scores can be used to enhance teaching recommendations in the mathematics subject in KSA.
3. To use the obtained information to identify strategies that can be used to teach mathematics in KSA and compare them to the established standards, such as those in Singapore.
4. To develop instruments that can be used to measure the key variables of the study.

5. To put the different instruments of data collection under a pilot test.

Preliminary hypothesis was developed based on the literature review of past scholarly research. These hypotheses were refined based on the information and the insight gained during the pilot phase. The revised hypotheses are discussed in the results section of this paper. These hypotheses were subsequently tested on a representative sample of teachers from Saudi Arabia during the data collection phase described in the methodology section.

4.2 METHODOLOGY

A pilot study is a smaller kind of full-scale study, otherwise referred to as a trial run done in anticipation of the actual study. Most times, this kind of study is often referred to as a ‘feasibility’ study (Ruel et al., 2015). Part of the process of a pilot study involves pre-testing the instruments of research, including the survey and the questionnaire in the case of this study. This pilot study was, therefore, conducted after the researcher developed a clear vision of the research topic and research questions, the techniques and methods, and the research schedule. The pilot presented an opportunity to try out all the research techniques and methods that the researcher had in mind to find out if they will work in practice.

The value of the pilot study in the current research cannot be overestimated. The study was essential to avoid the waste of time and resources. It was needed to uncover potential flaws in measurement procedures and to operationalise the study variables. This was applicable to the actual study since the researcher used two varying measurement procedures with the study participants to collect information and do a pre and post-test. This helped clear out practical challenges, such as duplication of information to teachers and the time consumed in the data collection process.

Through the pilot study, it was possible to identify unclear or ambiguous items in the survey and questionnaire. Even though the study did not use self-designed questionnaires for the tests, piloting of the research instruments was necessary. The items of the questionnaire were read to the study participants. It was important to pilot this action to eliminate unclear items, determine time limits, and enhance the clarity of the instructions.

The researcher used the pilot study to decipher the non-verbal behavior of the study participants. This behavior gave key information about any potential issues arising from the content or the wording of the items presented in the questionnaire. The reaction of the teachers to the questions was noted during the administration of the survey.

The pilot study was the first phase of the research procedure after the literature study. The pilot study in the current research can be defined mostly as a try-out of research practices and methods, but also of the survey and questionnaire. The study took place in a setting that was convenient for the researcher, and one that resembled the one used during the actual study.

The researcher compiled a survey administered through Google to 46 teachers. The survey targeted teachers located in the Kingdom of Saudi Arabia. KSA was selected since in many respects its characteristics would be similar to those needed in the actual study. During the recruitment process, the researchers targeted teachers teaching grade 4. The procedures used to select the study participants were based on convenience, but the researcher took care to ensure the participants were selected appropriately to stand for the different dimensions that are key to the study in regard to age, gender, qualifications, professional experience, as well as geographical location.

A number of techniques were used during the pilot phase to develop a solid understanding of the perception of teachers and their experience teaching mathematics. This included administering surveys to key informants, reviewing studies along with key policy and training documents on mathematics teacher development in Saudi Arabia, and conducting a few questionnaires with the teachers. The survey and questionnaire yielded key background and contextual information concerning the progress made in mathematics development, key policy decisions, and the perception that teachers have about mathematics development in Saudi Arabia. The participants were informed from the beginning that the purpose of the survey was to gain a solid understanding of the reality of mathematics development in Saudi Arabia. They were also assured that the information provided would be confidential and that they were at the liberty to discuss personal experiences. The survey started with the question: “Do you teach Math or Science?” The following questions sort to identify the age range, teaching experience, highest qualification, the number of students per classroom, and the amount of time spend by teachers in the classroom. A guide was developed that influenced the subsequent questions, and an illustration of this survey is presented in the appendix section. More specifically, the survey sought to illustrate the perspectives of the teachers regarding the deficient performance of Saudi Arabian schools in the mathematics subject in the past years. The survey featured 25 questions that were divided into three parts – general questions, classroom experience, and causes and recommendations.

Even though the study was more interested in collecting primary data, it was essential to collect a lot of secondary data in the pilot stage of the research process. The researcher relied mostly on reports and journal articles detailing key policies, projects, research studies, teaching techniques, and procedures in the area of mathematics teacher development. These sources of information can be found in the bibliography of the study and are cited in the literature review section, among other parts. As part of secondary data collection, the researcher conducted a detailed analysis of the materials used to teach mathematics in Saudi Arabia. This review helped understand key knowledge, skills, and abilities that mathematics teachers are required to transmit to their students. The bibliography contains references to these documents as well. Even though not utilized in this study directly, this information can be used to develop a profile of best/ ideal practices that teachers can use when addressing challenges in mathematics learning in their classrooms.

The collected data was presented in frequencies and percentages and later analysed through inferential statistics. Inferential tests were used to find significant differences and relationships between pairs of variables represented in the survey. Significance level was determined at an alpha of 0.05. Significant tests were those with p-values less than or equal to 0.05.

4.3 Result

4.3.1 Descriptive Analysis

In this section, descriptive statistics are calculated and reported for all the survey questions, including demographic variables and constructs measuring TIMSS scores in mathematics. Demographics information include Teaching Subject, Age Group, Years of Experience, Highest Qualification, Number of Students in the Classroom, Teaching Hours per Week, and Specialty. Demographic information is presented and summarized in Table 1 by frequency and percentages. The sample proportions are graphically presented by pie and bar charts. Questionnaire responses are also summarized and presented as frequencies, percentages, means, and standard deviations, and graphically presented by bar charts.

4.3.2 Demographic Information

Descriptive analysis of demographic variables revealed that most respondents 76% teach mathematics, while 24% of them teach science. The sample seems young as most respondents, 89% are less than 40 years old. Respondents seem to have extensive experience; the majority, 63% have more than 10 years of experience. The sample is also well educated, as most respondents, 78% hold bachelor's degrees, in addition to 13% who hold master's degree.

Regarding a number of students those respondents teach in a class, the majority, 61% teach between 26 and 35 students, while 22% teach between 15 and 25 students in a class. More than half of the sample, 57% use more than 10 teaching hours. Finally, the majority, 72% stated that they are specialists in mathematics.

Table 4-1 Frequencies & Percentages of Demographic Variables (N = 46)

Demographic Variables	Frequency	Percent
Teaching Subject		
Maths	35	76.09%
Science	11	23.91%
Age		
25-30 years old	3	6.52%
31-35 years old	13	28.26%
36-40 years 0ld	25	54.35%
41-50 years old	4	8.70%
more than 50 years old	1	2.17%
Years of Experience		
1-5 years	9	19.57%
6-10 years	8	17.39%
11-15 years	12	26.09%
16-20 years	15	32.61%
more than 20 years	2	4.35%
Highest Qualification		
Diploma	2	4.35%
High Diploma	1	2.17%
Bachelor	36	78.26%
Master	6	13.04%
Ph.D.	1	2.17%
Number of Students in the Classroom		
15-20 students	5	10.87%
21-25 students	5	10.87%
26-30 students	14	30.43%
31-35 students	14	30.43%
more than 30 students	8	17.39%
Teaching Hours per Week		
1-5 teaching hours	6	13.04%
6-10 teaching hours	14	30.43%
11-15 teaching hours	8	17.39%
16-20 teaching hours	13	28.26%
more than 20 hours	5	10.87%
Specialty		
Specialist in mathematics	33	71.74%
Specialist in science	7	15.22%
Specialist in one and teaches the other	6	13.04%

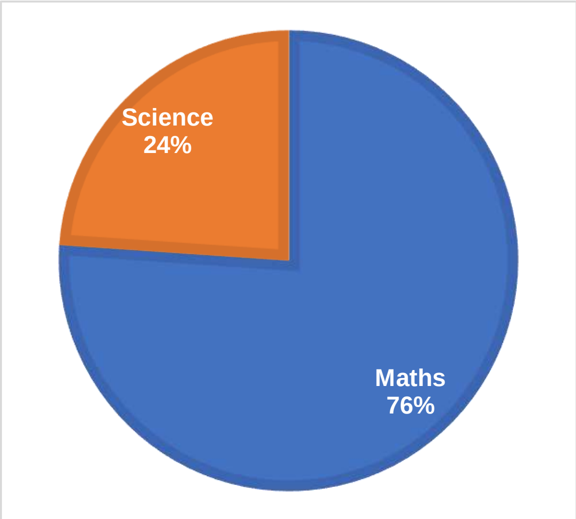

Figure 4-1 Teaching Subject.

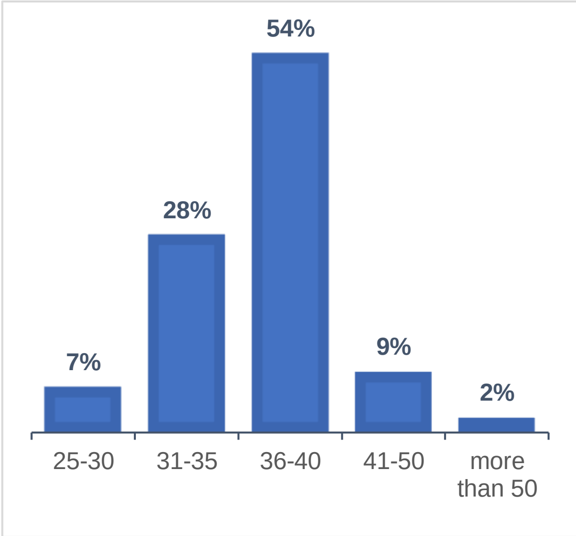

Figure 4-2 Age Groups

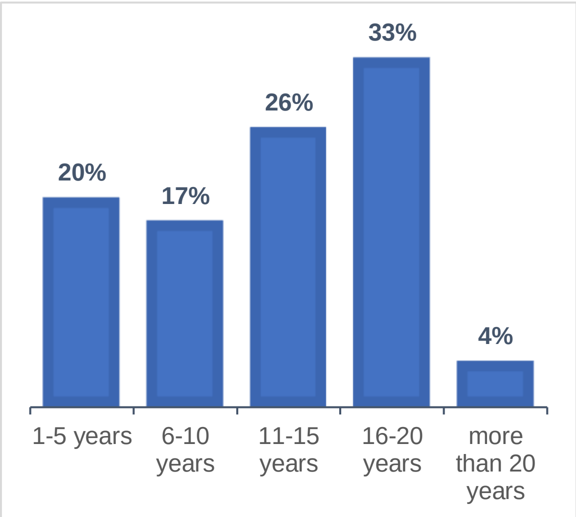

Figure 4-3 Years of Experience

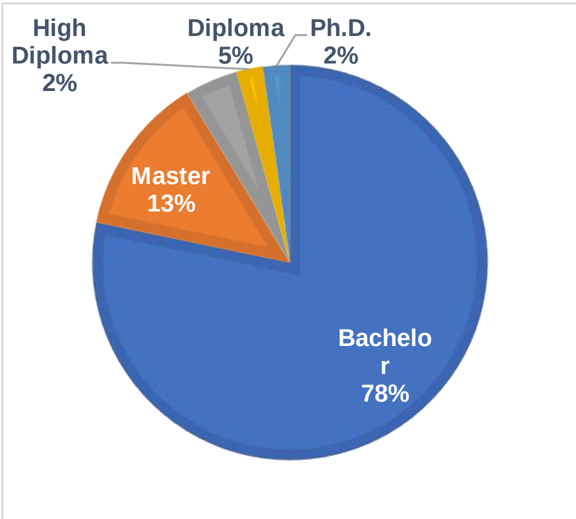

Figure 4-4 Highest Qualification

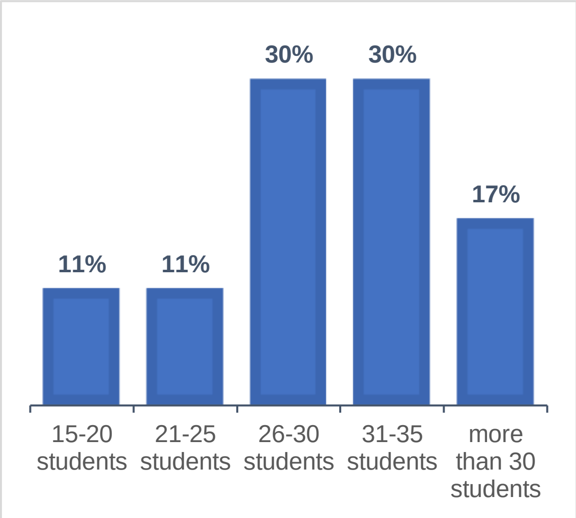

Figure 4-5 Number of Students in the Classroom

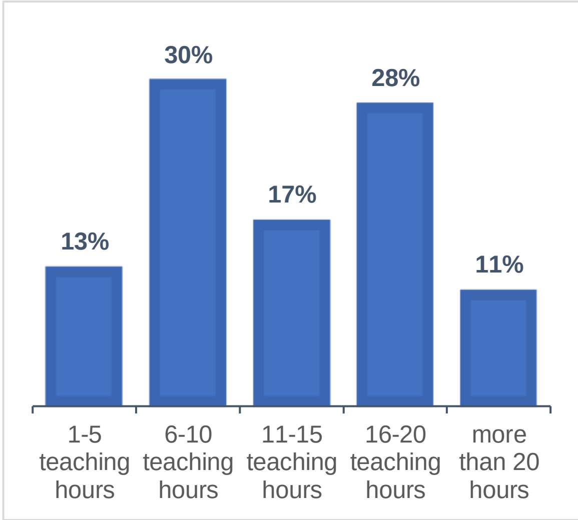

Figure 4-6 Teaching Hours per Week

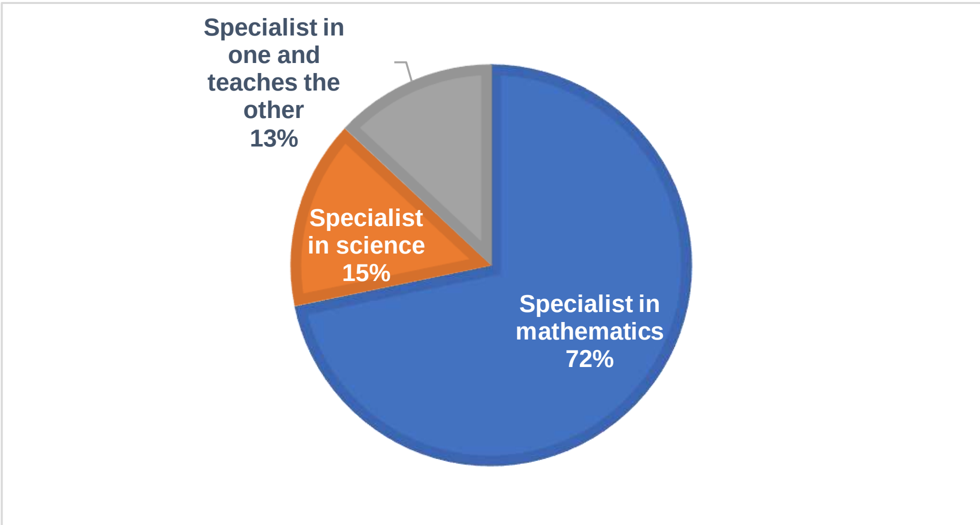

Figure 4-7 Specialty

4.3.3 Questionnaire Responses

Frequencies and percentages are calculated and reported for questionnaire items in Tables (4.2) and (4.3) followed by graphical illustration in bar charts in Figures (4.8) and (4.9). This descriptive analysis reveals that, on average, 30% of respondents gave high rating scores, while 45% gave medium rating scores, and 26% gave low rating scores to teachers' development aspects.

Specifically speaking, the highest rating score was given to the aspect "Teachers' understanding of the curriculum in your school", indicating that teachers' understanding of the curriculum is high. The next highest-ranked aspect was the implementation of the school curriculum. “Teachers' expectations for student achievement”, “Student’s ability to achieve academic school goals”, and “Job satisfaction for teachers in school” were given, on average, medium ratings. The lowest rated aspect was “School leadership’s support for teachers’ professional development”, followed by “Cooperation between school leadership and teachers to plan education”. Other aspects of teachers’ development that could need to be improved are: “Job satisfaction for teachers in school”, “Student’s ability to achieve academic school goals”, “Student’s desire to do good work at school”.

Table 4-2 Frequencies & Percentages of Mathematics & Science Teachers Development in KSA (N = 46) Part 1

Items	very low	low	medium	high	very high
7- Teachers' expectations for student achievement?	3	8	27	7	1
	6.52%	17.39%	58.70%	15.22%	2.17%
8- Teachers' understanding of the curriculum in your school?	0	1	14	26	5
	0.00%	2.17%	30.43%	56.52%	10.87%
9- Teacher’s ability to inspire students?	1	6	20	16	3
	2.17%	13.04%	43.48%	34.78%	6.52%
10- Cooperation between school leadership and teachers to plan education?	2	15	21	5	3
	4.35%	32.61%	45.65%	10.87%	6.52%
11- Student’s ability to achieve academic school goals?	6	10	27	3	0
	13.04%	21.74%	58.70%	6.52%	0.00%
12- School leadership’s support for teachers’ professional development?	6	14	17	8	1
	13.04%	30.43%	36.96%	17.39%	2.17%
13- Student’s desire to do good work at school?	3	12	15	12	4
	6.52%	26.09%	32.61%	26.09%	8.70%
14- Job satisfaction for teachers in school?	8	8	26	2	2
	17.39%	17.39%	56.52%	4.35%	4.35%
15- Implementation of the school curriculum?	4	0	18	20	4
	8.70%	0.00%	39.13%	43.48%	8.70%
Total	33	74	185	99	23
	7.97%	17.87%	44.69%	23.91%	5.56%

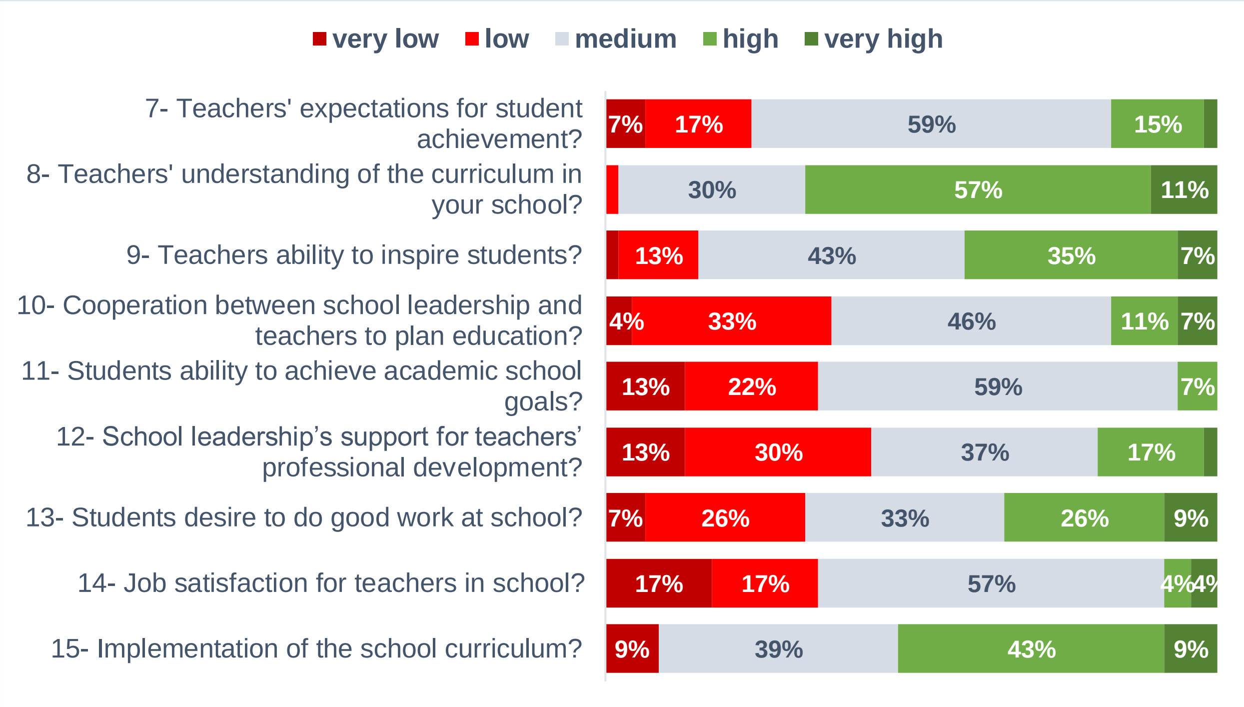

Figure 4-8 Bar Chart of Mathematics & Science Teachers Development in KSA (N = 46) Part 1

The second part of the descriptive analysis of questionnaire items is related to the items measured on frequency scale (never to always). On average, the majority of respondents, 81% at least "sometimes" perform the seven items listed in Table 3. The analysis revealed that the most frequently performed item was "Request to save the rules, procedures and facts by the student", followed by "Using Activity Books in the classroom" and "Correct homework in the classroom". The least frequent item was "Interact with other teachers from classroom visits and discussions".

Table 4-3 Frequencies & Percentages of Mathematics & Science Teachers Development in KSA (N = 46) Part 2

Items	never	rarely	sometimes	often	Always
16- Request to save the rules, procedures, and facts by the student?	2	6	11	16	11
	4.35%	13.04%	23.91%	34.78%	23.91%
17- Solve problems individually by the student?	1	7	20	14	4
	2.17%	15.22%	43.48%	30.43%	8.70%
18- Request explanation of answers by student?	1	2	26	12	5
	2.17%	4.35%	56.52%	26.09%	10.87%
19- Using Activity Books in the classroom?	0	4	17	16	9
	0.00%	8.70%	36.96%	34.78%	19.57%
20- Use computer programs in the classroom?	3	13	13	8	9
	6.52%	28.26%	28.26%	17.39%	19.57%
21- Correct homework in the classroom?	0	3	18	13	12
	0.00%	6.52%	39.13%	28.26%	26.09%
22- Interact with other teachers from classroom visits and discussions?	2	16	17	6	5
	4.35%	34.78%	36.96%	13.04%	10.87%
Total	9	51	122	85	55
	2.80%	15.84%	37.89%	26.40%	17.08%

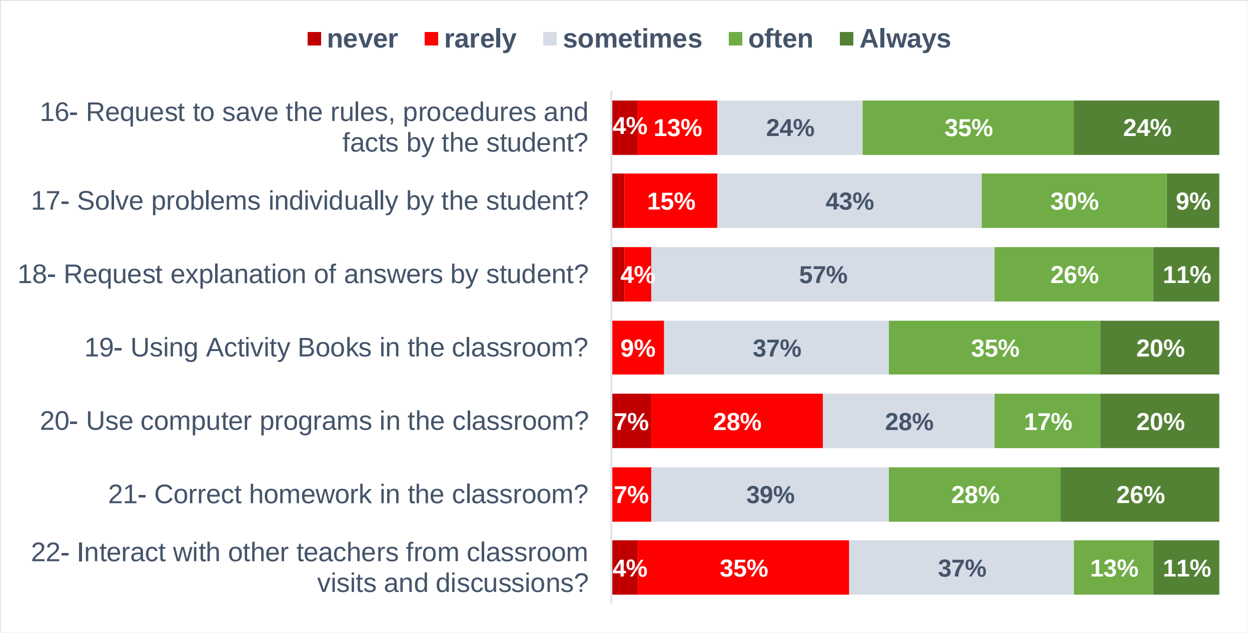

Figure 4-9 Bar Chart of Mathematics & Science Teachers Development in KSA (N = 46) Part 2

4.3.4 Inferential Analysis

In this section, statistical techniques and tests are used to find significant differences and relationships between pairs of questionnaire variable. Significance level is determined at the alpha of 0.05. Significant tests are those with p-values ≤ 0.05.

4.3.5 Mathematics vs. Science Differences

Two independent samples t-test was performed to find whether there are significant differences between math and science teachers with regard to teachers' development and performance. The test revealed a significant difference in mean scores of "Implementation of the school curriculum" and "Using Activity Books in the classroom" between math and science teachers, as p-values < 0.05. Teachers teaching math scored higher means than teachers teaching Science. There were no other significant differences between both groups of teachers.

Table 4-4Independent Samples t-test - Categorical Variable: Teaching Subject

	Descriptive Statistics				Independent Samples t-test Statistics	
	Maths		Science			
Items	**Mean**	**SD**	**Mean**	**SD**	**t**	**Sig.**
7- Teacher's expectations for student achievement?	2.94	.684	2.73	1.191	.572	.578
8- Teachers' understanding of the curriculum in your school?	3.80	.677	3.64	.674	.700	.488
9- Teacher's ability to inspire students?	3.37	.843	3.09	.944	.936	.354
10- Cooperation between school leadership and teachers to plan education?	2.89	.963	2.64	.809	.775	.442
11- Student's ability to achieve academic school goals?	2.60	.812	2.55	.820	.194	.847
12- School leadership's support for teachers' professional development?	2.71	.926	2.45	1.214	.753	.456
13- Student's desire to do good work at school?	3.09	1.040	2.91	1.221	.472	.640
14- Job satisfaction for teachers in school?	2.74	.919	2.18	1.079	1.696	.097
15- Implementation of the school curriculum?	3.60	.881	2.91	1.136	2.115	.040
16- Request to save the rules, procedures and facts by the student?	3.63	1.140	3.55	1.128	.211	.834
17- Solve problems individually by the student?	3.34	.968	3.09	.701	.797	.430
18- Request explanation of answers by student?	3.34	.802	3.55	.934	-.703	.486
19- Using Activity Books in the classroom?	3.80	.868	3.18	.874	2.058	.046
20- Use computer programs in the classroom?	3.09	1.292	3.36	1.027	-.650	.519
21- Correct homework in the classroom?	3.74	.886	3.73	1.104	.048	.962
22- Interact with other teachers from classroom visits and discussions?	2.83	.985	3.18	1.250	-.972	.336

4.3.6 Correlation Analysis

Correlation analysis was performed to investigate relationships between pairs of variables in the current study questionnaire. Pearson's r correlation coefficients were calculated and reported in Table 4.5. The analysis revealed interesting findings; there are many significant relationships between pairs of variables in this study. Following are sample interpretation of the most important relationships found and reported below.

- There is a significant positive relationship between Q7 and Q9, r = 0.515 with p-value < 0.001, indicating that higher mean scores of “Teachers' expectations for student achievement” indicate higher mean scores of “Teacher’s ability to inspire students”.
- There is a significant positive relationship between Q11 and Q13, r = 0.638 with p-value < 0.001, indicating that higher mean scores of “Student’s ability to achieve academic school goals” indicate higher mean scores of “Students desire to do good work at school”.
- There is a significant positive relationship between Q10 and Q12, r = 0.585 with p-value < 0.001, indicating that higher mean scores of “Cooperation between school leadership and teachers to plan education” indicate higher mean scores of “School leadership’s support for teachers’ professional development”.

Table 4-5 Pearson's r Correlation Coefficients

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
7	.233	.515**	.237	.468**	.360*	.408**	.305*	.280	.121	.220	-.034	.128	-.203	.253	.143
8		.471**	.467**	-.145	.205	-.078	.193	.430**	.020	.258	.251	-.030	.072	.253	.033
9			.455**	.408**	.281	.511**	.302*	.521**	.171	.480**	.418**	.253	.102	.211	.152
10				.259	.585**	.119	.316*	.550**	-.173	.112	.177	.352*	.239	.127	.235
11					.428**	.638**	.242	.148	.161	.223	.214	.104	-.137	-.236	-.017
12						.160	.475**	.478**	.074	.209	.142	.309*	.081	.020	.141
13							.101	.003	.143	.328*	.479**	.407**	.012	-.077	.082
14								.367*	.161	.377**	.166	.347*	.254	.277	.291*
15									.178	.133	.169	.251	.128	.005	.145
16										.349*	.096	-.115	-.197	.049	-.048
17											.380**	.123	.060	.325*	.282
18												.127	.224	-.038	.040
19													.290	.022	.202
20														.094	.355*
21															.386**

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

4.4 Discussion and Conclusion based on the pilot study

Based on the study findings, the teachers' understanding of the curriculum in school had the highest rating score. These findings implied that many mathematics teachers in Saudi Arabia have a solid understanding of the curriculum. Besides, it could also mean that teachers have a wide understanding of school subjects and believe that the current guidelines only present a single approach to constructing a curriculum. That includes awareness of different instructional materials, teaching processes, and learning objectives. In most cases, teachers are expected to choose suitable tools from a few available curricular materials. These findings are consistent with reviewed scholar works on curriculum knowledge (Carroll, 2010; Remillard & Kim, 2017). According to these studies, teachers with a solid understanding of the curriculum realise that they have a multitude of tools to choose from while teaching. These professionals also recognise that there are various ways to structure a curriculum, for instance, in an integrative manner. Mathematics teachers with a good understanding of the curriculum also demonstrate lateral knowledge, which is the ability to know what the students are learning in different subjects. Based on this assumption, it is expected that professional teachers be aware of what learners are doing outside of their own classes. Other domains with medium ratings from the pilot study findings include the expectations of teachers for student achievement, the ability of the student to achieve academic school goals, and job satisfaction for the teachers in school.

The findings also showed that school leadership support for teachers' professional development was the lowest-rated aspect. These findings mean that most teachers in the pilot study sample believe that their leaders do not provide them with adequate support to fulfil their obligations. These findings are consistent with recent literature supporting the fact that teachers need the support of school leaders to experience professional development (Hairon & Dimmock, 2012; Nooruddin & Bhamani, 2019; Postholm, 2012; Tsakeni Maria & Jita Loyiso, 2019). Leaders in the school setting can help reduce the teaching burden, provide new ideas, and present a fresh outlook. These findings further mean that teachers and school leaders can come up with better solutions whenever they work together. Teachers are usually closer to the issues that emanate in the school setting than leaders are, and can help devise effective solutions to these challenges (Postholm, 2012). However, even if teachers provide solutions to some of the challenges experienced in school independently, that alone cannot guarantee the success of teachers. For teachers to be effective and take part in professional development, they need leaders to support them. Support may come in the form of placing them in leadership positions that are consistent with their skills and temperaments (Hairon & Dimmock, 2012; Nooruddin & Bhamani, 2019). Leaders must also give teachers opportunities for professional development so as they can increase their efficacy. Additionally, teachers need school leaders to provide clear guidelines concerning whatever is expected of them as leaders. In addition to leadership support, other aspects that were rated low include cooperation between school leadership and teachers to plan education.

The pilot study also examined the activities that were often completed by teachers in Saudi Arabia. Those that came up top on the list were requesting to save the rules, procedures, and facts by the student; using activity books in class; and correcting homework in the classroom. The activity that was least carried out by the teachers was interacting with other teachers from classroom visits and discussions. Probably, the lack of teacher interaction contributed immensely to the poor performance in mathematics in Saudi Arabia. Whenever teachers work together, they develop key professional and personal relationships. They can draw support from each other and delegate tasks to allow them to feel effective. Hence, collaboration between teachers contributes to teacher development.

The results of the pilot study were used to inform the main study in various ways. The pilot study helped fine-tune the main study by pre-testing the validity. While developing the survey, it was difficult writing questions that wouldn't be leading, biased, opinionated, or confusing. Pilot testing the questions that were asked in the survey helped the researcher understand if the questions were clear and asking what was intended. The pilot study also gave the researcher insight into the actual scope of the project. This made sure that I understood how long the project was going to take and the resources that were needed. It was optimal for the researcher to understand this information before the launch of the study to stay within the budget and meet the deadlines. Besides, the pilot test helped test the reliability of the study. A good research study must be both valid and reliable. The pilot study helped determine if the methods used were precise and if the research was easy to replicate.

In conclusion, the pilot study sought to examine factors contributing to mathematics teacher development in KSA. The pilot study was valuable for the quantitative nature of the research project. The pilot study tested the feasibility of the quantitative method and identified variables for testing in the actual study.

Chapter 5 TIMSS 2015

THE FINDINGS FROM THE ANALYSIS OF THE TIMSS SURVEY DATA

5.1 Introduction

This analysis was conducted in four stages: descriptive analysis, regression analysis, t-test, and chi-square tests and data validation tests. Descriptive analyses were used to provide an overall view of the entire data set and included frequency and measures of central tendency such as the mean, median, standard deviation, mode, and variance. Further, to establish the relationships between data items, correlation, regression, and artificial neuron networks were used. Relationships that showed significance with the categorical demographic variables were further examined using t-tests and chi-square tests. Lastly, validation tests included the measure of sampling adequacy and reliability of the scales used as a means to validate the findings.

Before the analyses were conducted, the researcher prepared and cleaned the data. The data provided were first exported to MS Excel using data labels. This enabled the examination and modification of the codes without interfering with the data. Codes that were modified included the coding of scales such as Yes/No/Not applicable where No/Not applicable were coded as “0” and yes as “1’. Moreover, the responses "Agree a lot", "Agree a little", "Disagree a lot, and "Disagree a little" were changed to "Disagree a lot" as "1", "Disagree a little" as "2", "Agree a little" as "3", and "Agree a lot" as "4'.The change of the coding of these scales was meant to facilitate a consistent and logical scale for subsequent analyses. Following these changes, the data that had been previously exported to the MS Excel file was recoded according to the new key and pasted back to the SPSS file.

Data cleaning involved the removal of unneeded data. To determine what was needed and what was unneeded, the variable names and labels were renamed, and this process of renaming enhanced familiarity with the data and the various categories. First, all the variables on science were cleared. Second, the data were sorted by the subject taught. All the entries attributed to science were cleared, leaving variables and data entries for mathematics variables and entries. All other variables that were identifiers were also removed, leaving only the teacher ID as the only identifier.

5.2 The findings of descriptive analyses

Descriptive analyses were conducted for all variables as a way to describe the entire dataset. These tests as aforementioned were either measure of counts: frequency and multiple response counts or were measures of central tendency. The demographic attributes were described by counts, variables with Yes/No responses (dichotomous) were described by multiple response analysis, and ordinal variables bundled into a group as well as scale (continuous) variables were described by measures of central tendency. The findings follow the variable list.

5.2.1 Demographic variables

Demographics data for teachers (N=378), shows that 50.9% were male while 49.1% were female, the highest percent of teachers were (30–39) years old by 56.3%, had bachelor's or equivalent by 52.4%, Mathematics was the major area of study of 36.8% of teachers, while 35.7% of teachers had a specialization in Mathematics who their major area of study was education. Finally, the average years have been teaching was 13 years with Std. Deviation of 7.619. (Table 5.1)

Table 5-1 Teacher's background information

		N	%
Gender	Female	185	49.1%
	Male	192	50.9%
Age of Teacher	Under 25	6	1.6%
	25–29	34	9.1%
	30–39	211	56.3%
	40–49	111	29.5%
	50–59	13	3.5%
What is the highest level of formal education you have completed?	Did not complete Upper secondary	13	4.8%
	Upper secondary	25	9.3%
	Post-secondary, non-tertiary	70	26.0%
	Short-cycle tertiary	8	3.0%
	Bachelor's or equivalent	141	52.4%
	Master's or equivalent	12	4.5%
What was your major or main area(s) of study?			
Education prim		122	32.3%
Education second		31	8.2%
Mathematics		139	36.8%
Science		173	45.8%
Language test		14	3.7%

Other	33	8.7%
If your major or main area of study was education, did you have a specialization in ..		
Mathematics	135	35.7%
Science	164	43.4%
Language/reading	3	.8%
Other subject	27	7.1%
How many years will you have been teaching altogether? (Minimum =0, Maximum =35, Mean= 12.99, Std. Deviation = 7.619)		

5.2.2 Descriptive Statistics

Descriptive Statistics of teachers' responses were applied as minimum, maximum, mean, standard deviation. Then, according to the Likert scale which using in each section, RII (Relative important index), was selected to rank the criteria according to their relative importance. The following formula is used to determine the relative index:

$$RII = \sum \frac{W}{A\,N} \qquad (1)$$

Where (W) is the weighting as assigned by each respondent on the Likert scale with (1) implying the least weight, (A) is the highest weight in the scale, and (N) is the total number of the sample.

1) Akadiri O.P., 2011, Development of a Multi-Criteria Approach for the Selection of Sustainable Materials for Building Projects, PhD Thesis, University of Wolverhampton, Wolverhampton, UK.

The question of the questionnaire has three levels of Likert scale as follow:

5-point Likert scale had equal interval length (0.80; (1- (1/5)), such mean interval [1: 1.80) corresponding to scale 1, [1.80: 2.60) corresponding to scale 2, [2.60: 3.40] corresponding to scale 3, [3.40: 4.20) corresponding to scale 4 and [4.20: 5] corresponding to scale 5**.**

4-point Likert scale has equal interval length (0.75; (1- (1/4)), such [1: 1.75) corresponding to scale 1, [1.75: 2.50) corresponding to scale 2, [2.50: 3.25) corresponding to scale 3 and [3.25: 4] corresponding to scale 4**.**

3-point Likert scale has equal interval length ($\widetilde{0.66}$; (1-(1/3)), such [1: 1.66] corresponding to scale 1, [1.67: 2.33] corresponding to scale 2, and [2.34: 3] corresponding to scale 3**.**

5.2.2.1 School Emphasis on Academic Success

How would you characterize each of the following within your school?

Phrases of characterization within teachers' school has 5-point Likert scale, as 1 for very low, 2 for low, 3 for medium, 4 for high and 5 for very high. The first rank was for the phrase (teachers' understanding of the school's curricular goals) with RII (82.80%). While the phrase (parental involvement in school activities) had the last rank with RII (56.32%). Overall mean score was (3.61) out of (5) degree at the interval [3.40 : 4.20), with St. D (0.610) and RII (72.28%) indicate that 72.28% of the teachers have a very high level of characterization. (Table 5.2). The variable 'school emphasis on academic success' sufficiently measures student achievement. There are various aspects that characterized this variable including the teachers' understanding of the school's curricular goals, degree of success in implementing the school's curriculum, expectations for student achievement, ability to inspire students, and parental involvement in school activities. Together, these aspects were characterized as either very high emphasis, medium emphasis, and high emphasis.

Table 5-2 School emphasis on academic success

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Teachers' understanding of the school's curricular goals	372	1	5	4.14	.717	82.80%	1
b) Teachers' degree of success in implementing the school's curriculum	370	1	5	3.99	.716	79.73%	5
c) Teachers' expectations for student achievement	367	1	5	3.56	.717	71.28%	11
d) Teachers working together to improve student achievement	372	1	5	4.09	.910	81.83%	2
e) Teachers' ability to inspire students	371	1	5	3.95	.819	78.98%	6
f) Parental involvement in school activities	370	1	5	2.82	1.086	56.32%	17
g) Parental commitment to ensure that students are ready to learn	372	1	5	2.97	.969	59.41%	15
h) Parental expectations for student achievement	371	1	5	3.39	.848	67.71%	12
i) Parental support for student achievement	371	1	5	3.05	1.010	60.97%	14
j) Parental pressure for the school to maintain high academic standards	370	1	5	2.91	1.067	58.22%	16
k) Students' desire to do well in school	370	1	5	3.59	.874	71.73%	10
l) Students' ability to reach school's academic goals	369	1	5	3.33	.776	66.56%	13
m) Students' respect for classmates who excel in school	370	1	5	3.78	.829	75.57%	9
n) Clarity of the school's educational objectives	368	1	5	4.02	.783	80.38%	4
o) Collaboration between school leadership and teachers to plan instruction	369	1	5	4.08	.927	81.68%	3
p) Amount of instructional support provided to teachers by school leadership	368	1	5	3.93	.926	78.70%	7
q) School leadership's support for teachers' professional development	369	1	5	3.86	.999	77.13%	8

Overall	372	1.88	5	3.61	.610	72.28%	

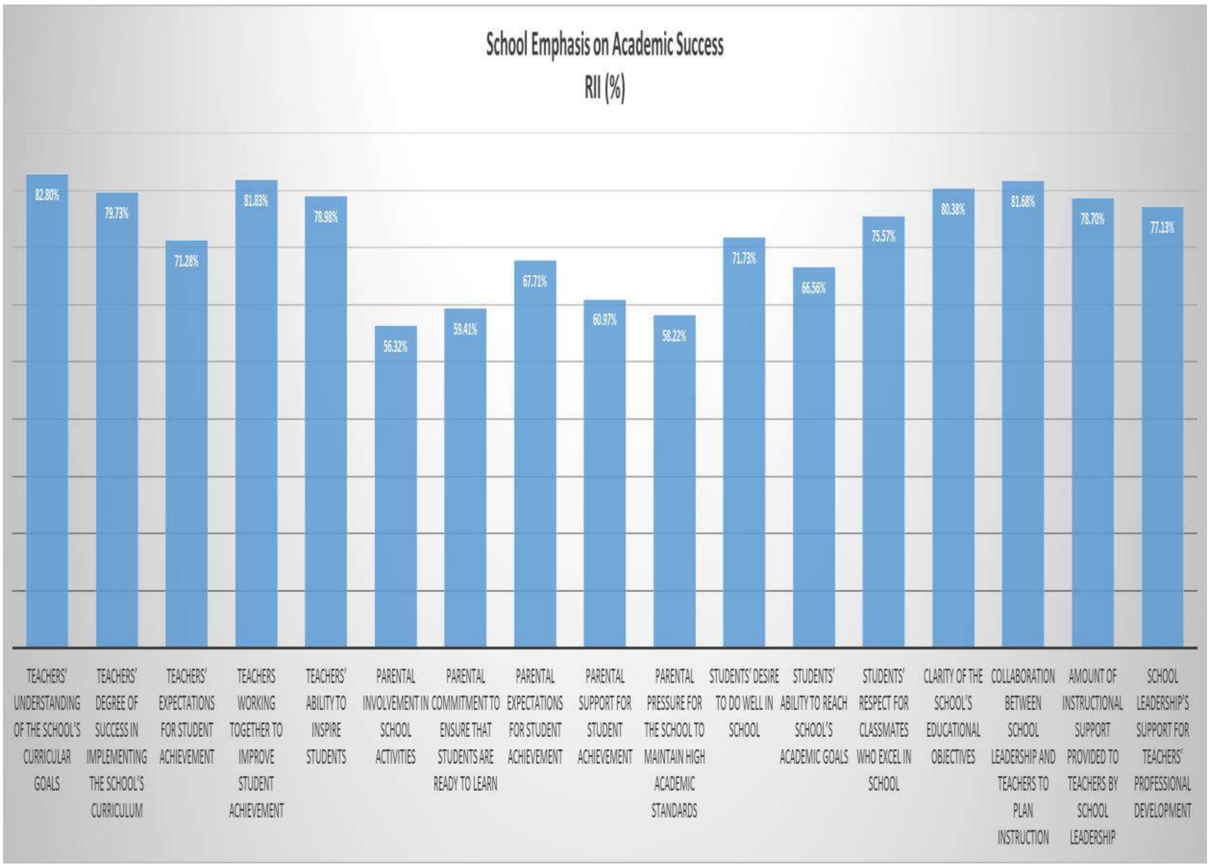

Figure 5-1 School emphasis on academic success

The teachers were asked to rate how they would characterize various aspects related with academic success in their school. Based on the responses, many teachers seem to prioritize understanding the school’s curricular goals, working together to improve student achievement, and collaborating with the school leadership to plan instruction. However, one factor that seems to affect emphasis on academic success is that of parental involvement in school activities.

5.2.2.2 School Environment

The questions of this section have 4-point Likert scale, as 1 for Disagree a lot, 2 for Disagree a little, 3 for Agree a little and 4 for Agree a lot. The first rank was for phrase (I feel safe at this school) with mean score (3.66), St. D (.634) and RII (91.38%), while the last rank was for (The students respect school property) with mean score (3.12), St. D (.882) and RII (77.99%). Overall mean score was (3.40) out of (4) degree fall at the mean interval [3.25: 4] with St. D (0.553) and RII (84.94%) indicate that 84.4% of teachers have a high level of agreements about school environment. (Table 5.3)

Table 5-3 School environment: Student conduct and school safety

Phrases	N	Minimum	Maximum	Mean	Std. Deviation	RII	Rank
a) This school is located in a safe neighborhood	376	1	4	3.59	.729	89.69%	2
b) I feel safe at this school	377	1	4	3.66	.634	91.38%	1
c) This school's security policies and practices are sufficient	375	1	4	3.49	.712	87.13%	3
d) The students behave in an orderly manner	376	1	4	3.26	.766	81.45%	7
e) The students are respectful of the teachers	376	1	4	3.34	.780	83.44%	6
f) The students respect school property	376	1	4	3.12	.882	77.99%	8
g) This school has clear rules about student conduct	376	1	4	3.35	.798	83.64%	5
h) This school's rules are enforced in a fair and consistent manner	376	1	4	3.39	.812	84.71%	4
Overall	377	1.38	4.00	3.40	.553	84.94%	

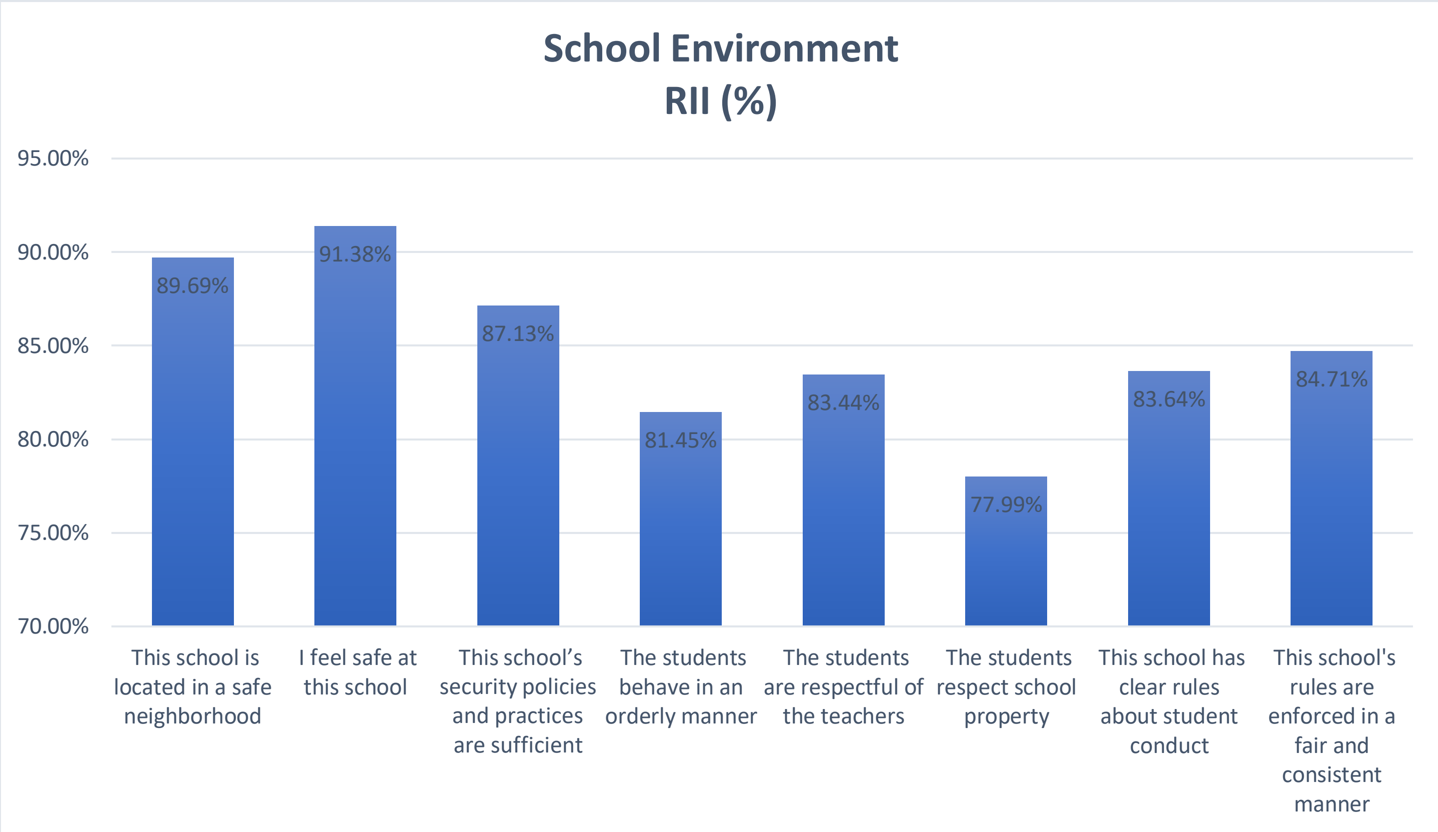

Figure 5-2 school environment

In your current school, how severe is each problem?

The answer of this question has 4-point Likert scale, as 1 for Not a problem, 2 for Minor problem, 3 for Moderate problem and 4 for Serious problem. The first rank was for the problem (Teachers do not have adequate technological resources) with mean score (2.30), St. D (1.096) and RII (57.50%), while the last rank was for the problem (The school classrooms are not cleaned often enough) with mean score (1.84), St. D (.980) and RII (46%). Overall mean score was (2.09) out of (4) degree fall at the mean interval [1.75: 2.50) with St. D (0.897) and RII (52.25%) which consider a minor level of problems in general. (Table 5.4)

Table 5-4 School environment: infrastructural and instructional limitations

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) The school building needs significant repair	373	1	4	1.86	1.021	46.5%	6
b) Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students)	372	1	4	2.01	1.047	50.25%	5
c) Teachers do not have adequate instructional materials and supplies	373	1	4	2.29	1.072	57.25%	2
d) The school classrooms are not cleaned often enough	373	1	4	1.84	.980	46%	7
e) The school classrooms need maintenance work	374	1	4	2.04	1.019	51%	4
f) Teachers do not have adequate technological resources	374	1	4	2.30	1.096	57.5%	1
g) Teachers do not have adequate support for using technology	372	1	4	2.24	1.084	56%	3
Overall	374	1.00	4.00	2.09	.807	52.25%	

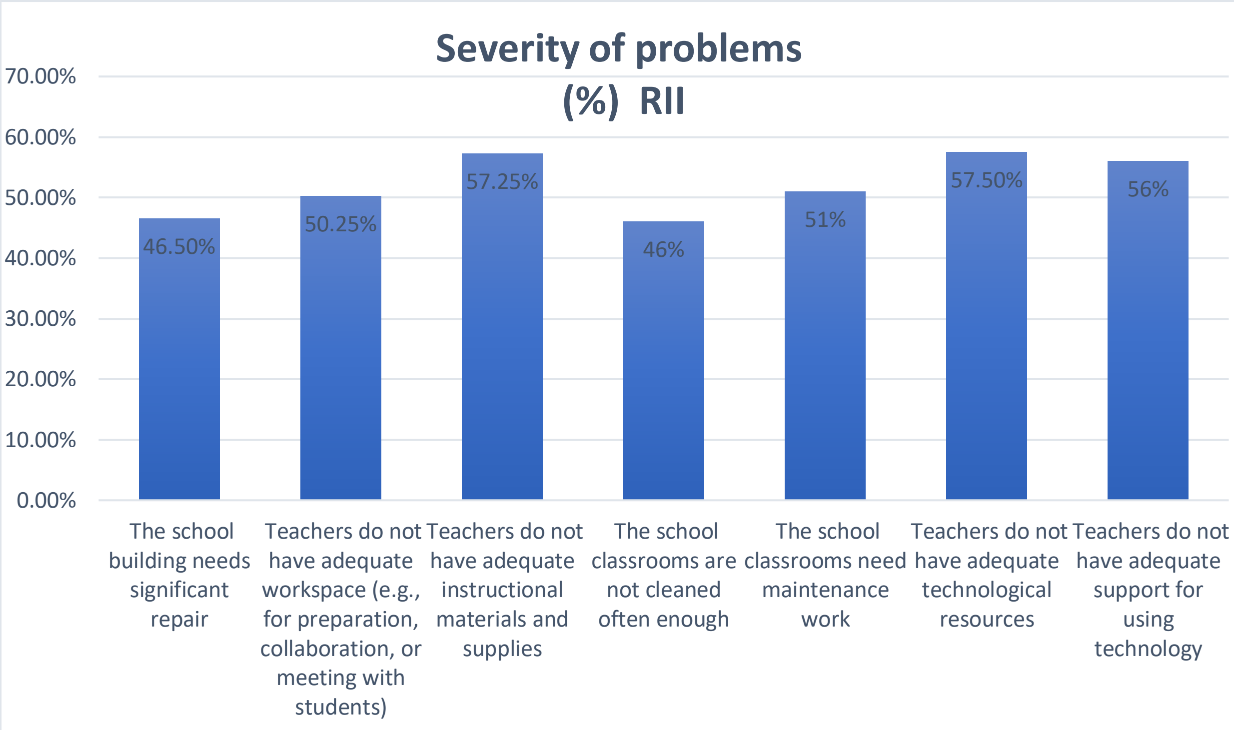

Figure 5-3 school problems

The teachers were asked to consider their current school environment. The responses showed that many teachers felt safe at their school and that many of the learning institutions are located in a safe neighbourhood. Many teachers also felt that the security policies and practices in their schools were sufficient. Even so, many teachers were not sure whether the students respected school property.

The teachers were also asked to rate the severity of different problems within the school environment. The most severe problems entailed teachers not having enough technological resources and instructional materials and supplies. On the contrary, many teachers found the cleanliness of the classroom to be the least severe problem within their schools.

5.2.2.3 About Being a teacher.

How often do you have the following types of interactions with other teachers?

The answer to this question has 4-point Likert scale, as 1 for Never or

almost never, 2 for Sometimes, 3 for Often and 4 for Very Often. The first rank was for the phrase (Share what I have learned about my teaching experiences) with mean score (2.91), St. D (.837) and RII (72.86%), while the last rank was for the phrase (Collaborate in planning and preparing instructional materials) with mean score (2.56), St. D (.893) and RII (64.07%). Overall mean score was (2.76) out of (4) degree fall at the mean interval [2.50: 3.25) with St. D (0.701) and RII (68.95%) indicate that 68.95% of teachers had interactions with others very often. (Table 5.5)

Table 5-5 Interactions between teachers and other teachers

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Discuss how to teach a particular topic	376	1	4	2.77	.808	69.22%	4
b) Collaborate in planning and preparing instructional materials	375	1	4	2.56	.893	64.07%	7
c) Share what I have learned about my teaching experiences	374	1	4	2.91	.837	72.86%	1
d) Visit another classroom to learn more about teaching	376	1	4	2.76	.866	68.88%	5
e) Work together to try out new ideas	376	1	4	2.78	.882	69.61%	2
f) Work as a group on implementing the curriculum	375	1	4	2.78	.947	69.40%	3
g) Work with teachers from other grades to ensure continuity in learning	376	1	4	2.74	.911	68.62%	6
Overall	376	1.14	4.00	2.76	.701	68.95%	

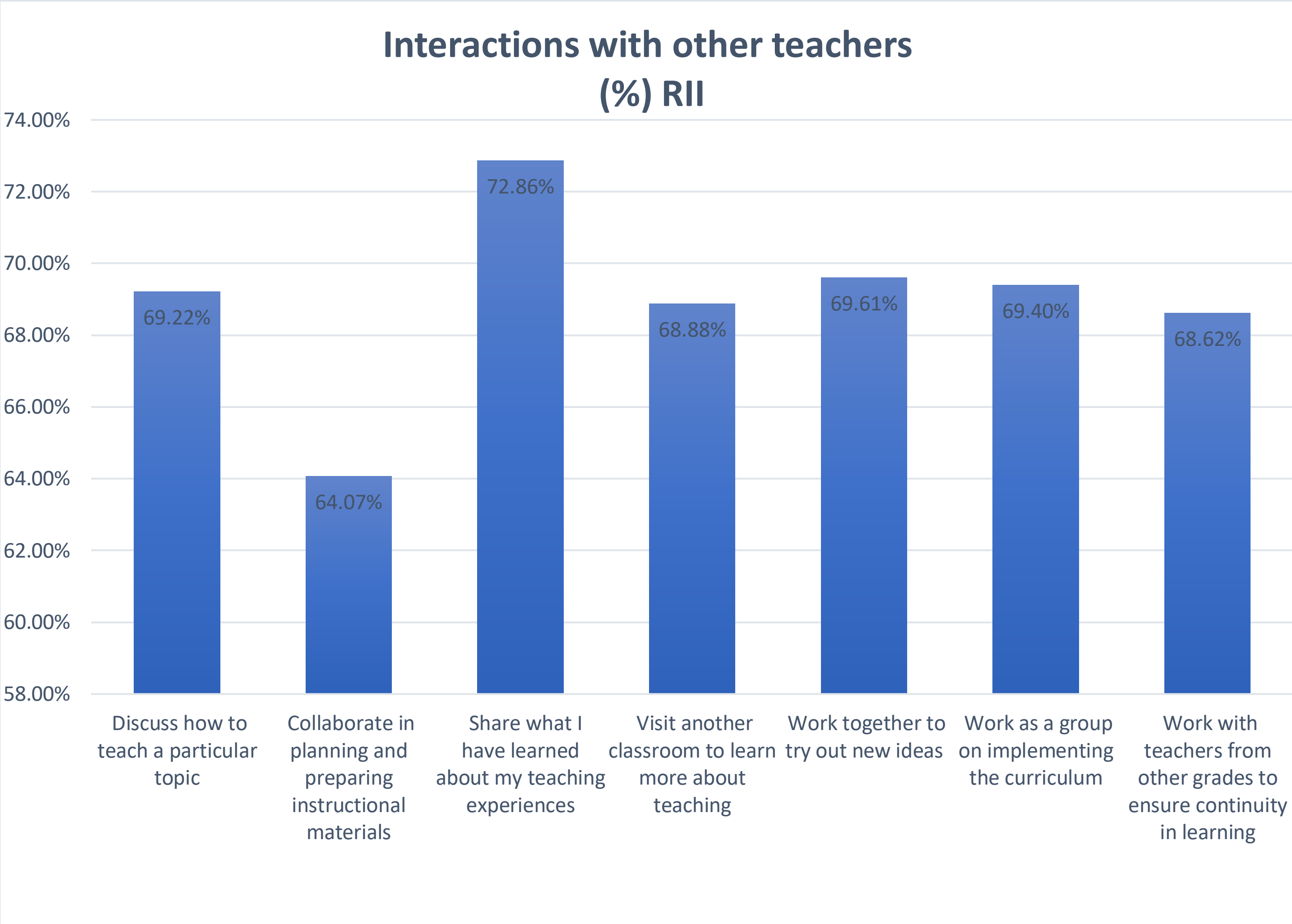

Figure 5-4 teacher interaction

How often do you feel the following way about being a teacher?

The answer of this question has 4-point Likert scale, as 1 for Never or almost never, 2 for Sometimes, 3 for Often and 4 for Very Often. The first rank was for the phrase (I am proud of the work I do) with mean score (3.66), St. D (.618) and RII (91.38%), while the last rank was for the phrase (I am going to continue teaching for as long as I can) with mean score (3.25), St. D (.942) and RII (81.35%). Overall mean score was (3.46) out of (4) degree fall at the mean interval [3.25: 4] with St. D (0.596) and RII (86.60%) indicate that 86.60% of teachers had very high level of feeling about being a teacher. (Table 5.6)

Table 5-6 Teachers' feelings about their work

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) I am content with my profession as a teacher	375	1	4	3.49	.742	87.13%	3
b) I am satisfied with being a teacher at this school	373	1	4	3.32	.881	82.98%	6
c) I find my work full of meaning and purpose	375	1	4	3.61	.641	90.13%	2
d) I am enthusiastic about my job	375	1	4	3.46	.711	86.60%	4
e) My work inspires me	374	1	4	3.46	.741	86.56%	5
f) I am proud of the work I do	374	1	4	3.66	.618	91.38%	1
g) I am going to continue teaching for as long as I can	374	1	4	3.25	.942	81.35%	7
Overall	375	1.00	4.00	3.46	.596	86.60%	

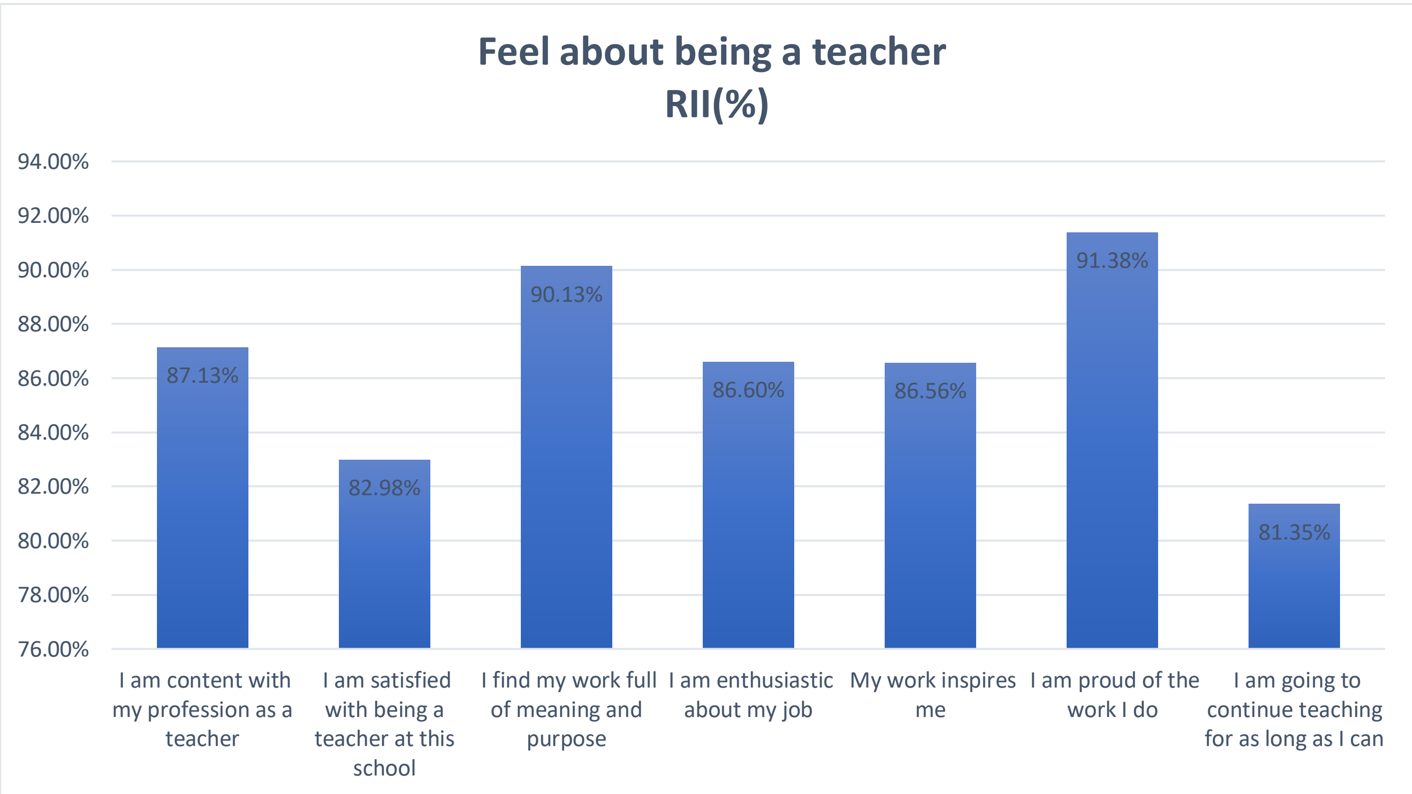

Figure 5-5 teacher feelings.

Indicate the extent to which you agree or disagree with each of the following statements?

The answer of this question has 4-point Likert scale, as 1 for Disagree a lot, 2 for Disagree a little, 3 for Agree a little and 4 for Agree a lot. The first rank was for phrase (I need more time to assist individual students) with mean score (3.33), St. D (.785) and RII (83.25%), while the last rank was for (I have too many administrative tasks) with mean score (1.95), St. D (.987) and RII (48.75%). Overall mean score was (2.66) out of (4) degree fall at the mean interval [2.50: 3.25) which consider a little level of agreements with St. D (0.588) and RII (66.57%). (Table 5.7)

Table 5-7 Problems facing teachers.

Phrases	N	Min	Max	Mean	Std. Deviation	RII	Rank
a) There are too many students in the classes	377	1	4	2.84	1.162	71.00%	3
b) I have too much material to cover in class	372	1	4	3.12	.897	78.00%	2
c) I have too many teaching hours	377	1	4	2.81	1.043	70.25%	4
d) I need more time to prepare for class	376	1	4	2.81	.908	70.25%	4
e) I need more time to assist individual students	377	1	4	3.33	.785	83.25%	1
f) I feel too much pressure from parents	375	1	4	2.27	.931	56.75%	5
g) I have difficulty keeping up with all of the changes to the curriculum	375	1	4	2.18	1.001	54.50%	6
h) I have too many administrative tasks	376	1	4	1.95	.987	48.75%	7
Overall	377	1.00	4.00	2.66	.588	66.57%	

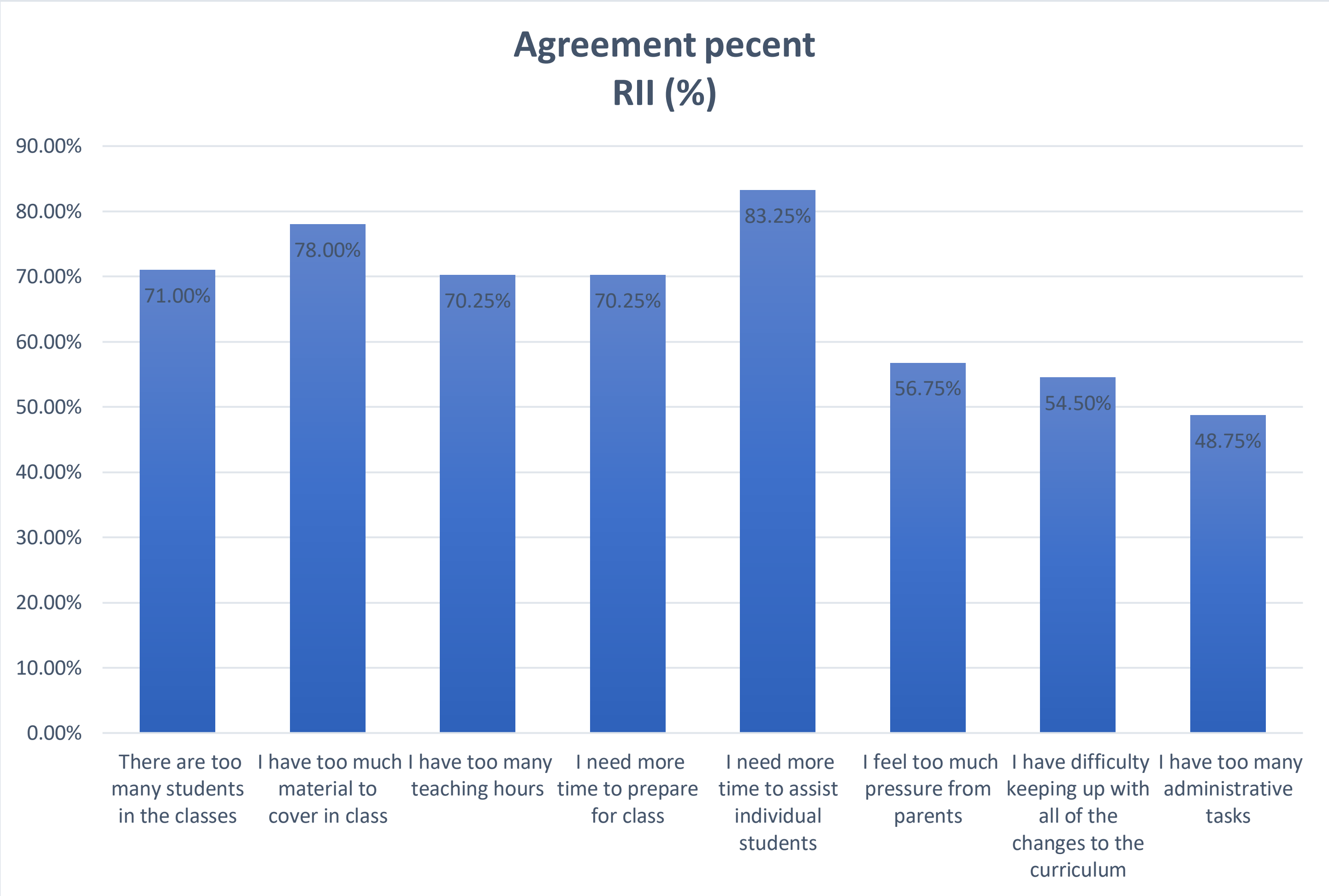

Figure 5-6 Problems facing teachers.

The teachers were asked to rate their interactions with other educators. The most common experience about being a teacher was that of sharing the learning outcomes from the teaching experiences. Most teachers also found working together to try out new ideas and working as a group to implement the curriculum as being significant experiences. The least experience about being a teacher was that of collaborating in the planning and preparing instructional materials.

The teachers were also asked to rate their feelings about certain constructs of being a teacher. The findings showed that most of the respondents were proud of their teaching profession. Many teachers also found their work to be full of meaning and purpose and were content with their profession. However, some teachers were concerned about the possibility to continuing to teach for as long as they could.

From the findings, it is also clear that many teachers would appreciate if they got more time to assist individual students. Most of the teachers also noted that they had a lot of material to cover in class, besides the high number of students in their classes. However, a majority of the teachers were less concerned about the many administrative tasks associated with their profession.

5.2.2.4 About Teaching the TIMSS Class

Table 5.8 shows that the number of students are in TIMSS class ranged between 6 to 58 with mean value 25.03 and St. Dev 9.741, while the number of students are in TIMSS class from the fourth grade ranged between 1 to 49 with mean value 23.20 and St. Dev 8.832. Finally the number of fourth grade students who had experience difficulties understanding spoken language of test ranged between 0 to 35 with mean 3.95 and St. D 5.769. (Table 5.8)

Table 5-8 The number of students per class

	N	Min	Max	Mean	Std. Dev
How many students are in this class?	321	6	58	25.03	9.741
How many of the students in this class are in <fourth grade>?	301	1	49	23.20	8.832
How many <fourth grade> students experience difficulties understanding spoken <language of test>?	326	0	35	3.95	5.769

How often do you do the following in teaching this class?

The answer of this question has 4-point Likert scale, as 1 for Never, 2 for Some lessons, 3 for About half the lessons and 4 for Every or almost every lesson. The first rank was for phrase (Link new content to students' prior knowledge) with mean score (3.56), St. D (.687) and RII (89%), while the last rank was for (Ask students to complete challenging exercises that require them to go beyond the instruction) with mean score (2.16), St. D (.888) and RII (54.07%). Overall mean score was (3.08) out of (4) degree fall at the mean interval [2.50: 3.25) with St. D (0.535) and RII (77.06%), indicate that, in general teachers had done this practices in teaching this class about half the lessons. (Table 5.9)

Table 5-9 The teaching methods.

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Relate the lesson to students' daily lives	375	1	4	3.38	.785	84.60%	3
b) Ask students to explain their answers	374	1	4	3.09	.875	77.14%	5
c) Bring interesting materials to class	373	1	4	2.96	.845	74.06%	6
d) Ask students to complete challenging exercises that require them to go beyond the instruction	375	1	4	2.16	.888	54.07%	8
e) Encourage classroom discussions among students	374	1	4	3.30	.789	82.49%	4
f) Link new content to students' prior knowledge	375	2	4	3.56	.687	89.00%	1
g) Ask students to decide their own problem-solving procedures	375	1	4	2.79	.856	69.80%	7
h) Encourage students to express their ideas in class	375	1	4	3.41	.744	85.27%	2
Overall	375	1.25	4	3.08	.535	77.06%	

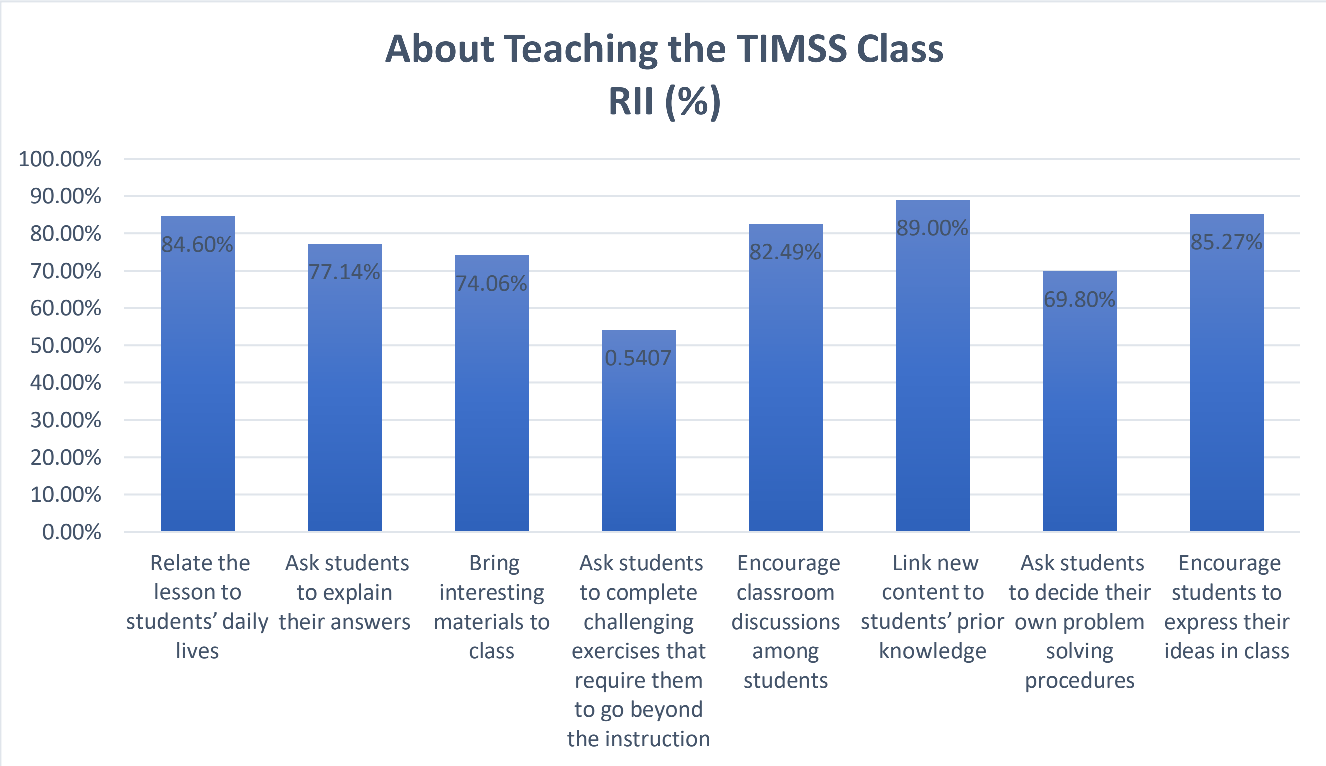

Figure 5-7 teaching methods.

In your view, to what extent do the following limit how you teach this class?

The answer of this question has 3-point Likert scale, as 1 for Not at all, 2 for Some, 3 for A lot. The first rank was for phrase (Uninterested students) with mean score (2.19), St. D (.601) and RII (73%), while the last rank was for (Students with physical disabilities) with mean score (1.30), St. D (.540) and RII (43.33%). Overall mean score was (1.83) out of (3) degree fall at the mean interval [1.66: 2.33) with St. D (0.345) and RII (61%), indicate a moderate level of limitation. (Table 5.10)

Table 5-10 Limitations in teaching

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Students lacking prerequisite knowledge or skills	376	1	3	2.06	.579	68.67%	2
b) Students suffering from lack of basic nutrition	376	1	3	1.78	.632	59.33%	5
c) Students suffering from not enough sleep	374	1	3	1.92	.601	64.00%	4
d) Disruptive students	375	1	3	2.04	.608	68.00%	3
e) Uninterested students	375	1	3	2.19	.601	73.00%	1
f) Students with physical disabilities	371	1	3	1.30	.540	43.33%	7
g) Students with mental, emotional, or psychological disabilities	375	1	3	1.51	.602	50.33%	6
Overall	376	1.00	3.00	1.83	.345	61.00%	

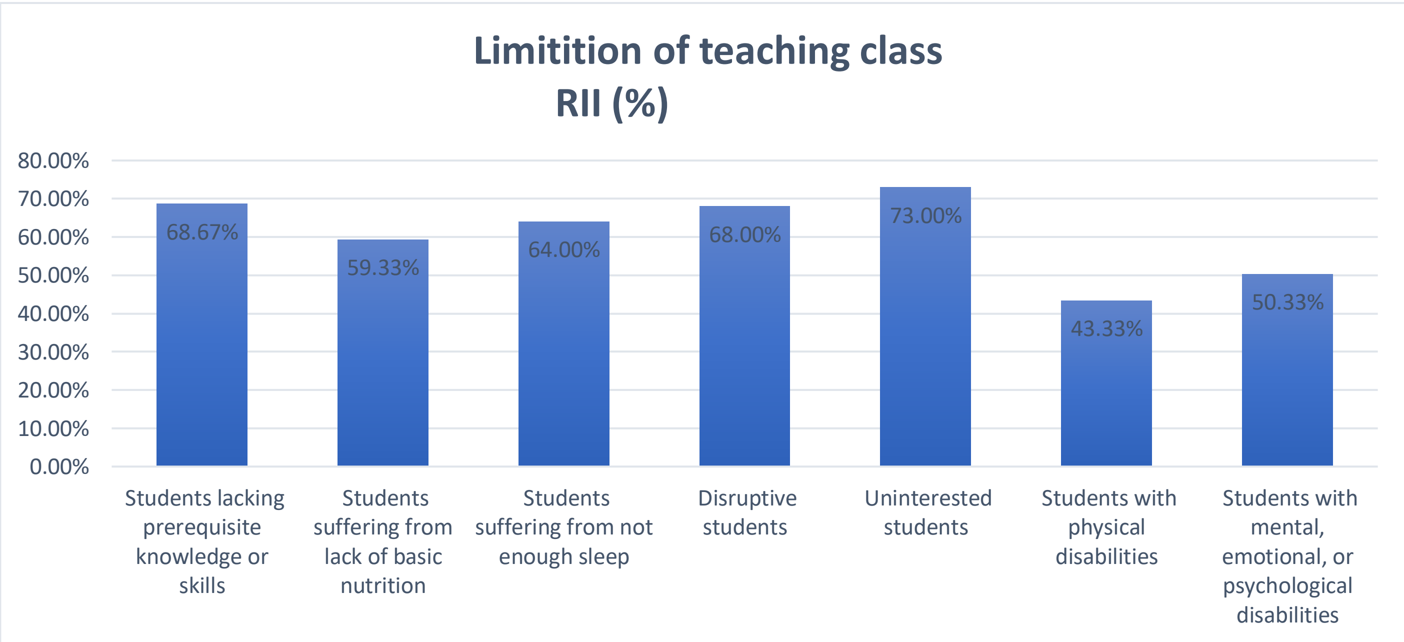

Figure 5-8 limitation of teaching class

The number of students in the TIMSS class ranged between 6 to 58, among which 1-49 were in fourth grade. Some fourth-grade students experienced difficulties understanding the spoken language of the test, while others did not. While teaching the TIMSS class, many teachers linked new content to the students' prior knowledge, encouraged the students to express their ideas in class, and related the lesson to the daily lives of the students. The least common practice while teaching the TIMSS class was that of asking the students to complete challenging exercises that require them to go beyond the instruction.

The teachers were also asked to rate some of the limitations associated with teaching a TIMSS class. The most common limitation was dealing with uninterested students and learners lacking the necessary knowledge or skills. Very few teachers thought that students with physical disabilities limited the teaching of the TIMSS class.

5.2.2.5 Teaching Mathematics to the TIMSS Class

When teachers were asked, how much time do they spend teaching mathematics to the students in this class, 149 teachers answered this question by minimum 9, maximum 480, mean 222.58 minutes per week with Std. D 63.958.

In teaching mathematics to this class, how would you characterize your confidence in doing the following?

This question has 5-point Likert scale, 1 for very low, 2 for low, 3 for medium, 4 for high and 5 for very high. The first rank was for the phrase (Inspiring students to learn mathematics) with RII (94.09%). While the phrase (Improving the understanding of struggling students) had the last rank with RII (79.03%). Overall mean score was (4.25) out of (5) degree at the interval [4.20 : 5], with St. D (0.511) and RII (85.07%) indicate a very high level of characterization. (Table 5.11)

Table 5-11 Teacher confidence.

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Inspiring students to learn mathematics	186	2	5	4.70	.524	94.09%	1
b) Showing students a variety of problem solving strategies	186	3	5	4.33	.647	86.67%	3
c) Providing challenging tasks for the highest achieving students	186	2	5	4.16	.807	83.12%	7
d) Adapting my teaching to engage students' interest	184	2	5	4.25	.695	85.00%	4
e) Helping students appreciate the value of learning mathematics	186	2	5	4.42	.703	88.49%	2
f) Assessing student comprehension of mathematics	186	2	5	4.07	.743	81.40%	8
g) Improving the understanding of struggling students	185	2	5	3.95	.809	79.03%	9
h) Making mathematics relevant to students	186	2	5	4.22	.711	84.30%	5
i) Developing students' higher-order thinking skills	186	2	5	4.18	.775	83.55%	6
Overall	186	2.56	5.00	4.25	.511	85.07%	

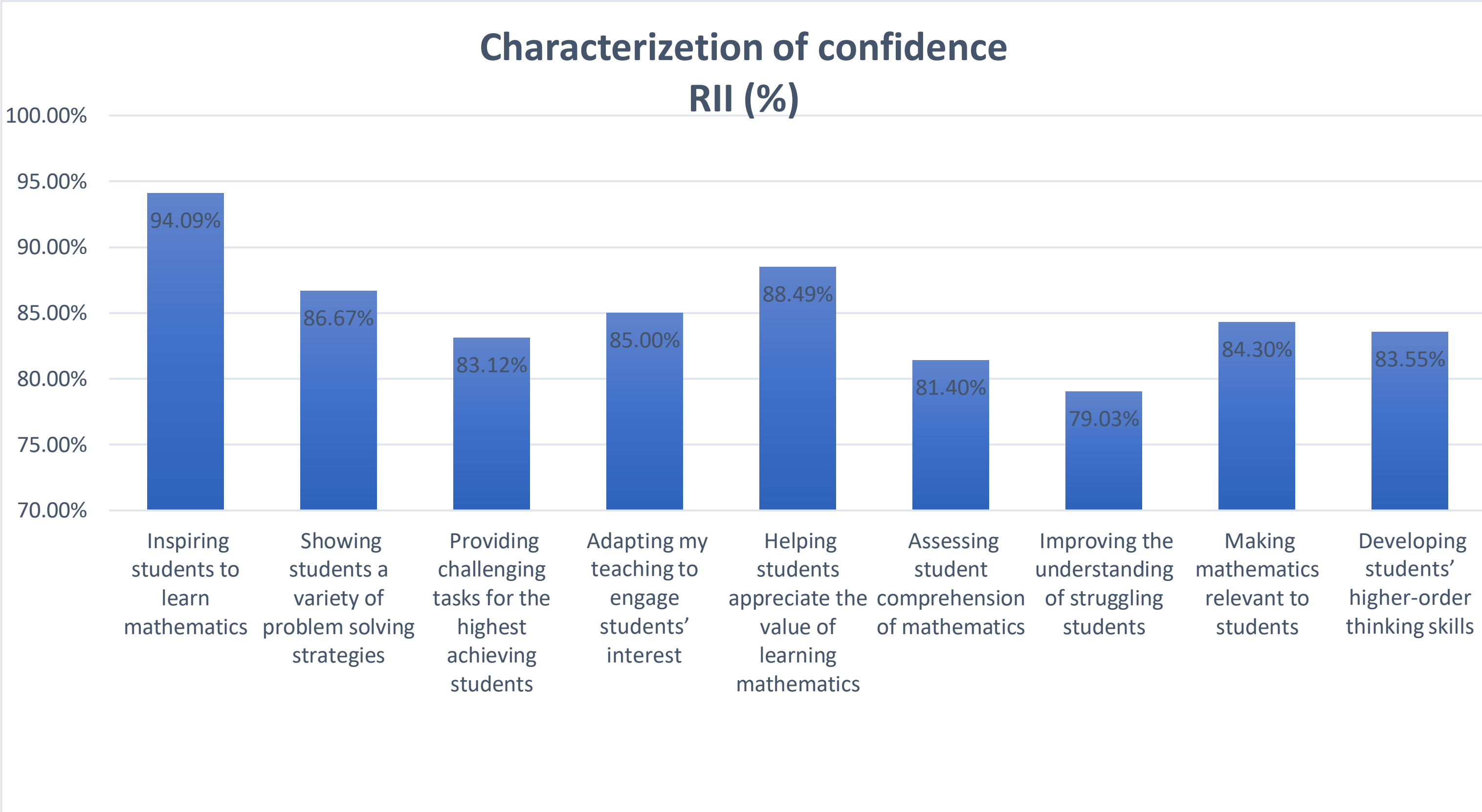

Figure 5-9 Teacher confidence.

In teaching mathematics to this class, how often do you ask students to do the following?

The answer of this question has 4-point Likert scale, as 1 for Never, 2 for Some lessons, 3 for About half the lessons and 4 for Every or almost every lesson. The first rank was for phrase (Listen to me explain new mathematics content) with mean score (3.70), St. D (.631) and RII (74.07%), while the last rank was for (Work in same ability groups) with mean score (2.43), St. D (.996) and RII (48.65%). Overall mean score was (3.17) out of (4) degree fall at the mean interval [2.50: 3.25) with St. D (0.455) and RII (63.38%), indicate that, in general teachers had done these practices in teaching this class about half the lessons. (Table 5.12)

Table 5-12 Frequency of asking students to perform certain activities in class.

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Listen to me explain new mathematics content	182	2	4	3.70	.631	74.07%	1
b) Listen to me explain how to solve problems	182	1	4	3.52	.703	70.44%	2
c) Memorize rules, procedures, and facts	179	1	4	3.44	.750	68.72%	3
d) Work problems (individually or with peers) with my guidance	179	1	4	3.37	.814	67.49%	4
e) Work problems together in the whole class with direct guidance from me	180	1	4	3.36	.803	67.22%	5
f) Work problems (individually or with peers) while I am occupied by other tasks	180	1	4	2.45	.970	49.00%	8
g) Take a written test or quiz	180	1	4	3.19	.797	63.78%	6
h) Work in mixed ability groups	179	1	4	3.08	.902	61.56%	7
i) Work in same ability groups	178	1	4	2.43	.996	48.65%	9
Overall	182	1.67	4.00	3.17	.455	63.38%	

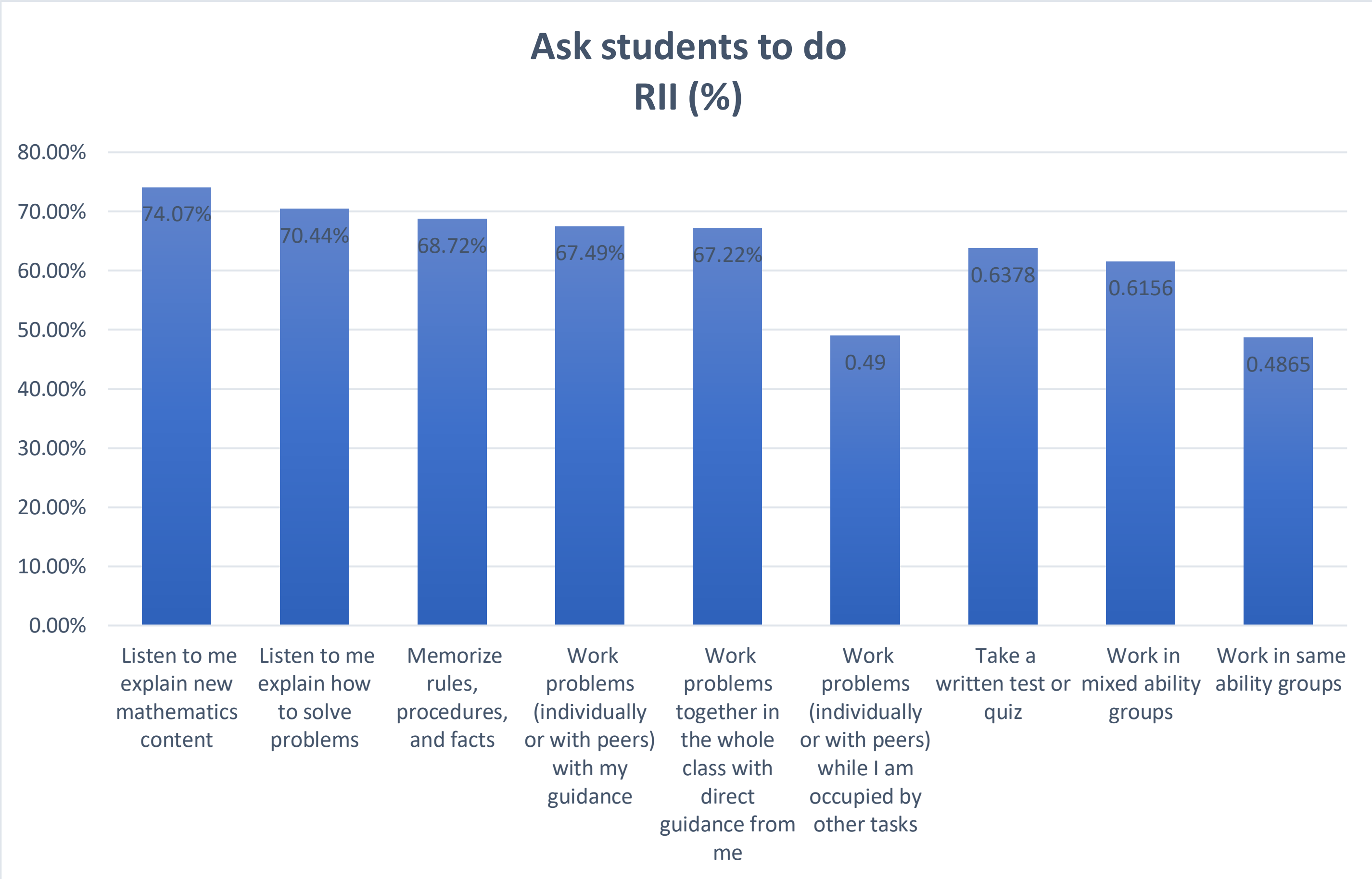

Figure 5-10 asking students to perform certain activities in class.

The teachers were asked to characterize their confidence in teaching mathematics to the TIMSS class. Many of the teachers drew their confidence from inspiring students to learn mathematics and helping them to appreciate the value of the subject. The least common source of confidence entailed providing challenging tasks for the highest achieving students.

The teachers were also asked to rate their practices while teaching mathematics to the TIMSS class. Most teachers asked the students to listen to them while explaining new mathematics content and solving problems. Very few teachers asked the students to work in the same ability groups.

5.2.2.6 Using Calculators and Computers for Teaching Mathematics to the TIMSS Class

Are the students in this class permitted to use calculators during mathematics lessons?

Almost students didn't permit to use calculators in class as the highest percent, while 16.2% had restricted use and only 4.9% had unrestricted use as the least. (Table 5.13)

Table 5-13 Frequency of using calculator.

	N	%
Yes, unrestricted use	9	4.9%
Yes, restricted use	30	16.2%
No, calculators are not permitted	146	78.9%
Total	185	100.0%

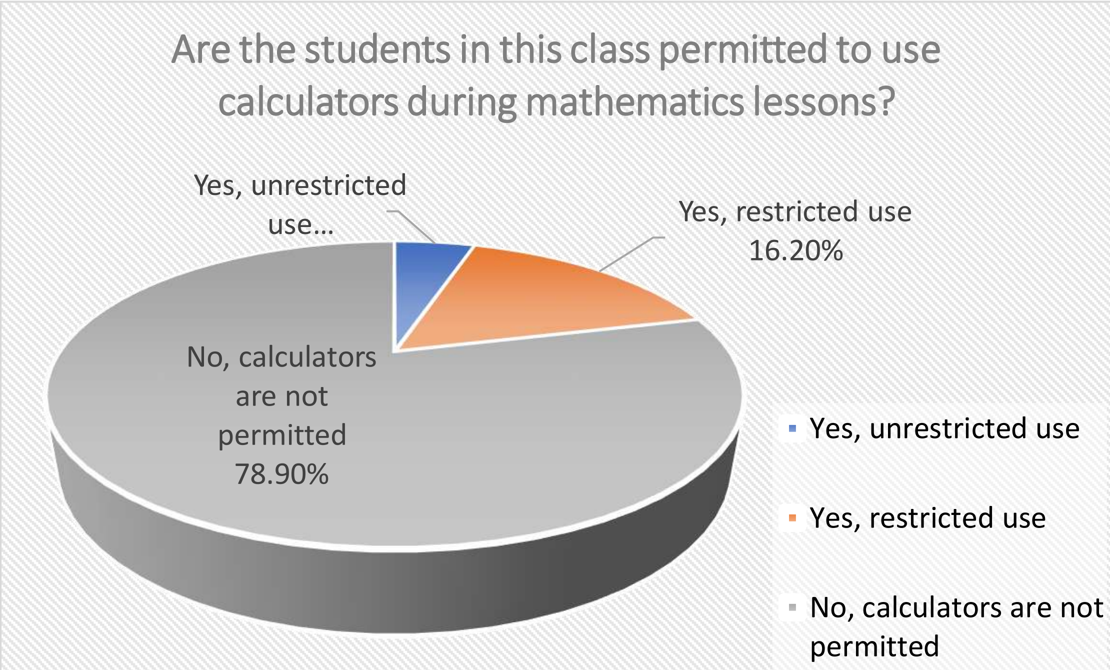

Figure 5-11 percentage of using calculator.

Computers and Access for the students

Almost students hadn't computers available to use during their mathematics lessons with 80% as the highest percent, while 20% had, 3% of those who had computers had a computer for each student, 38% has computers that they can share, and the school has computers that the class can use sometimes for 86% of them. (Table 5.14)

Table 5-14 The frequency of using computers.

		Yes		No		Total	
		N	**%**	**N**	**%**	**N**	**%**
Do the students in this class have computers (including tablets) available to use during their mathematics lessons?		37	20%	148	80%	185	100%
If yes, what access do the students have to computers?	a) Each student has a computer	1	0.03%	36	0.97%	37	100%
	b) The class has computers that students can share	14	0.38%	23	0.62%	37	100%
	c) The school has computers that the class can use sometimes	32	0.86%	5	0.14%	37	100%

How often do you have the students do the following activities on computers during mathematics lessons?

The answer of this question has 4-point Likert scale, as 1 for Never or almost never, 2 for Once or twice a month, 3 for Once or twice a week and 4 for Every or almost every day. The first rank was for phrase (Practice skills and procedures) with mean score (2.73), St. D (.804) and RII (90.99%), while the last rank was for (Explore mathematics principles and concepts) with mean score (2.30), St. D (.618) and RII (76.58%). Overall mean score was (2.54) out of (4) degree fall at the mean interval [2.50: 3.25) with St. D (0.600) and RII (84.68%). i.e. on average, the students done the activities on computers during mathematics lessons once or twice a week. (Table 5.15)

Table 5-15 Using of computers/calculators to explore mathematics principles, skills and ideas.

Phrases	N	Min	Max	Mean	Std. Dev	RII	Rank
a) Explore mathematics principles and concepts	37	1	3	2.30	.618	76.58%	3
b) Practice skills and procedures	37	1	4	2.73	.804	90.99%	1
c) Look up ideas and information	37	1	4	2.59	.832	86.49%	2
Overall	37	1.00	3.67	2.54	.600	84.68	

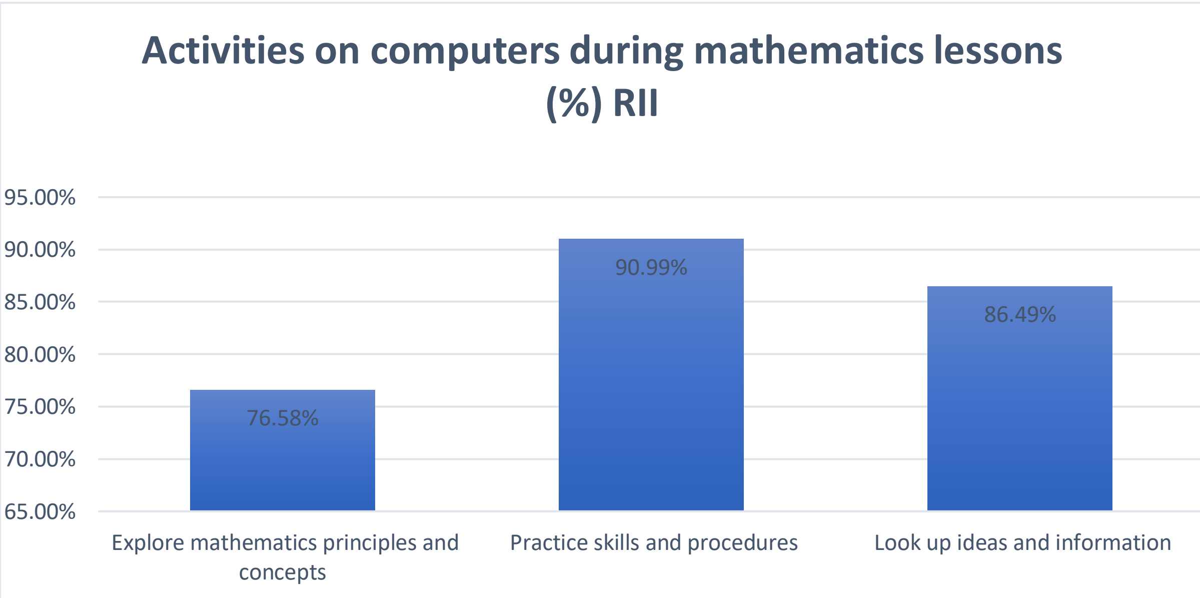

Figure 5-12 Percentage of using of computers/calculators to explore mathematics principles, skills and ideas.

A majority of the students were not permitted to use calculators during the mathematics lesson. However, there were a few students who had restricted and unrestricted use of calculators. Additionally, most of the students did not have computers to use during their mathematics lessons. When using computers, many teachers often asked their students to practice mathematics skills and procedures.

5.2.2.7 Mathematics Topics Taught to the TIMSS Class

The answer to these questions has 3-point Likert scale, as 1 for Not yet taught or just introduced, 2 for Mostly taught this year, 3 for Mostly taught before this year. Overall mean score for numbers was (2.20) out of (3) degree fall at the mean interval [1.66: 2.33) with St. D (0.334) and RII (73.26%), indicate that numbers which addressed by the TIMSS mathematics test mostly taught this year. Overall mean score for Geometric shapes and measures was (1.92) out of (3) degree fall at the mean interval [1.66: 2.33) with St. D (0.376) and RII (64.17%), indicate that Geometric Shapes and Measures which addressed by the TIMSS mathematics test mostly taught this year. Finally, data display also mostly taught this year with mean score (2.06) out of (3) with St. D (.564) and RII (68.57%). (Table 5.16)

Table 5-16 Topics taught: Numbers, Geometry, Data display

	N	Min	Max	Mean	Std. Dev	RII	Rank
Numbers							
a) Concepts of whole numbers, including place value and ordering	185	1	3	2.48	.609	82.52%	2
b) Adding, subtracting, multiplying, and/or dividing with whole numbers	184	1	3	2.49	.533	83.15%	1
c) Concepts of multiples and factors; odd and even numbers	184	1	3	2.06	.769	68.66%	6
d) Concepts of fractions (fractions as parts of a whole or of a collection, or as a location on a number line)	185	1	3	2.29	.479	76.40%	3
e) Adding and subtracting with fractions, comparing and ordering fractions	184	1	3	1.99	.543	66.30%	7
f) Concepts of decimals, including place value and ordering, adding and subtracting with decimals	185	1	3	1.93	.443	64.32%	8
g) Number sentences (finding the missing number, modeling simple situations with number sentences)	183	1	3	2.11	.605	70.49%	5
h) Number patterns (extending number patterns and finding missing terms)	182	1	3	2.20	.695	73.44%	4

Overall	186	1.13	3.00	2.20	.334	73.26%	
Geometric Shapes and Measures							
a) Lines: measuring, estimating length of; parallel and perpendicular lines	182	1	3	2.13	.768	71.06%	1
b) Comparing and drawing angles	184	1	3	2.07	.597	68.84%	4
c) Using informal coordinate systems to locate points in a plane (e.g., in square B4)	183	1	3	1.78	.626	59.38%	6
d) Elementary properties of common geometric shapes	180	1	3	2.04	.680	67.96%	5
e) Reflections and rotations	181	1	3	1.29	.582	42.91%	7
f) Relationships between two-dimensional and three-dimensional shapes	185	1	3	2.09	.555	69.55%	2
g) Finding and estimating areas, perimeters, and volumes	184	1	3	2.08	.558	69.20%	3
Overall	185	1.14	3.00	1.92	.376	64.17%	
Data Display							
a) Reading and representing data from tables, pictographs, bar graphs, or pie charts	184	1	3	2.08	.609	69.38%	1
b) Drawing conclusions from data displays	184	1	3	2.03	.618	67.75%	2
Overall	184	1.00	3.00	2.06	.564	68.57%	

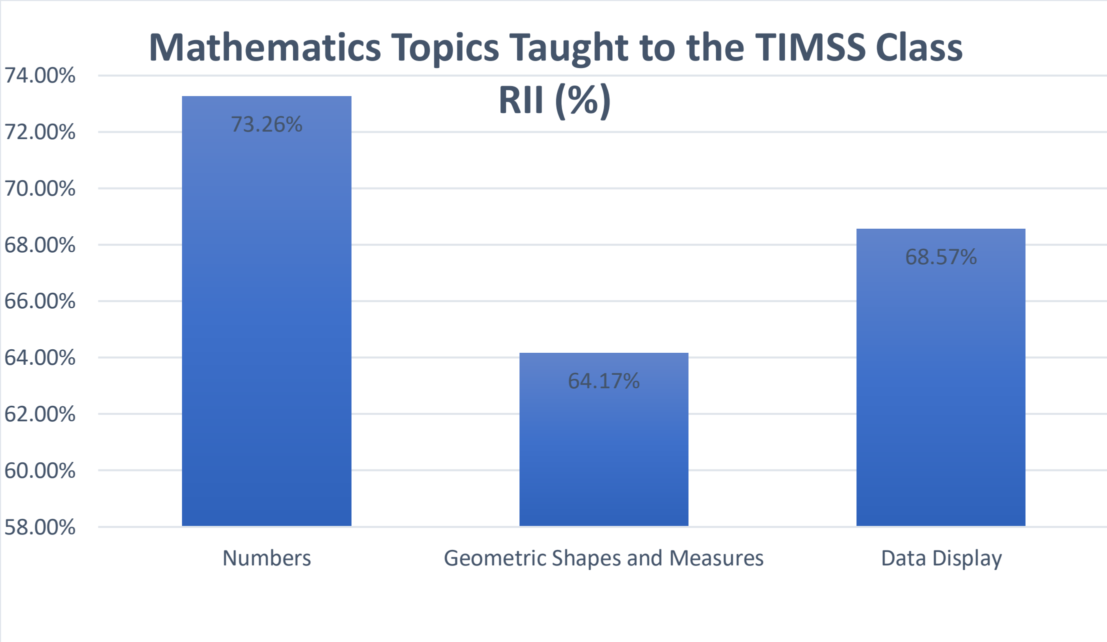

Figure 5-13 topic taught.

The most popular mathematics topics taught to the TIMSS class on numbers entailed adding, subtracting, multiplying, and/or diving with whole numbers. The least taught topic on numbers involved concepts of decimals, including place value and ordering, adding and subtracting with decimals. Concerning geometric shapes and measures, many teachers taught the measuring and estimation of parallel and perpendicular lines. Only a few teachers loved teaching reflections and rotations. The most common taught topic on data display was reading and representing data from tables, pictographs, bar graphs or pie charts.

5.2.2.8 Mathematics Homework for the TIMSS Class

45.7% of teachers usually assign mathematics homework to the students in this class every day, 69.1% assign mathematics homework by 15 minutes or less, 81.1% never correct assignments and give feedback to students, 68.2% always discuss the homework in class and 81.3% never monitor whether or not the homework was completed. (Table 5.17)

Table 5-17 Frequency of homework assignment, time, and assessment.

		N	%
A. How often do you usually assign mathematics homework to the students in this class?	No mathematics homework	2	1.1%
	Less than once a week	4	2.2%
	1 or 2 times a week	40	21.5%
	3 or 4 times a week	55	29.6%
	Every day	85	45.7%
	Total	186	100.0%
B. When you assign mathematics homework to the students in this class, about how many minutes do you usually assign?	15 minutes or less	123	69.1%
	16–30 minutes	50	28.1%
	31–60 minutes	4	2.2%
	More than 60 minutes	1	.6%
	Total	178	100.0%
C. How often do you do the following with the mathematics homework assignments for this class?	a) Correct assignments and give feedback to students		
	Never or almost never	142	81.1%
	Sometimes	33	18.9%
	Total	175	100%
	b) Discuss the homework in class		
	Never or almost never	2	1.1%
	Sometimes	55	30.7%
	Always or almost always	122	68.2%
	Total	179	100%
	c) Monitor whether or not the homework was completed		
	Never or almost never	143	81.3%
	Sometimes	33	18.7%
	Total	176	100%

A majority of the teachers assigned mathematics homework to students every day. Over half of the teachers assigned homework within the range of 15 minutes or less. Many teachers never or almost never correct assignments and give feedback to the students. Additionally, many of the teachers never or almost never monitored whether or not the homework was completed. Instead, most of the teachers discussed the homework in class.

5.2.2.9 Mathematics Assessment of the TIMSS Class

Assessment of students' ongoing work and classroom tests had little or no emphasis from 72.4% of teachers, while 27% had some emphasis for it, and 0.6% only of teachers had major emphasis for it. About national or regional achievement tests, 44.3% of teachers had some emphasis for it, 40.8% had little or no emphasis, and 14.9% had major emphasis. (Table 5.18)

Table 5-18 Emphasis on assessments.

	Major emphasis		Some emphasis		Little or no emphasis		Total
	N	%	N	%	N	%	
a) Assessment of students' ongoing work	1	0.6%	47	27%	126	72.4%	174
b) Classroom tests (for example, teacher-made or textbook tests)	1	0.6%	47	27%	126	72.4%	174
c) National or regional achievement tests	26	14.9%	77	44.3%	71	40.8%	174

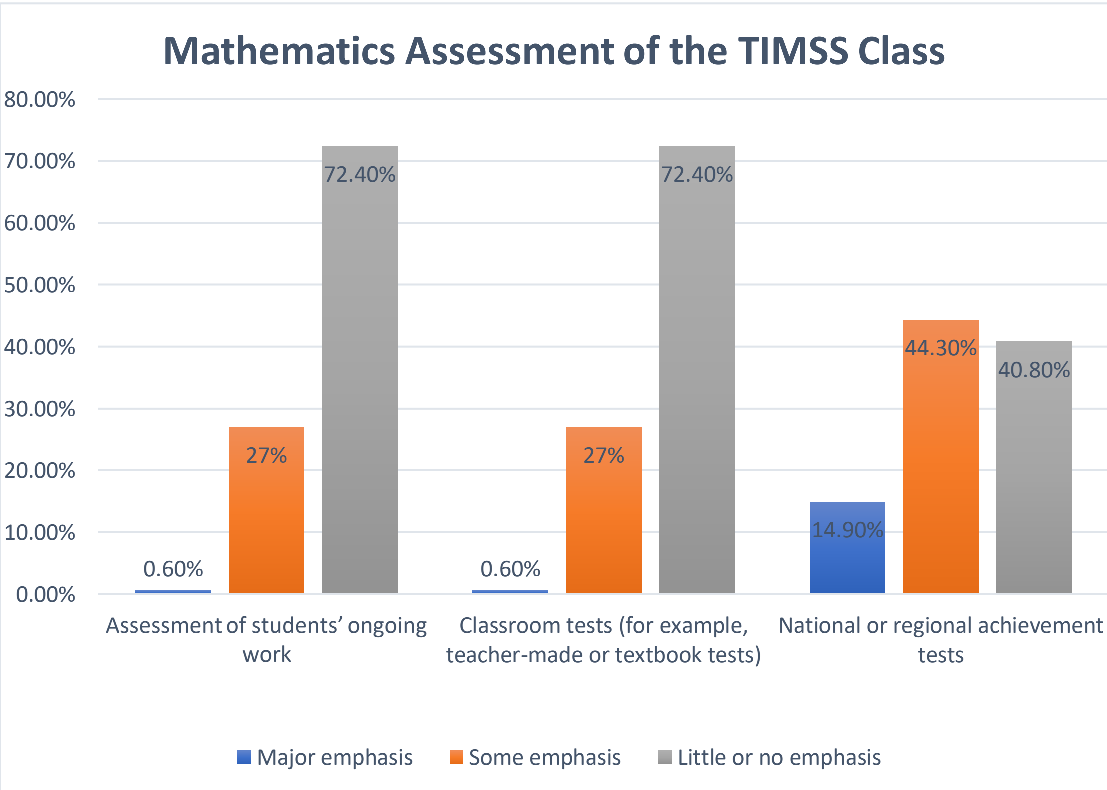

Figure 5-14 mathematics assessment

A majority of the teachers placed little or no emphasis on the assessment of students' ongoing work and classroom tests. Besides, there was an almost equal number of students who placed some emphasis or no emphasis on national or regional achievement tests.

5.2.2.10 Preparation to Teach Mathematics

The highest percent of teachers 67% had participate in professional development of Mathematics pedagogy/instruction, followed by 52.4% for Improving students' critical thinking or problem-solving skills, followed by 48.4% for Mathematics content, followed by 47% for Addressing individual students' needs, followed by 43.2% for Integrating information technology into mathematics, followed by 41.45 for Mathematics curriculum and the least 38.9% for Mathematics assessment. (Table 5.19)

Table 5-19 Areas of professional development.

Area	Yes		No		Total
	N	%	N	%	
a) Mathematics content	88	48.4%	94	51.6%	182
b) Mathematics pedagogy/instruction	124	67%	61	33%	185
c) Mathematics curriculum	75	41.4%	106	58.6%	181
d) Integrating information technology into mathematics	80	43.2%	105	56.8%	185
e) Improving students' critical thinking or problem-solving skills	97	52.4%	88	47.6%	185
f) Mathematics assessment	72	38.9%	113	61.1%	185
g) Addressing individual students' needs	87	47%	98	53%	185

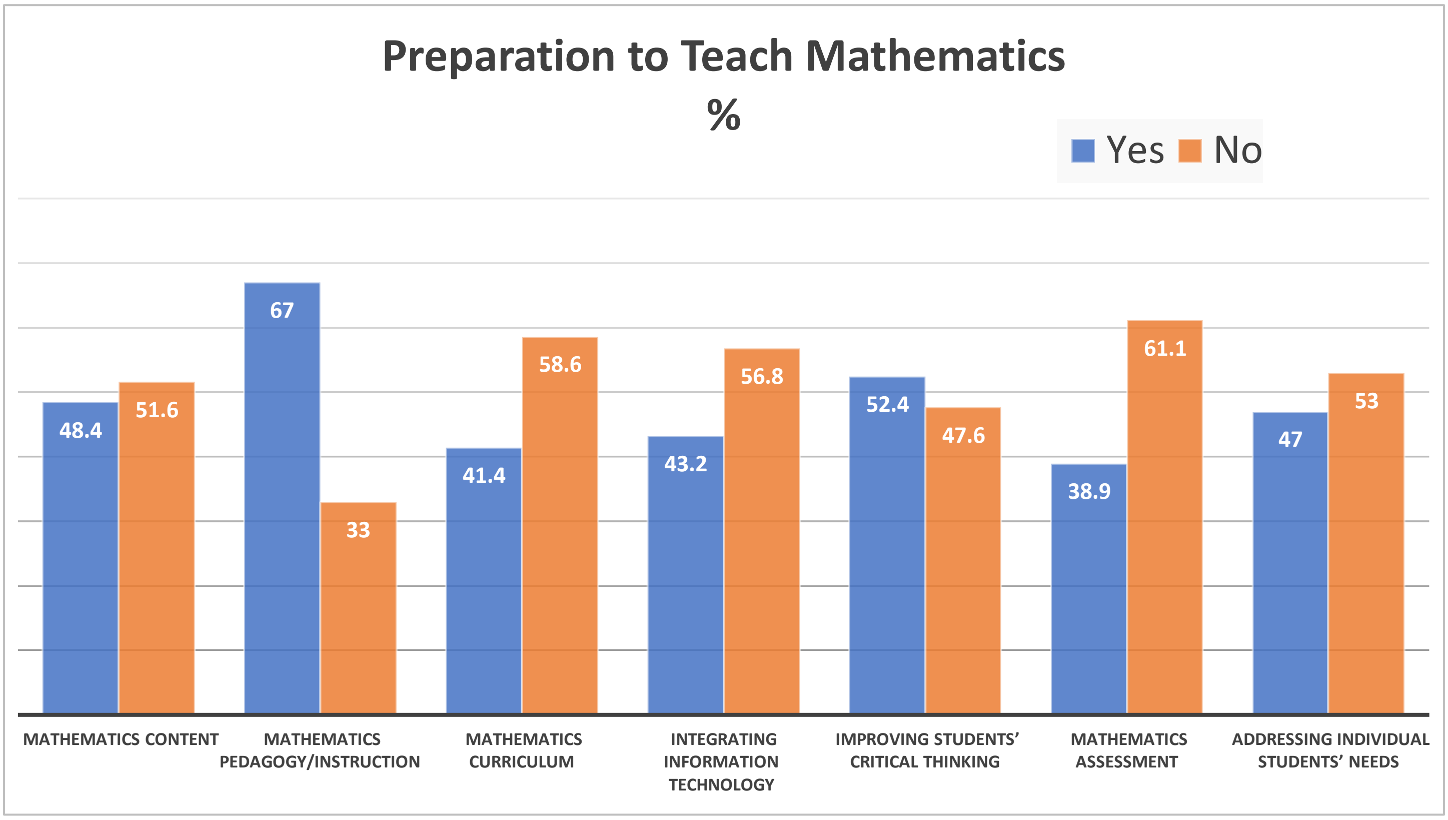

Figure 5-15 teacher participate in professional development.

In the past two years, how many hours in total have you spent in formal <in-service/professional development?

Table 5-20 Professional development in hours.

Hours	N	%
None	25	13.7
Less than 6 hours	37	20.2
6–15 hours	63	34.4
16–35 hours	38	20.8
More than 35 hours	20	10.9
Total	183	100.0

In the past two years, 34.4% of teachers had 6-15 hours in total spent in formal development, followed by 20.8% had 16- 35 hours, followed by 20.2% had less than 6 hours, followed by 10.9% had more than 35 hours, while 13.7% had none.

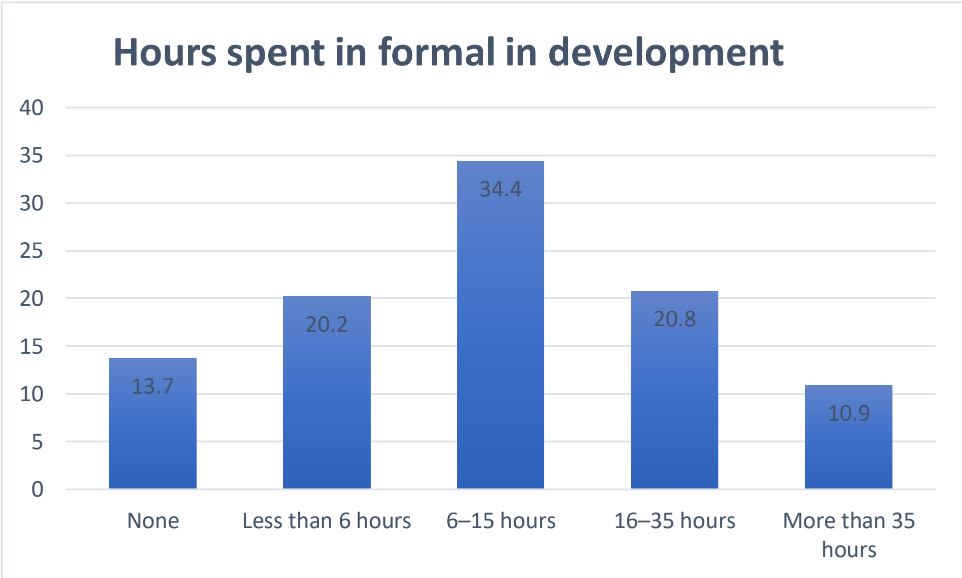

Figure 5-16 Hours spent in formal professional development.

Table 5.21 show the responds towards preparation' section which has 3-point Likert scale for each question, as 1 for Not well prepared, 2 for somewhat prepared and 3 for very well prepared. We deal with not applicable as missing.

Table 5-21 Teacher feelings about the preparedness to teach numbers, geometry, and data display.

Sub-scale	Phrases		Very well prepared (3)	Somewhat prepared (2)	Not well prepared (1)
Numbers	a) Concepts of whole numbers, including place value and ordering	N	150	14	2
		%	80.6	7.5	1.1
	b) Adding, subtracting, multiplying, and/or dividing with whole numbers	N	166	6	1
		%	89.2	3.2	.5
	c) Concepts of multiples and factors; odd and even numbers	N	134	14	1
		%	72.4	7.6	.5
	d) Concepts of fractions (fractions as parts of a whole or of a collection, or as a location on a number line)	N	158	16	3
		%	84.9	8.6	1.6
		N	148	18	3

	e) Adding and subtracting with fractions, comparing and ordering fractions	%	80.0	9.7	1.6
	f) Concepts of decimals, including place value and ordering, adding and subtracting with decimals	N	150	21	3
		%	80.6	11.3	1.6
	g) Number sentences (finding the missing number, modeling simple situations with number sentences)	N	143	19	3
		%	76.9	10.2	1.6
	h) Number patterns (extending number patterns and finding missing terms)	N	134	24	6
		%	72.8	13.0	3.3
Geometric Shapes and Measures	a) Lines: measuring, estimating length of; parallel and perpendicular lines	N	122	23	2
		%	66.7	12.6	1.1
	b) Comparing and drawing angles	N	151	12	0
		%	81.2	6.5	0.0
	c) Using informal coordinate systems to locate points in a plane (e.g., in square B4)	N	111	23	4
		%	62.0	12.8	2.2
	d) Elementary properties of common geometric shapes	N	134	16	2
		%	73.6	8.8	1.1
	e) Reflections and rotations	N	63	20	9
		%	34.1	10.8	4.9
	f) Relationships between two-dimensional and three-dimensional shapes	N	152	19	1
		%	83.1	10.4	.5
	g) Finding and estimating areas, perimeters, and volumes	N	147	19	3
		%	79.9	10.3	1.6
Data Display	a) Reading and representing data from tables, pictographs, bar graphs, or pie charts	N	146	19	3
		%	78.9	10.3	1.6
	b) Drawing conclusions from data displays	N	150	14	5
		%	81.1	7.6	2.7

Table 5.22 show the descriptive statistic for table 22, from which the overall mean score for preparation to teach numbers found (2.86) out of (3) with St. D (0.301) and RII (95.42%),

indicate that 95.42% of teachers had prepared very well to teach numbers. Geometric shapes and measures have overall mean score (2.85) out of (3) with St. D (0.301) and RII (94.89%), indicate that 94.89% of teachers had prepared very well to teach geometric shapes and measures. Also, teachers had prepared very well to teach data display with mean score (2.86) out of (3) with St. D (.392) and RII (95.18%).

Table 5-22 descriptive statistics.

	N	Min	Max	Mean	Std. Dev	RII	Rank
Numbers							
a) Concepts of whole numbers, including place value and ordering	166	1	3	2.89	.349	96.39%	3
b) Adding, subtracting, multiplying, and/or dividing with whole numbers	173	1	3	2.95	.237	98.46%	1
c) Concepts of multiples and factors; odd and even numbers	149	1	3	2.89	.332	96.42%	2
d) Concepts of fractions (fractions as parts of a whole or of a collection, or as a location on a number line)	177	1	3	2.88	.379	95.86%	4
e) Adding and subtracting with fractions, comparing and ordering fractions	169	1	3	2.86	.398	95.27%	5
f) Concepts of decimals, including place value and ordering, adding and subtracting with decimals	174	1	3	2.84	.408	94.83%	7
g) Number sentences (finding the missing number, modeling simple situations with number sentences)	165	1	3	2.85	.407	94.95%	6
h) Number patterns (extending number patterns and finding missing terms)	164	1	3	2.78	.496	92.68%	8
Overall	185	1.00	3.00	2.86	.301	95.42%	
Geometric Shapes and Measures							
a) Lines: measuring, estimating length of; parallel and perpendicular lines	147	1	3	2.82	.422	93.88%	5
b) Comparing and drawing angles	163	2	3	2.93	.262	97.55%	1

c) Using informal coordinate systems to locate points in a plane (e.g., in square B4)	138	1	3	2.78	.484	92.51%	6
d) Elementary properties of common geometric shapes	152	1	3	2.87	.376	95.61%	3
e) Reflections and rotations	92	1	3	2.59	.666	86.23%	7
f) Relationships between two-dimensional and three-dimensional shapes	172	1	3	2.88	.346	95.93%	2
g) Finding and estimating areas, perimeters, and volumes	169	1	3	2.85	.403	95.07%	4
Overall	183	1.57	3.00	2.85	.301	94.89%	
Data Display							
a) Reading and representing data from tables, pictographs, bar graphs, or pie charts	168	1	3	2.85	.404	95.04%	2
b) Drawing conclusions from data displays	169	1	3	2.86	.427	95.27%	1
Overall	173	1.00	3.00	2.86	.392	95.18%	

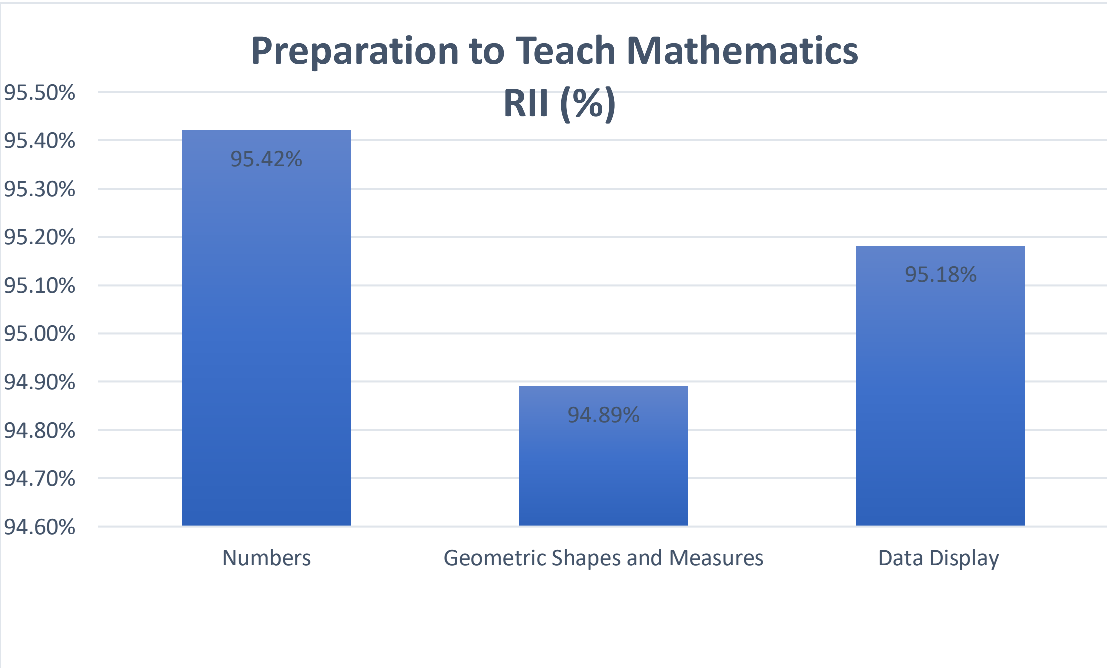

Figure 5-17 preparation to teach mathematics.

The teachers were asked whether they had participated in professional development to teach mathematics within the past two years. Among the various professional development opportunities listed, a majority had participated in mathematics pedagogy/instruction. Over half of the teachers had also participated in improving students' critical thinking or problem-solving skills. A majority of the teachers had not taken part in mathematics assessment. A majority of the teachers had also spent between 6-15 hours in formal in-service/ professional development.

5.2.2.11 CONCLUSION

Based on the responses received from the TIMSS questionnaire, the following conclusions can be drawn. Many teachers concentrate on understanding the school's curricular goals and collaborating to improve student achievement. Also, schools located in safe neighbourhood are a top priority of many teachers. Many teachers lack adequate technological resources and instructional materials and supplies to teach mathematics. A majority of the teachers share learning outcomes from their teaching experiences. Many of the teachers are proud of their profession and would appreciate if they got more time to help individual students. During a TIMSS class, many teachers connect new content to the students' previous knowledge and encourage the learners to express ideas in class. However, many teachers struggled with uninterested students and learners that do not have the necessary knowledge or skills. Many of the teachers become confident whenever they inspire students to learn mathematics. In addition, they like it when the students listen to them while they explain new concepts in mathematics. Many students do not use calculators and computers during a mathematics lesson. It was also clear that most teachers prefer tutoring on adding, subtracting, multiplying, and/ or dividing with whole numbers; measuring and estimation of parallel and perpendicular lines; and reading and representing data from tables, pictographs, bar graphs or pie charts. Students received homework requests on almost daily basis, but many of the teachers placed very little or no emphasis on assessment. Lastly, it was also evident that many teachers have participated in mathematics pedagogy/ instruction, but many of them need to undergo training on mathematics assessment.

5.3 The factors impacting student achievement.

To determine the factors impacting student achievement, the data were analysed to determine whether to accept or reject hypothesized relationships leading to student achievement. First of all, a variable that could represent student achievement was identified: the students' ability to reach the school's academic goals. The first step was to identify the set of variables that could be used to form a workable model that reflects the factors that could significantly contribute to enhancing the students' ability. First, a correlation analysis was conducted. Since all the variables were found to be significantly correlated with each other, it made it difficult to determine which variables could be better predictors of student achievement.

This led to conducting an Artificial Neural Network (ANN) with a multilayer perceptron. One of the drawbacks of ANN is that it indicates possible relationships between the dependent and the independent variables and cannot help in specifying whether the relationship is linear or non-linear. Therefore, the variables selected as the best fit for the model must be tested using the OLS regression test to determine linearity.

The ANN model returned results with a training error of 33.9% and a testing error of 39.7%. From the parameter estimates, three hidden layers and five outputs were identified. The model and set of independent variables were identified by examining the most important independent variable and its normalised importance. Out of the 16 independent variables, students' desire to do well in school was found to be the most important, at 0.144 with normalized importance of 100%. Using this variable, other variables with larger synaptic weights were further identified. These corresponded to hidden layer 2 and output layer 5. The set of chosen independent variables, their synaptic weights, and their importance and normalised importance are shown below.

Table 5-23 The independent variables were chosen based on their synaptic weights corresponding to hidden layer 2.

	H(1:2)	Importance	Normalized Importance
Success in implementing school curricular	-0.297	0.048	33.60%
Expectations for student achievement	-0.503	0.092	63.80%
Working together to improve student achievement	-0.369	0.068	47.60%
Parental commitment to student readiness to learn	-0.375	0.027	18.60%
Parental expectations for student achievement	-0.543	0.073	50.70%
Parental support for student achievement	-0.379	0.07	48.90%
Parental pressure to maintain high academic standards	-0.498	0.046	31.70%
Students' desire to do well in school	-1.062	0.144	100.00%
Students' respect for classmates who excel	0.693	0.054	37.40%
Collaboration between school leadership and teachers	0.341	0.073	50.70%
Leadership support for professional development	-0.243	0.056	38.80%

5.3.1 Testing the chosen independent variables for linearity.

The chosen independent variables were tested to determine if they had a linear relationship with the dependent variable- students' ability to reach the school's academic goals. The model returned an R square value of 0.530 which means that 53% of the variance in the dependent variable could be explained by the independent variables. This model was also found to be significant at a 99% confidence level (p 0.000). Out of the 16 variables, five were found to lack significance while the remaining were found to be significant at 95% and 99% confidence levels. Out of all the significant factors, the collaboration between the teachers and school leadership was found to negatively and significantly related to student achievement. The reverse relationship seems to contradict the literature, and therefore, may be coincidental and is thus dropped from further considerations.

Table 5-24 The regression model for the emphasis on academic success

	Student achievement
The model (R squared)	*0.530****
(Constant)	0.069
Students' desire to do well in school	0.275***
Expectations for student achievement	0.153**
Parental expectations for student achievement	0.055
Collaboration between school leadership and teachers	-0.157**
Parental support for student achievement	0.161**
Working together to improve student achievement	0.075
Students' respect for classmates who excel	0.157**
Success in implementing school curricular	0.031
Parental pressure to maintain high academic standards	0.066
Leadership support for professional development	0.157***
Parental commitment to student readiness to learn	-0.041

Other relationships were based on hypotheses developed from a theoretical understanding of possible relationships between variables.

5.3.2 Other factors that could impact student achievement:

The other factors that could impact student achievement were hypothesised as follows:

H1a: Teaching methods positively and significantly impact the student's ability to reach the school's academic goals.

H10: Teaching methods have no relationship with the student's ability to reach the school's academic goals.

H2a: Limitations in teaching negatively and significantly impact the student's ability to reach the school's academic goals.

H20: Limitations in teaching has no relationship with the student's ability to reach the school's academic goals.

H3a: The use of computers or calculators positively and significantly impact the student's ability to reach the school's academic goals

H30: The use of computers or calculators has no relationship with the student's ability to reach the school's academic goals

H4a: Homework and assessment positively and significantly impact the student's ability to reach the school's academic goals.

H40: Homework and assessment has no relationship with the student's ability to reach the school's academic goals.

H5a: The classroom experience positively and significantly impacts the student's ability to reach the school's academic goals.

H50: The classroom experience has no relationship with the student's ability to reach the school's academic goals.

H6a: The content taught positively and significantly impact the student's ability to reach the school's academic goals.

H60: The content taught has no relationship with the student's ability to reach the school's academic goals.

H7a: The school environment positively and significantly impacts the student's ability to reach the school's academic goals.

H70: The school environment has no relationship with the student's ability to reach the school's academic goals.

H8a: Problems within the school environment negatively and significantly impact the student's ability to reach the school's academic goals.

H80: Problems within the school environment have no relationship with the student's ability to reach the school's academic goals.

H9a: The teacher's intention to continue teaching positively and significantly impact the student's ability to reach the school's academic goals.

H90: The teacher's intention to continue teaching has no relationship with the student's ability to reach the school's academic goals.

Testing H1: Teaching methods and student achievement

The model was found to be significant (R squared 0.148, $p<0.01$, CL 99%). Further, one teaching method was found to positively and significantly contribute to students' ability to reach the school's academic goals – encourage students to express their ideas (0.273, $p<0.01$, CL 99%). Therefore, the null hypothesis is rejected and it is inferred that encouraging students to express their ideas (a teaching method) positively and significantly impacts student achievement.

Table 5-25 The impact of teaching methods on academic success

	Student achievement
Model (R squared)	*0.148****
(Constant)	2.198***
Relate lesson to students' daily lives	0.036
Ask students to explain their answers	-0.045
Bring interesting material to the class	0.084
Provide challenging exercises beyond the classroom	-0.019
Encourage classroom discussion	0.147
Link new content to students' prior knowledge	0.025
Ask students to devise their problem-solving procedures	-0.018
Encourage students to express their ideas	0.273***

Testing H2: Limitations in teaching and student achievement

The model was found to be significant (R squared 0.182, $p<0.01$, CL 99%). Two limitations were also found to negatively lower student achievement including students' lack of prerequisite knowledge and skills (-0.265, $p<0.05$, CL 95%) and students' lack of enough sleep (-0.280, $p<0.05$, CL 95%). Hypothesis 2 is thus proven and it can be inferred that students' lack of prerequisite knowledge and skills and lack of enough sleep (limitations in teaching) negatively and significantly impact student achievement.

Table 5-26 The impacts of limitations on student success

	Student achievement
Model (R squared)	*0.182****
(Constant)	4.029***
Students lack prerequisite knowledge/skills	-0.265**
Students lack basic nutrition	-0.188
Students lack enough sleep	-0.28**
Students are disruptive	-0.182
Students are uninterested	0.01
Students have physical disabilities	0.136
Students have mental, emotional or psychological disabilities	-0.085
Teaching time spent in minutes	0.001

Testing H3: The use of computers and calculators and student achievement

The model was found to be significant (R squared 0.089, $p<0.05$, CL 95%). However, none of the coefficients were significant. Therefore, the null hypothesis was adopted that the use of computers and calculators has no impact on student achievement.

Table 5-27 The impact of computers or calculators on student achievement

	Student achievement
Model (R squared)	*0.089***
(Constant)	3.267***
Permission to use calculators during lessons	-0.026
Availability of computers during the lessons	-1.393
Each student has a computer	-1.17
Shareable computers in class	0.433
Computers in school that students can use sometimes	-0.046
Explore mathematics principles & concepts	0.545
Practice skills and procedures	-0.048
Look up ideas and information	0.198

Testing H4: Homework and assessments and student achievement

The model was found to be significant (R squared 0.128, p<0.01, CL 99%). One coefficient was also found to be significant – emphasis on assessing students' ongoing work (0.511, p<0.01, CL 99%). The null hypothesis is thus rejected, and it is inferred that the emphasis on assessing students' ongoing work (homework assessment) positively and significantly impacts student achievement.

Table 5-28 The impact of homework and assessment on student achievement

Model (R squared)	Student achievement *0.128****
(Constant)	1.406**
How often is homework assigned	0.078
Time spent on homework	-0.152
Corrects assignments and give feedback	0.098
Discuss the homework in class	0.016
Monitor whether or not, the homework was completed	-0.123
Emphasis on assessing students' ongoing work	0.511***
Emphasis on classroom tests	0.138
Emphasis on national or regional achievement tests	0.066

Testing H5: The classroom experience and student achievement

The model was found to be significant (R squared 0.166, $p<0.01$, CL 99%). Two factors were further found to positively and significantly contribute to student achievement – asking students to listen to an explanation on how to solve problems (0.273, $p<0.05$, CL 95%) and asking students to work problems individually with the teacher's guidance (0.200, $p<0.05$, CL 95%). The null is thus rejected, and it is inferred that asking students to listen to an explanation on how to solve problems and to solve problems individually with the teacher's guidance (the classroom experience) positively and significantly impact student achievement.

Table 5-29 The impact of classroom experience on student achievement

Model (R squared)	Student achievement *0.166****
(Constant)	2.234***
Listen to an explanation of a new concept	-0.131
Listen to an explanation of how to solve problems	0.273**
Memorize rules, procedures, and facts	-0.042
Work problems individually with the teacher's guidance	0.2**
Work problems as a class with teacher's guidance	0.056
Work problems individually while occupied with other tasks	-0.106
Work in mixed abilities groups	0.124
Work in same abilities groups	0.115

Testing H6: The content covered and student achievement.

The impact of content (topics taught) was examined using three separate regression models: numbers, geometry, and data display. Out of the three models, only one model was found to be significant – Numbers (R squared 0.106, $p<0.01$, CL 99%). In the significant model, only one factor positively and significantly related to student achievement – multiples and factors, even and odd numbers (0.210, $p<0.05$, CL 95%). The null is thus rejected, and it is inferred that teaching multiples and factors, even and odd numbers (content covered: numbers) is positively and significantly related to student achievement.

Table 5-30 The impact of content covered on student achievement.

	Student achievement
Model 1: Numbers (R squared)	*0.106****
(Constant)	1.983***
Concepts of whole numbers	0.146
Addition, subtraction, multiplication	0.173
Multiples and factors, even and odd numbers	0.21**
Concepts of fractions	0.077
Adding and subtracting fractions	-0.2
Concepts of decimals	0.264
Number patterns	-0.065
Model 2: Geometry (R Squared)	*0.046*
(Constant)	2.952***
Lines	-0.074
Angles	0.161
Coordinate systems	-0.021
Geometric shapes	0.068
Reflection and rotation	0.025
Relationships between shapes	-0.24
Estimating between areas	0.273
Model 3: Data display (R squared)	*0.007*
(Constant)	3.281***
Read and display data	0.152
Draw conclusions	-0.132

Testing H7: The school environment and student achievement

The model was found to be significant (R squared 0.207, $p<0.01$, CL 99%). Moreover, one factor was found to positively and significantly impact student achievement – students respect school property (0.281, $p<0.01$, CL 99%). The null is thus rejected, and it is inferred that the respect of school property (school environment) positively and significantly impacts student achievement.

Table 5-31 The impact of the school environment on academic success.

Model (R squared)	Student achievement 0.207***
(Constant)	1.353***
School is located in a safe neighbourhood	-0.022
The teacher feels safe at school	0.174
School's security policies are sufficient	0.057
Student's behave in an orderly manner	-0.04
Students respect teachers	0.016
Students respect school property	0.281***
The school has clear rules about student conduct	0.191
School rules are reinforced fairly and consistently	-0.06

Testing H8: Problems in the school environment and student achievement

The model was found to be significant (R squared 0.221, p<0.01, CL 99%). Two problems within the school environment were found to lower student achievement – teachers don't have adequate instructional supplies (-0. 152, p<0.01, CL 99%) and school classrooms and not cleaned often enough (-0. 171, p<0.01, CL 99%). The null hypothesis is therefore rejected, and it is inferred that inadequate instructional supplies and not often cleaned classrooms (problems within the school environment) negatively and significantly impact student achievement.

Table 5-32 The impact of the problems in the school environment on student achievement.

Model (R squared)	Student achievement 0.221***
(Constant)	3.823***
School buildings need significant repair	-0.083
Teachers don't have adequate workspace	-0.041
Teachers don't have adequate instructional materials and supplies	-0.152***
School classrooms are not cleaned often enough	-0.171***
School classrooms need maintenance work	-0.043
Teachers lack adequate technological resources	0.111
Teachers lack adequate support for technology use	-0.091

Testing H9: The teacher's intention to continue teaching and student achievement.

The teacher's intention to continue teaching was a single environment drawn from feelings about being a teacher. Aside from the independent variable, demographic variables were also used as control variables. The model was found to be significant (R squared 0.119, p<0.05, CL 95%). All the demographic variables were found to be insignificant. However, the independent variable- continuing to teach positively and significantly related to student achievement (2.675, p<0.01, CL 99%). The null is thus rejected, and it is inferred that teachers' feelings about their willingness to continue teaching positively and significantly impact student achievement.

Table 5-33 The impact of teachers' turnover intentions on student achievement.

Model (R squared)	Student achievement *0.119***
(Constant)	2.675***
Continuing to teach (turnover)	0.264***
Demographic (control)	
Years been teaching	0.025
Teacher's gender	-0.193
Teacher's age	-0.12
Highest level of education	0.05

5.3.3 Other Factors that Impact Significant Predictors of Student Achievement

To understand the web of causation, other possible theoretical relationships between the variables and significant predictors of student achievement were tested. These findings are presented below.

The impact of feelings about being a teacher:

The researcher sought to determine the impact of feelings about being a teacher on the teachers' intention to continue teaching. Two factors were found to be significantly related to the predictor: years been teaching (-0.032, p<0.05, CL 95%) and contentment with the profession (0.661, p<0.01, CL 99%). These imply that younger teachers who are more contented with their profession are more likely to have higher feelings of continuing to teach (lower turnover intentions).

Table 5-34 The impact of feelings about being a teacher on significant predictors.

Model (R squared)	Continuing to teach *665****
(Constant)	0.208
Demographic (control)	
Years been teaching	-0.032**
Teacher's gender	0.026
Teacher's age	-0.032
Highest level of education	0.006
Independent variables	
Content with profession	0.661***
Satisfied with being a teacher	-0.045
Work is meaningful and purposeful	0.171
Enthusiastic about job	0.219
Inspired by work	0.135
Proud of the work	-0.142

The impact of curriculum:

Measures of the curriculum under the school emphasis on academic achievement were either excluded from the initial model (success in implementing the school curriculum) or found to be insignificant (understanding curricular goals). However, the researcher thought these could impact the teachers' expectations of student achievement, which was a significant predictor of student achievement. According to the findings, the model is significant (R square 0.275, p<0.01, CL 99%). Examining the coefficients, success in implementing school curricular positively and significantly impacts teachers' expectations of student achievement (0.371, p<0.01, CL 99%). Also, understanding of curricular goals positively and significantly impacts teachers' expectations of student achievement (0.186, p<0.05, CL 95%).

Table 5-35 The relationship between curricular and expectations of student achievement.

	Expectations for student achievement
Model (R squared)	0.275***
(Constant)	1.261***
School emphasis on academic success/Success in implementing school curricular	0.371***
School emphasis on academic success/Understanding of curricular goals	0.186**

The impact of confidence:

Of the three models, only two were found to be significant: encourage students to express their ideas (R square 0.287, $p<0.01$, CL 99%), and work problems individually with the teachers' guidance (R square 0.294, $p<0.01$, CL 99%). Moreover, the findings show that the confidence to develop students' higher-order thinking skills positively and significantly impacts the encouragement of students to express their ideas (0.282, $p<0.05$, CL 95%). However, for the second model, gender was found to be negatively and significantly associated with working problems individually with the teachers' guidance (-0.462, $p<0.01$, CL 99%). This implies that female teachers tend to ask students more, to work problems individually with their guidance.

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Table 5-36 The relationship between confidence and other predictors

	Teaching methods	Frequency of asking	
	Encourage students to express their ideas	Listen to an explanation of how to solve problems	Work problems individually with the teacher's guidance
Model (R squared)	*0.287****	*0.162*	*0.294****
(Constant)	0.215	1.34	1.234
Years been teaching	-0.004	0.025	-0.007
Teacher's gender	-0.048	-0.123	-0.462***
Highest level of education	-0.04	0.043	-0.016
Teacher's age	0.022	-0.226	0.146
Confidence to inspire students to learn mathematics	0.072	0.12	0.075
Confidence to show students a variety of problem-solving strategies	0.158	-0.003	0.01
Confidence to provide challenging tasks to high achievers	0.129	0.001	-0.093
Confidence to adapt teaching to engage students' interest	-0.038	0.157	-0.138
Confidence to help students appreciate Mathematics	0.029	0.051	0.081
Confidence to assess students' comprehension	0.042	-0.123	0.205
Confidence to improve the understanding of struggling students	-0.009	-0.087	0.022
Confidence to make mathematics relevant	0.081	0.108	0.106
Confidence to develop students' higher-order thinking skills	0.282**	0.218	0.226

The impact of interactions with other teachers:

All the models were found to be significant including contentment with profession (R square 0.303, p<0.01, CL 99%), success in implementing the school curricular (R square 0.302, p<0.01, CL 99%), understanding curricular goals (R square 0.247, p<0.01, CL 99%), and the confidence to students' higher-order thinking skills (R square 0.202, p<0.01, CL 99%), the confidence to inspire students to learn mathematics (R square 0.119, p<0.01, CL 99%) and the confidence to improve the understanding of struggling students (R square 0.224, p<0.01, CL 99%). Significant relationships are stated as follows:

- Working as a group to implement the curriculum positively and significantly impacts contentment with the profession (0.387, p<0.01, CL 99%) especially among less-educated teachers (-0.189, p<0.01, CL 99%).
- Working as a group to implement the curriculum positively and significantly impacts the success of implementing the school curriculum (0.427, p<0.01, CL 99%)
- Working as a group to implement the school curriculum positively and significantly impacts understanding of curricular goals (0.246, p<0.01, CL 99%)
- Working as a group to implement the school curriculum positively and significantly impacts teachers' confidence to inspire students to learn mathematics (0.130, p<0.05, CL 95%)
- Working as a group to implement the school curriculum positively and significantly impacts teachers' confidence to improve the understanding of struggling students (0.268, p<0.01, CL 99%)
- Working together to try new ideas positively and significantly impacts teachers' confidence to develop students' higher-order thinking skills (0.207, p<0.05, CL 95%)

Table 5-37 The relationship between the interaction between teachers and significant predictors

	Feelings	Curricular		Confidence		
	Content with profession	Success in implementing school curricular	Understanding of curricular goals	To develop students' higher-order thinking skills	To inspire students to learn mathematics	To improve the understanding of struggling students
Model (R squared)	0.303***	0.302***	0.247***	0.202***	0.119***	0.224***
(Constant)	2.226***	2.609***	2.922***	2.132***	3.084***	1.798***
Years been teaching	-0.014					
Teacher's gender	0.061					
Highest level of education	-0.189***					
Teacher's age	0.275					
Discuss how to teach	0.019	0.107	0.033	0.016	-0.002	-0.073
Collaboration in planning and preparing instructional material	0.045	0.005	0.023	-0.066	-0.005	0.15
Sharing learned experiences	0.139	-0.114	-0.079	-0.108	0.06	-0.002
Visit another classroom to enhance learning about teaching	-0.125	0.137	0.117	0.167	-0.003	0.094
Working together to try new ideas	-0.016	-0.082	0.131	0.207**	0.061	-0.135
Work as a group to implement curriculum	0.387***	0.427***	0.246***	0.173	0.13**	0.268***
Work with teachers from other grades for continuity of learning	0.002	-0.002	-0.028	-0.012	-0.021	0.131

The impact of the school environment:

The model was found to be significant (R square 0.336, p<0.01, CL 99%), with students' respect for school property established to positively and significantly impact teachers' contentment with the profession (0.328, p<0.01, CL 99%). This implies that an increase in students' respect for school property enhances teachers' contentment with their profession.

Table 5-38 The relationship between the school environment and teachers' contentment with the profession

	Feelings about being a teacher
	Content with profession
Model (R squared)	*0.336****
(Constant)	1.116
Years been teaching	-0.002
Teacher's gender	-0.05
Highest level of education	-0.095
Teacher's age	0.178
School is located in a safe neighbourhood	-0.107
The teacher feels safe at school	0.098
School's security policies are sufficient	0.122
Students behave in an orderly manner	-0.034
Students respect teachers	0.202
Students respect school property	0.328***
The school has clear rules about student conduct	0.094
School rules are reinforced fairly and consistently	-0.004

In testing the perceived relationship between problems within the school environment and contentment with the profession, the model was found to be significant (R square 0.167, p<0.05, CL 95%). From the significant coefficients, it is established that the level of education relates negatively and significantly with contentment (-0.179, p<0.05, CL 95%), Thus, persons who have lower levels of education are more likely to be more content with their profession.

Table 5-39 The relationship between problems within the school environment and contentment with the profession

	Feelings about being a teacher
	Content with profession
Model (R squared)	*0.167***
(Constant)	4.067***
Years been teaching	-0.013
Teacher's gender	-0.183
Highest level of education	-0.179**
Teacher's age	0.268
School buildings need significant repair	-0.097
Teachers don't have adequate workspace	-0.121
Teachers don't have adequate instructional materials and supplies	0.032
School classrooms are not cleaned often enough	-0.108
School classrooms need maintenance work	0.078
Teachers lack adequate technological resources	-0.043
Teachers lack adequate support for technology use	-0.015

The impact of classroom experience:

One model was found to be significant content with the profession (R square 0.220, p<0.01, CL 99%). It was established that too many teaching hours significantly lower the feelings of contentment with the profession (-0.184, p<0.05, CL 95%), especially among the teachers with lower levels of education (-0.166, p<0.05, CL 95%).

Table 5-40 The relationship between classroom experience and significant predictors

	Feelings about being a teacher	Frequency of asking	
	Content with profession	Listen to an explanation of how to solve problems	Work problems individually with the teacher's guidance
Model (R squared)	*0.22****	*0.12*	*0.11*
(Constant)	4.736***	1.859***	1.973***
Years been teaching	-0.016		
Teacher's gender	-0.144		
Highest level of education	-0.166**		
Teacher's age	0.312		
Too many students in the class	-0.106	-0.089	0.035
Too much material to cover	0.041	0.155**	0.159
Too many teaching hours	-0.184**	0.018	-0.143
Need for more time to prepare	0.042	0.005	-0.014
Need more time to assist individual students	-0.209	0.039	0.107
Too much pressure from parents	-0.062	0.004	0.111
Difficulty keeping up with curriculum changes	0.13	0.045	-0.001
Too many administrative tasks	0.05	-0.147**	-0.153***
Number of students in the class		0.011	0.003
Number of students in fourth grade		0.008	-0.003
Number of students with test language difficulties		-0.008	-0.021

The impacts of topics taught:

All the models were found to lack significance and therefore, the perceived relationship between the topics covered and significant predictors does not stand.

Table 5-41 The perceived relationship between the topics covered in class and significant predictors.

	Curricular	
	Understanding of curricular goals	Success in implementing school curricular
Model (R squared)	*0.119*	*0.123*
(Constant)	2.789***	2.701***
Concepts of whole numbers	-0.005	-0.06
Addition, subtraction, multiplication	0.038	0.24
Multiples and factors, even and odd numbers	0.137	0.181
Concepts of fractions	0.274	0.06
Adding and subtracting fractions	0.059	0.127
Concepts of decimals	0.15	0.163
Number sentences	0.053	0.105
Number patterns	-0.048	0.059
Geometry topics		
Lines	-0.058	-0.211**
Angles	0.134	0.014
Coordinate systems	-0.024	-0.15
Geometric shapes	0.036	0.101
Reflection and rotation	-0.043	0.026
Relationships between shapes	-0.023	0.183
Estimating between areas	-0.048	-0.23
Data display topics		
Read and display data	-0.338**	-0.029
Draw conclusions	0.33	-0.019

The impact of teacher feelings of preparedness:

Of all the relationships examined, only one model was found to be significant – multiples and factors, even and odd numbers (R square 0.214, $p<0.05$, CL 95%). From the significant model, one coefficient is significant. Therefore, teacher preparedness to teach concepts of multiples and factors positively and significantly impacts coverage of multiple factors, even and odd numbers (0.246, $p<0.01$, CL 99%).

Table 5-42 The relationship between the preparedness to teach numbers and significant predictors.

	Teaching methods	Topic numbers
	Encourage students to express their ideas	Multiples and factors, even and odd numbers
Model 1: Numbers (R squared)	*0.137*	*0.214***
(Constant)	2.686	2.283***
Years been teaching	-0.011	0.007
Teacher's gender	-0.227	-0.112
Highest level of education	-0.049	0.01
Teacher's age	0.115	-0.085
Concepts of whole numbers	0.254**	-0.108
Adding, subtracting, multiplying	-0.453***	0.066
Concepts of multiples and factors	0.039	0.246***
Concepts of fractions	0.169	-0.142
Adding and subtracting with fractions	0.064	-0.036
Concepts of decimals	0.058	0.173
Number sentences	0.045	-0.05
Number patterns	-0.121	-0.092

All the models were found to lack significance and therefore, the perceived relationship between preparedness to teach geometry topics and significant predictors do not stand.

Table 5-43 The perceived relationship between the preparedness to teach geometry and significant predictors.

	Teaching methods Encourage students to express their ideas	Topic numbers Multiples and factors, even and odd numbers
Model 2: Geometry (R squared)	*0.077*	*.324[a]*
(Constant)	2.687***	2.354***
Years been teaching	-0.008	0
Teacher's gender	-0.283	-0.274
Highest level of education	0.01	-0.017
Teacher's age	0.115	-0.047
Number patterns	-0.028	
Lines	0.017	-0.048
Angles	-0.073	-0.049
Coordinate systems	0.048	0.046
Geometric shapes	0.117	0.109
Reflection and rotation	-0.027	0.096
Relationships between shapes	0.052	0.065
Finding and estimating areas	-0.151	-0.045

All the models were found to lack significance and therefore, the perceived relationship between preparedness to teach data display and significant predictors do not stand.

Table 5-44 The perceived relationship between the preparedness to teach data display topics and significant predictors.

	Teaching methods Encourage students to express their ideas	Topic numbers Multiples and factors, even and odd numbers
Model 3: Data display (R squared)	*0.038*	*.220[a]*
(Constant)	2.537***	2.781***
Years been teaching	-0.009	-0.004
Teacher's gender	-0.249	-0.214
Highest level of education	-0.007	-0.052
Teacher's age	0.075	-0.062
Reading and representing data	0.076	0.161
Drawing conclusions	0.003	-0.133

The impact of professional development:

Of the relationships tested, only two models were found to be significant: confidence to develop students thinking skills (R square 0.230, p<0.01, CL 99%) and the confidence to improve the understanding of struggling students (R square 0.209, p<0.05, CL 95%). Examining the coefficients of the significant models, it was established that professional development aimed at the improvement of critical thinking or problem-solving skills positively and significantly impact teachers' confidence to develop students' higher-order thinking skills (0.436, p<0.01, CL 99%) and especially among female teachers (-0.335, p<0.01, CL 99%). Also, professional development in pedagogy or instruction positively and significantly impact teachers' confidence to improve the understanding of struggling students (0.513, p<0.05, CL 95%).

Table 5-45 The relationship between professional development and significant predictors

	Teaching methods	Teacher preparedness	Confidence		
	Encourage students to express their ideas	Concepts of multiples and factors	To develop students' higher-order thinking skills	To inspire students to learn mathematics	To improve the understanding of struggling students
Model (R squared)	*0.18*	*0.073*	*0.23****	*0.162*	*0.209***
(Constant)	2.108***	3.314***	2.953***	3.249***	3.047***
Years been teaching	-0.002	-0.005	0.007	0.007	0.006
Teacher's gender	-0.212	-0.282	-0.335**	-0.075	-0.226
Highest level of education	0.014	-0.123	0.077	0.026	0.134
Teacher's age	0.046	-0.05	-0.052	0.047	-0.254
Mathematics content	-0.048	0.243	-0.133	-0.169	0.038
Mathematics pedagogy or instruction	0.295	-0.123	0.368	0.176	0.513**
Mathematics curriculum	-0.187	-0.268	0.061	-0.025	-0.317
Integrating IT into the curriculum	-0.129	-0.133	0.006	-0.068	0.074
Improving critical thinking or problem-solving skills	0.28	0.085	0.436**	0.254**	0.207

Mathematics assessment	-0.043	0.165	0.064	0.187	-0.219
Addressing individual student needs	0.099	0.019	-0.199	0.058	0.111
Hours in professional development	0.153**	0.136	0.08	0.026	0.026

The impact of majors studied:

The perceived relationship between the majors and teacher confidence does not stand since none of the models was found to be significant.

Table 5-46 The perceived relationship between teachers' majors and significant predictors

	Teacher confidence to:		
	To develop students' higher-order thinking skills	To inspire students to learn mathematics	To improve the understanding of struggling students
Model (R squared)	*0.094*	*0.135*	*0.074*
(Constant)	3.412***	3.854***	3.142***
Years been teaching	0.013	0.008	0.004
Teacher's gender	-0.23	-0.125	-0.146
Highest level of education	0.1	0.05	0.15
Teacher's age	-0.098	-0.032	-0.174
Education - primary/elementary	-0.087	-0.135	0.008
Education-secondary	-0.629	-0.559***	-0.304
Mathematics	-0.269	-0.122	-0.233
Science	0.325	0.223	0.169
Language test	0.047	0.294	-0.13
/Other	0.355	-0.059	0.252

The impact of specialization:

All the models were found to lack significance and therefore, the perceived relationship between specialization and teacher confidence does not stand.

Table 5-47 The perceived relationship between specialization and significant predictors

	Teacher confidence:		
	To develop students' higher-order thinking skills	To inspire students to learn mathematics	To develop students' higher-order thinking skills
Model (R squared)	*0.061*	*0.052*	*0.061*
(Constant)	3.66***3	3.799***	3.663***
Years been teaching	0.008	0.005	0.008
Teacher's gender	-0.287	-0.102	-0.287
Highest level of education	0.05	-0.018	0.05
Teacher's age	-0.099	0.029	-0.099
Mathematics	-0.04	0.004	-0.04
Science	0.086	0.134	0.086
Language/reading	-1.289	0.139	-1.289
Other subjects	0.091	0.287	0.091

Exploring the Significant Demographic Variables

Of the significant variables, gender was found to have negative and significant impacts on the confidence to develop higher-order skills and the frequency of asking students to work problems individually with the teacher's guidance. Moreover, education was also found to have negative and significant impacts on contentment with the profession.

Exploring the impact of gender

The impact of gender was further explored using independent samples t-test, and the computation of Cohen's d from the t-test findings to determine the effect size. The Cohen's d was computed in MS Excel from the t-test as follows:

$$d = t\sqrt{\frac{N_1 + N_2}{N_1 N_2}}$$

Table 5-48 The findings of t-test and computation of Cohen's d

		Work problems individually with the teacher's guidance	Confidence to develop students' higher-order thinking skills
N1	Female	89.0000	92.0000
N2	Male	90.0000	94.0000
Mean1	Female	2.6517	3.3478
Mean2	Male	2.1000	3.0106
SD	Female	0.6589	0.6864
	Male	0.8618	0.8230
t	Equal variances assumed	4.8075	3.0312
	Equal variances not assumed	4.8146	3.0371
Sig. (2-tailed)	Equal variances assumed	0.0000	0.0028
	Equal variances not assumed	0.0000	0.0027
	N1+N2	179.0000	186.0000
	N1*N2	8010.0000	8648.0000
	(N1+N2)/(N1*N2)	0.0223	0.0215
	Square root	0.1495	0.1467
	Cohen's d	**0.7187**	**0.4445**

The t-test findings indicate that females have a significantly higher mean compared to the males for both working problems individually with the teacher’s guidance (Female 2.6517>Male 2.1000, $p<0.01$ CL 99%) and for the confidence to develop higher-order thinking skills ((Female 3.3478>Male 3.0106, $p<0.01$ CL 99%). When the effect size is examined, it is established that for working problems individually with the teacher’s guidance, the effect size is moderate (>0.50) indicating that there is a 0.7187standard deviation difference between the two groups. For the confidence to develop students' higher-order thinking skills, the effect size is small (>0.20) indicating that there is a 0.445 standard deviation difference between the males and the females.

Exploring the impact of the highest level of education:

The highest level of education was established to be negatively and significantly related to the feeling of contentment with the profession. To further explore this relationship, gender and feeling of contentment with profession were analysed using a cross tab, and the dependence of the subgroups evaluated using the chi-square test. From the bar chart below, it is observed that at lower levels of education (did not complete upper secondary, upper secondary and post-secondary non-tertiary) the respondents were either very content or often content. Although at the bachelor's level, the majority were very often content, those who were never or almost never content were also a number, same as those who were content only sometimes. Additionally, at the master’s level, those who indicated being very content, and those who were never content were of the same number.

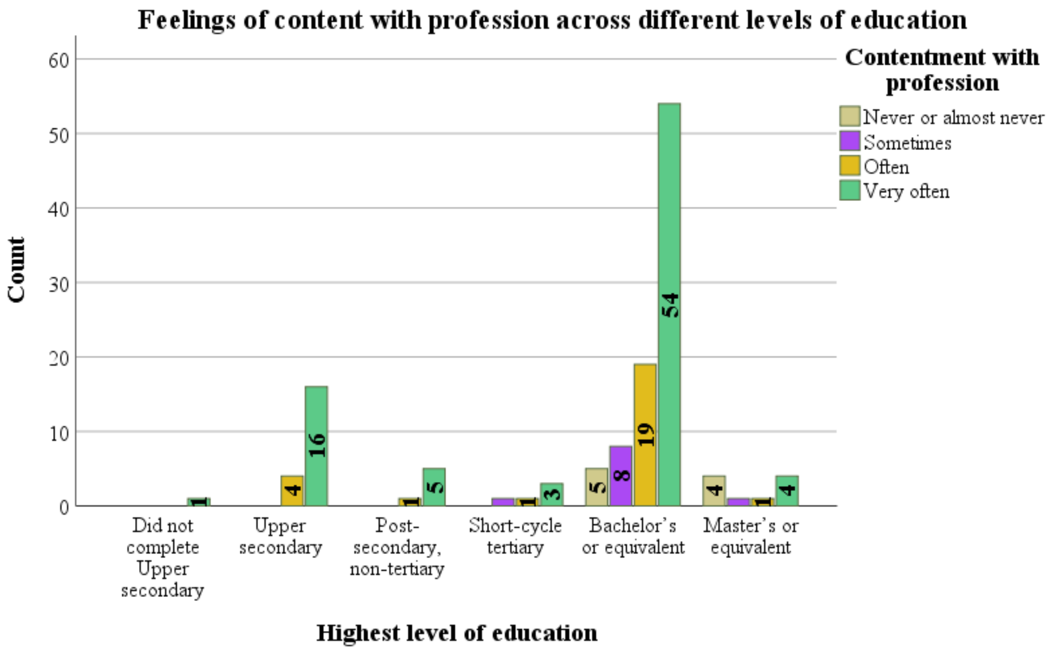

Figure 5-18 The distribution of contentment across different professions

Considering the chi-square test, the null hypothesis is that there is no relationship between the categorical variables. The findings show that there is statistically no relationship between the level of education and contentment (x (15) 24.398, p>0.05).

Table 5-49 The findings of the chi-square test

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.398[a]	15	0.059
Likelihood Ratio	20.690	15	0.147
Linear-by-Linear Association	9.129	1	0.003
N of Valid Cases	128		

The chi-square test is not reliable when there are too many cells that have low counts. In this case, the test results showed that 18 cells (75%) had an expected count of less than five. Therefore, the independence implied here may not be relied upon.

Other Tests:

Other tests were conducted to validate the findings of this study. These mainly concerned the reliability of the scales and the entire sample. The findings are presented by the scale examined. Most of the scales had very high levels of reliability above 0.7. However, one scale had a very low level of reliability – mathematics assessment with a score of only 0.375. The two other scales below 0.7 were limitations to teaching (0.579) and topics taught: numbers (0.665). Overall, the level of reliability is high.

Table 5-50 The reliability for all the scales

Scale	Number of items	Cronbach's alpha
School emphasis on academic success	17	0.924
School environment	8	0.864
Problems in the school environment	7	0.869
Interactions with teachers	7	0.908
Teachers' feelings about work	7	0.909
Teachers experience in class	8	0.729
Teaching methods	8	0.777
Limitations to teaching	7	0.579
Confidence	9	0.880
Frequency of asking	9	0.705
Topics taught numbers	8	0.665
Topics taught geometry	7	0.716
Topics taught Data display	2	0.817
Do with homework	3	0.789
Mathematics assessment	3	0.375
Teacher feelings of preparedness: numbers	8	0.728
Teacher feelings of preparedness: Geometry	7	0.717
Teacher feelings of preparedness: Data display	2	0.830

5.3.4 Conclusion

The findings above show that student achievement emanates from a complex set of causative factors. The most important factor as indicated in the ANN is the student's desire to do well in school. Also, it was established that curriculum success or understanding does not have a direct impact on student achievement, but it impacts the teachers' expectations of student achievement which positively and significantly impact the ability to succeed. Of all the other factors that impact significant predictors of student achievement, the interactions between teachers emerged as the most influential, impacting the most number of variables which in turn have positive effects on achievement. Lastly, the use of computers or calculators, or teachers' specialization or majors have no impact on student achievement or significant predictors of student achievement. The findings are largely reliable, as most of the measurement scales had values of Cronbach's alpha of more than 0.7.

5.4 DISCUSSION

The aim of the study was to examine the impact of international assessments on mathematics teacher development in the Kingdom of Saudi Arabia. To achieve this aim, the researcher investigated the factors contributing to low TIMSS scores; examined how TIMSS scores can promote teaching recommendations in the mathematics subject; and identified strategies used to teach mathematics in KSA and compared them to the established standards in the Singaporean Education System. The key research question tied to this research question, therefore, was "Is there a link between international assessment scores and mathematics development practices in KSA?" This chapter discusses the findings tied to the aims, objectives, and research questions and ties them to previous literature reviewed in the earlier chapters of this study.

5.4.1 Factors contributing to low TIMSS scores.

TIMSS provides student achievement data along with background data through the self-report questionnaires. From this data, it is possible to discover student level factors that are crucial in predicting mathematics achievement. Comparing the factors that are important in predicting achievement provides a broad understanding of achievement differences and how they are related to certain background characteristics.

The study findings identified two limitations that negatively contributed to low TIMSS scores. These factors included the students' lack of prerequisite knowledge and skills and the lack of enough sleep. If students start a mathematics class without the prerequisite knowledge, they may have challenges making sense of learning materials and eventually fall behind. Such an encounter can have a negative effect on their ability to effectively meet learning outcomes for the course. Additionally, if the learners' prior knowledge about the mathematics topic is inaccurate, they may add new knowledge on top of erroneous assumptions (Star et al., 2009). Some assumptions that teachers make about students' previous knowledge in the mathematics class can also be problematic. It is, therefore, important that teachers check out their assumptions concerning the mathematics knowledge that students bring to the class. This can be especially important for introductory classes in the mathematics subject. In one mathematics class, there could be some students with advanced knowledge sitting beside those who do not have such an opportunity. One way to identify students' understanding of prerequisite knowledge is through surveys. Teachers can conduct a survey in the first week of class to identify gaps in the students' knowledge (Star et al., 2009). This can enable teachers to develop strategies meant to address potential challenges.

The other limitation, lack of enough sleep, has a significant influence on mathematics achievement. When learners are struggling to grasp mathematical concepts, it is common to see them trying to catch up by desperately studying into the night (Engle-Friedman et al., 2003; Gunzelmann et al., 2009; Ng et al., 2009). Besides, if they are worried this could end up affecting their sleep pattern. Well, the findings of this study revealed that for mathematics performance, sleep deprivation is the worst state that a student can be in. Past research has shown that sleep is very crucial for the development of young people, and this affects their mental ability and mathematics performance at school (Engle-Friedman et al., 2003; Gunzelmann et al., 2009; Ng et al., 2009). Specifically, Ng et al. (2009) made similar observations to the current study by associating sleep deprivation with a decrease in mathematics performance. Lack of sleep also affects the physical health of learners, leading to bad behaviour that affects their cognitive abilities. Without enough sleep, students learn from reduced concentration, lowered awareness of the environment and situation, limited attention span, and diminished problem-solving abilities (Gunzelmann et al., 2009). Poor sleep patterns also reduce the ability of students to keep information they have learned (Goel et al., 2009). So, if students are recording low TIMSS scores in mathematics in KSA, it would be wise to examine the amount of decent sleep they are getting. This will probably be beneficial to the learner, enhancing their general mental and physical health and boosting their ability to pay attention, multi-task, and plan tasks on the mathematics subject. Decent sleep is most important during exam time, since stress and anxiety about time constraints could mean many students staying up late “cramming” even on nights before the exam.

Another significant finding tied to this aim was related to the problems in the school environment. The findings showed that two problems within the school environment can contribute to low TIMSS scores. These factors included teachers’ lack of adequate instructional supplies and inadequate cleaning of school classrooms. To begin with, teachers’ lack of adequate instructional supplies is the principal cause of math difficulties for most students in KSA. This notion has been supported effectively in previous studies that show that students can be taught to enhance their performance by using appropriate teaching instructional resources (Mupa & Chinooneka, 2015). Provided the lower TIMSS scores in mathematics, the progress of students is hindered without the right instructional supplies. Consequently, it is necessary to enhance their performance standards by developing teaching resources and an effective mathematics curriculum. This could also mean that without improved mathematics instruction and resources by teachers, these students may continue to experience much failure and frustration.

Related to the school environment is the cleanliness of school classrooms. The findings of the study revealed that the classroom environment has a major impact on student performance in mathematics. An inadequately cleaned classroom can present unfavourable conditions for learning. Recent studies support this finding and show that students and teachers require clean and well-ventilated classrooms to facilitate the teaching and learning process. Studies further back this up by indicating how school facilities affect health, engagement, and learning in mathematics and other subjects as well (Yang et al., 2013). Thus, these findings imply that without adequate and clean facilities, it is exceedingly difficult to serve many students, more so those with complex needs. Inadequately cleaned classrooms increase absenteeism and sickness; reduce morale and productivity; and eventually lower the test scores (Yang et al., 2013). Based on these findings, developing an efficient classroom cleanliness program makes it possible to develop a conducive learning environment.

The teacher’s intention to continue teaching might contribute to low TIMSS scores. The findings revealed that the teachers’ feelings about their willingness to continue teaching affected student achievement positively and significantly. Younger teachers were found to be more contented with their profession and were more likely to have higher feelings of continuing to teach. Eventually, this results in lower turnover intentions and better TIMSS scores. The teacher’s intention to continue teaching has been examined in previous literature from the perspective of satisfaction. For instance, Fulton and Britton (2011) suggested that many teachers are likely to be satisfied and develop an intention to continue teaching whenever there is safety in a school and when security policies and practices are enough. These conditions, together with many others, are likely to lead to better student achievement in the mathematics subject. Kraft et al. (2016) also reported similar findings by suggesting that low levels of teacher satisfaction can contribute to teacher turnover, which eventually affects student achievement. Additional factors that can enhance the teacher's intention to continue teaching as identified by Kraft et al. (2016) include better school leadership, better relationships among teachers, and improvement in academic expectations. Johnson et al. (2011) also made similar observations by indicating that a positive attitude among teachers appeared to contribute to better student outcomes, more so in the mathematics subject. From the findings of this study, together with supporting scholarly works, the school environment contributes to the teacher's intention to teach, which further affects the scores reported by students in mathematics.

5.4.2 How TIMSS scores can be used to promote teaching recommendations in the mathematics subject.

TIMSS scores can facilitate professional development. Based on the findings of the study, teachers who undergo professional development have better confidence to develop students' thinking skills and can easily help improve the understanding of struggling students. Several past scholarly studies support the claim that teacher professional development contributes to better student outcomes. For instance, Lumpe et al. (2012) suggested that participation in professional development helped predict student achievement. The outcome of another study by Bruce et al. (2010) also supports the findings of the current study by revealing high teacher efficacy and student achievement in one district upon implementing a professional learning program. These findings are further supported by those of Althauser (2015) who noted that continued professional development may contribute to better student achievement in the mathematics subject. Basically, the findings of the current study, together with those of past supporting studies, imply that any form of teacher professional development can benefit students by enhancing their performance in mathematics.

KSA mathematics teachers can use TIMSS as a tool for analysing and improving their independent practice. For example, they could do so by watching videos of other teachers teaching or they could alternatively take TIMSS test items by themselves. Additionally, TIMSS has also pinpointed interesting models that can facilitate professional development, such as the Japanese and Singaporean lesson study groups (Song et al., 2018; Ünal et al., 2011). Changing instruction in the KSA will not only require adoption of alternative methods of preparation and professional development among teachers but may also require adoption of alternative approaches to organising the school environment, apportioning time, and teacher duties.

Moreover, TIMSS scores can promote teaching recommendations in the mathematics subject by serving as a gauge of quality. With TIMSS, it is possible to pinpoint whether KSA mathematics teachers develop key concepts and procedures through examples, discussions, and demonstrations, or whether the teacher simply stated these aspects (Song et al., 2018). For instance, one teacher may state the formula followed in calculating the area of a right triangle as ½ base multiplied by the height. However, another teacher may develop this procedure by illustrating how the formula can be obtained by joining two triangles to form a rectangle. In Singapore, German, and Japanese lessons, mathematics concepts and procedures are usually well developed. However, in KSA, these concepts are usually only stated instead of being developed. KSA teachers can use the scores from other top performers in the mathematics subject to promote their own teaching recommendations.

5.4.3 Strategies used to teach mathematics in KSA.

The study sought to reveal some strategies used to teach mathematics in KSA. Encouraging students to express their ideas is one of the teaching methods found to positively and significantly contribute to student's ability to reach the schools' academic goals. Other strategies used entailed teachers asking students to listen to an explanation on how to solve problems, along with asking students to work on problems individually with the teacher's guidance. These strategies were found to affect student achievement positively and significantly. Previous studies that have explored the role of teacher interaction in mathematics performance support these findings (Martin & Rimm-Kaufman, 2015; Rimm-Kaufman et al., 2015). These studies found that establishing a classroom environment that encourages positive and healthy interactions can motivate learners to channel their energy and desires to reach their academic goals. Possibly, these findings imply that students in classrooms with warm, caring, and responsive teachers work harder, enjoy learning about mathematics, and share their ideas and materials with other learners in the classroom. Together, the studies by Martin and Rimm-Kaufman (2015) and Rimm-Kaufman et al. (2015) draw attention to the benefits of developing supportive interactions between teachers and students to facilitate mathematics learning.

Teachers in KSA also use computers and calculators to teach mathematics. Stated otherwise, teachers have embraced the use of technology in the mathematics classroom, an aspect that has challenged the way teachers organise learning and achievement among learners.

Despite the use of technology in the KSA mathematics classroom, it is unfortunate that mathematics scores are still substandard. These findings are contradictory to previous studies that have examined the use of computers in the classroom and its impact on student learning. For instance, Drijvers, Doorman, Boon, Reed, & Gravemeijer (2010) found a positive relationship between the use of technology in the mathematics classroom and student achievement. Similarly, Pilli and Aksu (2013) presented evidence in their study to support the fact that the use of computers for learning and teaching mathematics at the primary school level resulted in better achievement, attitude, and retention among the learners. While the use of technology in class can reinforce student achievement, this study also shows that computers can be detrimental to student performance. Using technology in the mathematics classroom should, therefore, be implemented cautiously while taking into consideration potential repercussions.

Teachers in KSA emphasize on assessing students' ongoing work in the mathematics subject. This strategy was found to affect student achievement positively and significantly. This form of evaluation is referred to as continuous assessment. These findings are consistent with previous studies that have explored the benefits of continuous assessment. For instance, Cheah (2010) found the use of continuous assessment beneficial, since it allows learners to take part in remedial and enrichment activities that enhance their performance. What these findings mean is that KSA mathematics teachers can use continuous assessment to examine the communication and critical thinking skills of their students and create the best strategies to enhance their performance. Considering that mathematics performance in KSA has been poor, teachers should review their approach towards continuous assessment to develop better strategies for improving student scores.

Teachers' ability to work as a group was also identified as a useful strategy for teaching mathematics in KSA. This strategy positively and significantly affected teachers' contentment with the profession, more so among less-educated teachers. Besides, working as a group to implement the school curriculum positively and significantly affected the confidence of teachers to inspire students to learn mathematics. This is consistent with past research that has shown that teacher-centred collaborative activities meant to teach mathematics were more effective at improving mathematics achievement (Akiba & Liang, 2016). Together, these findings suggest that the education sector and schools in KSA should consider investing their professional development funds and resources in supporting teacher-centred collaborative activities. Such a strategy can help improve mathematics learning in KSA.

5.4.5 Implications for future practice

The findings from this study have several implications for future practice of mathematics education in KSA. First, future practice should consider evaluating prior knowledge of mathematics students to facilitate better TIMSS scores. Evaluation can be done using direct measures such as tests, portfolios, and concept maps, or indirect measures, such as self-reports, experiences, and inventory of previous courses. The type of evaluation should differ from the one where teachers ask students to describe their motivation for taking the mathematics subject or the one that inquiries about how they learn best. Instead, the assessment should solely focus on the previous knowledge that the teacher assumes the students have and need to be successful in the mathematics class. For instance, teachers could ask about the familiarity of students with core concepts and themes, or rather, could focus on examining whether learners can define the basic terms they should already know. Apart from using surveys, other gauging strategies could be used as well. As an example, teachers could pose key questions about the subject content that can lead to brainstorming discussions or miniature group exercises that generate a sense of where students are in their thinking. Such a strategy can provide a wide impression of what students already know about the mathematics subject content. Depending on the strategies used to gauge prerequisite knowledge, teachers may need to adapt the mathematics syllabus if the content they want to cover, and the student's previous knowledge does not align.

Recommendations to the KSA ministry of education concern establishing a reliable framework to guarantee job satisfaction among teachers. Even though the role of teachers' work in student outcomes is widely recognised, whether these professionals are satisfied with their working environment in KSA has often been disregarded. Guaranteeing teacher satisfaction has many key and far-reaching implications. First, satisfaction adds to teacher well-being considering that well-satisfied teachers are less exposed to stress and burnout. Also, there is evidence proving that students of teachers who are satisfied with their job feel better (Toropova et al., 2021). Satisfied teachers provide higher instructional quality and better learning support for their students. It is also important to consider the fact that teachers who are content show stronger commitment to their job and are less susceptible to leaving their profession. This is crucial when mathematics performance in KSA has been consistently poor.

5.5 Conclusion

The results revealed, once again, the impact of international assessments on mathematics teacher development in KSA. Precisely, the study identified factors contributing to low TIMSS scores, which affect both the students and the teachers. The identified factors include students' lack of prerequisite knowledge and skills; students' lack of enough sleep; teachers' lack of adequate instructional supplies; inadequate cleaning of school classrooms; and the teachers' feelings about their willingness to continue teaching.

Even though the study presents significant findings, its method suffers from various limitations. For starters, although the TIMSS questionnaire incorporated several aspects of the school working environment, some factors captured in the vast body of literature could not be considered. Additionally, since the study used data from the fourth-grade mathematics teachers in KSA, the generalisability of the results may be limited to this specific group of teachers. Second, there is a complex interplay between environmental factors at school and unique characteristics of teachers. As such, there is a need to explore the internal structure of this relationship in greater detail. There is a high chance that some relations between these factors could be reciprocal, and it is important for future studies to deeply consider directionality. Third, the TIMSS study used a cross-sectional design, which may not allow the making of causal inferences. Therefore, future studies must carry out a trend analysis of the factors associated with international assessments and their impact on mathematics teacher development in KSA. Last, as many other countries are also experiencing poor mathematics scores, comparative research on the impact of international assessments is warranted.

My intentions for the future are as follows.

- I believe that engaging in continuous improvement is the best way forward to fulfilling my career growth and meeting my professional objectives.
- Upon completing this research, I would love to conduct lecturers and workshops concerning the impact of international assessments on mathematics teacher development in KSA.
- Additionally, I would like to take on the role of training, guiding, and coaching to facilitate better performance in the mathematics subject. Such activities and engagements will help keep me updated in this quickly changing industry since I believe continuous professional development is the route to imposing change in my discipline.

Chapter 6 Methodology main study

6.1 Introduction

By reviewing current literature, it is clear scholarly work in this field of study is deficient or inadequate, which encourages additional research into the impact of international assessments on mathematics teacher development in KSA. This chapter exhibits the research methodology adopted to answer the primary research question: *Is there a link between international assessment scores and mathematics development practices in KSA?* Study objectives were considered in choosing a suitable research strategy, which entails decisions about the approaches of gathering information and analysing the data (Creswell & Clark, 2017). A detailed discussion of the research processes, data collection technique, and data analysis justifies the methods used in the study. Besides, the section presents an evaluation of measurement and structural models using Partial Least Square.

6.2 Research Methodology

To answer the research question, the study followed a quantitative methodology. Creswell and Clark (2017) defined quantitative research as a method where the researchers examine concepts as an explanation for the answers to their questions. As a result of conducting a quantitative study, the researcher developed research questions, hypotheses, and research objectives that helped shape the focus of the study, as advised by Creswell and Clark (2017). The study emphasised objective measurements and the statistical analysis of the data got through surveys. The goal of conducting the current study using a quantitative approach was to determine the relationship between two variables tied to international assessment scores and mathematics development practices in KSA. The researcher followed a descriptive approach when conducting the study, meaning that the study subjects were measured once. Because of the descriptive nature, the study managed to establish only associations between variables rather than causality. Using a quantitative approach had certain benefits to this study. First, the methodology allowed for the collection of data using structured research instruments. Second, the results of the study relied on larger sample sizes that were representative of the population. This also means that the study can be replicated due to its high reliability. Third, this methodology allowed for the careful design of all the aspects of the study before the data could be collected. Additionally, a quantitative methodology presented the study with a decent opportunity to generalise concepts surrounding international assessments and teacher development more widely and predict future results.

6.3 Research Processes

While examining the link between international assessment scores and mathematics development practices in KSA, the study followed a deductive approach. By taking a deductive approach, the research started with a persuasive social theory and tested its implications using the collected data. Stated otherwise, the study moved from the general to more specific levels. The research began by theorising or development of hypothesis, followed by an analysis of data, and the last step being the determination of whether the developed hypotheses are supported or not. This research approach is common in scientific investigations (Creswell & Clark, 2017; Soiferman, 2010). The researcher examined what other studies have done, analysed existing theories associated with international assessment scores and mathematics development, and tested hypothesis that emerged from these theories. The figure below outlines the steps involved in using a deductive approach to research.

Figure 6-1 Research process

Based on the analysis of previous studies, the study developed and tested the following seven hypotheses:

H1: There is a significantly positive impact of teacher interaction on teaching methods.

H2: There is a significantly positive impact of teaching methods on classroom experience.

H3: There is a significantly positive impact of teacher confidence on teacher satisfaction.

H4: There is a significantly positive impact of leadership support on teacher emphasis.

H5: Teaching method mediates the relationship between teacher interaction and teacher confidence.

H6: Teacher confidence mediates the relationship between teaching methods and teacher satisfaction.

H7: Leadership support mediates the relationship between teacher confidence and teacher emphasis.

6.4 Data Collection Technique

To test the hypotheses, quantitative data was collected through surveys. Surveys are one of the most straightforward ways to gather data on what people think and do. In essence, surveys were used in the current study since they are easy to create and administer, can reach a wider audience, have a wider geographical reach, and can result in a high response speed (Sue & Ritter, 2012). However, the researcher was cautious that samples responding to surveys may not always represent the wider population.

6.4.1 Web Survey

The survey was sent over the internet to a sample of study respondents. The respondents received the web surveys through various mediums, such as email, social media, or links embedded over a website. The primary benefit of using web surveys is that they were extremely low cost, and the data collection instrument was convenient due to the sheer magnitude of reach. The survey used was like the "TIMSS 2015 Trends in International Mathematics and Science Study – Teacher Questionnaire Mathematics," which targeted to teachers of 4^{th} grade students. The survey collected information such as the academic and professional background of the teachers; instructional practices; classroom resources; and attitudes towards teaching. The content of the survey was developed based on the information obtained from the literature concerning the features of effective professional development and the factors that influence the ability of teachers to implement certain teaching strategies.

6.4.2 Sampling

In the data collection process, the researcher relied on probability sampling techniques. In probability sampling, the chances of selecting a study subject from the sampling frame is clear (Lim & Ting, 2012). The researcher used probability sampling techniques to distinguish a representative sample from where the data would be obtained. A representative sample has key features of the population from which it was obtained in important ways for research to be conducted (Lim & Ting, 2012). As part of probability sampling, it is important to get a representative sample to avoid generalisability challenges. Generalizability refers to the notion that the findings of the study will provide useful insights about a larger group than the sample from which the findings were drawn. Generalisability was attained by ensuring that all the subjects had an evenly balanced chance of being selected. The sample was, therefore, randomly selected for inclusion in the study. However, the use of random selection does not mean that the sample used was perfect. Generalizing from a sample of a general population must contain some degree of error, which is often referred to as the sampling error. One advantage of quantitative research is that a larger sample size can be analysed compared to qualitative research (Lim & Ting, 2012). Therefore, mathematics teachers in KSA of both genders were invited to participate, as the aim of the study was to examine the link between international assessment scores and mathematics development practices in KSA. Eventually, the sample used in the study consisted of 326 teachers. Teachers were invited to take part in the study through an anonymous link shared by the researcher.

6.4.3 The Questionnaire

A questionnaire form of data collection was used to gain primarily quantitative responses from the study participants. Principally, closed questions were used to collect a large amount of data to test the hypotheses. The first part of the questionnaire was designed to obtain demographic information from the study participants. This section collected information on the gender, age, teaching experience, highest level of formal education, and teachers' knowledge of the international TIMSS test. The remainder of the questionnaire was listed into seven sections. The seven parts in the questionnaire are as follows – teacher interaction, teaching methods, leadership support, teacher confidence, classroom experience, teacher emphasis on academic success, and teacher satisfaction. Four- or five-point Likert Scale items were used to answer questions under the seven sections.

6.4.4 Ethical Considerations

The study involved study participants and there were several ethical considerations that were made to ensure the research process is honourable. The first ethical consideration handled in the study was to ensure that information collected on the study participants conformed with the data protection act. Hence, no identifying information about the participants was asked, such as name or email. The only demographical questions included in the survey were age range, gender, teaching experience, and highest level of education which all adhere to the anonymity of the study participants.

Before completing the questionnaire, the participants were required to agree to a consent form. The consent form outlined that they understood why they had been invited to take part in the study. Additionally, the consent form sought to have the participants acknowledge that they understood what would be asked of them and that their participation was totally voluntary.

An additional ethical consideration related to some of the questions asked within the questionnaire, which the participants may have interpreted as either personal or intrusive. Because of such possibilities, the survey required that participants leave questions they did not feel comfortable answering blank. Such a provision upheld ethical guidelines without lessening the validity of the test if the missing responses were to be taken out.

6.5 Data Analysis

Quantitative data is useful when the researcher uses quantifiable measurements and can carry out sophisticated statistical analyses. Upon completion of data collection, data analysis was carried out through structural equation modelling (SEM) and partial least square (PLS). These approaches were selected since they allowed for effective interpretation of the results.

6.5.1 Introduction to Structural Equation Modelling (SEM)

Structural Equation Modelling refers to second-generation data analysis techniques used to overcome the shortcomings of first-generation methods, such as multiple regression, logistic regression, analysis of variance, exploratory and confirmatory factor analysis, cluster analysis, and multidimensional scaling among many others (Hair et al., 2017). These methods allow researchers to include unobservable variables measured indirectly by indicator variables. SEM also facilitate accounting for measurement error among the observed variables. There are certain considerations a researcher must put in mind before using structural equation modelling. The researcher must choose the most suitable multivariate analysis method based on the research question and the empirical data collected. Key considerations to consider include the composite variables, measurement, measurement scales, coding, and data distributions.

The first consideration, composite variables, refers to a linear combination of a number of variables that are selected based on the research problem under investigation. The variables selected for analysis in this study included teacher interaction, teaching methods, leadership support, teacher confidence, classroom experience, teacher emphasis on academic success, and teacher satisfaction. These variables were combined together by computing a set of weights and multiplying the weights by the associated data observations for the variables. The mathematical formula used for this calculation was as follows.

$$\textit{Composite value} = w1 \,.\, x1 + w2 \,.\, x2 + \ldots + w5 \,.\, x5,$$

In the above mathematical formula, x represents the individual variables, while w represents the weights.

The second consideration, measurement, refers to the process of assigning numbers to a variable following a set of rules. The rules used in measurement apportioned numbers to the variables used in the study in a way that precisely represented the variable. Apart from the variables associated with the demographic data, the rules were much difficult to apply on the other variables since they were abstract constructs (Hair et al., 2017). It is not possible to directly measure abstract concepts, such as teacher interaction or teaching methods. However, it is possible to measure indicators or rather manifestations of what has been agreed upon. It was possible to indirectly measure the variables used in the study, except by combining various items to form a scale. Single-item constructs were used to measure the variables. Even though this was a good way to make the questionnaire shorter, it reduced the quality of measurement within the study (Hair et al., 2017). The researcher also sought to reduce measurement errors by ensuring the questions used in the survey were worded correctly, reducing misunderstandings of the scaling approach, and ensuring correct application of the statistical method.

The next consideration when using SEM is the measurement scales. A measurement scale refers to a tool designed with a fixed number of close-ended responses that can be used to obtain an answer to a question (Hair et al., 2017). Measurement scales can either be nominal, ordinal, interval, and ratio. In this study, an ordinal scale was used to assign numbers and classify responses on the questionnaire. Having measured the data on an ordinal scale, the study was able to provide information on the order of observations. Despite the useful of the ordinal scale, the researcher was aware of the challenges involved in measuring arithmetic means or variances for ordinal data.

The fourth consideration was coding. This refers to the assignment of numbers to groups in a way that promotes measurement (Hair et al., 2017). When conducting survey research, the collected data is usually pre-coded, which is the process of assigning numbers beforehand to answers, potentially through scale points stipulated in a questionnaire. For instance, a 5-point Likert Scale used in the current study assigned number 5 to the highest endpoint “Very often” and number 1 to the lowest endpoint “Almost never.” Collected data can also be postcoded by assigning numbers to groups of responses. Overall, coding is an important process when applying SEM since it determines when and how different types of scales are used (Hair et al., 2017). Since the study used a 4 or 5-point Likert scale with different categories, the researcher had to pay attention to coding to meet the equidistance requirement. Even though a Likert scale is ordinal, the researcher tried to present it appropriately to approximate an interval-level measurement to allow the corresponding variables to be used in SEM.

The last factor while applying SEM was data considerations. Upon collecting data from the participants, the answers were presented as a distribution across the pre-defined response categories (Hair et al., 2017; Wong, 2019). Even though many forms of distributions exist, the use of SEM required the study to distinguish normal from the nonnormal distributions. However, since Partial Least Square (PLS-SEM) was used, it was not necessary to make assumptions about the data distributions.

Even though the collected data was of a similar type, SEM was used in the main study but not for earlier analyses of data. That was because of the three major advantages that SEM has over traditional multivariate techniques. First, SEM enabled explicit assessment of measurement error. Second, the method allowed the estimation of latent or rather unobserved variables through the observed variables. Third, SEM provided an opportunity for model testing where a structure could be imposed and examined as to fit of the data. The other multivariate techniques unconsciously ignore measurement error by not modelling it explicitly, whereas SEM models approximate these error variance parameters for the independent and dependent variables. What's more, SEM allows the estimation of latent variables based on observed variables.

6.5.2 Partial Least Square (PLS)

Structural equation modelling exists in two forms: covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM or PLS path modelling). CB-SEM is often used in studies that need to confirm or reject theories associated with various variables tested statistically (Hair et al., 2017; Wong, 2019). This method determines how well a proposed theoretical model can predict the covariance matrix for the collected data set. On the contrary, PLS-SEM is mostly used to develop theories in exploratory research. This approach focuses on illustrating the variance in the dependent variables when evaluating the model. The quantitative data collected in the current study was analysed using PLS-SEM. The use of PLS-SEM over CB-SEM in the current study was based on the fact that the researcher was less involved in the development of theory.

While using PLS-SEM, the researchers first developed path models based on the study variables. Path models are diagrams that illustrate a picture of the hypotheses and variable relationships examined upon the application of SEM (Hair et al., 2017; Vinzi, 2010). Path models represent constructs as circles or ovals. The indicators in the path model are the proxy variables with raw data that are measured directly. These indicators are represented as rectangles (Vinzi, 2010). The arrows used in the path model were single headed since they were representing directional relationships between the examined variables. These single-headed arrows were also regarded as predictive relationships and with a strong theoretical support may be considered as causal relationships (Hair et al., 2017; Vinzi, 2010). The path model used in this study was developed based on theory and relied on both measurement and structural theory.

The application of PLS-SEM was based on the fact that the method works efficiently with small sample sizes and does not make assumptions about the underlying data (Mehmetoglu & Venturini, 2021; Vinzi, 2010). Besides, PLS-SEM has the ability to handle both reflective and formative measurement models. Hence, the approach can be used in a number of situations within the research setup (Hair et al., 2017; Vinzi, 2010; Wong, 2019). However, the researcher was cautious of several limitations associated with the use of PLS-SEM. When used in its basic form, the method cannot be used when structural models have causal loops or when circular relationships exist between the latent variables. Additionally, PLS-SEM does not have a decent global goodness-of-fit measure. Because of this limitation, it is not a good option to test and confirm theory in research.

Partial Least Squares were used due to the many advantages they have over traditional regression methods. A key benefit of using PLS for the current study was due to its ability to strongly handle more descriptor variables compared to compounds. The approach to analysis can model various outcome variables. Besides, PLS also provide more predictive accuracy and a much-reduced chance correlation. However, the researcher was cautious about the potential of PLS disregarding real correlations of the descriptor variables.

6.5.3 Reflective and Formative Constructs

In the application of SEM, it is important to consider reflective and formative constructs. Reflective measures embody the effects of an essential construct, meaning that causality comes from the construct to its measures (Avkiran & Ringle, 2018; Hair et al., 2017; Hair Jr. et al., 2021). Reflective measures assume that indicators linked with a certain construct should be highly correlated with each other. Besides, individual items must be interchangeable and it should be possible to leave out a single item without altering the meaning of the construct (Hair et al., 2017; Hair Jr. et al., 2021). On the contrary, formative measurement models assume that causal indicators form the construct through linear combinations. Formative indicators are not interchangeable, and this is one of their main features. The selected method, PLS-SEM can deal with both formative and reflective measurement models. In fact, PLS-SEM is regarded as the primary method when the theorised model includes formative measures. The method deals with formative measurement models and settings where endogenous constructs are examined formatively with no limitation (Avkiran & Ringle, 2018; Hair et al., 2017). Hence, PLS-SEM used in the study dealt with reflective and formative measurement models without extra requirements or constraints. Model complexity was not an issue for PLS-SEM since data meeting the minimum sample size requirements was collected.

6.6 Evaluating Measurement and Structural Models using Partial Least Square

6.6.1 Measurement Model

While evaluating measurement models, it is important to differentiate between constructs that are measured reflectively and those that are measured reflectively. The two methods have different underlying concepts and the researcher must consider different evaluative measures (Hair et al., 2017; Vinzi, 2010; Wong, 2019). In most cases, reflective measurement models are examined based on their internal consistency, reliability, and validity. Researchers cannot apply the scale used for reflective measurement models on formative ones. The first step when dealing with formative measures is to ensure content validity prior to collecting the data and estimating the PLS path model (Avkiran & Ringle, 2018; Hair et al., 2017; Hair Jr. et al., 2021). After estimating the model, various metrics can be used to examine the formative measures for convergent validity and the presence of collinearity.

6.6.1.1 Internal Consistency

The study first evaluated internal consistency using the Cronbach's alpha. The Cronbach's alpha provides an approximation of the reliability of the data depending on the interlink between the observed indicator variables (Hair et al., 2017; Wong, 2019). The statistic used to calculate Cronbach's alpha is presented below.

Cronbach's α = (MM – 1) . (1 - ∑I = 1 Msi2st2).

In the above formula, s i 2 stands for the variance of the indicator variable *i* of a certain construct. The variance is measured with *M* indicators. By using the Cronbach's alpha, the study assumes that all the indicators used in the study are equally reliable. Since the PLS-SEM model was used, the study prioritised the indicators based on their individual reliability.

6.6.1.2 Indicator Reliability

Indicator reliability describes the size of the outer loading. In essence, the outer loadings of all the indicators should be statistically significant at a minimum. The indicators of a reflective construct are considered as unconventional approaches that examine related constructs (Hair et al., 2017). Hence, indicators of a certain reflective construct are required to share a high percentage of variance. The present study evaluated indicator reliability by considering the outer loadings of the indicators. Higher outer loadings could mean that the associated indicators have a lot in common. However, a significant outer loading could still be fairly weak, and the study ensured that the standardized outer loadings were 0.708 or higher (Hair et al., 2017; Wong, 2019). A general rule of thumb with indicator reliability is that a latent variable should be able to rationalize a huge part of every indicator's variance, in most cases at least 50%. That means that an indicator's outer loading must be above 0.708 (Hair et al., 2017; Wong, 2019). Indicators with outer loadings ranging between 0.40 and 0.70 were considered for elimination from the scale, only if their elimination would contribute to an increase in the composite reliability.

6.6.1.3 Convergent Validity

Convergent validity describes the extent to which a measure correlates positively to other measures of the same construct. Average variance extracted (AVE) was used to establish convergent validity at the construct level (Hair et al., 2017). An AVE value of 0.50 or higher showed that on average, the construct under study explained more than half of the variance of its indicators. On the contrary, an AVE of less than 0.50 shows that, on average, more variance remained in the error of the items in comparison to the variance explained by the construct. The AVE was not used on single-item constructs since the outer loading of these indicators is usually set at 1.00.

6.6.1.4 Discriminant Validity

The degree to which a construct can be distinguished from other constructs by empirical standards was also measured through discriminant validity. This measurement helped demonstrate that constructs were unique and that they captured phenomena not exemplified by other constructs within the model. Two approaches were used to measure discriminant validity: cross-loadings and Fornell-Larcker criterion (Hair et al., 2017; Vinzi, 2010). When using the cross-loadings approach, the outer loading of an indicator on the associated construct must be greater than any of its cross-loadings on the other constructs. The study assessed and reported cross-loadings through a table with rows for the indicators and columns representing the latent variable. Discriminant validity was established by having the loadings exceed the cross-loadings. However, a discriminant validity problem was noted whenever cross-loadings exceeded the outer loadings of the indicators.

The Fornell-Larcker criterion was also used to measure discriminant validity. The logic behind this approach is that a construct shares more variance with its associated indicators compared to other constructs. This method compared the square root of the AVE values with the correlations of the latent variable (Hair et al., 2017; Vinzi, 2010). It was expected that the square root of every construct's AVE would be greater than the highest correlation with other constructs. Another method that was used to examine the outcome of the Fornell-Larcker criterion was to determine if the AVE was larger than the squared correlation with other constructs. For discriminant validity to be confirmed, the square root of each constructs AVE must be larger compared to its correlation with other constructs.

6.6.2 Structural Model

After confirming that the construct measures are reliable and valid, the next step is to assess the results of the structural model. This step involves analysing the predictive abilities of a model and the relationships between the constructs. A systematic approach to achieve this is to assess structural model for collinearity issues, assess the significance and relevance of the structural model relationships, examine the level of R^2, assess the f^2 effect size, assess the predictive relevance q^2 and assess the q^2 effect size.

6.6.2.1 Collinearity Assessment

The study assessed for collinearity by applying similar measures as those used in the assessment of formative measurement models. The researcher examined every set of the predictor constructs independently for every subpart of the structural model. The study approach was interested in checking whether critical levels of collinearity exist between every set of predictor variable. Tolerance values falling below 0.20 (VIF value above 5) in the predictor construct were regarded as critical levels of collinearity (Hair et al., 2017). Where critical levels of collinearity were noted, the researchers considered eliminating the constructs, combining predictors into one construct, or developing higher-order constructs to deal with collinearity issues.

6.6.2.2 Structural Model Path Coefficients

After assessing for collinearity, the researchers obtained estimates for the structural model relationships, otherwise referred to as path coefficients. The path coefficients represented the hypothesised relationships among the constructs. The coefficients had standardised values ranging between – 1 and + 1 (Hair et al., 2017). Resulting values can be smaller or larger than the estimates but usually fall in between these boundaries. Estimated values close to +1 represented a strong positive relationship that is statistically significant. The closer the estimated values are to 0 the weaker the relationship (Hair et al., 2017). In most cases, low values very close to 0 are usually not significantly distinct from 0 (Hair et al., 2017). The standard error determined whether a coefficient was significant. The study used *p* values to examine significance levels. Upon assuming a 5% significance level, the *p* value obtained must be smaller than 0.05 to suggest that the relationship under examination is significant at a 5% level. The results of the path model were interpreted by testing the significance of all the structural model relationships, utilising *t* values, *p* values, and the bootstrap confidence intervals. The structural model path coefficients were evaluated relative to each other. That means that if a single path coefficient is larger than the other, the effect on the endogenous latent variable is much greater.

6.6.2.3 Coefficient of Determination (R^2 Value)

The third measure used to examine the structural model was the coefficient of determination (R^2 value). This coefficient measured the predictive power of the model, which was computed as the squared correlation between a certain endogenous construct's real and predicted values (Hair et al., 2017). The coefficients exemplify the amount of variance in the endogenous constructs as justified by all the exogenous constructs associated to it. R^2 refers to the squared correlation of the real and predicted values and captures all the data that has been used for model estimation. This value is used to determine the predictive power of the model and stands for a measure of in-sample predictive power. In most cases, R^2 values range from 0 to 1. Higher levels stand for better predictive accuracy (Hair et al., 2017). There are no rules concerning acceptable R^2 values since this depends on the complexity of the model and the discipline of research. However, values of 0.20 are regarded as high in consumer behaviour and success driver studies. In other fields, values of 0.75 are considered substantial, 0.50 as moderate, and 0.25 as weak.

6.6.2.4 Effect Size f2

Apart from evaluating the R^2 values, changes in R^2 can be used to examine if the omitted construct has a major impact on the endogenous constructs. The resulting measure is referred to as the f^2 effect size. The effect size was calculated using the following formula:

f2 = R included 2 – R excluded 2 1 - R included 2

Where R included 2 and R excluded 2 refer to the R^2 values of the endogenous latent variable whenever a selected exogenous latent variable is either incorporated in or omitted from the model (Hair et al., 2017). The change in the R^2 values was computed by assessing the PLS path model twofold. f^2 values of 0.02 represent small, 0.15 represent medium, and 0.35

represent large effects of the exogenous latent variable. Effect size values below 0.02 demonstrate that there is no significant effect.

6.6.2.5 Blindfolding and Predictive Relevance Q2

The researcher also examined the Stone-Geisser's Q^2 value. This measure was used as an indicator of out-of-sample predictive power of a model or rather its predictive relevance. A PLS model that showcases predictive relevance tends to precisely estimate data not used in the model estimation (Hair et al., 2017). Within the structural model, Q^2 values greater than 0 for a certain reflective endogenous latent variable showed the predictive relevance of the path model for a certain dependent construct. In the study, Q^2 values were collected using the blindfolding approach for a certain omission distance *D.* The study used the cross-validated redundancy approach to calculate the Q^2 values. Generally, prediction through cross-validated redundancy fits the PLS-SEM approach effectively (Hair et al., 2017). Q^2 values greater than 0 suggested that the model had predictive relevance for particular endogenous constructs. On the contrary, values of 0 and below showed that the model did not have predictive relevance.

6.6.2.6 Effect Size q^2

The relative impact of predictive relevance was compared by measuring the q^2 effect size. The effect size allowed the researcher to examine the contribution of an exogenous construct to the value of an endogenous latent variable (Hair et al., 2017). Based on the outcome, values of 0.02 showed small, 0.15 showed medium, while values of 0.35 showed large predictive relevance for certain endogenous constructs. The following formula was used to facilitate this measurement.

$$q^2 = \text{Q included 2} - \text{Q excluded 2 1} - \text{Q included 2.}$$

6.6.3 Mediating Relationship

Mediation happens when a third mediator variable ensues between two other related constructs. In simpler terms, a change in the exogenous construct influences a change in the mediator variable, which causes a change in the endogenous construct within the PLS path model. In every study, a strong priori theoretical or rather conceptual support is needed to examine profound mediating effects (Hair et al., 2017). Whenever such support is existent, mediation can be a profitable statistical analysis. Testing for the type of mediation in the developed model in the study involved running various analyses. The first analyses addressed the significance of the indirect effect through the mediator variable. Where a direct effect was significant, the study concluded that an omitted mediator was a possibility. The study distinguished between different types of mediation and non-mediation based on whether the model relationships were significant and their relationship to each other. The researcher tested mediating effects using bootstrapping rather than the Sobel test, which cannot be applied in a PLS-SEM context. The bootstrapping approach made no assumptions about the shape of the distribution of the variables neither did it judge the sampling distribution of the statistics. This made it easier to apply this method on a small sample size with increased levels of confidence. The study also considered all the basic model evaluation criteria while assessing mediation models (Hair et al., 2017). These include convergent validity, reliability, discriminant validity, R^2, and multicollinearity, among many others. All mediators were included together to examine multiple mediation models. This approach also helped distinguish between the specific indirect and the total indirect effects.

Chapter 7 Data analysis and result

7.1 Chapter Overview:

The chapter presents the results of the data analysis utilising the statistical techniques described in Methodology chapter. based on the objective of the study, to find out how to improve teachers and their methods to achieve a higher result in TIMSS tests. It is hypothesised that the poor performance is attributed to lack of quality teaching. Recent reports have theorised that the education in Saudi schools does not help students get a grip on mathematics, despite the growth in literacy within KSA in the recent past. Mathematics scores were also of interest to the current study considering that the Kingdom spends a lot of its budget on education compared to other wealthy nations. Despite the expenditure, recent TIMSS tests showed that over half of Saudis below 13 years old attained the lowest benchmark. This chapter first presents demographic profile of the respondents followed by widely accepted pls analysis. The pls analysis is divided into Measurement and structural model assessment. The Measurement model includes assessment of Reliability and validity of the constructs, following this structural model presented to ascertain the following hypothesised relationships:

H1: There is a significantly positive impact of Teacher interaction on Teaching Methods.

H2: There is a significantly positive impact of Teaching Methods on Classroom Experience.

H3: There is a significantly positive impact of Teacher confidence on Teacher Satisfaction.

H4: There is a significantly positive impact of Leadership support on Teacher Emphasis.

H5: Teaching method mediates the relationship between Teacher interaction and Teacher confidence.

H6: Teacher confidence mediates the relationship between teaching methods and teacher satisfaction.

H7: Leadership support mediates the relationship between teacher confidence and teacher emphasis.

7.2 The Demographic Profile of the Respondents

The statistics for demographic profiles of respondents provide further insight into the study participants. The total of the study responses were 326 Teachers. Among these respondents, (132, 40.5%) were males and (194, 59.5%) were females. (158, 48.5%) of the respondents had Age between 30-39 years old whereas the study had least respondents (7, 2.1%) from under 25 years old and 50-59 years old. Majority of the responses in the study had experience between 6 to 10 years (97, 29.8%) whereas the study had least respondents (1, .3%) that had more than 30 years' experience. Finally, the highest number of respondents had a bachelor's degree (275, 78.8%), whereas the study had least respondents having doctoral degree (3, .9%). Table 7.1 shows the demographic information of the respondents who participated in this study.

Table 7-1 Demographic Profile of the Respondents

Profile	Descriptive	Number of Respondents	Percentage
Gender	Male	132	40.5
	Female	194	59.5
Age	Under 25 years old	7	2.1
	25–29 years old	26	8
	30–39 years old	158	48.5
	40–49 years old	128	39.3
	50–59 years old	7	2.1
Experience	1-5 years	54	16.6
	6-10 years	97	29.8
	11-15 years	49	15
	16-20 years	76	23.3
	21 – 25 years	40	12.3
	26-30 years	9	2.8
	more than 30 years	1	.3
Highest education level	Diploma	24	7.4
	high diploma	9	2.8
	Bachelor's degree	257	78.8
	Master's degree	33	10.1
	doctoral degree	3	.9

7.3 Model Evaluation

The study seeks to assist the inter-relationship among all variable names such as teacher interaction, teaching methods, leadership support, teacher confidence, classroom experience, teacher emphasis on academic success and teacher satisfaction.

The model to be assessed is presented in figure 7.1.

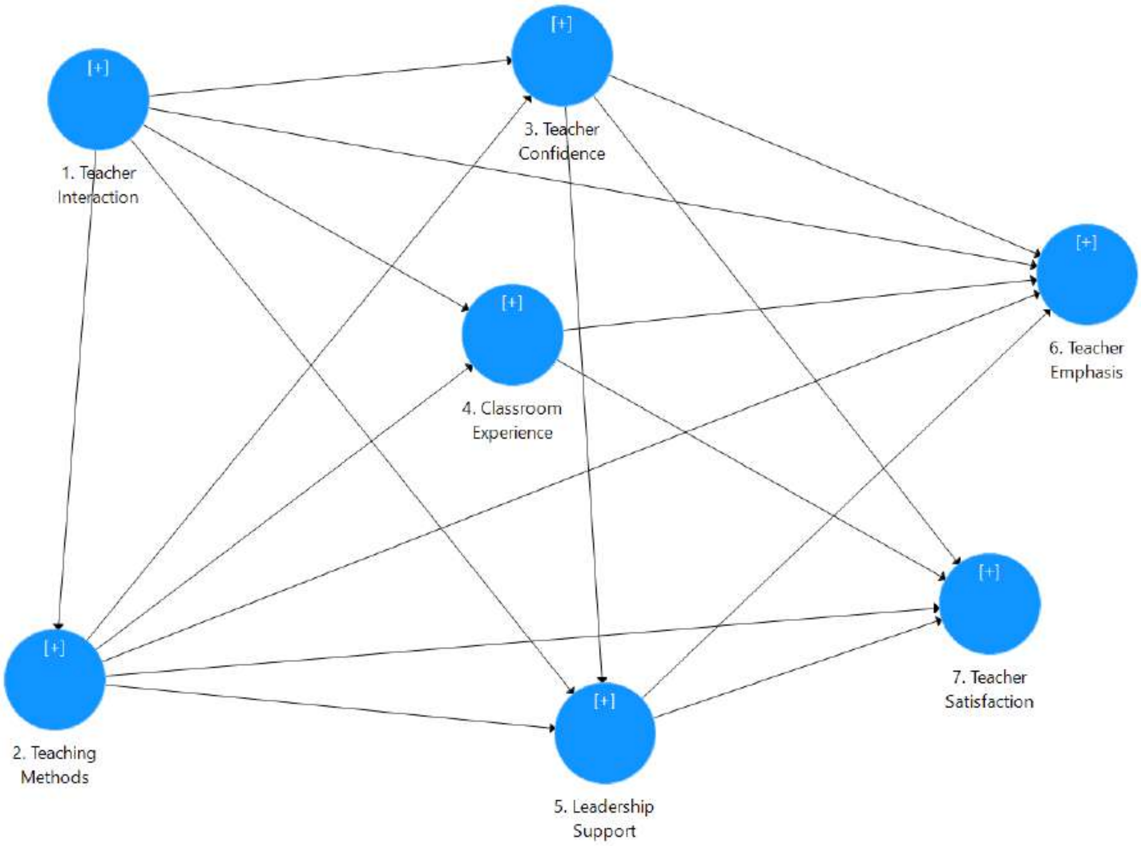

Figure 7-1 Research Model

7.4 Measurement Model assessment

To assess the quality of the constructs, measurement model is evaluated. The evaluation of measurement model includes establishment of construct reliability and validity.

7.4.1 Factor Loadings

Factor loading can be described as the degree to which every component in the correlation matrix connects to the provided principal component. The lowest factor loading is usually -1.0, while the maximum is usually +1.0. Higher absolute values show a higher relationship among the items with the basic factor (Pett et al., 2003, p.299). Two of the items (CE8 and CE9 from Classroom Experience) in the study had factor loading less than the recommended value of .60 (Hair et al., 2016). Factor loadings are presented in table 7.2.

Table 7-2 Factor Loadings

	Classroom Experience	Leadership Support	Teacher Confidence	Teacher Emphasis	Teacher Interaction	Teaching Methods	Teacher Satisfaction
CE1	0.753						
CE2	0.799						
CE3	0.687						
CE4	0.815						
CE5	0.790						
CE6	0.702						
CE7	0.609						
LS1		0.882					
LS2		0.915					
LS3		0.860					
TC1			0.710				
TC2			0.798				
TC3			0.788				
TC4			0.858				
TC5			0.856				
TC6			0.839				
TC7			0.816				
TC8			0.845				
TE1				0.800			
TE2				0.812			
TE3				0.611			
TE4				0.809			
TE5				0.808			

TE6	0.732			
TI1		0.742		
TI2		0.803		
TI3		0.756		
TI4		0.829		
TI5		0.886		
TI6		0.876		
TI7		0.870		
TM1			0.611	
TM2			0.661	
TM3			0.672	
TM4			0.679	
TM5			0.737	
TM6			0.758	
TM7			0.691	
TM8			0.721	
TM9			0.654	
TS1				0.825
TS2				0.617
TS3				0.801
TS4				0.893
TS5				0.903
TS6				0.825
TS7				0.826

7.4.2 Indicator Multicollinearity

Variance Inflation Factor is a statistic used to examine the multicollinearity of study variables (Fornell & Bookstein, 1982). A VIF value below 5 is considered appropriate (Hair et al., 2016). Table 7.3 presents the VIF values for the indicators in the study and reveals that VIF for each of the indicators is below the recommended threshold.

Table 7-3 Indicator Multicollinearity

Items	VIF
CE1	2.938
CE2	3.590
CE3	1.840
CE4	2.239
CE5	2.009
CE6	1.686
CE7	1.300
LS1	1.924
LS2	3.220
LS3	2.539
TC1	1.973
TC2	2.572
TC3	2.100
TC4	2.997
TC5	3.071
TC6	2.824
TC7	2.780
TC8	2.877
TE1	2.128
TE2	2.328
TE3	1.322
TE4	2.000
TE5	2.088
TE6	1.513
TI1	2.038

TI2	2.417
TI3	1.855
TI4	2.482
TI5	3.624
TI6	3.652
TI7	3.380
TM1	1.436
TM2	1.497
TM3	1.675
TM4	1.664
TM5	1.901
TM6	1.978
TM7	1.854
TM8	1.877
TM9	1.460
TS1	2.467
TS2	1.410
TS3	2.105
TS4	4.259
TS5	4.558
TS6	2.515
TS7	2.647

7.4.3 Reliability Analysis

Reliability is best described as the degree to which an instrument used for measurement in research is steady and objective (Mark, 1996). Reliability is mostly considered based on the repeatability of variables. An instrument that is repeated many times should be able to generate similar results (p.285). Cronbach Alpha and Composite Reliability (CR) are the most common approaches used to ascertain reliability. The results for both Cronbach's Alpha and composite reliability are presented in Table 7.4 The Cronbach's Alpha ranged from .857 to .927 whereas Composite Reliability statistics ranged from .890 to .940. A reliability figure above the required limit of .70 is considered appropriate for both indicators of reliability (Hair et al., 2011). This is a confirmation of construct reliability.

Table 7-4 Reliability Analysis

	Cronbach's Alpha	Composite Reliability
Teacher Interaction	0.921	0.937
Teaching Methods	0.860	0.890
Teacher Confidence	0.927	0.940
Classroom Experience	0.860	0.893
Leadership Support	0.865	0.916
Teacher Emphasis	0.857	0.894
Teacher Satisfaction	0.915	0.933

7.4.4 Construct Validity

When using the PLS-SEM approach, it is possible to prove the existence of construct validity by checking whether there is convergent and discriminant validity.

7.4.4.1 Convergent Validity

Convergent validity measures the extent to which various attempts to quantify a single concept agree with each other. Any two or more measures that are valid are expected to covary at a high rate (Bagozzi et al., 1991, p. 425). The advised AVE value is .50. Whenever the value is higher than the recommended, the items under analysis are believed to measure the underlying construct, which establishes construct validity (Fornell & Larcker, 1981). Convergent validity results based on the AVE statistics in the current study show that all the constructs except for Teacher interaction has AVE values greater than .50. However, the AVE value for Teaching Methods (TM) is very close to .50, and since the composite reliability value is greater than .70, according to Malhotra and Dash (2011), AVE provides a rigorous but precise measure of convergent validity. When compared to Composite Reliability, AVE is more strict. Applying the underlying principles of CR, it is possible to conclude that the construct had adequate convergent validity, despite more than 50% of the variance arising from error. It is also important to evaluate convergent validity together with CR in cases where AVE is lower than .50 (Ping, 2004). Hence, convergent validity is not an issue in the current study.(Table 7.5).

Table 7-5 Convergent Validity (AVE)

Constructs	Average Variance Extracted (AVE)
Teacher Interaction	0.681
Teaching Methods	0.474
Teacher Confidence	0.664
Classroom Experience	0.547
Leadership Support	0.785
Teacher Emphasis	0.586
Teacher Satisfaction	0.668

7.4.4.2 Discriminant Validity

The most basic definition of discriminant validity is the extent to which measures of varying concepts are considered to be unique. The idea is that if at least two concepts are distinct, the rightful measures should have a low rate of correlation (Bagozzi et al., 1991, p. 425).

7.4.4.2.1 Fornell and Larcker Criterion

One way of measuring discriminant validity is by using the Fornell and Larcker (1981) criterion. A construct's AVE square root that is greater than its correlation with the rest of the constructs confirms the existence of discriminant validity. This was the case in the current study, as illustrated in Table 7.6. These findings strongly support the existence of discriminant validity.

Table 7-6 Discriminant Validity (Fornell and Larcker Criterion)

	Teacher Interaction	Teaching Methods	Teacher Confidence	Classroom Experience	Leadership Support	Teacher Emphasis	Teacher Satisfaction
Teacher Interaction	***0.825***						
Teaching Methods	0.521	***0.688***					
Teacher Confidence	0.546	0.514	***0.815***				
Classroom Experience	0.305	0.59	0.333	***0.74***			
Leadership Support	0.441	0.271	0.408	0.065	***0.886***		
Teacher Emphasis	0.559	0.443	0.475	0.233	0.614	***0.766***	
Teacher Satisfaction	0.383	0.375	0.531	0.238	0.349	0.333	***0.818***

Note. Bold and Italic Values indicate Square Root of AVE,

7.4.4.2.2 Cross Loadings

Cross loadings are useful in examining whether an item that is part of a construct loads solidly onto its parent construct rather than the other constructs in a research study. The outcome of this test (Table 7.7) demonstrates that factor loading of all the items was stronger on the basic construct to which they belong rather than on the other constructs (Wako & Faraj, 2005). Using the basic knowledge of cross loadings, the variables under test achieved discriminant validity.

Table 7-7 Discriminant Validity (Cross Loadings)

	Classroom Experience	Leadership Support	Teacher Confidence	Teacher Emphasis	Teacher Interaction	Teaching Methods	Teacher Satisfaction
CE1	0.753	0.024	0.204	0.219	0.131	0.378	0.148
CE2	0.799	-0.018	0.232	0.164	0.168	0.414	0.174
CE3	0.687	-0.046	0.183	0.099	0.126	0.337	0.091
CE4	0.815	0.017	0.259	0.128	0.235	0.480	0.195
CE5	0.790	0.105	0.278	0.251	0.289	0.492	0.171
CE6	0.702	0.081	0.238	0.121	0.276	0.442	0.212
CE7	0.609	0.127	0.296	0.194	0.298	0.460	0.207
LS1	0.123	0.882	0.424	0.649	0.460	0.301	0.344
LS2	-0.020	0.915	0.303	0.486	0.363	0.168	0.295
LS3	0.049	0.860	0.339	0.461	0.326	0.233	0.276
TC1	0.162	0.266	0.710	0.216	0.321	0.292	0.442
TC2	0.297	0.391	0.798	0.362	0.457	0.449	0.432
TC3	0.266	0.377	0.788	0.409	0.503	0.448	0.393
TC4	0.304	0.338	0.858	0.416	0.489	0.438	0.458
TC5	0.286	0.317	0.856	0.387	0.425	0.422	0.415
TC6	0.276	0.315	0.839	0.420	0.434	0.399	0.413
TC7	0.238	0.311	0.816	0.401	0.439	0.410	0.423
TC8	0.316	0.336	0.845	0.449	0.464	0.469	0.489
TE1	0.250	0.397	0.356	0.800	0.440	0.384	0.242
TE2	0.229	0.390	0.341	0.812	0.451	0.339	0.183
TE3	0.096	0.348	0.346	0.611	0.324	0.280	0.214
TE4	0.167	0.513	0.350	0.809	0.500	0.337	0.257

TE5	0.182	0.463	0.418	0.808	0.432	0.356	0.273
TE6	0.144	0.644	0.369	0.732	0.402	0.333	0.334
TI1	0.246	0.298	0.317	0.416	0.742	0.375	0.234
TI2	0.254	0.298	0.484	0.45	0.803	0.418	0.315
TI3	0.298	0.255	0.418	0.412	0.756	0.503	0.404
TI4	0.234	0.336	0.481	0.423	0.829	0.442	0.297
TI5	0.236	0.45	0.439	0.518	0.886	0.457	0.329
TI6	0.242	0.479	0.517	0.515	0.876	0.394	0.316
TI7	0.259	0.403	0.474	0.482	0.870	0.422	0.313
TM1	0.370	0.212	0.355	0.325	0.343	0.611	0.194
TM2	0.440	0.174	0.299	0.279	0.364	0.661	0.255
TM3	0.320	0.175	0.398	0.309	0.366	0.672	0.267
TM4	0.395	0.188	0.380	0.267	0.458	0.679	0.281
TM5	0.384	0.235	0.298	0.308	0.362	0.737	0.256
TM6	0.478	0.222	0.357	0.378	0.369	0.758	0.238
TM7	0.409	0.161	0.354	0.310	0.315	0.691	0.265
TM8	0.416	0.157	0.344	0.279	0.325	0.721	0.248
TM9	0.432	0.148	0.395	0.283	0.314	0.654	0.313
TS1	0.190	0.263	0.373	0.225	0.285	0.256	0.825
TS2	0.136	0.434	0.305	0.306	0.206	0.163	0.617
TS3	0.215	0.226	0.463	0.253	0.305	0.345	0.801
TS4	0.217	0.289	0.547	0.340	0.404	0.409	0.893
TS5	0.196	0.301	0.501	0.302	0.412	0.367	0.903
TS6	0.229	0.263	0.399	0.235	0.272	0.299	0.825
TS7	0.166	0.246	0.391	0.229	0.253	0.244	0.826

7.4.4.2.3 Heterotrait-Monotrait Ratio (HTMT)

HTMT depends on the valuation of the relationship between the constructs under study. The HTMT ratio can facilitate the confirmation of discriminant validity. However, there is no clarity over the recommended HTMT threshold. Kline (2011) recommended .85 or less, while Teo et al. (2008) put forth a liberal threshold of .90 or less. Based on the findings in table 7.8, the ratio was less than the stipulated .90.

Table 7-8 Discriminant Validity (HTMT Ratio)

	Teacher Interaction	Teaching Methods	Teacher Confidence	Classroom Experience	Leadership Support	Teacher Emphasis	Teacher Satisfaction
Teacher Interaction							
Teaching Methods	0.586						
Teacher Confidence	0.584	0.571					
Classroom Experience	0.333	0.675	0.362				
Leadership Support	0.479	0.305	0.446	0.126			
Teacher Emphasis	0.625	0.516	0.528	0.266	0.681		
Teacher Satisfaction	0.408	0.412	0.569	0.261	0.393	0.369	

7.5 Structural Model

Before testing the hypotheses based on the significance of path coefficients, R-Square, f-Square, Q-Square, Goodness of Fit (GoF) are presented.

7.5.1 Coefficient of Determination (R2)

The study has several endogenous variables affected by different exogenous variables. The results of the analysis reveal R^2 value of .271 for Teaching Methods, this shows that 27.1% variance in Teaching Methods can be accounted by Teacher interaction.

Teacher confidence has a R^2 value of .371, this shows that 37.1% variance in teacher confidence can be accounted to teacher interaction and teaching methods.

The results of the analysis reveal R^2 value of .348 for classroom experience, this shows that a 34.8% variance in classroom experience can be accounted to teaching methods and Teacher interaction.

Leadership support has a R^2 value of .235, this shows that a 23.5% variance in leadership support can be accounted to Teacher interaction and teaching methods.

The results of the analysis reveal R^2 value of .509 for teacher emphasis, this shows that a 50.9 % variance in teacher emphasis can be accounted to Teacher interaction, teaching methods, teacher confidence, classroom experience and leadership support.

Finally, the results of the analysis reveal R^2 value of .315 for Teacher satisfaction, this shows that a 27.1% variance in Teacher satisfaction can be accounted to Teacher confidence, leadership support, teaching methods and classroom experience. (Table 7.9).

The R-Square values for all the endogenous constructs was found higher than the suggested threshold .10 (Falk & Miller, 1992) suggesting the in-sample predictive power of the model.

Table 7-9 R-Square Statistics

Constructs	R Square
Teaching Methods	0.271
Teacher Confidence	0.371
Classroom Experience	0.348
Leadership Support	0.235
Teacher Emphasis	0.509
Teacher Satisfaction	0.315

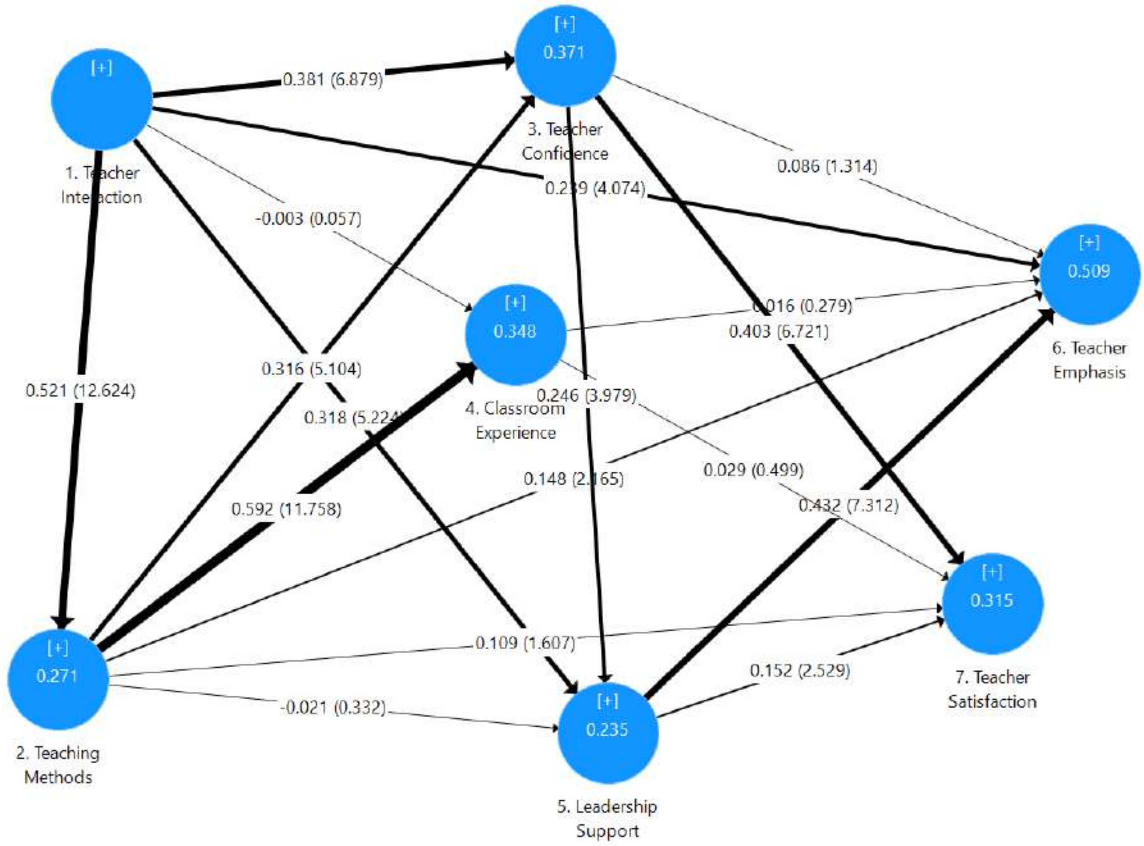

Figure 7-2 Coefficient of Determination (R2)

7.5.2 Effect size f^2

In the current study, the endogenous variables are controlled by a number of predictor variables. Because of this, the f^2 effect size should also be given. This statistic is responsible for determining whether the elimination of an independent variable from a model can have a major effect on the R-Square statistics of an endogenous variable (Hair et al., 2013). A scrutiny of the the f^2 statistic also showed that removing the teaching interaction and teaching method variables had a major impact on the R-Square of Teach Confidence. The f-square effect size ranged from small (<=.02) to large (< .35) (Cohen, 1988). The effect size and its significance are presented in table 7.10.

Table 7-10 f-Square Effect Size

	Effect Size	STDEV	T Statistics	P Values
Teacher Interaction -> Teaching Methods	0.372	0.080	4.649	0.000
1. Teacher Interaction -> 3. Teacher Confidence	0.168	0.054	3.108	0.002
1. Teacher Interaction -> 4. Classroom Experience	0.000	0.005	0.002	0.998
1. Teacher Interaction -> 5. Leadership Support	0.154	0.050	3.074	0.002
1. Teacher Interaction -> 6. Teacher Emphasis	0.067	0.035	1.910	0.056
2. Teaching Methods -> 3. Teacher Confidence	0.115	0.051	2.257	0.024
2. Teaching Methods -> 4. Classroom Experience	0.392	0.092	4.265	0.000
2. Teaching Methods -> 5. Leadership Support	0.003	0.008	0.342	0.732
2. Teaching Methods -> 6. Teacher Emphasis	0.022	0.021	1.010	0.312
2. Teaching Methods -> 7. Teacher Satisfaction	0.009	0.012	0.794	0.427
3. Teacher Confidence -> 6. Teacher Emphasis	0.009	0.017	0.538	0.591
3. Teacher Confidence -> 7. Teacher Satisfaction	0.154	0.053	2.893	0.004
4. Classroom Experience -> 6. Teacher Emphasis	0.000	0.007	0.048	0.961
4. Classroom Experience -> 7. Teacher Satisfaction	0.001	0.005	0.144	0.885
5. Leadership Support -> 6. Teacher Emphasis	0.285	0.083	3.423	0.001
5. Leadership Support -> 7. Teacher Satisfaction	0.028	0.022	1.250	0.211

7.5.3 Blindfolding and Predictive Relevance Q2

Effect size (Q^2) for predictive relevance of endogenous variables is also tested. The statistic indicates that the Q-square for all the endogenous variables is greater than 0, showing a medium predictive relevance (Hair et al., 2016). results are presented in table 7.11.

Table 7-11 Predictive Relevant - Q-Square

	Q^2
2. Teaching Methods	0.123
3. Teacher Confidence	0.240
4. Classroom Experience	0.178
5. Leadership Support	0.145
6. Teacher Emphasis	0.285
7. Teacher Satisfaction	0.203

Another measure of fit aside from the referred to statistics is the Standardized Root Mean Square Residual (SRMR). When using this test, a good fit refers to a value below 0.10 or 0.08 (Hu & Bentler, 1999). In the current study, the SRMR value was 0.062.

7.5.4 Good of fit of the Model (GOF)

Tenenhaus, Vinzi,Chatelin,and Lauro (2005),defined GOF as the global fit measures, it is the geometric mean of both average variance extracted (AVE) and the average of R-squared of the endogenous variables. The purpose of GOF is to account on the study model at both level, namely measurement and structural model with focus on the overall performance of the model (Chin,2010;Henseler & Sarstedt, 2013)

The criteria of GOF to determine whether GOF values are no fit, small, medium, or large to be consider as global valid PLS model have been given by Wetzels, Odekerken-Schroder, and Van Oppen (2009).guidlines below presents these criteria :

- GOF less than 0.1 No Fit
- GOF between o.1 and 0.25 Small fit
- GOF between 0.25 and 0.36 Medium fit
- GOF Greater than 0.36 Large fit

According to the above Table, and the value of the GOF (0.449), it can be concluded that the GOF model of this study is Large enough to considered sufficient global PLS model Validity.

AVE = 4.809 /7= 0.687

R squared =1.765/6=0.2942

GOF = 0.449   Large Fit

7.6 Hypotheses Testing

H1: There is a significantly positive impact of Teacher interaction on Teaching Methods.

H1 evaluates whether teacher Interaction has a significant impact on the teaching Methods. The results revealed that teacher Interaction have a significant effect on teaching Methods ($\beta = .521$, $t = 13.075$, $p < .001$). Hence H1 was **supported**.

H2: There is a significantly positive impact of Teaching Methods on Classroom Experience.

H2 evaluates whether Teaching Methods has a significant impact on the classroom experience. The results revealed that Teaching Methods have a significant effect on Classroom Experience ($\beta = .592$, $t = 11.437$, $p < .001$). Hence H2 was **supported**.

H3: There is a significantly positive impact of Teacher confidence on Teacher Satisfaction.

H3 evaluates whether teacher confidence has a significant impact on the teacher Satisfaction. The results revealed that teacher confidence have a significant effect on teacher Satisfaction ($\beta = .403$, $t = 6.842$, $p < .001$). Hence H3 was **supported**.

H4: There is a significantly positive impact of Leadership support on Teacher Emphasis.

H4 evaluates whether leadership support has a significant impact on the teacher emphasis. The results revealed that Leadership support have a significant effect on teacher emphasis ($\beta = .432$, $t = 7.965$, $p < .001$). Hence H4 was **supported**.

A Summary of Hypotheses results in presented in the table 7.12.

Table 7-12 Hypotheses Results

Hypotheses	Path Coefficient	Standard Deviation	T Statistics	P Values	Decision
H1: TM -> CE	0.592	0.052	11.437	0.000	Supported
H2: TM -> TE	0.147	0.069	2.127	0.033	Supported
H3 :TM -> TC	0.316	0.062	5.094	0.000	Supported
H4 : TM -> TS	0.109	0.064	1.695	0.090	Not Supported
H5 :TM-> LS	0.056	0.062	0.913	0.361	Not Supported
H6 :CE-> TE	0.016	0.058	0.279	0.780	Not Supported
H7 :CE-> TS	0.029	0.059	0.495	0.620	Not Supported
H8 :TC-> TE	0.087	0.069	1.273	0.203	Not Supported
H9 :TC-> TS	0.403	0.059	6.842	0.000	Supported
H10 :TI -> TM	0.521	0.040	13.075	0.000	Supported
H11 :TI -> CE	-0.003	0.057	0.054	0.957	Not Supported
H12 :TI -> TE	0.239	0.058	4.096	0.000	Supported
H13 :TI -> TC	0.381	0.054	7.114	0.000	Supported
H14 :TI -> LS	0.412	0.056	7.333	0.000	Supported
H15 :LS-> TE	0.432	0.054	7.965	0.000	Supported
H16 :LS -> TS	0.153	0.058	2.620	0.009	Supported

Note. TM: Teaching Methods, CE: Classroom Experience,TE : Teacher emphasis on academic success,TC:Teacher confidence, TS:Teacher satisfaction,LS:Leadership support,

CE: Classroom experience, TI: Teacher Interaction.

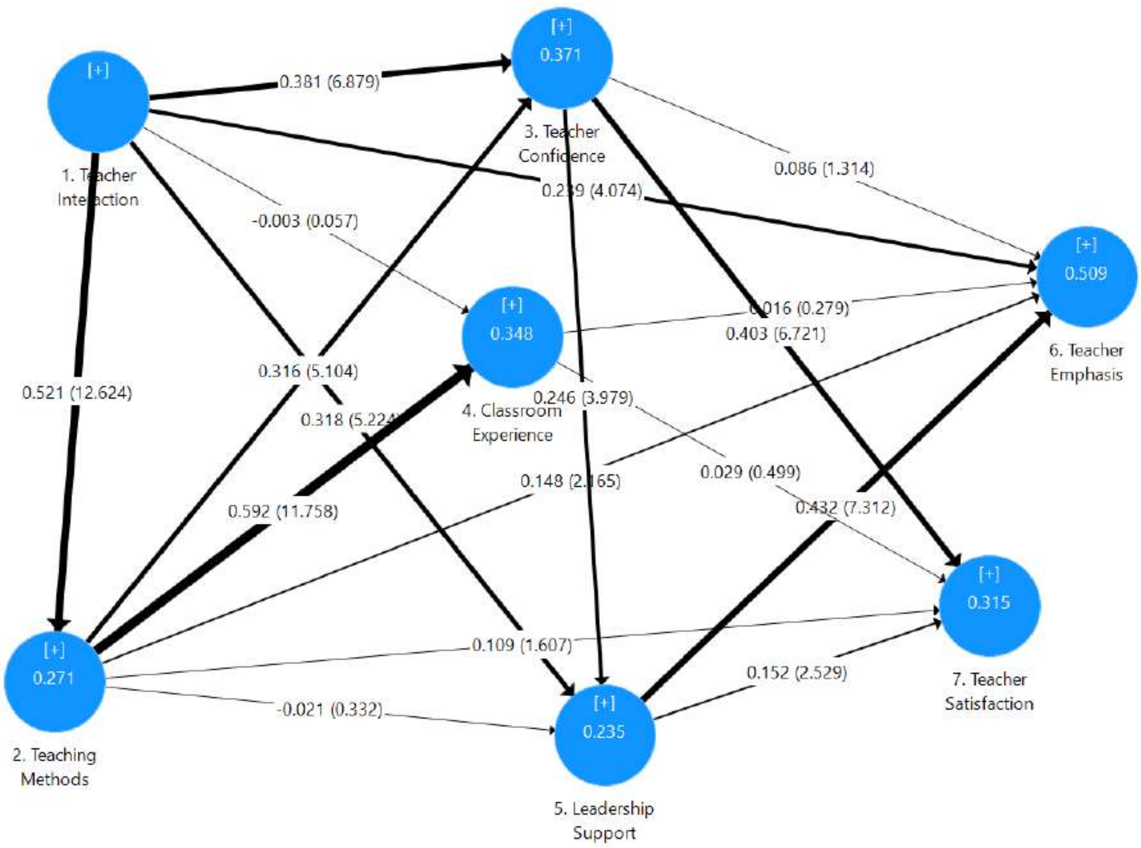

Figure 7-3 The structural model.

7.7 Mediation Analysis

H5: Teaching method mediates the relationship between Teacher interaction and Teacher confidence.

Mediation analysis was performed to assess the mediating role of Teaching method on the relationship between teacher interaction and teacher confidence.

The results (see Table 7.13) revealed significant mediating role of Teaching Method (H5: $\beta = 0.164$, $t = 4.337$, $p < 0.001$). The total effect of Teacher Interaction on teacher confidence was significant ($\beta = .546$, $t = 12.733$, $p < 0.001$), with the inclusion of the mediator the direct effect was still significant ($\beta = 0.381$, $t = 7.096$, $p < 0.001$). Hence, TM partially mediates the relationship between TI and TC.

H6: Teacher confidence mediates the relationship between teaching methods and teacher satisfaction.

Mediation analysis was performed to assess the mediating role of teacher confidence on the relationship between teaching methods and teacher satisfaction.

The results (see Table 12) revealed significant mediating role of teacher confidence (H6: β = 0.127, t = 4.183, p < 0.001). The total effect of teaching methods on teacher satisfaction was significant (β = .262, t = 4.392, p < 0.001), with the inclusion of the mediator the direct effect was insignificant (β = 0.109, t = 1.669, p = 0.095). Hence, TC completely mediates the relationship between TM and TS.

H7: Leadership support mediates the relationship between teacher confidence and teacher emphasis.

Mediation analysis was performed to assess the mediating role of Leadership support on the relationship between teacher confidence and teacher emphasis.

The results (see Table 12) revealed significant mediating role of leadership support (H7: β = 0.106, t = 3.390, p = 0.001). The total effect of Teacher confidence on teacher emphasis was significant (β = .193, t = 2.701, p < 0.001), with the inclusion of the mediator the direct effect was insignificant (β = 0.086, t = 1.236, p = 0.217). Hence, LS completely mediates the relationship between TC and TE. Mediation analysis results are presented in table 7.13.

Table 7-13 Mediation Analysis Results

	Total Effect		Direct Effect		Specific Indirect Effect				
	Coefficient	P-value	Coefficient	P-value	Coefficient	SD	T value	P value	BI(2.5%:97.5%)
H5: TI-TM-TC	.546	.000	.381	.000	.164		4.377	.000	.094-.245
H6: TM-TC-TS	.262	.000	.109	.095	.127		4.183	.000	.072-.183
H7: TC-LS-TE	.193	.007	.086	.217	.106		3.390	.001	.057-.172

Chapter 8 Discussion and conclusion

8.1 Introduction

The purpose of this study was to find out how KSA teachers and their methods can be improved to attain top results in the TIMSS test. The study was inspired by the fact that KSA has been recording low average scale scores in the recent TIMSS assessments, with a comparatively high margin existing between the Kingdom and Singapore which has the best education policy with excellent TIMSS scores globally. To achieve the aim of the study, the researcher sought to achieve three key objectives. The first was to investigate the factors contributing to low TIMSS scores in mathematics in KSA. The second was to examine how TIMSS scores can be used to enhance teaching recommendations on the mathematics subject in KSA. The last objective was to identify the strategies used to teach mathematics in KSA and compare them to the developed standards in the education system in Singapore. Singapore was selected since pupils in this country record high mathematics performance on international assessments, an occurrence that has encouraged various educational initiatives. The primary research question in the study examined whether a link exists between international assessment scores and mathematics development practices in KSA. A number of hypotheses were developed to help meet the objective of the study. The chapter presents the interpretations of each hypothesis, the implications for future practice, the limitations of the study, and the suggestions for future research practice.

8.2 Discussion of the Findings

Teacher interaction and teaching methods

The first hypothesis evaluated whether teacher interaction has a significant impact on teaching methods. The results supported the hypothesis and showed that teacher interaction had a significant effect on teaching methods. When tested on the structural model, teaching methods actually accounted for a minimal percentage of teacher interaction. Each day, mathematics teachers in KSA make countless real-time decisions and facilitate a lot of interactions between themselves and their students. These interactions determine the teaching method, which may refer to general principles along with pedagogy and management approaches used for classroom instruction. That means that a teacher's teaching approach depends on their desire to facilitate interaction within the classroom setting. These findings are supported in past literature on teacher interaction suggesting that teachers who develop a positive interaction with their students promote an environment that is more helpful to learning and one that meets emotional, developmental, and educational needs (Martin & Rimm-

Kaufman, 2015; Rimm-Kaufman et al., 2015). Together, the findings from these studies suggest that the countless interactions that occur daily between the teacher and student make the two parties comfortable, influencing the teaching methods. Hence, teachers in KSA can enhance mathematics performance by increasing teacher interaction and using the right teaching methods. Teacher interaction, along with teaching methods, creates an environment that encourages positive and healthy relations among mathematics learners and helps them channel their energies and desires to attain their academic goals.

Teaching methods and classroom experience

The second hypothesis examined whether there is a significant positive impact of teaching methods on classroom experience. This hypothesis implied that an increase in using positive teaching methods resulted in a better classroom experience. The results supported the hypothesis and suggested that teaching methods have a significant effect on classroom experience. According to this relationship, a teacher's teaching method and the classroom experience affect the achievement of learners. The most suitable model of teaching and creating a suitable learning environment is one that creates a fun learning environment and focuses on improving student achievement. These findings are also supported by those of previous studies examining the impact of teaching methods and classroom experience on student achievement (Akiba & Liang, 2016). Akiba & Liang, in their study found that the achievement of students depends on the learning resources available to them. Consequently, appropriate teaching methods facilitate the acquisition of abstract concepts and ideas and prevents rote learning. Some of the teaching methods teachers may consider based on these findings include those that encourage collaboration and those that incorporate informal learning activities (M. Bernard et al., 2019; Norton, 2017). Another method may entail teacher-driven research activities which have been found to be effective in facilitating student achievement and increased understanding of the mathematics subject (Kaur, 2009; Mupa & Chinooneka, 2015). Teachers in the contemporary society may also consider including computer-based tools as part of their teaching method. Reviewed studies support the possibility that these digital resources can duplicate the functionality of traditional tools with an increased level of efficiency (Pepin et al., 2017; Ruthven & Hennessy, 2002). Besides, digital tools make it possible for learners to interact in various forms based on the immediate feedback arising from their actions. Based on the findings of the study, along with the supporting literature (Akiba & Liang, 2016; Kaur, 2009; Mupa & Chinooneka, 2015; Norton, 2017; Pepin et al., 2017; Ruthven & Hennessy, 2002), teaching methods have a significant influence on classroom experience, and this helps determine the success of the learning process in the mathematics subject.

Teacher confidence and teacher satisfaction

The third hypothesis theorised that there is a significant positive impact of teacher confidence on teacher satisfaction. Confidence refers to a teacher's feeling of self-assurance emanating from their appreciation of their abilities or qualities. Such a feeling of self-assurance tends to affect the satisfaction of teachers with their profession and their working conditions. A mathematics teacher who is confident is likely to motivate learners, try out alternative teaching methods, or confront difficulties much more often, leading to a high level of satisfaction. The findings supported the hypothesis and implied that teacher confidence has a significant effect on teacher satisfaction. This means that mathematics teachers who were confident tended to have a high level of satisfaction. Confidence arose from the aspects of self-efficacy, such as mathematics instruction and classroom engagement. These findings are supported in previous literature examining teacher confidence, self-efficacy, and teacher satisfaction (Sadler, 2013; Hativa, 2000; Akerlind, 2003; Burton, 2004; Peker, 2009). Generally, these studies support the concept that the extent to which a mathematics teacher believes in themselves influences their ability to affect student performance. Some teachers are likely to demonstrate extreme levels of nervousness, negative self-talk, challenges in concentration, and sweaty palms, among other symptoms. Teachers with such signs cannot be satisfied with their work since they are convinced, they cannot be successful in their practice. Some of these characteristics contribute to poor mathematics scores in KSA. Teacher confidence has also been found to relate to job satisfaction (Burton, 2004; Norton, 2017), with teachers having a better chance to feel satisfied with their work when they feel confident in carrying out their key work-related tasks or attaining their work-related goals and objectives. These findings highlight the significance of self-efficacy and self-esteem in teacher satisfaction. Further studies on teacher confidence and teacher satisfaction could, therefore, consider evaluating additional confounding factors, such as self-efficacy and self-esteem and the contribution they add to teaching confidence. Together, these findings suggest it is essential or beneficial for mathematics teachers in KSA to be comfortable in their role for the sake of their satisfaction and that of their students.

Leadership support and teacher emphasis on academic success

The fourth hypothesis conceived a significant positive impact of leadership support on teachers' emphasis on academic success. For mathematics teachers to be effective, they need the school leadership to support them. The support may range from placing the teachers in positions that match their skills, personality traits, and talents to giving them chances for professional development so they can enhance their efficacy. Besides, mathematics teachers need to work with leaders who provide clear guidelines about what is expected of them as leaders. The results of the study supported the theory and showed that leadership support has a significant effect on teacher's emphasis on academic success. These findings mean that the role of school leaders is changing from that of managing learning institutions to supporting instructional reforms in different content areas. This finding is supported in the literature in that past studies show that leadership support can help establish high-quality instructional practices (Coburn, 2003). Additionally, leadership support has been identified as a key strategy for successful education reform. Additional studies that provide consistent findings include Vale et al. (2010), Boston et al. (2017) and Garcia-Martinez et al. (2018). Based on these findings, leaders in KSA schools should support mathematics teachers' emphasis on academic success by facilitating instructional improvement and encouraging particular instructional practices (Coburn, 2003). The leaders can develop a network and structures within their schools to allow and support ongoing improvements in teachers' pedagogical content knowledge and teaching practice. The findings tied to this hypothesis are also consistent with past literature on the significance of teacher emphasis on academic success (Hoy et al., 2008, Smith & Sean Kearney, 2013). Mathematics teachers who receive support from the school leaders stand a better chance of setting high but achievable goals and perform better at instilling diligent work (Hoy et al., 2008, Smith & Sean Kearney, 2013). Together, studies by (Boston et al., 2017; Coburn, 2003; Hoy et al., 2008; Marcon et al., 2018; Smith & Sean Kearney, 2013; Vale et al., 2010) suggest leaders should support teachers in developing mathematics content material that meets the needs of the students. The leaders can only achieve this by going beyond the formal positions provided to them by the Ministry of Education. By affecting teacher emphasis on academic success, leadership support can eventually contribute to better student achievement in the mathematics subject in KSA. Teachers who are supported create an environment that allows learners to believe that an academic outcome is within their reach.

Teaching method, teacher interaction, and confidence

Next, the study posited that the teaching method used mediates the relationship between teacher interaction and teacher confidence. The outcome of mediation analysis revealed that the approach used to teach partially mediated the correlation between teacher interaction and teacher confidence. One challenge teachers' experience in the modern KSA society is to provide an interactive classroom environment. Such a challenge arises because mathematics teaching and learning has changed from being a purely cognitive process to being a more social process. These findings imply that teaching methods that emphasize classroom interaction not only focus on providing the correct answer but also on providing learners with shared learning experiences. Interactive teaching methods allow learners to share and discuss novel ideas, question, and refine each other's approaches, and develop a common understanding within the classroom community. These findings are well supported in past literature examining the concept of teaching practice (Baker et al., 2002; Corkin et al., 2019; Rimm-Kaufman et al., 2015; Rittle-Johnson, 2006). Rittle-Johnson (2006) suggested that teaching practice involving the use of self-explanation and instruction helped the students learn and remember the correct procedures, enhancing teacher interaction and confidence. Corkin et al. (2019) found that teaching methods aligned with student-centred teaching encouraged the students' understanding and rigor in mathematics content. However, like many other studies, the current research, together with supporting past literature, is uncertain over the methods that teachers should use to facilitate interaction and teacher confidence. Based on past research, teacher-directed methods involving the teacher communicating the mathematics lesson to the learners directly could be the most suitable approach for facilitating interaction and teacher confidence (Baker et al., 2002; Rittle-Johnson, 2006). Rimm-Kaufman et al. (2015) also found that students in classrooms with teachers who are warm, caring, and responsive worked hard, enjoyed learning about math, and shared ideas and materials with other learners in their classroom. Rimm-Kaufam et al. (2015) also supported the findings of the current study by revealing that learners in classrooms with teachers who used proactive methods to behaviour management, encouraged smooth transitions between activities, and made learning goals clear before learning had better cognitive, emotional, and social engagement in their mathematics learning. Put together, these findings imply that the approach used for teaching mathematics in KSA is the most significant school-related factor influencing teacher interaction, teacher confidence, and student achievement. The results also underscore the need to use the right teaching method to encourage interaction and instil teacher confidence in the mathematics classroom.

Teacher confidence, methods, and satisfaction

The study also speculated that teacher confidence mediates the relationship between teaching methods and teacher satisfaction. Based on the outcome of mediation analysis, the findings showed that teacher confidence entirely mediated the relationship between the methods used to teach and the satisfaction of the teachers. Teaching, as a profession, requires a teacher to embody various characteristics and qualities for them to perform their duty responsibly and successfully. Among many other things, this study argues that it is essential, or at least beneficial, for a mathematics teacher in KSA to be someone who is or can become comfortable in their role for the sake of their students. A major component to attaining this objective is to be confident in their ability to teach the mathematics subject effectively (M. Bernard et al., 2019; Norton, 2017). These findings imply that teachers with a greater level of self-confidence in the classroom use appropriate teaching methods that positively affect the learning experience of the students. A confident teacher enjoys a better teaching experience, meaning that their level of satisfaction is high. Lack of confidence among teachers serves as an obstacle for students and presents few or no opportunities for students to gain clarification. Where teachers lack confidence, it is possible to infer that there is a negative impact on teaching methods, teacher satisfaction, and the learning experience for students (Burton, 2004; Sadler, 2013). Probably, one of the factors that contribute to the level of self-confidence is teaching experience. Novice mathematics teachers tend to have a lower level of self-confidence arising from the fear of being asked a question they readily do not know the answer. This comes from perceptions that they may not have enough knowledge of the subject or topic they are covering. This is clearly supported in past literature examining teacher confidence, teaching methods, and teacher satisfaction (Hativa, 2000; Sadler, 2013). For instance, Sadler (2013) associated feelings of confidence with content knowledge and teacher skills. Many other studies also tend to suggest that self-confidence improves as the teachers change their teaching approach (Hativa, 2000; AKerlind, 2003; Burton, 2004). Poor performance in mathematics in KSA could be as a result of a low level of teacher confidence, which affects the teaching methods used and equally reduces the level of satisfaction. Teachers with low levels of confidence experience challenges communicating their own understanding successfully to the learners, affecting the learning process. A possible way to deal with low levels of confidence would be for learning institutions to implement teacher development programs that are sensitive to and support the confidence and content knowledge of mathematics teachers. Other factors contributing to low levels of confidence can resolve as mathematics teachers adopt an interactive approach to teaching.

Leadership support, teacher confidence, and teacher emphasis on academic success

The last hypothesis suggested that leadership support facilitates the relationship between teacher confidence and teacher emphasis on academic success. The findings showed that leadership support entirely mediated the relationship between teacher confidence and teacher emphasis. What this means is that providing mathematics teachers with adequate support builds their confidence and helps them focus more on helping their students attain high levels of academic success. Leadership support is important for teachers along with their students, not only for promoting student-centred learning, but also in dealing with and incorporating new standards and practices. Mathematics teachers can often find it overwhelming to prepare, organize, and implement new criteria without the support of leaders, and this can have an immense effect on their confidence. When interpreted, this could also mean that leaders can help mathematics teachers balance math concepts, establish fluency in their procedures, adopt new strategies to increase their mathematical thinking, and establish instructional goals for the mathematics subject. This is in support of past literature on leadership support, teacher confidence, and teacher emphasis on academic success (Boston et al., 2017; García-Martínez et al., 2018; Scherer & Nilsen, 2016). For instance, Scherer and Nilsen (2016) found that teachers with strong pedagogical content knowledge, supposedly arising from leadership support, placed a lot of emphasis on student academic success. Boston et al. (2017) and Garcia-Martinez et al. (2018) also make similar conclusions by implying a positive link between leadership and teacher professionalism, teaching and learning, along with student performance. All in all, these findings point to the possibility that leaders in KSA can support mathematics teachers in developing knowledge that meets the needs of the learners. Through such support, teachers gain more confidence and place a lot of emphasis on academic success.

8.3 Implications for Future Practice

8.3.1 Mathematics education in KSA

The findings of this study have certain implications for mathematics education in KSA. To begin with, schools in KSA must consider working together with the MOE to identify priorities that can transform mathematics instruction. Transforming the mathematics scores will potentially not work without developing a few priorities that must be implemented to increase student achievement (Santana et al., 2020). Leaders in the education sector must be involved in observing mathematics instruction so they can get an idea of whatever is happening in classrooms. In the future, it is important for leaders to set aside time in the mathematics classroom to see instruction in action. Upon collecting data from classrooms, school leaders can sit down and discuss trends clear across the school and in certain grade levels concerning mathematics performance. Such discussions can help set 2-3 priorities for mathematics instruction and help identify specific goals that can improve mathematics performance across grade and in schools. The findings of this study can also be extended to help teachers and school administrators at the MOE in Saudi Arabia.

Second, future mathematics education should focus on helping leaders and teachers identify factors to look for in an effective math classroom. This can be achieved by engaging these experts in professional learning. Experience is considered the best teacher and leaders and teachers who engage in professional learning stand a better chance of identifying the factors needed to make sense of mathematics. Professional learning presents an opportunity for teachers to engage in mathematical experiences and disclose that they can make sense of mathematics using novel learning experiences, hands-on learning, and social interaction. Through this opportunity, teachers gain more confidence and can emphasize more on academic success. School leaders can also use such professional learning opportunities to discover conditions that support learning and those that encourage the instructional practice of teachers.

8.3.2 Recommendations to the KSA Ministry of Education

The findings of the study inform certain recommendations to the KSA Ministry of Education. A major emphasis of the ministry going forward should be on developing school-based math leaders. As evident in this paper, leadership support is essential in facilitating student achievement considering that teacher leaders are regarded as the first effective teachers. Teacher leaders are able to showcase each day the competencies associated with effective mathematics classroom instruction. The Ministry should encourage every school to identify their math teacher lead, who may or may not have a formal background in mathematics. These teacher leads can be provided with the opportunity to take extra qualifications in mathematics through strategic courses. These courses provide an opportunity to enhance practice and attempt to address how mathematics knowledge can be mobilized to enhance practice throughout a school. Math lead teachers can also work collaboratively with school administrators to strategize how to enhance mathematics success. In line with this recommendation, the Ministry of Education should also consider developing powerful models that support school-based mathematics leaders to support teachers in advancing their mathematics teaching practice and content knowledge. Ultimately, it is believed that this recommendation will enhance student achievement.

Second, the Ministry of Education should set up an appropriate framework and encourage follow-up with all the stakeholders involved in instructional support. Specifically, the Ministry should provide leaders with the opportunity to nurture mathematical instructional practice by using research-based best practices to support their teachers. Some of the practices that could be supported include number talks, math menus, and 3-act problems. It is also important that institutional leaders visit classrooms regularly to see how teachers are executing practices learned from professional development. Instructional leaders can only play this role effectively if the Ministry of Education is involved fully in setting up appropriate foundations.

Third, the Ministry of Education should consider setting up a mathematics laboratory in KSA to facilitate mathematics learning across the country. Mathematical knowledge becomes an enormous burden when it cannot be translated into practice. To prevent this from happening, teachers need to give students the chance to integrate theory with practice, an approach that helps apply arithmetic facts and principles practically. For the country to achieve its 2030 vision, the Ministry must consider setting up and using a mathematics laboratory that can help assimilate theory and practical applications in the teaching and learning of the subject. Eventually, such a move will help students improve their performance in mathematics and make it easier for them to learn other subjects as well, with little complexity. This recommendation is consistent with past studies that identified mathematics as being the base of science and technology.

8.4 Limitation of the Study and Recommendation for Future Study

The current study is not without limitations. First, the study was limited to mathematics teachers in the Kingdom of Saudi Arabia. It was also limited to the outcome of the teachers across different constructs of the developed model. An additional limitation is that the measures of mathematics instructional practice used in the study are much less refined. The items used to examine teacher development seem to be under-specified. In general, the author believes that assessing the quality of teachers and their experiences while teaching mathematics requires the use of more refined items than those included in the study (teacher interaction, teaching methods, leadership support, teacher confidence, classroom experience, teacher emphasis on academic success, and teacher satisfaction). In the future, it would be valuable to strengthen the research model so that the same teachers can be tested more than once. Besides, it would be prudent for future studies to compare mathematics teaching experiences in Saudi Arabia with those of countries with an established education system, such as Singapore.

8.5 Conclusion

8.5.1 Overall conclusion to the thesis

The purpose of this study was to find out how KSA teachers and their methods can be improved to attain top results in the TIMSS test. To achieve the aim of the study, the researcher sought to achieve three key objectives. (1) To investigate the factors contributing to low TIMSS scores in mathematics in KSA. (2) To examine how TIMSS scores can be used to enhance teaching recommendations on the mathematics subject in KSA. (3) To identify the strategies used to teach mathematics in KSA and compare them to the developed standards in the education system in Singapore. The primary research question in the study examined whether a link exists between international assessment scores and mathematics development practices in KSA. A number of hypotheses were developed to help meet the objective of the study. All the hypotheses were supported, and the findings were as follows:

1. Teacher interaction has a significant effect on teaching methods. Every day, mathematics teachers in KSA make various real-time decisions and facilitate a lot of interactions between themselves and their students. These interactions determine the teaching method, which refers to the general principles of pedagogy and management approaches used for classroom instruction.
2. Teaching methods have a significant effect on classroom experience. Appropriate teaching methods facilitate the acquisition of abstract concepts and ideas and prevents the possibility of experiencing rote learning. To facilitate a better classroom experience, teachers should consider methods that encourage collaboration and those that support informal learning activities.
3. Teacher confidence has a significant effect on teacher satisfaction. Mathematics teachers who are confident are more likely to motivate learners, an aspect that can contribute to teacher satisfaction. Confidence arises from aspects such as self-efficacy, such as mathematics instruction and classroom management.
4. Leadership support has a significant effect on teacher emphasis on academic achievement. Mathematics teachers can only be effective if they receive adequate support from the school leadership. Support may come in terms of placing the teachers in positions that match their skills, personality traits, and talents to give

them a better chance of professional development. Another way would be for mathematics teachers to work with leaders who provide clear guidelines about what is expected of them as leaders.

5. Teaching method partially mediates the relationship between teacher interaction and teacher confidence. Methods that emphasize classroom interaction focus on providing the correct answer and provide learners with shared learning experiences. Through interactive teaching methods, learners share and discuss novel ideas and questions, and refine each other’s approaches.
6. Teacher confidence completely mediates the relationship between teaching methods and teacher satisfaction. Teaching requires a teacher to embody various characteristics and qualities for them to perform their duty responsibly and successfully. It is essential for a mathematics teacher in KSA to be someone who is or can become comfortable in their role for the sake of their students. A key component to attaining this objective is to be confident in their ability to teach the mathematics subject effectively.
7. Leadership support completely mediates the relationship between teacher confidence and teacher emphasis on academic achievement. This means that providing mathematics teachers with enough support builds their confidence and helps them focus on helping their students attain high levels of academic success. Teachers need leadership support for promoting student-centred learning and dealing with new standards and practices. School leaders should help mathematics teachers balance math concepts, establish fluency in their procedures, adopt new strategies to facilitate mathematical thinking, and develop instructional goals for the mathematics subject.

8.5.2 Statement of personal development

My intentions for the future are as follows. First, I plan to conduct more independent research on each of the variables identified in this study to identify how they can facilitate better results in future TIMSS tests. As a researcher, a lot of my personal development will entail publishing research, attending conferences, and gaining the skills needed to do my research well. However, there are additional activities that I could partake to boost my influence in the KSA education sector. For instance, I will opt to gain teaching experience or rather run a conference or symposium to present my findings to teachers and stakeholders in the education sector. The most suitable opportunity would be the conference on TIMSS results KSU centre for excellence in mathematics and science teaching. Being proactive about these aspects will make my abilities stand out in the future.

8.5.3 Contributions

The current study adds to research on the impact of international assessments on mathematics teacher development in KSA. Unlike similar literature, this study presents and evaluates several teacher factors and how they influence the teaching practice.

8.5.4 Recommendations

The following recommendations arise based on the findings of the study:

1. Mathematics teachers in KSA are required to understand factors that contribute to effective learning to ensure they make their classes active, conducive, and more fun. Mathematics instruction remains overwhelmingly teacher-centred and should focus on helping students think critically and apply their knowledge to real-world situations. Many mathematics teachers consider mathematics as a rigid and fixed body of knowledge, and think their responsibility is to transmit the knowledge to their students. However, understanding the factors that contribute to effective learning can change this narrative. Teachers must find a way to make the classroom an inquiry-based environment where learning is considered an active and constructive activity where learners explore, develop conjectures, and solve problems. Mathematics teachers must also find ways to encourage students to discuss and communicate their ideas and results within small and cooperative groups.
2. Mathematics teachers in KSA should use learning methods based on the understanding level of the students and the material under study. If students are to develop mathematical proficiency, teachers must have a clear vision of the objectives of instruction and what proficiency means for different levels of students. Teachers need to know the mathematics they teach and the horizons of that mathematics concerning where it can lead and where leaners are headed with it. Teachers need to use their knowledge in a flexible manner to appraise and adapt instructional materials. Besides, they need to represent content in a honest and accessible manner and assess what students are learning.

3. School leadership should support mathematics teachers and take part in the learning process to guarantee better performance in the future. Professional development is necessary if mathematics classroom practice is to be changed. School leadership can support teacher learning by developing a learning culture, shaping opportunities for learning and providing resources, encouragement, time, and monitoring. School leadership must acknowledge their duty as facilitators for teachers’ learning and ensure that proper learning conditions are put in place to create a learning culture at the school.

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APPENDIX

Appendix A: Pilot Survey Questions

General Questions

This survey to investigate why Saudi Arabia have got poor result in TIMSS test since 2003 until 2015?

1 –Are you teach Math or Science?

A. Math
B. Science

2- What is your age?

A. 25-30 years
B. 31-35 years
C. 36-40 years
D. 41-50 years
E. More than 50 years

3- How many years have you been teaching?

A. 1- 5 years
B. 6-10 years
C. 10-15 years
D. 16-20 years
E. More than 20 years

4- What is your highest qualification?

A. Diploma
B. High Diploma
C. Bachelor's degree
D. Master's degree
E. PhD Degree

5- How many students are there in the classroom?

A. 15-20 Student

B. 21-25 Student
C. 26-30 Student
D. 31-35 Student
E. More than 35 Student

6- In typical week How much time do you spend teaching?

A. 1-5 hours
B. 6-10 hours
C. 11-15 hours
D. 16-20 hours
E. More than 20 hours

7- How would you characterize each of the following within your school: Teachers' expectations for student achievement?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

8- Teachers' understanding of the curriculum in your school?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

9- Teachers' ability to inspire students?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

10- Collaboration between school leadership and teachers to plan instruction?

A. Strongly Agree
B. Agree
C. Neutral
D. Disagree
E. Strongly Disagree

11- Students' ability to reach school's academic goals?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

12- School leadership's support for teachers' professional development?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

13- -Students' desire to do well in school?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

14-teachers' job satisfaction in your school?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

15- School’ curriculum implementation in your school?

A. Very High
B. High
C. Medium
D. Low
E. Very Low

16- How often do you ask students to memorize rules, procedures, and facts?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

17- How often do you ask students to solve problems individually?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

18- How often ask students to explain their answers?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

19- How often do you use activity books in class room?

A. Always
B. Often
C. Sometimes
D. Rarely

E. Never

20- How often do you use computer software in classroom?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

21- How often do you usually assign homework to the students in this class?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

22- How often do you have following types of interactions with other teachers?

A. Always
B. Often
C. Sometimes
D. Rarely
E. Never

23- Are you specialist in mathematics, specialist in science or specialist in one and teach other?

A. specialist in mathematics
B. specialist in Scientist
C. specialist in one and teach other.

24- Based on the attached chart What are the reasons that led to the low level of student achievement in the international TIMSS tests in the past years? (open question)

Appendix B: TIMSS 2015 Questions

***About You**

G1: By the end of this school year, how many years will you have been teaching altogether?

1-5 years, 6-10 years, 11-15 years,16-20 years, 21 – 25 years, 26-30 years, more than 30

G2- Are you female or male?

G3-How old are you?

Under 25, 25–29, 30–39, 40–49, 50–59, 60 or more

G4-What is the highest level of formal education you have completed?

Diploma, high diploma, bachelor's degree, master's degree, doctoral degree

G5- A. During your <post-secondary> education, what was your major or main area(s) of study?

a) Education. Primary/Elementary. b) Education-Secondary. c) Mathematics

d) Science. e) language of test. f) Other.

B. If your major or main area of study was education, did you have a <specialization> in any of the following? *Check one circle for each line.* Yes, No a) Mathematics. b) Science.

c) Language/reading. d) another subject.

***School emphasis on academic success**

6- How would you characterize each of the following within your school?

Very high, High, Medium, Low, very low

a) Teachers' understanding of the school's curricular goals

b) Teachers' degree of success in implementing the school's curriculum

c) Teachers' expectations for student achievement

d) Teachers working together to improve student achievement

e) Teachers' ability to inspire students

f) Parental involvement in school activities

g) Parental commitment to ensure that students are ready to learn

h) Parental expectations for student achievement

i) Parental support for student achievement

j) Parental pressure for the school to maintain high academic standards

k) Students' desire to do well in school

l) Students' ability to reach school's academic goals

m) Students' respect for classmates who excel in school

n) Clarity of the school's educational objectives

o) Collaboration between school leadership and teachers to plan instruction

p) Amount of instructional support provided to teachers by school leadership

q) School leadership's support for teachers' professional development

***School environment**

G7- Thinking about your current school, indicate the extent to which you agree or disagree with each of the following statements (Agree a lot, agree a little, Disagree a little, Disagree a lot)

a) This school is located in a safe neighborhood.

b) I feel safe at this school.

c) This school's security policies and practices are sufficient.

d) The students behave in an orderly manner.

e) The students are respectful of the teachers.

f) The students respect school property.

g) This school has clear rules about student conduct.

h) This school's rules are enforced in a fair and consistent manner.

G8- In your current school, how severe is each problem?

Not a problem, Minor problem, Moderate problem, Serious problem

a) The school building needs significant repair.

b) Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students).

c) Teachers do not have adequate instructional materials and supplies.

d) The school classrooms are not cleaned often enough.

e) The school classrooms need maintenance work.

f) Teachers do not have adequate technological resources.

g) Teachers do not have adequate support for using technology.

***About Being a teacher**

G9- How often do you have the following types of interactions with other teachers?

Very often, Often, Sometimes, Never or almost never

a) Discuss how to teach a particular topic

b) Collaborate in planning and preparing instructional materials

c) Share what I have learned about my teaching experiences

d) Visit another classroom to learn more about teaching

e) Work together to try out new ideas

f) Work as a group on implementing the curriculum

g) Work with teachers from other grades to ensure continuity in learning

G10- How often do you feel the following way about being a teacher?

Very often, Often, Sometimes, Never or almost never

a) I am content with my profession as a teacher

b) I am satisfied with being a teacher at this school

c) I find my work full of meaning and purpose

d) I am enthusiastic about my job

e) My work inspires me

f) I am proud of the work I do

g) I am going to continue teaching for as long as I can

G11- Indicate the extent to which you agree or disagree with each of the following statements.

(Agree a lot, agree a little, disagree a little, Disagree a lot)

a) There are too many students in the classes.

b) I have too much material to cover in class.

c) I have too many teaching hours.

d) I need more time to prepare for class.

e) I need more time to assist individual students.

f) I feel too much pressure from parents.

g) I have difficulty keeping up with all of the changes to the curriculum.

h) I have too many administrative tasks.

***About Teaching the TIMSS Class**

G12-A. How many students are in this class?

B. How many of the students in G12A are in fourth grade?

G13- How many <fourth grade> students experience difficulties understanding spoken <language of test>? ______ student

G14- How often do you do the following in teaching this class?

Every or almost every lesson, About half the lessons, Some lessons ,Never

a) Relate the lesson to students' daily lives

b) Ask students to explain their answers

c) Bring interesting materials to class

d) Ask students to complete challenging exercises that require them to go beyond the instruction

e) Encourage classroom discussions among students

f) Link new content to students' prior knowledge

g) Ask students to decide their own problem-solving procedures

h) Encourage students to express their ideas in class

G15- In your view, to what extent do the following limit how you teach this class?

Not at all, Some, A lot

a) Students lacking prerequisite knowledge or skills.

b) Students suffering from lack of basic nutrition.

c) Students suffering from not enough sleep.

d) Disruptive students.

e) Uninterested students.

f) Students with physical disabilities.

g) Students with mental, emotional, or psychological disabilities.

***Teaching mathematics to the TIMSS Class**

M1- In a typical week, how much time do you spend teaching mathematics to the students in this class? _____________ minutes per week

M2-In teaching mathematics to this class, how would you characterize your confidence in doing the

following? Very high, High Medium Low

a) Inspiring students to learn mathematics

b) Showing students, a variety of problem-solving strategies

c) Providing challenging tasks for the highest achieving students

d) Adapting my teaching to engage students' interest

e) Helping students appreciate the value of learning mathematics

f) Assessing student comprehension of mathematics

g) Improving the understanding of struggling students

h) h) Making mathematics relevant to students.

i) Developing students' higher-order thinking skills.

M3- In teaching mathematics to this class, how often do you ask students to do the following?

Every or almost every lesson About half the lessons Some lessons, Never

a) Listen to me explain new mathematics content

b) Listen to me explain how to solve problems

c) Memorize rules, procedures, and facts

d) Work problems (individually or with peers) with my guidance

e) Work problems together in the whole class with direct guidance from me

f) Work problems (individually or with peers) while I am occupied by other tasks

g) Take a written test or quiz

h) Work in mixed ability groups

i) Work in same ability groups

*** Using Computers and computers for Teaching Mathematics to the TIMSS Class**

M4- Are the students in this class permitted to use calculators during mathematics lessons? Check one circle only.

Yes, with unrestricted use.

Yes, with restricted use.

No, calculators are not permitted.

M5- Do the students in this class have computers (including tablets) available to use during their mathematics lessons?

Check one circle only. Yes, No. if No go to #M6.

IF yes

B. What access do the students have to computers?

Check one circle for each line. Yes, No

a) Each student has a computer

b) The class has computers that students can share.

c) The school has computers that the class can use sometimes.

C. How often do you have the students do the following activities on computers during mathematics lessons? Check one circle for each line.

Every or almost every day, Once or twice a week, Once or twice a month, Never or, almost never

a) Explore mathematics principles and concepts.

b) Practice skills and procedures.

c) Look up ideas and information.

*** Mathematics Topics Taught to the TIMSS Class**

M6- The following list includes the main topics addressed by the TIMSS mathematics test. Choose the response that best describes when the students in this class have been taught each topic. If a topic was in the curriculum before the <fourth grade>, please choose "Mostly taught before this year." If a topic was taught half this year but not yet completed, please choose "Mostly taught this year." If a topic is not in the curriculum, please choose "Not yet taught or just introduced."

Mostly taught before this year, mostly taught this year, Not yet taught or just introduced.

A) Number

a) Concepts of whole numbers, including place value and ordering

b) Adding, subtracting, multiplying, and/or dividing with whole numbers

c) Concepts of multiples and factors; odd and even numbers

d) Concepts of fractions (fractions as parts of a whole or of a collection, or as a location on a number line)

e) Adding and subtracting with fractions, comparing and ordering fractions

f) Concepts of decimals, including place value and ordering, adding and subtracting with decimals

g) Number sentences (finding the missing number, modelling simple situations with number sentences)

h) Number patterns (extending number patterns and finding missing terms)

B. Geometric Shapes and Measures

a) Lines: measuring, estimating length of; parallel and perpendicular lines

b) Comparing and drawing angles

c) Using informal coordinate systems to locate points in a plane (e.g., in square B4)

d) Elementary properties of common geometric shapes

e) Reflections and rotations

f) Relationships between two-dimensional and three-dimensional shapes

g) Finding and estimating areas, perimeters, and volumes

C. Data Display

a) Reading and representing data from tables, pictographs, bar graphs, or pie charts

b) Drawing conclusions from data displays

***Mathematics Homework for the TIMSS Class**

M7-A. How often you assigned student with homework in mathematics?

I do not assign pupils homework, once a week, 1 or 2 times a week, 3 or 4 times a week, Every day

B. When you assign mathematics homework to the students in this class, about how many minutes do you usually assign? (Consider the time it would take an average student in your class.)

15 minutes or less, 16-30 minutes, 31-60 minutes, more than 60 minutes.

C. How often do you do the following with the mathematics homework assignments for this class?

Always or almost always, Sometimes, Never, or almost, never.

a) Correct assignments and give feedback to students.

b) Discuss the homework in class.

c) Monitor whether or not the homework was completed.

*** Mathematics Assessment of the TIMSS Class**

M8-How much emphasis do you place on the following sources to monitor students' progress in mathematics? Major emphasis, Some emphasis, Little or no emphasis

a) Assessment of students' ongoing work.

b) Classroom tests (for example, teacher-made or textbook tests).

c) National or regional achievement tests.

*** Preparation to Teach Mathematics**

M9- In the past two years, have you participated in professional development in any of the following? Yes, No

a) Mathematics content

b) Mathematics pedagogy/instruction

c) Mathematics curriculum

d) Integrating information technology into mathematics

e) Improving students' critical thinking or problem-solving skills

f) Mathematics assessment

g) Addressing individual students' needs

M10- In the past two years, how many hours in total have you spent in formal <in-service/professional development> (e.g., workshops, seminars, etc.)

for mathematics?

None, less than 6 hours, 6–15 hours, 16–35 hours, more than 35 hours

M11- How well prepared do you feel you are to teach the following mathematics topics? If a topic is not in the <fourth grade> curriculum or you are not responsible for teaching this topic, please choose "Not applicable."

Not applicable Very well prepared, somewhat prepared, not well prepared.

A. Number

a) Concepts of whole numbers, including place value and ordering

b) Adding, subtracting, multiplying, and/or dividing with whole numbers

c) Concepts of multiples and factors; odd and even numbers

d) Concepts of fractions (fractions as parts of a whole or of a collection, or as a location on a number line)

e) Adding and subtracting with fractions, comparing and ordering fractions

f) Concepts of decimals, including place value and ordering, adding and subtracting with decimals

g) Number sentences (finding the missing number, modelling simple situations with number sentences)

h) Number patterns (extending number patterns and finding missing terms)

B. Geometric Shapes and Measures

a) Lines: measuring, estimating length of; parallel and perpendicular lines

b) Comparing and drawing angles

c) Using informal coordinate systems to locate points in a plane (e.g., in square B4)

d) Elementary properties of common geometric shapes

e) Reflections and rotations

f) Relationships between two-dimensional and three-dimensional shapes

g) Finding and estimating areas, perimeters, and volumes

C. Data Display

a) Reading and representing data from tables, pictographs, bar graphs, or pie charts

b) Drawing conclusions from data displays

Appendix C: Main survey Questions.

Mathematics teacher survey

The aim of the survey is to explore The Impact of International Assessments on Mathematics Teacher Development in the Kingdom of Saudi Arabia. This questionnaire is to identify the reasons that led to fourth-grade students obtaining low results in TIMSS 2015.

Please be aware that the information gathered in this study will only be used for research purposes. The anonymisation of all data will protect the participants' privacy; as a result, none of the participants or workplaces will be identifiable. Data will be securely stored, with only the researcher and the supervisor having access.

The survey has 12 questions that can be easily answered by chooses the appropriate box/ boxes from multiple choices.

It should take no longer than 15 minutes to answer the questions. Please note that by clicking on OK below, you are agreeing to participate in this research study.

General Questions

About You

1- Are you female or male?

Female	Male

2-How old are you?

Under 25	25-29	30-39	40-49	50-59	60 or more

3- By the end of this school year, how many years will you have been teaching altogether?

1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years	More than 30 years

4-What is the highest level of formal education you have completed?

Diploma	High Diploma	Bachelor's Degree	Master's Degree	Doctoral Degree

5-How well do you know the international TIMS test?

I know nothing about the test.	
My knowledge is a little.	
My knowledge is good.	
My knowledge is very good.	
My knowledge is excellent.	

6- How often do you have the following types of interactions with other teachers?

Tick one box for each row

Phrases	Very often	Often	Sometimes	Never or almost never
a) Discuss how to teach a particular topic				
b) Collaborate in planning and preparing instructional materials				
c) Share what I have learned about my teaching experiences				
d) Visit another classroom to learn more about teaching				
e) Work together to try out new ideas				
f) Work as a group on implementing the curriculum				
g) Work with teachers from other grades to ensure continuity in learning				

7- How often do you do the following in teaching this class?

Every or almost every lesson, About half the lessons ,Some lessons, Never

Tick one box for each row

Phrases	Every or almost every lesson	About half the lessons	Some lessons	Never
a) Relate the lesson to students' daily lives				

b) Ask students to explain their answers				
c) Bring interesting materials to class				
d) Ask students to complete challenging exercises that require them to go beyond the instruction				
e) Encourage classroom discussions among students				
f) Link new content to students' prior knowledge				
g) Ask students to decide their own problem-solving procedures				
h) Encourage students to express their ideas in class				

8- How would you characterize each of the following within your school?

Very high, High, Medium, Low, very low

Tick one box for each row

Phrases	Very high	High	Medium	Low	very low
n) Clarity of the school's educational objectives					
o) Collaboration between school leadership and teachers to plan instruction					
p) Amount of instructional support provided to teachers by school leadership					
q) School leadership's support for teachers' professional development					

9- In teaching mathematics to this class, how would you characterize your confidence in doing the following? Very high, High Medium Low

Tick one box for each row

Phrases	Very high	High	Medium	Low
a) Inspiring students to learn mathematics				
b) Showing students a variety of problem solving strategies				
c) Providing challenging tasks for the highest achieving students				
d) Adapting my teaching to engage students’ interest				
e) Helping students appreciate the value of learning mathematics				
f) Assessing student comprehension of mathematics				
g) Improving the understanding of struggling students				
h) Making mathematics relevant to students				
i) Developing students’ higher-order thinking skills				

10 - In teaching mathematics to this class, how often do you ask students to do the following?

Every or almost every lesson About half the lessons Some lessons, Never

Tick one box for each row

Phrases	Every or almost every lesson	About half the lessons	Some lessons	Never
a) Listen to me explain new mathematics content				
b) Listen to me explain how to solve problems				
c) Memorize rules, procedures, and facts				
d) Work problems (individually or with peers) with my guidance				
e) Work problems together in the whole class with direct guidance from me				
f) Work problems (individually or with peers) while I am occupied by other tasks				
g) Take a written test or quiz				
h) Work in mixed ability groups				
i) Work in same ability groups				

11- How would you characterize each of the following within your school?

Very high, High, Medium, Low, very low

Tick one box for each row

Phrases	Very high	High	Medium	Low	very low

a) Teachers’ understanding of the school’s curricular goals					
b) Teachers’ degree of success in implementing the school’s curriculum					
c) Teachers’ expectations for student achievement					
d) Teachers working together to improve student achievement					
e) Teachers’ ability to inspire students					

12- How often do you feel the following way about being a teacher?

Very often, Often, Sometimes, Never or almost never

Tick one box for each row

Phrases	Very often	Often	Sometimes	Never or almost never
a) I am content with my profession as a teacher				
b) I am satisfied with being a teacher at this school				
c) I find my work full of meaning and purpose				
d) I am enthusiastic about my job				
e) My work inspires me				
f) I am proud of the work I do				
g) I am going to continue teaching for as long as I can				

Thank you for completing this Survey.

Appendix D Research Ethic and approval

Section 1: Approval from MoE to conduct the field study.

Section 2: Research Ethic.

Section 3: Saudi Ministry of Education Permission Letters.

المملكة العربية السعودية
وزارة التعليم
(٢٨٠)
وكالة التخطيط والتطوير
مركز بحوث سياسات التعليم

وزارة التعليم
Ministry of Education

الرقم: ٥٢٧٩٧
التاريخ: ١٠/٤/١٤٤٠هـ
المشفوعات:

Section 1: Approval from MoE to conduct the field study

الموضوع: تسهيل مهمة الباحث/ ماجد بن بخيت العطوي

سعادة الملحق الثقافي السعودي في ايرلندا وفقه الله

السلام عليكم ورحمة الله وبركاته

إشارة الى خطاب سعادتكم رقم (بدون) وتاريخ ٢٠١٨/١١/٢٨م بشأن طالب الدكتوراه بجامعة مدينة دبلن ماجد بن بخيت العطوي، والذي يقوم بإعداد دراسة بعنوان "أثر التقييمات الدولية على تطوير معلمي الرياضيات في المملكة العربية السعودية".

نفيد سعادتكم بأنه لا مانع لدينا من حيث المبدأ من تسهيل مهمة الباحث على أن يتم تزويدنا لاحقاً بأدوات البحث بصورتها النهائية وتحديد العينة المستهدفة، للنظر في إمكانية الموافقة من عدمها.

وتقبلوا وافر التحية والتقدير،،

مدير عام مركز بحوث سياسات التعليم

١٠/٤/١٤٤٠هـ

د. عبدالرحمن بن عبدالكريم مرزا

Section 2: Research Ethic.

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

Mr Mjaed Alatawi

DCU Institute of Education

22 September 2017

REC Reference: **DCUREC/2017/141**

Proposal Title: **The Impact of International Measurement Structures (E.G. TIMSS) On Recommendation For teachers**

Applicant(s): **Mr Mjaed Alatawi, Dr Thomas McCloughlin**

Dear Mjaed,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this project.

Materials used to recruit participants should state that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

Donal O' Gorman

Dr Dónal O'Gorman
Chairperson
DCU Research Ethics Committee

DCU Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
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التاريخ: 2018-11-28
رقم ملف الطالب: IR18127

Section 3: Saudi Ministry of Education Permission Letters.

إفادة

تفيد الملحقية الثقافية السعودية في إيرلندا بأن الطالب/ ماجد بخيت عوده العطوي رقم السجل المدني:1030121949، قد ابتعث من قبل وزارة التعليم بتاريخ 11-07-2016 لدراسة مرحلة دكتوراه، وستنتهي بعثته بتاريخ 30-06-2020.

تم منحه هذه الإفادة - دون أدنى مسؤولية -بناءً على طلبه لتقديمها مدير عام المركز الوطني لبحوث وسياسات التعليم-وزارة التعليم

ونقبلوا خالص التحية والتقدير،

الملحق الثقافي

أ.د. عبدالله بن محمد الضلعان