UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL, HUMAN AND MATHMATICAL SCIENCES

Southampton Education School

Mathematics Teachers' Knowledge and Practices of Classroom Assessment in Saudi Arabian Primary Schools

by

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ABSTRACT

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MATHEMATICS TEACHERS' KNOWLEGE AND PRACTICES OF CLASSROOM ASSESSMENT IN SAUDI ARABIAN PRIMARY SCHOOLS

Manahel Mohammed Alafaleq

Classroom assessment is a permanent activity for teachers to motivate students to learn and to enhance the quality of instruction. Therefore, this study seeks to explore mathematics teachers' knowledge of classroom assessment and their practices in Saudi Arabian primary schools. The present study also considers the relationship between teachers' assessment knowledge and their practices by investigating whether their practices are consistent with their assessment knowledge. Moreover, the present study aims to identify factors that influence teachers' knowledge and practices of classroom assessment.

The study is based on the pragmatic paradigm as both quantitative and qualitative approaches were applied to achieve the aims of the study. A questionnaire survey was developed and employed to collect data from 109 participants while the classroom observation and semi-structured interviews were conducted with 10 primary mathematics teachers.

The findings of this study reveal that primary mathematics teachers have different levels of assessment knowledge according to the ways they understand the purposes of applying assessment in their classes. The findings also indicate teachers' lack of awareness regarding what they should assess in mathematics classes. The study indicates a gap between teachers' assessment knowledge and their practices of classroom assessment since teachers' knowledge is not always reflected in their practices of assessment. In addition, the findings show that primary mathematics teachers are implementing various assessment techniques; however, teachers seem to give more importance to traditional assessments than alternative assessments. Moreover, the findings of the study indicate the role of context on teachers' current understandings of assessment and their practice of classroom assessment.

These findings are discussed in relation to the evidence from previous research. The study provides the contribution to the literature, the recommendations for a number of stakeholders and suggestions for future research.

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DECLARATION OF AUTHORSHIP

I, Manahel Mohammed Alafaleq

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Mathematics Teachers' Knowledge and Practices of Classroom Assessment in Saudi Arabian Primary Schools

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. [Delete as appropriate] None of this work has been published before submission [or] Parts of this work have been published as: [please list references below]:

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Date: .....

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Chapter 1: Introduction

1.1 Background

Due to the ever growing need to improve students' educational experiences, many countries, including Saudi Arabia, have set lofty goals for learning. To reach these goals, teachers need to adopt an effective instruction model based on students' needs and their levels of achievement. Teachers also need to ensure students are involved in effective classroom discussions and design various learning tasks, which would help to provide clear evidence about pupils' progress (Leahy, Lyon, Thompson and Wiliam, 2005).

Assessment is considered a critical part of improving learning since it contributes to the gathering of relevant information. In 1995, the National Council of Teachers of Mathematics (NCTM) published its Assessment Standards for School Mathematics. The standards emphasise that teachers should understand why they use classroom assessment as a part of their daily schoolwork. They should also have an awareness of exactly how they are conducting assessments, and the impact of assessments on students' learning. It is important to realise that assessments are a powerful tool that should enhance the learning of mathematics and reflect what students know about the subject and what they still need to learn (NCTM, 1995).

In addition, Gipps (1994) states that assessments can be used to help develop the curriculum and teaching practice. Conducting educational assessments is a systematic process that involves gathering, interpreting, recording and employing information about students' responses to learning activities (Harlen, Gipps, Broadfoot, and Nuttall, 1992).

The notion of assessment has received increasing attention from many educational researchers, resulting in a shift away from the narrow vision of assessment as something that merely measures students' achievement, to a deeper understanding of its benefits in terms of the promotion of learning outcomes (Stiggins, 1992; NCTM, 1995; Black and Wiliam, 1998b; Wiliam, 2011, 2017). To gain the greatest benefits from assessment, such as identifying students' needs, motivating students to learn, and monitoring instructions, it should be employed in classrooms using a variety of methods (Black and Wiliam, 1998a; 1998b). Many researchers are in favour of alternative over traditional forms of assessment as they claim that alternative assessment has motivational aspects and is more challenging for students (Shepard, 2000; McMillan, Myran and Workman, 2002).

Accordingly, alongside traditional tests, alternative assessment methods have been developed over time to be more authentic so they are more effective at evaluating students' academic performance (Popham, 2014). Assessment is best implemented when teachers succeed in using various methods before providing students with comprehensive feedback on their work. Teachers also need to know how to use assessment information to make instructional decisions (Shepard, 2000; Black, 2001). According to Stiggins (1992, p. 35):

> "The quality of instruction is a function of teachers' understanding of the strengths and weaknesses of their students. The depth of that understanding, in turn, hinges on the quality of teachers' assessments of student achievement. Thus, sound instruction requires the sound classroom-level assessment of student achievement".

Therefore, the more teachers know about their students, the more effective they will be in helping students to more deeply understand what they learn. In this sense, Bodin (1993) states that nothing can be known about students' understanding unless they respond to a given cognitive task. It seems clear from the empirical studies in the classroom assessment literature that assessment is a central part of the learning process when it is employed in a way that helps teachers to gain a greater understanding of both their own performance and their students' progress. These concerns about understanding and using assessment effectively are worth investigating because they may contribute to improve the theory and practice of classroom assessment.

1.2 Statement of the problem

Classroom assessment is considered one of the most challenging aspects of a teacher's role, as it requires highly effective decision-making skills in both learning and teaching (McMillan, 2008). While teachers spend approximately between 30% to 50% of classroom time on assessment or activities related to assessing students (Stiggins, 1992), limited research has explored teachers' knowledge of classroom assessment directly, or investigated how their practices of classroom assessment relate to what they know about assessment (Abell, 2007; Abell and Siegel, 2011). Thus, there is a need to comprehensively understand what teachers know about assessment, especially in the context of mathematics. In Saudi Arabia, decision makers have realised the need to reform education to ensure a better future for the country. Accordingly, in 2006, a series of reforms were conducted to develop in general the educational context as these reforms started from improving education in the primary schools. The main concern of this reform was to improve teaching quality and students' learning in mathematics and science in Saudi Arabian schools due to the poor performance of Saudi Arabia in the Trends in International Mathematics and Science

Study (TIMSS). It should be noted that Saudi Arabia was first involved in TIMSS in 2003; the country achieved a low score regarding student performance (Wiseman, Sadaawi and Alromi, 2008). As well, the TIMSS data shows that Saudi Arabia did worse in 2015 than 2011 for grade 4 maths (Mullis, Martin, Foy and Hooper, 2016). Thus, the recent mathematics reform in primary schools in Saudi Arabia has included the textbooks and the assessment approach. The idea behind reforming assessment approach in primary schools was to transfer from assessment that just evaluate students' achievement to promote students' learning and teaching. This reform was established based on NCTM's *Principles and Standards for School Mathematics* (1995) which ensure the need for a significant assessment, that,

> "Should support the learning of important mathematics and furnish useful information to both teachers and students; when assessment is an integral part of mathematics instruction, it contributes significantly to all students' mathematics learning" (NCTM, p. 21).

In any educational system, teachers play a significant role in enhancing students' learning as research demonstrates that teaching methods used by teachers and their behaviour in classrooms may explain between 60% and 70% of students' performance in mathematics (Muijs and Reynolds, 2000). In this sense, some Saudi studies show that many teachers in Saudi schools are still applying assessment in a test-based format, rather than concentrating on utilising assessments to promote students' learning and instructions (Alsadaawi, 2008; 2010; H. Alghamdi, 2015). Furthermore, Alhareth and Aldighrir (2014) have argued that teachers are mainly concerned with students memorising enough information to pass a test and obtain good scores rather than strengthening their knowledge base and critical thinking skills. Despite the Ministry of Education's increased focus on this issue, several Saudi researchers have indicated that assessment in Saudi Arabia has neglected to enhance some important cognitive and communications skills due to the dominance of traditional assessment (Darandari and Murphy, 2013; Alaudan, 2014).

It is clear that teachers are facing a considerable challenge in Saudi Arabian schools, particularly in primary mathematics classes, in that they need to develop not only their instructions but also their assessment practice. Accordingly, there is a need to focus on teachers' assessment literacy more deeply to understand their needs and then design professional development programmes to meet their needs for better education.

On the other hand, most studies conducted in the Saudi Arabian context have aimed primarily to investigate how teachers understand the new policy of assessment in primary schools (Alotaibi, 2011; Alqarni, 2015; S. Alghamdi, 2015). Furthermore, a small number of studies have focused on

minor problems of assessment (e.g., Alhadlk, 2005; Al-Saedie, 2005). In addition, some studies have investigated teachers' understanding of formative assessment or teachers' implementations of particular strategies of assessment (e.g., Alsadaawi, 2008; Al-rumaih, 2009; Aldosary, 2014; H. Alghamdi, 2015).

To my knowledge, existing research has not comprehensively investigated teachers' understanding of assessment or explored the link between teachers' understanding and their practices. Therefore, the present study seeks to fill this gap by exploring the context of classroom assessment in more depth to determine mathematics teachers' knowledge about assessment and how they perform assessment in their classes.

1.3 The aims of the study

With specific reference to teachers' knowledge and their practice related to assessment in mathematics classes, the aims of the current study are as follows:

- To explore primary mathematics teachers' knowledge about classroom assessment.
- To investigate primary mathematics teachers' classroom practices when they implement assessments.
- To identify the relationship between what mathematics teachers state they know and what they actually do regarding classroom assessment.
- To identify the contextual factors that influence mathematics teachers' knowledge and practices about classroom assessment.

1.4 Significance of the study

The current study is expected to have both theoretical and practical implications. From a theoretical point of view, the rationale for conducting the current study is the lack of evidence and empirical research in the field of classroom assessment in Saudi Arabia and in understanding the knowledge and practice of teachers concerning assessment. Also, by exploring teachers' knowledge, this study will provide a theoretical framework for teachers' assessment knowledge, which will help researchers and educators in Saudi Arabia to understand any gaps in knowledge with regards to mathematics teachers. This also may enhance further research in classroom assessment and teachers' knowledge.

In addition, the study has been conducted due to an interest in identifying what happens in mathematics classes in relation to assessing students, and to explore teachers' abilities in transferring their knowledge into practice. As it is assumed that the practices of teachers are

based on what they know (Schon, 1995), this study will provide insight into teachers' practices in mathematics classes, which could be used in developing teachers' understanding about teaching and learning mathematics.

In addition, the study attempts to investigate the relationship between teachers' knowledge concerning assessment and their practices in mathematics classes, which may help in identifying the potential gaps between theory and practice. The present study applied different methods to collect the required data. A questionnaire, classroom observation and semi-structured interviews were developed for the purposes of this study, which may interest other researchers who have similar concerns.

From a practical point of view, the study is expected to provide primary mathematics teachers with insights into how to use assessments in ways that promote students' learning in mathematics and improve instruction.

Furthermore, the Saudi Arabia vision 2030 has placed a strong emphasis on the educational system outcomes to be aligned with nation's needs, which include improving the quality of learning environment, developing teacher professionalism and students' academic performance (Government of Saudi Arabia, 2018). It is hoped that the current study supports the government's vision by exploring teacher professionalism in assessing students and evaluating the effectiveness of assessment practices in mathematics classes. Consequently, such findings will provide Saudi policy makers with information that may help them in making decisions regarding students' assessment and teachers' development programmes. Furthermore, this study has the potential to inform decision makers about contextual factors that may affect teachers' knowledge and practices. The study will offer recommendations about how to address these challenges in classroom assessment.

Finally, it is anticipated that the some questions regarding students' levels of achievement in mathematics might be answered by exploring how mathematics teachers understand and implement assessment in mathematics classrooms.

1.5 Outline of the thesis

The thesis is divided into nine chapters, which are structured as follows:

Chapter 1 is the introduction, consisting of background information about assessments and their significance in learning and teaching. In addition, this chapter provides a discussion of the significance of the study and statements of the problem. The aims of the study and the outline of the thesis are also presented.

Chapter 2 presents the general background of the educational system in Saudi Arabia, including an overview of the state itself, covering its history, geographical location, and economic conditions. In addition, it presents the structure of the general school system in Saudi Arabia. The system of assessment in the context of primary schools and the stages of reforms conducted in students' assessment and the mathematics curriculum are presented. The chapter concludes with the general educational goals in Saudi Arabia and the mathematics educational goals at the primary stage.

Chapter 3 presents a review of the literature relating to the following topics: information about classroom assessments including definitions; the main purposes of classroom assessments; and assessment types, including summative and formative, in terms of their significance, definitions and the relationship between them. There is also an overview of the concept of knowledge and its types; the professional knowledge of teachers; and the role of teachers with regards to assessment. This chapter presents some research studies that have investigated teachers' assessment knowledge in general and mathematics teachers' knowledge and practices of assessment in Saudi Arabia. The challenges of assessment in mathematics classes is provided. The final section provides a summary of the chapter.

Chapter 4 begins with a definition of teachers' assessment knowledge, and the theoretical basis of knowledge of assessment. It also provides the framework of this study regarding teachers' assessment knowledge including what, why, and how to assess. The chapter also provides a definition of assessment practices along with the theoretical foundation of teachers' practices of assessment. The link between knowledge and assessment is discussed with the contextual factors in education.

Chapter 5 addresses the philosophical perspective and the paradigm of the study. It also provides a detailed description of the rationale for the methodological approach and the research design. It provides the study's instruments, including a questionnaire, interviews, and observations. This is followed by the process of conducting the main study and the data analysis procedure. In addition, this chapter includes the piloting and sampling procedure. It discusses the validity and reliability of the study and presents ethical considerations.

Chapter 6 presents the quantitative findings, starting with a description of the characteristics of the participants. Using the teachers' responses in the questionnaires, this study explores teachers' knowledge about what, why, and how to assess. This chapter also provides the analysis of participants' responses on the scale of assessment practices and assessment challenges in relation to teachers' knowledge and practices.

Chapter 7 presents an overview of observed classes and the findings collected from the classroom observations. Using the teachers' responses in the interviews, this chapter investigates teachers' knowledge about the three domains of assessment knowledge and teachers' practices of assessment before, during, and after lessons. The findings from teachers' interviews regarding contextual factors that impact their knowledge and use of assessment are also presented in this chapter.

Chapter 8 synthesises the findings from the quantitative and qualitative data about the teachers' knowledge and teachers' practices of assessment, and the role of context in teachers' knowledge and practices. The findings will reveal the nature of the relationship between teachers' knowledge and practices and will jointly answer the research questions.

The thesis ends with Chapter 9, which provides a summary of the entire study and highlights the major findings. It also describes the theoretical and methodological contributions of the study and provides suggestions to mathematics teachers, educational supervisors, and policy makers. The limitations of this study and recommendations for future studies are also provided. This chapter concludes with some of my final thoughts.

1.6 Summary

This chapter has highlighted the statement of the problem in the current study. In this chapter, the aims of the study were presented and the significance of the study was also outlined. Moreover, the potential contribution to the field of the study was presented. An overview of the whole thesis was also provided. In order to fully understand mathematics teachers' knowledge and their practices regarding classroom assessment, it is necessary to understand the educational context in which the study was conducted; thus, this will be the subject of the next chapter.

Chapter 2: Education Background in Saudi Arabia

2.1 Introduction

This chapter presents an overview of the education system in Saudi Arabia, which relates to the context of the current study. A brief background will be introduced in regards to Saudi Arabia as a nation, including: the history, geographical location and economic state. Moreover, this chapter describes the structure of the education system within the country and the current goals that have been stipulated. This includes the main reforms in the education system, which have been implemented to improve the overall curriculum. In addition, this chapter details the reforms to students' assessment regulations and explains the present assessment system, which is used in primary schools. Finally, the learning goals of mathematics in primary schools are presented, as well as recent projects, which aim to improve the education of education in Saudi Arabia.

2.2 General background

The modern state of Saudi Arabia was officially named as the Kingdom of Saudi Arabia (KSA) in 1932 following the unification of the Kingdom of Hejaz and Najd to the other parts of the country by King Abdul Aziz Al-Saud (Wynbrandt, 2010). Saudi Arabia is located to the south-west of Asia and it is the largest country in the Arabian Peninsula, as it occupies over 2,150,000 square kilometres (830,000 square miles). It is bordered by Iraq, Kuwait, and Jordan in the North; Yemen and Oman to the South, the Arabian Gulf; Qatar and the United Arab Emirates in the East and the Red Sea to the West (Ministry of Economy and Planning, 2015a). According to the last census, which was conducted in 2014, the total population of Saudi Arabia is 30,770,375 million, while 20,702,536 million of the total population are Saudi citizens (Ministry of Economy and Planning, 2015b).

The capital city of Saudi Arabia is Riyadh and the country is divided into 13 administrative regions, while there are 134 provinces throughout the Kingdom. Altogether, approximately 30% of the country’s total land area is covered by sandy-deserts, although the topography differs from region to region as well as the climate (Ministry of Economy and Planning, 2015a) In addition, the economy of Saudi Arabia mainly relies on its oil industry, while other minerals such as gold and silver are also prominent. In total, 18% of global oil reserves are located in the Eastern region of Saudi Arabia (Ministry of Economy and Planning, 2015a).

The Arabic language is the native spoken language throughout Saudi Arabia, which is the language of the Qur'an, Islam's holy book. Nevertheless, the English language is widely used in many business sectors (e.g., Medical, business and economic) (Al-Sadan, 2000). In the Islamic world, Saudi Arabia occupies a special position, as the Islam's two holiest mosques are located in Makkah and Madinah in the Western region of the country. According to the importance of these two mosques in Islamic religion, about 20 million overseas Muslims visit the city of Makkah and Madinah annually, particularly in the Pilgrimage season (Ministry of Hajj, 2015).

2.3 The educational system in Saudi Arabia

The Saudi Arabian educational system is centralized through the government, which remains under the jurisdiction of the Ministry of Education. However, the progression of the educational authorities in Saudi Arabia has passed through many stages. Initially, the Directorate of Education, established in 1932 was the first authority of formal education in the country. This was followed by the establishment of the Ministry of Knowledge in 1953, which was created in order to supervise only male education. Likewise, the establishment of the General Presidency for Girls' Education in 1960 was instilled to supervise female education. In modern times, the Ministry of Education, which was established in 2003, has begun to supervise the general education for both male and female (Alsunbul, Alkhateeb, Metwalli and Nour-Deen, 2008). In general, education is inertly free for all Saudi citizens, as well as non-Saudi citizen students from all different countries.

The main goal of the Ministry of Education is to provide fundamental education that meets all students' requirements. Therefore, the Ministry is in charge of processing educational decisions, planning the curriculum and training the teachers in the country. However, educational polices in the country are normally established and authorised by the Supreme Committee for Educational Policy, which represents the highest authority of the educational structure in Saudi Arabia (Alaqeel, 2005). Nonetheless, the Education Evaluation Commission (EEC) has been established recently to work in collaboration with the Ministry of Education in order to evaluate the quality of education through all stages of education (EEC, 2018). Figure 1 illustrates the educational sectors in Saudi Arabia.

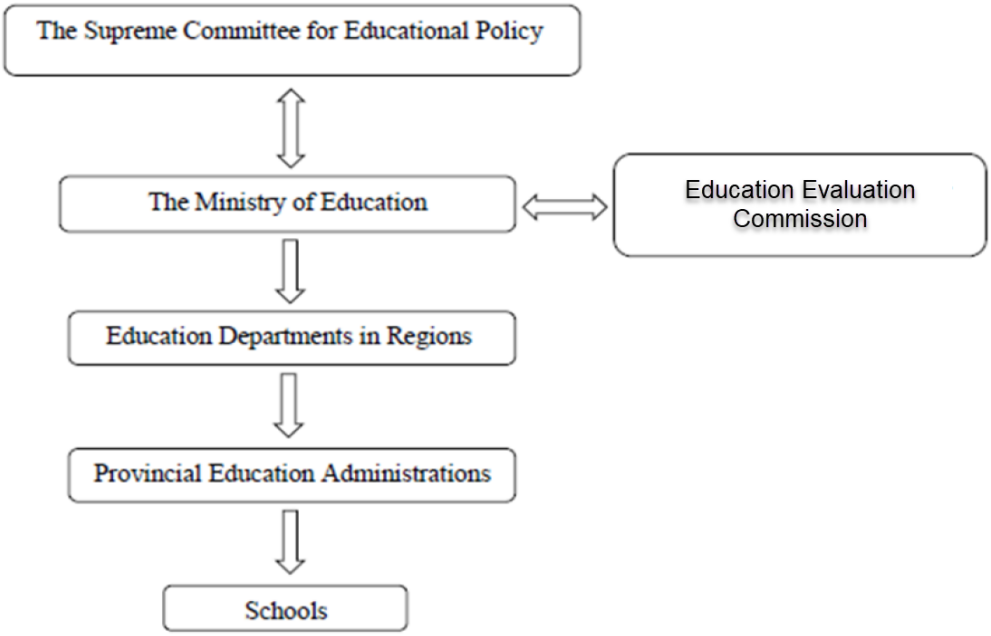

Figure 1: Educational sectors in Saudi Arabia

2.3.1 The structure of general schools system in Saudi Arabia

General education within Saudi Arabia is divided into two sectors: public and private. Like many other countries, the education system in both sectors consists of three stages before higher education, which are described as follows:

The Primary stage - This consists of six levels of grade, which is considered as the basis of overall future education. Children are required to enrol at primary schools at the age of six and they aim to provide children with the opportunity to master the basic skills, as students are taught a wide range of subjects like: religion education, Arabic language, social science, art, mathematics, and science, together with the English language starting at grade six (Alaqeel, 2005; Alsunbul et al., 2008).

The Intermediate stage - This consists of three levels of grade, where students' ages are most commonly set between twelve and fourteen. The main aim that is incorporated at intermediate schools is to provide students with the opportunity to pursue their educational development and incentives. Accordingly, through these years, students study the same subjects as they did at primary school, but more extensively (Alaqeel, 2005; Alsunbul et al., 2008).

The Secondary stage - This consists of three levels of grade, where students are aged between fifteen to eighteen years old. Secondary schools aim to prepare students to for higher education,

while during the first grade of this stage all students study the same subjects. Conversely, in the subsequent two grade levels students are required to select one of the following disciplines: administration and social science, natural science, or religion and Arabic Studies (Alaqeel, 2005; Alsunbul et al., 2008).

Education is compulsory for all students between the ages of six to fifteen. Nonetheless, co-education through gender is prohibited in the Saudi educational system, as girls and boys study in independent schools through all the different stages. During the three stages for both genders, the length of the academic year is normally approximately 36 weeks, which is divided into two semesters. Additionally, the average school day is comprised of 6-7 hours and the duration of each class period is 45 minutes at all stages.

Regarding the assessment system in Saudi Arabian schools, there are no final exams in the primary stage, as students are required to accomplish a certain criteria to be promoted to the next grade, whereas in the intermediate and secondary stages, students have to pass the final exams, which are conducted at the end of each semester (Al-Sadan, 2000; Alsunbul et al., 2008). In the occurrence that students fail to pass the final exams, he or she will be required to remain at the same grade level and repeat all grade subjects for another academic year. In addition, national tests are undertaken in secondary schools together with the schools internal tests, which are structured in order to assess students' achievements.

Since the context of the current study is the primary stage, the following section provides further details of students' assessment at this stage.

2.4 Assessment in the primary stage of education in Saudi Arabia

Students' assessment in Saudi Arabian primary schools has passed through many reforms. The main reason behind assessment reforms is due to the growing realization into the importance of assessment in education. In accordance, students' assessment in primary schools could be divided into three specific periods based on the assessment reforms that have been conducted in each period, which are detailed below.

2.4.1 The pre-reform students' assessment

Since the establishment of the Directorate of Education assessment in 1932, the aim of using assessment was a process of “measuring the education curriculum's outcomes” (Alhareth and Aldighrir, 2014, p. 883). Thus, the examination system was used as the main evaluation tool into

students' achievements, even though some subjects remain based on oral tests, such as with studies of the holy Quran (Al-Sadan, 2000).

In 1970, the Supreme Committee for Education Policy established new examination regulations and rules in order to organise students' assessment through examinations. However, these regulations were duly followed by an essential amendment in 1976 in order to ensure that teachers would understand the students' grading system, as they are only responsible for the preparation of students for exams (Alhadlk, 2005). Based on these regulations, teachers are required to use both numerical and word grades to assess students' performance that will enable the progression from one grade to another, as shown in Table 1.

Quality of performance	**Numerical Grade**
Excellent	90 to 100
Very good	75 to less than 90
Good	60 to less than 75
Fair	50 to less than 60
Fail	Below 50

Table 1: Pre-reform students' grading scale in primary schools

(Source: Al-Sadan, 2000)

Table 1 above demonstrates that the minimum score to pass through a grade is 50, whereas the maximum score that could be achieved is 100. Overall, the score is divided equally between the two set semesters in the academic year. Indeed, the final score for each subject is structured from three components: firstly, students' scores at the end of each term; secondly, quizzes are graded that are provided during the term; thirdly, the participation of students affects the overall score (Al-Sadan, 2000). In accordance, Table 2 below presents the process of assessing students in primary schools:

Academic year					
Term 1			**Term 2**		
Final exam	**Quizzes**	**Students' participation**	**Final exam**	**Quizzes**	**Students' participation**
30	10	10	30	10	10
50			50		
100					

Table 2: Pre-reform students' grading system in primary schools

(Source: Alhareth and Aldighrir, 2014)

It is evident that students in primary schools have been assessed by this process of grading for approximately 40 years in Saudi Arabia, although the Ministry of Education has made the decision to establish a new assessment approach, due to the urgent requirement to improve education quality and its outcomes in the country.

2.4.2 The post-reform students' assessment

In the second semester of the academic year 1998, the Ministry of Education embarked on a series of reforms through the students' assessment system in primary schools, as the previous assessment was mainly based on examinations, which had encouraged teachers to teach for the purpose of testing rather than learning (Alhareth and Aldighrir, 2014). There was a need to implement a new assessment that helped teachers gain better comprehension into student learning and the efficiency of their teachings. Hence, the new assessment was labelled *Continues Assessment,* as this term reflected the Ministry of Education's vision towards students' assessment, which should be conducted continuously, rather than at one specific time during the academic year (Alotaibi, 2011). Furthermore, the new regulations of students' assessment emphasised the concept that short tests should be aligned with specific assessment tools, for example: classroom activities and teachers' observations.

According to Alhadlk (2005) and Alotaibi (2011), the implementation of the new assessment moved through several stages prior to its establishment in all primary schools in the country, which were distinguished as follows:

- First stage: conducted in the second semester of the academic year 1998. This stage aimed to pilot the new assessment in certain cities, although it was limited to only a few

subjects. In this stage the initial forms and regulations were issued by the Ministry of Education to clarify the rules of the new assessment in pilot schools.

- Second stage: conducted in 1999 and this stage mainly aimed to implement the new assessment in the first three grades within primary schools throughout the country.
- Third stage: in 2006 the new assessment was implemented into the upper grade level, however, this implementation was limited in certain cities.
- Fourth stage: in 2007 the Supreme Committee for Education Policy issued the final rules of the regulations of the new student assessment. In this stage, the new assessment was implemented in all primary schools throughout the country.

In order to determine students' grading, as well as their progress between grades, the Ministry of Education has begun to analyse the content of the syllabus for all subjects, which incorporates both basic and secondary skills. Specifically, students are required to possess the ability to demonstrate basic skills, which are considered as the minimum level in order to progress to the next grade. Furthermore, teachers are required to assess both basic and secondary skills based on the set criteria by the Ministry. However, there is no specified figure in order to assess those students who are failing in one skill (basic or secondary), which consequently means that teachers can assess students through the use of different tools for an unspecified amount of time until they make a decision regarding the student's attainment. Likewise, there is no final test for those students who have failed to attain the minimum requirements, as the school counseling committee will evaluate the specific student's case and present a decision regarding their progress (Ministry of Education, 2007). Table 3 below shows a sample of the criteria that is used to assess two basic skills in mathematics for grade 2.

Skills	Criteria
Solving simple problems, involving multiplication and division	1. Use repeated addition, arrays, and counting in steps to complete multiplication. 2. Use repeated subtraction, equal sharing, and forming equal groups with remainders to complete division. 3. Know multiplication facts for 2 to 10.
Recognising triangle shape	1. Identify triangle shape. 2. Provide examples of triangles that can be found in our world. 3. Draw a triangle.

Table 3: A sample of basic skills assessment criteria in mathematics for grade 2

(Source: Alafaleq and Fan, 2014)

The regulation of the students' assessment stated that students should be graded on a scale of 1 to 4 that are based on the mastery level of basic and secondary skills, which are stated as follows (Ministry of Education, 2007):

1. A student who has mastered all basic and secondary skills will pass with a score of 1.
2. A student who has mastered all basic skills, together with 66% of secondary skills will pass with a score of 2.
3. A student who has mastered all basic skills, as well as 65% of secondary skills will pass with a score of 3.
4. A student who has failed to master one of the basic skills will receive a score of 4, which consequently means that he or she has failed to pass the grade level.

With the system in place, the follow-up students' assessment record is required to be utilised by the teachers in every class, as the skill should be listed in front of every student's name. This record helps teachers in writing reports in regards to their students' performances. Accordingly, based on the assessment regulations, the students' overall performance must be reported to their respective parents at four stages during the academic year (Ministry of Education, 2007).

Nonetheless, many issues have been experienced by teachers and educators since the implementation of continuous assessment in primary schools. Some of these issues were described by Alsadaawi (2010), as it was stated that there is no a clear standard that classifies the content of textbooks into basic or secondary skills. Moreover, certain secondary skills are imperative for the student learning process, although this can cause a contradiction with the

assessment philosophy. Furthermore, Alsadaawi (2010) states that teachers may concentrate on basic skills and consequently ignore separate important skills, such as higher-order thinking skills, as they have not been considered as basic skills.

In particular, Alhadlk (2005) states that the manner of implementing continuous assessment through the academic year exacerbates the burden felt by teachers, especially in the process of being required to assess failed students for an unlimited time through one semester.

2.4.3 The present student' assessment

Reforming students' assessment regulations that was issued in 2007 was necessary, due to many technical issues which arose following the implementation of continuous assessment. The reformed assessment regulation was released by the Ministry of Education, and it was implemented in all primary schools in the first semester in the academic year, 2015/ 2016.

The main aim of the current students' assessment is to address the weaknesses of previous regulations. Thus, the reformed regulations emphasises the importance of all learning skills in every subjects at the primary stage. Therefore, students' assessment criteria have been established based on learning outcomes for every subject. Overall, the students who fail to achieve at least 80% of the learning outcomes in each subject will not progress to the next grade, while their teachers are the only authority of responsibility for making decisions regarding students' progress between grades (Ministry of Education, 2015).

In addition, based on the new regulations teachers are advised to assess students with a verity of assessment tools, which include: projects, portfolios, observation, exams, homework, etc. Table 4 shows the main differences that exist between students' assessment regulations that were established in 2007 and the present regulations.

	Assessment established in 2007	The present assessment
Assessment criteria	Based on basic and secondary skills	Based on learning goals
Assessment tools	Mainly short tests	Different tools (e.g., tests, projects ...ext.)
Fail cases	Fail to master one of the basic skills in each subject.	Fail to achieve 80% of the learning outcomes in each subject.
The final decision regarding students' progress	By the school counseling committee (based on students' reports)	By teachers only

Table 4: The differences between assessment established in 2007 and the present assessment

Based on the present regulation, students are assessed based on two standards that are progressed between grades as shown in Table 5 (Ministry of Education, 2015).

Quality level of performance	Standard
Excellent	1. Achieve 95% or more of every skill 2. The total achieved percentage of all subject skills is 100%
Good	1. Achieve 85% to less than 95% of every skill 2. The total achieved percentage of all subject skills is 90% to less than 100%
Fair	1. Achieve 80% to less than 85% of every skill in the subject 2. The total achieved percentage of all skills in the subject is 80% to less than 90%
Failed	The Achieved percentage in one skill in the subject is less than 80%

Table 5: Students' assessment standards in the present assessment

At the time of writing the current study the present assessment regulations had only recently been implemented, which means that additional time is required in order to address the ways that teachers cope with them, and to what extend the regulations will benefit overall learning and teaching.

2.5 Education system goals in Saudi Arabia

The central aim of the education sector in Saudi Arabia is to prepare students to be beneficial members of their community. This main aim is then formulated into four sets of goals:

Knowledge goals - Saudi Arabian education aims to provide students with the appropriate knowledge, information and experience in different fields in order to prepare them for their individual life that will take place within society (Alsunbul et al., 2008).

Skills goals - Enabling students with both the physical and mental skills in which they will require in both their present life and future (Alsunbul et al., 2008).

Scientific thinking goals - Help students gain the right manner in the process of critical thinking and problem solving (Alsunbul et al., 2008).

Interest, values and tendencies goals - Provide students with the opportunity to develop good manners and habits (Alsunbul et al., 2008)

It is evident that education goals in Saudi Arabia cover a variety of aspects that are required to educate students without neglecting any particular aspect, which might benefit students in achieving their educational goals.

2.5.1 Mathematics education goals in primary stage

In Saudi Arabia subject goals are considered as a demonstration of the main goals of the education system in the country, as is true within many countries. For instance, the education goals for mathematics in primary schools correspond to the goals of the education system, which are divided into three categories (Ministry of Education, 2008):

Mathematical knowledge goals aim to provide opportunities for students in order to:

1. Attain mathematical knowledge, which is needed for everyday living in measurements, adding, and subtracting.
2. Understand their reasons for learning mathematics.
3. Understand the special language of mathematics, which include symbols and forms.
4. Comprehend the links between mathematics and other subjects.
5. Understand the nature of mathematics as an integrated system of knowledge.

Mathematics skills goals aim to develop students' skills of:

1. Basic mathematics skills, which are necessary to be used in everyday living.

2. The sense of numbers such as, recognising number relationships, judging, estimating.
3. Collecting and analysing quantitative data.
4. Communicating mathematically.

Thinking and problem solving skills goals aim to:

1. Develop students' abilities to use mathematical concepts and skills in solving mathematical problems.
2. Encourage students to apply problem-solving steps: identify problems, select important information, choose a strategy and check the answer.

Tendencies, attitudes and values goals aim to provide the opportunities that:

1. Enhance students' good values such as: objectivity, accuracy, esteem.
2. Develop and motivate students' interest in learning mathematics.

2.6 Mathematic curriculum in Saudi Arabia

In Saudi Arabia, the mathematics curriculum is standardised in both public and private schools and it is developed under the supervision of the Ministry of Education. The curriculum was designed to help students develop and enhance their mathematical knowledge and skills, in order to apply this knowledge in their general life and additional learning. In addition, textbooks were designed to help teachers and students to attain learning goal through this specific stage. Indeed, there is only one series of mathematics textbooks, which are taught throughout the country. In this sense, teachers are required to adhere to the textbooks' content in order to provide students with the same level of knowledge and skills throughout the country (Al-Sadan, 2000).

2.6.1 A new mathematics curriculum in primary stage

The mathematics curriculum has adapted to a variety of improvements, particularly through the primary stage of education, due to the rapid shift in the social and economic conditions in the country, which have produced the necessity to improve education (Alsaeed, Abdel Hamid and al-Shalhoub, 2011). The significant reforms in the mathematics curriculum were conducted in 2008, when the Ministry of Education adopted the King Abdullah bin Abdulaziz national project to improve the mathematics and science curriculum (Ministry of Education, 2008).

The project aimed to develop the quality of mathematics and science education in Saudi Arabian schools; improve students' performance and skills in mathematics; together with science; and subsequently enable them to compete in international competitions, whilst also improving

teaching methods by providing teachers with the guidance, recommendations, and strategies in teaching mathematics and science (Ministry of Education, 2008). According to the Ministry of Education (2008), there were several principle reasons that instigated the excessive reforms in the mathematics curriculum in primary schools. Firstly, the old curriculum focuses more on lower order thinking skills than higher ones; for examples, problem solving and critical thinking. Secondly, traditional teaching was the dominant approach in mathematics classrooms, where teachers controlled learning environments more than their students. Thirdly, there is a lack of learning resources that are aligned with textbooks' topics, which are required in order to help teachers and students. Fourthly, weak learning outcomes are present in terms of what should students know and be able to do in comparison to students from other countries at the same stage. Fifthly, there is a desire to improve the learning environment, as well as teachers' overall performance in providing sufficient levels of education and assessments.

As a part of the current project, the Ministry of Education collaborated with the Obeikan Research Development Company in order to introduce the new mathematics textbooks. The Obeikan company has adapted mathematics textbooks, which were designed by the McGraw-Hill, who is an American publisher. The content of textbooks has been translated into the Arabic language by the Obeikan team, who also worked on the suitability of textbook context for use in Saudi Arabian society (Obeikan, 2015).

The new mathematics curriculum in primary schools emphasises the need for a greater understanding of mathematics concepts rather than simply memorising them. The content of textbooks was selected to support: student-centered learning; students' skills in thinking; solving problems; reasoning; communicating; reflecting and decision-making. Furthermore, students' textbooks contain a wide range of basic mathematical knowledge and the majority of the context used in primary textbooks was selected to be compatible with students' environments and real life. Similarly, teachers' guidebooks were provided to all the teachers in order to enhance the teaching process of mathematics (Obeikan, 2015).

In addition, the number of mathematics classes in the primary stage has been increased by one class in each grade level. Hence, students in grade one are studying mathematics three times a week, which is duly increased to five times a week in grade two through to grade six, as shown in Table 6.

Grade level	One	Two	Three	Four	Five	Six
Number of mathematics classes per week	3	5	5	5	5	5
Percentage of total classes	11%	17%	17%	16%	16%	16%

Table 6: The number and percentage of mathematics classes in primary schools in Saudi Arabia

Table 6 demonstrates that the ratio of mathematics classes to the classes for all different subjects in the primary stage curriculum, which varies from 11% to 17%.

2.7 Summary

Education in Saudi Arabia has progressed rapidly during the past 20 years. In general, the substance of education in Saudi Arabia is based on preparing students for life by providing them with the opportunities to benefit from high quality of education. Therefore, many aspects in education are structured through constant improvements in order to address the issues in which students and teachers face in addition to developing education level in Saudi Arabia. In particular, the subjects of mathematics have constituted a large portion in these reforms ever since the establishment of the National Project to Improve Mathematics and Science.

In addition, the Ministry of Education has formulated the fundamental part of assessment, which is vital in improving teaching, and learning as a whole. Thus, a wide range of reforms into assessment regulations has subsequently been conducted. Assessment reforms were most prevalent at the primary stage, which has ensured the equity and objectivity of assessing students at this age. Hence, continual assessment has been introduced in primary schools as an alternative assessment to traditional testing techniques. However, according to various challenges, assessment rules have been reformed recently and introduced in a more modern form, which helps create a correlation between learning and assessment.

Chapter 3: Literature Review

3.1 Introduction

This chapter focuses previous research that is relevant to the current study. This includes the definitions of classroom assessment and the general purposes of using assessment in classrooms. In addition, this chapter presents the main forms of assessment and the correlation between summative and formative assessment. Furthermore, this chapter helps define the concept of knowledge and teachers' professional knowledge through literature evaluation. In order to identify teachers' knowledge and practice of assessments, the chapter provides details in regards to the level that teachers are assessment literate and what the literature states about teachers' knowledge and practice of assessments.

3.2 Classroom assessment

Classroom assessment is a very common term in education, as Earl (2013, p.2) states that classroom assessment are "the kind of assessment that happens every day in classrooms and everywhere". However, there are different views in relation to classroom assessments, as certain terms such as: 'evaluation', 'testing' and 'measurement' have been used interchangeably with the term 'assessment' (Gipps, 1994; Baehr, 2010). For instance, Sax (1997) refers to classroom assessments as the process of measuring students' performance for evaluating and grading purposes. Likewise, Baehr (2010) states that an assessment is an evaluation of learning outcomes or learners' performance by implementing examinations and providing feedback on students' knowledge, skills and attitudes in order to improve their performance and learning outcomes. Furthermore, Baehr (2010) refers to the term of ‘evaluation’ as a method to judge the quality level of performance, while assessments go beyond this term in order to seek ways for improving performance. Therefore, it is very clear that an assessment is a broader term than 'evaluation', 'testing' and 'measurement', as all of these terms are included in the assessment process.

In addition, Shepard (2001) argues that the shift to constructivism theory in learning played a fundamental part in moving classroom assessments from merely testing and ranking processes to provide a whole picture in regards to learning and teaching. Classroom assessments should help in targeting learning goals, and thus, assessments need to reflect what are being conducted in classrooms, as well as students’ thinking and learning (Shepard, 2001).

According to Stiggins (2008, p. 5), a classroom assessment is "the process of gathering evidence of student learning to inform instructional decisions". Subsequently, the gathered evidence should

be used beyond merely enhancing learning and teaching, and work to motivate students towards learning (Stiggins, 2008). A similar statement about assessments was provided by Burke (2010, p.19), as she states, "an assessment consists of all the tools that teachers use to collect information about student learning and instructional effectiveness". According to her, the common tools, which are used by teachers to assess students' learning, include tests, presentations, observations, and class work.

A broad description for the assessment process in the classroom, which was provided by Erwin (1991, p. 15), states that an assessment is a:

> "Systematic basis for making inferences about the learning and development of students. More specifically, assessment is the process of defining, selecting, designing, collecting, analysing, interpreting, and using information to increase students' learning and development".

Indeed, many researchers define classroom assessment as the function for collecting information about students' achievements, as this information needs to be utilised to change learning and teaching positively, as well as providing the potential for educational decisions (NCTM, 1995; Black and Wiliam, 1998a; Burke, 2010; Popham, 2014).

However, assessments could only improve learning and teaching when the collected information that relates to students is accurate and suitable for the aims of using the assessment (Burke, 2010). Hence, a classroom assessment could be considered as the bridge between teaching and learning, as it would be impossible to comprehend students' learning without implementing the assessment (Wiliam, 2011). Following on from this, the next section discusses the general purposes of using assessments in classrooms.

3.3 The main purposes of classroom assessment

Assessments play a significant role in the classroom, as they serve various purposes, such as judging students' achievement levels, which are used in order to promote students from one grade to the next grade level. Moreover, the literature revealed that assessments aim to identify students' strengths and weaknesses; assess students' progress; assess the extent that instructional strategies are effective; provide feedback in regards to students' learning; assess curriculum programs and provide information that helps in decision making (Gipps, 1990; Swearingen, 2002). Baird, Andrich, Hopfenbeck and Stobart (2017) review the connection between the theories of learning and the theories of assessment, and how these theories

influence each other. As there is always a need for assessments that reflect what happens during the learning process, and what knowing something means.

Furthermore, certain researchers have highlighted that the integration between assessment and instruction is considered as one of the significant purposes of assessment (Black and Wiliam, 1998b; Brookhart, 2005). According to Brookhart (2005, p.6), classroom assessment is "primarily formative", while additionally, he stated that an adequate assessment is not only used for measuring students learning, but also to generate a chain of learning episodes. Bachor and Anderson (1994) argue that the reason for using assessments is to monitor students' achievements in order to inform teachers, parents and students about their progress based on learning outcomes. Consequently, teachers are responsible for identifying students' weakness and strength, together with analysing these results to plan the teaching process.

Wiliam (2004a) argues that an assessment could be used in education for different purposes and in a variety of ways. Furthermore, Wiliam (2004b) states that the purpose of an assessment is mainly based on three functions: support learning, certify students and keep educational institution informed about learning quality. Additionally, Gipps and Stobart (1993) state an inclusive list of assessment uses in the classroom:

- Screening- which is related to testing students in order to identify individual special needs for students; and this is mainly conducted in the primary stages;
- Diagnosis- which identifies students' strengths and weaknesses during learning or after testing;
- Recording- in order to organise students' grades, which could be used in the process of transferring students from one grade to the next level;
- Feedback- provides information about students' progress or teachers' efficiency, as such information could be used to evaluate the educational system;
- Certification- to confirm that the students have achieved the required level of knowledge.

In addition, Briggs, Woodfield, Martin and Swatton (2008) argue that there are various purposes for classroom assessments in primary schools, as they provide different kinds of information, such as:

> "Information on which to base the next teaching and learning activities; feedback to the learners for motivation; information to assist in evaluating the teaching process; information that can be shared with parents and carers and information on which judgements are made about school effectiveness" (Briggs et al., 2008, p.7).

Overall, from this brief review about classroom assessment purposes, it is clear that an assessment serves the following groups: students, parents, teachers and policy makers. The next section will demonstrate the types of assessment in-depth, and why they are required in the classroom.

3.4 Forms of classroom assessment

As mentioned previously, an assessment serves many purposes in the formulation of education. Thus, before implementing assessments, teachers need to consider why they utilise an assessment, as well as what kind of information they want to gain through assessing. In general, many scholars have classified assessments into two types: summative and formative (e.g., Scriven, 1991; Black and Wiliam, 1998a; Burke, 2010).

3.4.1 Summative assessment

A summative assessment or 'assessment *of* learning' is normally implemented at the end of a unit or term. More specifically, it is a systematic process of recording the overall achievement of students in order to obtain a result that evaluates learning through the whole class (Harlen and James, 1997). A general definition provided by Black (1998, p. 28) states that a summative assessment is "an overview of previous learning". Hence, a summative assessment provides teachers with a general insight into students' achievements by collecting evidence of their attainment at the end of the learning stage.

Harlen and James (1997, p. 373) state the characteristics of a summative assessment to be as follows:

> "It takes place at certain intervals when achievement has to be reported; it relates to progression in learning against public criteria; the results for different pupils may be combined for various purposes because they are based on the same criteria; it requires methods which are as reliable as possible without endangering validity; it should be based on evidence from the full range of performance relevant to the criteria being used".

In accordance with this definition, the purpose of implementing a summative assessment is to describe students' achievements following a certain instructional period, as results are reported to parents, the school and students. Bloom, Hastings and Madaus (1971, p. 117) also state that a summative assessment is one assessment form which is:

> "Used at the end of a term, course, or program for purposes of grading, certification, evaluation of progress, or research on the effectiveness of a curriculum, course of study, or educational plan".

It should be noted that, some researchers identify summative assessments as an assessment of learning (e.g., Earl, 2013). Separately, Gipps (1994), classifies summative assessments based on their purpose through two types: Firstly, 'summing-up', which means providing a picture of students' achievements based on accumulating assessments that were originally formative; and secondly 'checking-up', which means tests at the end of the learning phase in order to collect evidence for final judgements.

Taras (2005, p. 468) describes the technique of a summative assessment as "a judgement which encapsulates all the evidence up to a given point; this point is seen as a finality at the point of the judgement". Therefore, unit tests; end of semester tests; annual tests and quizzes, are normally implemented to rank students' achievements as examples of summative assessments in classrooms. In fact, such activities are conducted by teachers at a certain time, in order to prepare reports in regards to students or promoting students from one grade to the next grade.

3.4.2 Formative assessment

The term 'formative' was first introduced in 1967 by Michael Scriven, when he distinguished between formative and summative evaluations. Scriven (1991) considers the role of formative evaluation to promote the efficiency of a curriculum, as the primary concern was curricular development. In contrast, a summative evaluation seeks to evaluate the outcomes of the curriculum which is unsatisfactory, due to the fact that there is no feasible way to improve summative results (Scriven, 1991). Subsequently, Bloom (1969) continues using the form of formative evaluations, as he expanded their usage in improving teaching and learning. Bloom (1969, p. 48) further stated that:

> "The use of 'formative evaluation' to provide feedback and correctives at each stage in the teaching-learning process. By formative evaluation we mean evaluation by brief tests used by teachers and students as aids in the learning process".

Accordingly, Bloom and his colleagues argued that formative assessment is a process, which concentrates on a learner-centred approach and provides information for teachers to alter their instruction or explore students' difficulties (Bloom, Hastings and Madaus, 1971).

Even though formative assessments were introduced in the 1960s, they have received more attention since Black and Wiliam (1998a) survey over 160 journals, which were published

between 1988 and 1997 for the purpose of improving classroom assessments and classroom learning. As a result, Black and Wiliam provide a broad definition of formative assessments as, "all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (Black and Wiliam, 1998a, p. 8). Furthermore, Black and Wiliam (1998b) state that the collected evidence, in relation to teaching and learning, is considered as a formative assessment, only when they are used to adjust instructions and meet students' needs.

In addition, Sadler (1989) argues that formative assessment or “assessment for learning,” is an integral part of instruction to be used in improving students’ work. According to Sadler (1989, p. 120):

> "A formative assessment is concerned with how judgments about the quality of student responses (performance, pieces or works) can be used to shape and improve student´s competence by short-circuiting the randomness and inefficiency of trial-and-error learning".

Similarly, Taras (2005) states that judgments could be conducted in formative assessments, in the same manner as summative assessments, and the only difference is that formative judgments aim to improve students. Furthermore, Sadler (1989) and Gipps (1994) argue the effectiveness of feedback in formative assessment practices, as they defined it as the key factor in the formative assessment process, which provides more information about the quality level of learning and teaching. Hence, providing feedback into students work is one of the main purposes of using formative assessments in the classroom, although the feedback should be provided effectively while monitoring students' progress of results in order to enhance students' learning (Cowie and Bell, 1999; Heritage, 2007).

Regarding the role of assessment in teaching, Popham (2008, p. 6) mentions that teachers’ and students’ roles in formative assessments to be "a planned process in which assessment-elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics". Therefore, Popham's definition emphasises that students are required to take part in the formative assessment process in the same manner as teachers. Involving students in assessment process is one of the important features of formative assessment, in this sense Wiliam (2000) argues that formative assessments are mainly based on teachers' roles in questioning and collecting information, together with students' roles in assessing themselves or their peers. (Wiliam, 2004b) further identifies questioning, feedback, sharing criteria with learners and student peer- and self-assessment as the components of formative assessment.

It should be noted that some researchers use the term ‘assessment for learning’ as a synonym of formative assessment (e.g., Earl, 2013; Popham, 2014). Moreover, regarding the characteristics of assessments for learning, the Assessment Reform Group (ARG, 2002) in the UK established 10 principles of assessment for learning as follows:

1. An assessment should be part of effective planning of teaching and learning.
2. An assessment should focus on how students learn.
3. An assessment should be recognised as central to classroom practice.
4. An assessment should be regarded as a key professional skill for teachers.
5. An assessment should be sensitive and constructive, because any assessment has an emotional impact.
6. An assessment should take account of the importance of learner motivations.
7. An assessment should promote commitment to learning goals and a shared understanding of the criteria by which they are assessed.
8. Learners should receive constructive guidance about how to improve.
9. An assessment for learning develops learners’ capacity for self-assessment, so that they can become reflective and self-managing.
10. An assessment for learning should recognise the full range of achievements of all learners.

The 10 principles provide an indicator for teachers to comprehend how much the assessment is for learning.

More recently, assessments into learning have been introduced as a type of formative assessment that are based on involving students in the assessment process through practicing self or peer assessments (Earl, 2013). According to Earl (2013), using assessment in learning could benefit students in improving their metacognition skills during the process of learning. In addition, Earl (2013) suggests that “assessment for learning,” would also include “assessment as learning,” where students practicing self and peer-assessment.

Similarly, Harlen and James (1997) state that formative assessments are a part of teaching, as they promote learning and focus on students to be a central part of the learning process. Otherwise, it is difficult for teachers to assign students’ strengths and weaknesses. Indeed, formative assessments can play different roles in the classroom, and thus teachers can use assessment information to predict students' performances, as well as motivate students. Hence, this could be achieved in various ways, such as through a teacher's observation of students practicing their discussions, portfolio, projects, and presentations (Popham, 2014). Black and Wiliam (2018) consider classroom dialogue as an essential tool for collecting formative information moreover, the formative interaction between teachers and students could be

realised in students' written work. Such written work or any other classwork and homework provide teachers with the opportunities to give students further formative feedback.

3.5 The relationship between summative and formative assessment

As previously mentioned, the literature has distinguished the differences between two forms of assessment: summative and formative. However, the question is whether the collected evidence from summative assessment could be used in the process of formative assessments and vice versa. According to Taras (2005), assessment tasks could be used to serve both summative and formative assessment, as she stated that assessments are primarily summative, which is based on the judgment that formative assessments are considered as summative assessments, although with feedback relating to students' achievements. Accordingly, Taras (2005) does not distinguish between summative and formative assessments, but concedes them to be set as an integral function.

Harlen (2012, p. 93) states that "there would be a strong tendency to gather frequently what is essentially summative evidence as a substitute for evidence that can be used formatively". Additionally, Harlen (2012) states that assessments could serve summative and formative purposes when they are first designed based on this aim. Nevertheless, evidence that is collected day to day through the observation of students while learning, questioning or reviewing tasks can be used by teachers for summative reporting, and thus, formative evidence could be collected for summative purposes (Harlen, 2012). In this sense, the distinction between formative and summative assessment is classified based on how to use and interpret assessment outcomes, since the same assessment outcomes can support either summative assessment or formative assessment (Wiliam, 2017). For example, when students respond to a test of multiplication facts, the teacher could recognise that the student has learned 80% of multiplication facts and that is a summative inference. Whereas the teacher might conclude that the student has difficulties with some of multiplication facts and that is a formative inference (Black and Wiliam, 2018).

The previous claims suggested that assessment information could be used either summatively or formatively. Accordingly, both summative and formative assessments are not considered as separate forms of assessment.

3.6 What is knowledge?

Since one of the current study’s aims is to assess the knowledge of teachers, it is essential to provide a discussion of the question of what it means when a person knows something. Indeed,

there is no doubt that all people seek to acquire knowledge across many different disciplines and to apply this in many different ways throughout their lives.

Therefore, for hundreds of years, at least from the time of the ancient Greeks, many philosophers have tried to define the word 'knowledge' and have paid attention to answering the question concerning what is knowledge philosophers have argued that knowledge includes its nature, theory and limitations and this is referred to as 'epistemology' (Moser, Mulder and Trout, 1998). It should also be noted that James Frederick, a Scottish philosopher, first used this word in the 1800s. Epistemology refers to two Greek words: 'episteme,' which means 'knowledge,' and 'logos,' which mean 'explanation' or 'reason' (Moser, Mulder and Trout, 1998).

Therefore, the term 'knowledge' is a very widely used in our daily discourse and we probably have some ideas about what knowledge we possess when someone asks us a question. For example, when we are asked for directions, or about any matter we have experienced before. In that case, we might consider that the term knowledge is almost self-evident, or a natural result of our experience.

So far, there is not broad agreement amongst philosophers, thinkers and researchers regarding definitions and views of knowledge and its sources (Lehrer, 2000). Historically, Plato was the founder of rationalism and, in the *Theaetetus*, he argues that human knowledge comes from true belief and he defines knowledge as a, 'justified true belief,' at the same time as he doubts the senses' ability to provide knowledge (Moser, Mulder and Trout, 1998). Based on Plato's definition, an individual knows a square is also a rectangle when he or she believes that a square is a rectangle this is a true belief and he or she must have the capacity to justify or prove this belief. Since that time, many philosophers have recognised the elements of truth, belief and justification as standard conditions for knowledge. Thus, an incorrect or false belief could not be considered to be knowledge.

The famous British philosopher, John Locke, claims that every human is born with a blank mind and it fills throughout life via the use of the sense organs. Thus, there is a relationship between the human sense organs and knowledge (Lowe, 1995). According to Locke's theory of knowledge, human ideas mainly come through the senses. For example, people know the sky is blue because they have experienced that through their senses and experiences (Lowe, 1995).

Moreover, Locke called these 'simple ideas of sensation' and considered complex ideas to be a set of simple ideas (Lowe, 1995). It is clear that Locke's notions about knowledge are opposed to what Plato argued about true belief and reasoning. Furthermore, René Descartes' (1596–1650) ideas about knowledge also contradict Locke's notions about knowledge. Descartes believes that

the senses and our experiences are not necessary to have knowledge since he defines knowledge as a case of doubt, rather than certainty. Moreover, he considers the senses as an unreliable source of knowledge and that the only way to get true knowledge is by applying pure reason (Pritchard, 2014).

Although, Kant disagrees with Locke's notion about the human mind being a blank vessel, he considers the senses to be a source of knowledge. As Kant states, we can only know things when they are presented to us via sense experience (Guyer, 1987). Kant claims that part of our knowledge is *a priori* which includes logical things, but most knowledge can be derived from sense experience (Guyer, 1987). In this case, not all knowledge needs to be justified, since *a priori* knowledge does not require any experience. In Kant's view, logical and mathematical relations, for example, 1+1=2, represent a truth that we believe in, but we do not need to justify this relation to prove that we possess knowledge (Guyer, 1987).

Bertrand Russell was one of the twentieth-century's empirical philosophers and he discusses two sorts of knowledge: *knowledge of truths*, which is about facts, and the *knowledge of things* (Egner and Denonn, 2009). In terms of the *knowledge of things*, he divides this into two kinds of knowledge and he calls them *knowledge by acquaintance* and *knowledge by description*. According to (Egner and Denonn, 2009), *knowledge by acquaintance* is an independent knowledge from the *knowledge of truths* as it does not refer to any inference of the truth. For example, an individual immediately knows that wood is solid when he or she touches it without knowing any truth about the wood itself. On the other hand, when he or she has knowledge of the wood itself as a physical object that is indirect knowledge and that knowledge is described as *knowledge by description*, which is obtained through direct acquaintance with sense-data. Russell talks about *a priori* knowledge and he deals with it as a sort of universal (Egner and Denonn, 2009).

Despite Plato's definition of knowledge being largely accepted amongst philosophers and thinkers, some post-nineteenth century philosophers tried to criticise his definition by showing it was not sufficiently accurate (Pritchard, 2014). For example, Gettier (1963) published a paper entitled, 'Is Justified True Belief Knowledge?' In this paper, he offers some counter-arguments to Plato's claims in order to prove that justified true belief is not always the right definition of knowledge. Williamson (2000) argues that knowing is completely a state of mind since knowledge does not need a basis of true belief. Moreover, Williamson (2000) states that the concept of knowledge cannot be analysed into simpler concepts.

From the previous discussion, it can be seen that the concept of knowledge has been discussed from various different viewpoints for a very long time. As a result, it is quite difficult to find a general definition of knowledge.

3.6.1 Types of knowledge

Many philosophers have tried to classify human knowledge into different types based on the nature and source of knowledge (Pritchard, 2014). Aristotle divided knowledge into three types: theoretical, technical and practical (Barnes, 2000). According to Aristotle, *theoretical* knowledge is about things that we cannot change and that we need to deal with as truth. *Practical* knowledge is about changeable things, or more precisely, it is related to how to live amongst other people, and *technical* knowledge is about how to make or create things and it should be noted that this type of knowledge cannot be transferred from one person to another as it is about skills (Barnes, 2000).

Aristotle established the categorisation of knowledge into different types, which guided other philosophers. Thereafter, two types of knowledge have been widely recognized: knowing *that* and knowing *how* (Ryle, 2002). I know *how* is about the ability to do something. For example, someone knows how to drive a car, but he or she cannot tell others how to drive. This kind of knowledge requires only skills and abilities to be involved in such activity and, in this case, we are talking about knowledge of procedures, which is also known as *procedural knowledge* or *practical knowledge*. According to Ryle (2002), knowing *that* is about knowing something is the case, which includes scientific facts. For example, I know that 1+1=2, or the internal angles of a triangle add up to 180 degrees and so on. This kind of knowledge is also called *declarative knowledge* or *propositional knowledge* as it is descriptive knowledge. It could be formulated into principles, ideas, schemas and theories from which we are able to learn and practice (Anderson, 1993).

Tacit and explicit knowledge is another classification of knowledge provided by Polanyi (2009) as he states that *tacit knowledge* is mainly about the information inside a human's brain and cannot be expressed by words. As he states people can tell less than they know. Polanyi's second type of knowledge is *explicit knowledge* and this is mainly about getting involved in activities. On the other hand, some philosophers oppose the idea of categorising knowledge into different types, such as Stanley and Williamson (2001). They state that knowing how cannot be considered to be a kind of knowledge since it is a special case of knowing. According to them, knowledge forms overlap and cannot be classified.

Even though knowledge has been defined in many different ways, it should be noted that the most broadly recognised distinctions are propositional knowledge and procedural knowledge.

Philosophers are mainly interested in propositional knowledge and the previous attempts to define knowledge mainly concerned propositional knowledge. In contrast, Gitomer and Zisk (2015) state that many studies have been conducted into the field of teachers' knowledge and most of these studies focus on practical knowledge as this form of knowledge concerns what should teaches do or how they teach. The following section will introduce some aspects of teachers' professional knowledge.

3.7 Teachers' professional knowledge

Personal knowledge in professional work was described by Eraut (2000, p. 114) as, "the cognitive resource which a person brings to a situation that enables them to think and perform". Teachers' professional knowledge is integrated with their skills as it is embedded in their practice, which refers to practical knowledge (Eraut, 2000; Sylvia and Fan, 2010).

Noticeably, the professional knowledge of teachers has become a growing concern of researchers and educators since the 1980s in order to investigate what kind of knowledge teachers need to master their work (e.g., Elbaz, 1981; Shulman, 1986).

Connelly and Clandinin (1997, p. 666) state that "teacher knowledge research is part of a revolution in how educators think about classroom practice". According to them, this revolution has been mainly based on what teachers should know and how they implement this knowledge whilst teaching. Elbaz (1981) refers to teacher knowledge to *practical knowledge* as she proposes five sources of teachers' practical knowledge, including situations, as well as personal, social, experiential and theoretical knowledge. Moreover, Elbaz (1981) identifies different kinds of knowledge that teachers need to possess: knowledge of instruction, knowledge of self, knowledge of the milieu, knowledge of their subject matter and knowledge of the curriculum.

Shulman (1986) identifies the concept of teachers' knowledge, which outlines the necessary knowledge for teachers. He distinguishes seven bases of teachers' professional knowledge which guide teachers' understanding of teaching and learning as follows:

> "1) general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter; 2) content knowledge; 3) curriculum knowledge, with particular grasp of the materials and programs that serve as 'tools of the trade ' for teachers; 4) pedagogical content knowledge of the subject matter that represents special amalgam of content and pedagogy; (5) knowledge of learners and their characteristic; 6) knowledge of educational ends, purposes, and values; and their philosophical and historical ground;

and 7) knowledge of educational contexts, ranging from workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures" (Shulman, 1986, p. 8).

In this sense, the attempt to classify teachers' knowledge results in providing a framework that emphasises how teacher should be professional in understanding content, pedagogy, learning process and curriculum objects that deepen understanding and can lead teachers to effective teaching. In 1991, the National Board of Certification in the USA issued an initial teaching profession policy which asserted that teachers are members of learning communities and are responsible for knowing the subject they teach and how to teach it. Further, teachers are responsible for monitoring students' learning and progress (NBPTS, 1991, cited in Harman, 2001)

- Teachers are responsible for managing and monitoring student learning.
- Teachers think systematically about their practice and learn from experience.
- Teachers are members of learning communities.

In regard to classroom assessment, some researchers propose an integrated model of teachers' knowledge in which classroom assessment is a part of the model. Darling-Hammond and Baratz-Snowden (2005) identify three significant areas that teachers need to know and understand: knowledge about students and their learning, knowledge of the subject matter and curriculum goals and knowledge of teaching. They emphasise that knowing how to assess is an essential part of teachers' knowledge about learning and teaching, as well as their knowledge about learning objectives. Carr et al. (2000) state that teachers' pedagogical content knowledge is clearly connected with knowing about student assessment procedures since assessment information can develop teachers' pedagogical content knowledge by providing the necessary information to make decisions about teaching. Hence, knowing about assessment affects teachers' decisions with regard to improving pedagogical strategies and curriculum implementations.

Scott, Webber, Aitkin and Lupart (2011) state that knowledge about assessment is a part of teachers' pedagogical knowledge as teachers' understanding of assessment can help them create optimal student learning which is essential for success. According to them, assessment activities are usually designed to progress instruction and learning. Therefore, teaching and assessment are combined. For example, implementing and designing valid assessments, developing rubrics and marking guides, requires teachers to learn and understand about assessment and integrate this knowledge into their own teaching philosophy (Scott, Webber, Aitkin and Lupart, 2011).

According to Shulman (1986), knowledge about different assessment methods and types is essential for teachers' pedagogical content knowledge since assessment is a substantial element of teachers' professional knowledge which all teachers should master.

It is clear that many researchers have contributed significantly to research on teachers' professional knowledge. However, they have explored and categorised teachers' knowledge in different ways. Most of the contributions in this field of education consider teachers' knowledge about assessment and its implications in the classroom as key pedagogical knowledge. McMillan (2001) states that teachers who have a solid background in assessment can integrate the results of this with instruction in order to select proper ways of teaching. The next section is based on the literature about assessment literacy for teachers as this term highlights the necessity of teachers having substantial assessment knowledge and skills and how they can reflect on their practice of assessment in the classrooms.

3.8 Teachers as assessment literate

By the late 1980s, some educators and researchers in the field of education paid more explicit attention towards teachers' competency as classroom assessors, which was also linked with the term *assessment literacy* (Stiggins, 1995). The point is what teachers should know and do to construct effective assessments since assessment literacy is considered to be a fundamental factor that connects assessment quality, teaching competency and student achievement (Mertler, 2003a). Furthermore, all teachers need to be assessment literate in order to be professional teachers (Popham, 2009).

As such, the notion of assessment literacy has emerged due to the constant attention paid to teachers' efficiency in the area of student assessment. Indeed, the American Federation of Teachers (AFT), the National Council on Measurement in Education (NCME), and the National Education Association (NEA) (1990) have jointly defined seven *Standards for Teacher Competence in Educational Assessment of Students*. The standards consist of the following principles (AFT, NCME and NEA, 1990, pp. 31-32):

1. Teachers should be skilled in choosing assessment methods appropriate for instructional decisions.
2. Teachers should be skilled in developing assessment methods appropriate for instructional decisions.
3. The teacher should be skilled in administering, scoring and interpreting the results of both externally produced and teacher-produced assessment methods.

4. Teachers should be skilled in using assessment results when making decisions about individual students, planning teaching, developing curriculum, and school improvement.
5. Teachers should be skilled in developing valid pupil grading procedures that use pupil assessments.
6. Teachers should be skilled in communicating assessment results to students, parents, other lay audiences, and other educators.
7. Teachers should be skilled in recognizing unethical, illegal, and otherwise inappropriate assessment methods and uses of assessment information.

These seven standards concerning educational assessment knowledge and skills reflect teachers' necessary knowledge and skills whilst performing assessment in their classrooms.

However, the term 'assessment literacy' was not used until it was coined for the first time by Richard Stiggins in 1991. Assessments literacy was introduced as the teacher's and administration's understanding of the principles of sound assessment and Stiggins considered it to be an essential characteristic of efficient teaching to know the specifics of how to provide high quality assessment (Stiggins, 1991).

Stiggins (1995, p. 240) describes the characteristics of assessment literates, as, "[they] know the difference between sound and unsound assessment. They are not intimidated by the sometimes mysterious and always daunting technical world of assessment". Moreover, Stiggins (1995) provides a further description of teachers who are considered to be assessment literate, saying that they should know what to assess, why they are doing the assessment, how to assess students' skills and knowledge, what the potential problems with assessment are, how to tackle these problems and how to predict the possible negative consequences of poor and inaccurate assessment data.

As such, assessment literate teachers need a deep knowledge of assessment concepts; how to apply proper assessment strategies; what the aims are, beyond selecting assessment tasks; how to interpret assessment information and how to make teaching decisions according to this information (Abell and Siegel, 2011).

According to Quilter and Gallini (2000), assessment literate teachers need to have the experience and ability to design, choose and interpret tests results and use those results appropriately for making decisions relating to student learning or instruction.

Erkens (2009, p. 13) defines assessment literacy, "as the state or quality of being knowledgeable and skilled in the comprehensive picture of assessment preparation and practice". According to Erkens (2009) having this important knowledge about assessment implications could help in

enhancing and monitoring student learning. Erkens (2009, p. 14) states that the assessment literate teacher is very likely able to:

- Create a formative culture and balanced assessment system conducive to learning.
- Identify the comprehensive and specific targets of rigorous and relevant learning expectations.
- Design accurate assessments to generate evidence that will sufficiently reflect these expectations.
- Employ in-the-moment strategies, prompts and questions to elicit reasoning and knowledge construction responses from learners.
- Deliver assessments in a safe and engaging environment.
- Analyse results from assessments.
- Respond accordingly to results from assessments with corrective feedback and responsive instruction.
- Reassess to verify learning and repeat the process as needed.
- Engage students as instructional decision-makers in meaningful ways throughout the entire teaching and learning process.

The point is that there is a massive amount of information that needs to be understood about assessment roles in teaching and learning journeys and such understanding can help to address the gap between what we know and what we need to know about assessment (Erkens, 2009).

In order to determine whether or not teachers have sufficient knowledge about assessment, five main questions are stated by Rowntree (1987, p. 11) which teachers should manage to answer regarding their classroom assessment knowledge and practice:

- Why assess?' Deciding why assessment is to be carried out and what outcomes the assessment is expected to produce.
- What to assess? Deciding, realizing or otherwise coming to an awareness of what one is looking for in people being assessed.
- How to assess?' Selecting from among available means, those assessments we regard as being most truthful and fair for various sorts of valued knowledge.
- How to interpret? Making sense of the outcomes of the observations or measurement or impressions we gather through whatever means we employ; explaining, appreciating, and attaching meaning to the raw ‘events’ of assessments.
- How to respond? Finding appropriate ways of expressing our response to whatever has been assessed and communicating it to those concerned.

Furthermore, regarding assessment literacy, Siegel and Wissehr (2011) state that teachers need to know about three aspects of assessment: assessment principles, assessment tools and assessment purposes. According to them, teachers with such knowledge can effectively understand the features of different assessment types and how to gather the necessary information about different students' learning by using a variety of methods.

Clearly, assessment literate teachers should be able to know more than how to design or select assessment tasks or interpret student results. Teachers need to shift their approach of assessment towards deep understanding of assessment purposes and how to transfer this understanding in their daily practice of assessment to enhance the whole learning and teaching process.

3.9 Research studies about teachers' assessment knowledge

Multiple studies have been conducted in various countries to investigate classroom assessment concerning teacher's knowledge about assessment; the researchers used different words such as, perceptions, conceptions, views and understanding to express the concept of knowledge. With this regards, many research has been conducted in relation to teachers' understanding of classroom assessment after AFT, NCME and NEA (1990) have released the Standards for Teacher Competence in the Educational Assessment of Students. For example, Plake (1993) conducted a study to examine teachers' assessment knowledge in assessing students. In order to attain the study's objectives, the researcher used a survey entitled, The Teacher Assessment Knowledge Questionnaire. The questionnaire consists of thirty-five items based on assessment standards by AFT, NCME and NEA (1990). The study sample consisted of 555 in-service teachers in the United States and the average score of correct answers was 23 out of 35 items. These findings showed moderate levels of teachers' understanding of assessment. Such a result drove the researcher to conclude that teachers were not fully understood how to assess student's learning.

A similar study was conducted by Mertler (2003b) to investigate both pre-service and in-service teachers' assessment literacy. The instrument of this study was a modified version of the Teacher Assessment knowledge Questionnaire and the results revealed that the average score of correct answers for in-service teachers was 22 items out of 36 items, which is a similar result to the study conducted by Plake (1993). Furthermore, Davidheiser's study in 2013 consisted of 35 items, also adopted from the Assessment Literacy Inventory, and this researcher placed this test online in order to test in-service high school teachers' assessment knowledge in the United States. The results of this study showed that teachers had a low performance on developing assessment

methods and the average score of teachers' correct answers was 24 out of 35 items, which was also consistent with Plake's (1993) and Mertler's (2003b) findings.

Further, the study by Mertler (2009) showed the effect of assessment training workshops on teachers' knowledge. This study examined the effectiveness of a two-week workshop on classroom assessment for seven in-service teachers. The workshop was designed based on the Standards for Teacher Competence in the Educational Assessment of Students and the participating teachers were pre-tested and post-tested by using the Assessment Literacy Inventory. The results indicated that teachers had limited knowledge about the purposes of assessment knowledge however; their knowledge was improved dramatically after the training workshop.

Another study also showed the teachers hold limited understanding of using assessment by Remesal (2011) who conducted a study in order to investigate teachers' views about the importance of assessment. The sample of this study consisted of fifty public schools in Barcelona, Spain. The findings of this study showed that teachers did not have a good understanding of the purposes of assessment and assessment's role in teaching and learning. Some studies have designed specific tests to investigate teachers' assessment knowledge. Regarding teachers' knowledge about how to interpret assessment results, King's (2010) study established a criterion-referenced questionnaire in order to measure educators' performance. The findings of this study showed that educators had inadequate knowledge with regards to norm-referenced and criterion-referenced assessment, as the educators only correctly answered 47% of the questions about the differences between norm-referenced and criterion-referenced tests and they only correctly answered 59% of the questions about measurements, reliability and validity.

In studding, teachers' attitudes and knowledge related to assessment, Alkharusi, Aldhafri, Alnabhani, and Alkalbani (2012) explored 165 in-service teachers' educational assessment attitudes, competence and knowledge. The participants were teaching different subjects in grades 5 to 10 and they were selected randomly from Muscat schools in Oman. The study found that teachers showed a low level of knowledge about classroom assessment on a descriptive survey, although the selected teachers had positive attitudes towards classroom assessment and perceived themselves as assessment literate.

In relation to teachers' perceptions, S. Alghamdi's (2015) study investigated seven teachers' perceptions of formative assessment in one primary school in Saudi Arabia. The researcher conducted semi-structured interviews to collect the data. The study revealed that teachers seemed not to understand in depth the concept of formative assessment, which affected their use of assessment tools. Although the sample of this study was small but it is still indicated the

lack of understanding regarding assessment forms. Another study was conducted in Saudi Arabian primary schools by Al-rumaih (2009) who has investigated the impact of using formative assessment on teachers' performance. A questionnaire was employed to collect the data from 60 teachers and the semi-structured used with 6 teachers. The findings of this study were similar to the past research, since the participants showed limited understanding of the implications of formative assessment.

In the context of mathematics, Alzoubi (2013) conducted a study to investigate mathematics teachers' knowledge about authentic assessment. The sample consisted of 91 teachers selected from Irbid city primary schools in Jordan. To fulfil this study's aims, the researcher developed a questionnaire and then the researcher observed twenty-seven mathematics classrooms. The findings revealed that teachers pay less attention towards alternative assessments methods as they do not realise the importance of assessment in learning mathematics. Moreover, some teachers held a belief that testing was the ideal approach for assessing students.

On the other hand, Suurtamm (2012) examined five mathematics teachers' perceptions about assessment methods and tools. The researcher observed teachers for a whole year and interviewed them after every classroom observation. The research indicated that the teachers showed a good understanding of assessment tools as they believed in the power of assessment to improve students' abilities in solving mathematics problems.

It is clear from the previous research that classroom assessment depends on the teacher's level of understanding of assessment's role in teaching and learning. Although the previous studies were conducted in many different countries, most of these studies' findings demonstrate that teachers' understanding and competence in classroom assessment is not as good as might be expected. In this sense, Stiggins (2008, p. 10) states that, "historically, educational leaders and teachers have not been given the opportunity to learn about sound classroom assessment practices". Stiggins (2008) further argues that the measurement-obsessed education community has minimised assessment's role to only one of its aspects that is testing, whilst less attention has been paid to assessment as an important tool for teachers and learners in the classroom. Popham (2009, p. 5) asserts the same notion by stating:

> "How many of today's teachers know little about educational assessment. For some teachers, test is a four-letter word, both literally and figuratively. The gaping gap in teachers' assessment-related knowledge is all too understandable".

3.10 Research studies about teachers' assessment practices in mathematics classrooms

The use of assessment activities are based on the purpose of assessment. As previously mentioned, summative assessment centers on evaluative and grade students achievement. Thus, summative assessment in mathematics is used in writing reports about students' academic achievement. Alternative strategies of assessment are used to provide evidence in order to describe students' learning (Even, 2005). The evidence from research showed that the majority of mathematics students are assessed by applying a short test at the end of the instructional session (Even, 2005). It could be concluded that teachers separate assessment from teaching as they just evaluate learning before they proceed to the next lesson. According to NCTM (1995) assessment is a routine process of any mathematics lesson rather than just to be used as an interpretation methods for students' learning.

Research on assessment practices of mathematics teachers has been conducted by a number of researchers. Research has explored how teachers assess students' achievement and how they implement traditional and alternative assessments activities in the classroom. Researchers have addressed what quality classroom assessment looks like and what teachers are doing with their students. For example, Alduwairi's (2013) study one of these study that aim to explore what mathematics teachers are practicing in their classes. The researcher investigated how secondary school mathematics teachers in Jordan use assessment models for three forms of assessment; assessment of learning, assessment for learning and assessment as learning. To answer the research question, the researcher observed 120 mathematics teachers whilst teaching and assessing students and the results of this study indicated that the majority of teachers rarely use assessment for learning and assessment as learning in mathematics classrooms. The participants mainly use assessment of learning with their students. A similar study was conducted by Al-Basheer and Barham (2012) in Jordan, which investigated 86 mathematics teachers' practices concerning alternative assessment strategies and their use of various tools of assessment. The results showed that nearly all participants depend on pen and paper tests. Furthermore, they used alternative assessment strategies less often than traditional assessment in their classes.

A study by, Murad (2001) also looked at the current assessment practices of teachers. In this study, primary school teachers' practices of classroom assessment have investigated in the Kingdom of Bahrain. The researcher concluded that, although many of the observed teachers applied various methods to assess their students, they still could not apply alternative assessment methods properly. The researcher also found that just few teachers were able to provide students with a clear and sufficient feedback. Traditional feedback often report whether the students'

answer is right or wrong since traditional feedback comes in the form of marks however, formative feedback comes in the form of verbal or written comments which aim to direct students while learning (Harlen, 2012).

Similar study by McMillan and Nash (2000) who examined 200 mathematics and English teachers' assessment and grading practices and to investigate how teaching decisions were influenced by the teachers' various practices. From classroom observations and interviews, the researchers found that teachers were influenced by their desire for grading and assessing students and they needed to implement different types of assessment, which aligned better with student learning.

It could be said that the past studies regarding assessment practices in mathematics have consistently expressed the concern about the adequacy of using assessment tools and grading students. Therefore, it could be concluded from these studies that mathematics teachers primarily tended to use objective strategies to assess student learning.

3.11 Research studies about Saudi Arabian primary mathematics teachers' knowledge and practices of assessment

In Saudi Arabia, the first aim of reforming assessment in primary schools is to minimise the reliance on exams in assessing students, and the second aim is to promote teachers to use assessment for formative purposes such as assess students' progress (Alotaibi, 2011). Few recent studies explored mathematics teachers' practices in relation to the two previous goals of the new assessment in primary schools. For example, H. Ahghamdi (2015) conducted a study aimed to investigate 133 primary mathematics teachers awareness and use of continues assessment tools such as self assessment, students' logs and classroom discussions. The researcher found that there was a significant difference between female and male teachers as female teachers demonstrated better understanding of assessment tools comparing to male teachers. In general both female and male teachers showed a good understanding of continues assessment tools and they used these tools in moderate levels.

Another study regarding using portfolios in primary mathematics classes conducted by Aldosary (2014) who examined 37 male teachers and 31 female teachers' implementations of portfolios with students in grad 6. This study showed that the mean value of teachers' use of portfolios was 2.17 indicating a weak level of implementing this strategy. A similar finding about using several strategies in assessment was addressed by another study. Alolayan (2014) explored teachers' attitudes towards using alternative assessment strategies in mathematics. The sample consists of

37 teachers who were asked to response to a developed questionnaire. The researcher found that teachers had a moderate attitudes toward using alternative assessment.

Although there are not sufficient evidence from the literature in Saudi Arabian context in relation to mathematics teachers' knowledge and their practices of assessment in primary schools, all mentioned studies insights reflect the low level of using alternative assessment. This provides a convincing rationale for conducting the current study. Furthermore, to understand the relationship between teacher knowledge and practice in assessment, the role of context should be investigated. The role of context is presented in the following section.

3.12 Assessment challenges in mathematics classrooms

One way to understand the relationship between teachers' knowledge and practice of assessment is through the context. Research on classroom assessment has shown a number of challenges in which teachers face when implementing assessment in mathematics classrooms. The most important challenge is the lack of knowledge about how to interpret assessment information and how to use assessment information to inform some instructions (Erickson, 2007).

In this sense, Heritage, Kim, Vendlinski, and Herman (2009) found that mathematics teachers were able to gather a sufficient information about students' understanding and they worked to promote students' levels of understanding. On the other hand, planning further teaching based on students' results seemed to be more challenging for teachers than preparing assessment tasks. In this sense, Erickson (2007) states that teachers should have pedagogical content knowledge and make their own judgment to modify the teaching approach in which they use.

In addition, teachers are facing challenges from outside the classrooms (Erickson, 2007). For example, workloads and time limitations might put some pressure on teachers. On that point, Saxe, Gearhart, Franke, Howard, and Crockett (1999) explored the pressures on teachers in relation to the shift of assessment methods. The researchers have observed the exercises and open-ended problems provided to students in order to collect data regarding their performance. Exercises and grades represent the old forms of assessment tasks whereas; open-ended problems and rubrics demonstrate the new forms. The challenges in using old forms mainly comes from curriculum materials, students and parents while, in the new assessment tasks, teachers found the main challenge was their need to professional development programmes to manage the new forms. From this study, it could realise that when adopting a new forms of assessment teachers should know how to use these new forms. Hence, teachers should be provided with a sufficient support by designing professional development programmes in order to keep their knowledge updated.

Furthermore, the long held belief that teachers have affect the transformation from traditional to alternative assessment (Erickson, 2007). For example, Watt (2005) investigated teachers' use of alternative methods in mathematics classrooms and their attitudes toward using these methods. The researcher found that teachers are pleased with using traditional tests in mathematics comparing to alternative assessment. Also, this study revealed that teachers tended to neglect using students' journals and self assessment, where teachers described these methods as unreliable and subjective. The researcher suggested to investigate teachers' perceptions regarding assessment before implementing any new assessment. In addition, (Erickson, 2007) argues that there is an assumption that learning occur after teaching, which underline teachers' preference of summative assessment. From the previous studies, it could be realised that teachers' skills with the different assessment techniques play an important role to encourage or discourage any new assessment.

In relation to the time limits for using assessment, Lyon (2011) presented a study of the relationship between teachers' beliefs about classroom assessment and their practices. In order to fulfil the study's aims, the researcher used classroom observations and reflective journals. The findings of this study demonstrated that teachers interpret assessment results by using a criterion- referenced approach, more than a norm-referenced approach. Moreover, teachers mostly do not have enough time to apply some types of assessment in which they know, such as alternative assessment tools. This study showed that although teachers believe in the value of using various methods in assessment, the time limits plays a major role in using these methods with students.

It seems the classroom context also may influence teachers' abilities to apply assessment strategies. According to Blatchford, Baines, Kutnick and Martin (2001) the number of students in classrooms could affect teachers' interactions with students. These authors further stated:

> "In small classes teachers have more flexibility to address or teach larger groups for particular occasions and purposes, while in a larger class they may be forced into a less flexible arrangement, with more and larger groups, which become the dominant unit for teaching and learning" (Blatchford, Baines, Kutnick and Martin, 2001, p.299).

Therefore, the small classes let teachers to manage the class and provide individual feedback on students work. Moreover, they could easier interact with small groups than the large groups.

Mathematics teachers in in Saudi Arabia face a variety of challenges in their work such as large class size, an empirical study by Alqarni (2015) showed that class size has an influence on mathematics teachers' use of assessment in primary schools. This study confirms that the small

class could result in better practices of assessment by providing students with more time to think and participate in different assessment activities.

Such constraints could have a negative effect on the implementation of the various tools of assessment. For example, H. Alghamdi (2015) examined the role of factors, which affect the implementation of continuous assessment tools in mathematics classes. The teachers' implementations for assessment tools have affected by large classes and lack of training programmes in assessment.

These findings are insightful to the current study as it reveals a potential challenges that mathematics teachers could face when using assessment. Nevertheless, the findings also shows how these challenges affects the teachers' decisions in classrooms. Hence, when exploring teacher's knowledge and practice, it is necessary to identify the factors in the context, which impact teachers use of their knowledge.

3.13 Summary

This chapter defines the term ‘assessment’ and shows how it is different from other terms, such as: evaluation, testing and measurements. Furthermore, the chapter presents the main purposes of implementing assessments in the classroom, which will be discussed in more details in the next chapter. Subsequently, this led to the definitions of both formative and summative assessments, as well as their purposes and how teachers could implement them in their classes.

As teachers’ knowledge of assessments is one of the current study’s objectives, it is important to provide a brief outline in regards to the philosophical perspective of human knowledge and its different forms. However, the discussion shows that it is difficult to find an accurate definition of knowledge. Following this, the current chapter then addressed the fact that teachers need to be assessment literate, while the chapter presented some western and eastern studies, which aimed to investigate teachers' knowledge and practices for assessment. Nevertheless, most findings showed that teachers do not have sufficient knowledge in relation to classroom assessment.

Chapter 4: Conceptual Framework

4.1 Introduction

The main purpose of writing this chapter is to construct the conceptual framework for the current study in order to understand the study's objective. This chapter begins with a diagram that represents the framework for the study, and then this chapter presents a definition of teachers' knowledge of assessment, followed by the theoretical foundation of teachers' knowledge of assessment. The framework of mathematics teachers' knowledge of assessment in the current study is also provided in this chapter. Then, this chapter provides a definition of mathematics teachers' practices of assessment, followed by the conceptual framework of assessment practices in mathematics. A discussion of the nature of the relationship between knowledge and practice is provided in this chapter, as well as of the factors that arise within an educational context. Finally, this chapter presents a summary of the chapter.

4.2 The study framework

In order to fulfil the aims of the current study, there is a need to explore what mathematics teachers' know about classroom assessment and how they practice assessment in mathematics classes, also consider how teachers' practices are related to their knowledge. Furthermore, it is worthy to identify whether there are any factors that may influence teachers' abilities to transfer their knowledge into actions. Consequently, the framework of the current study is illustrated in Figure 2.

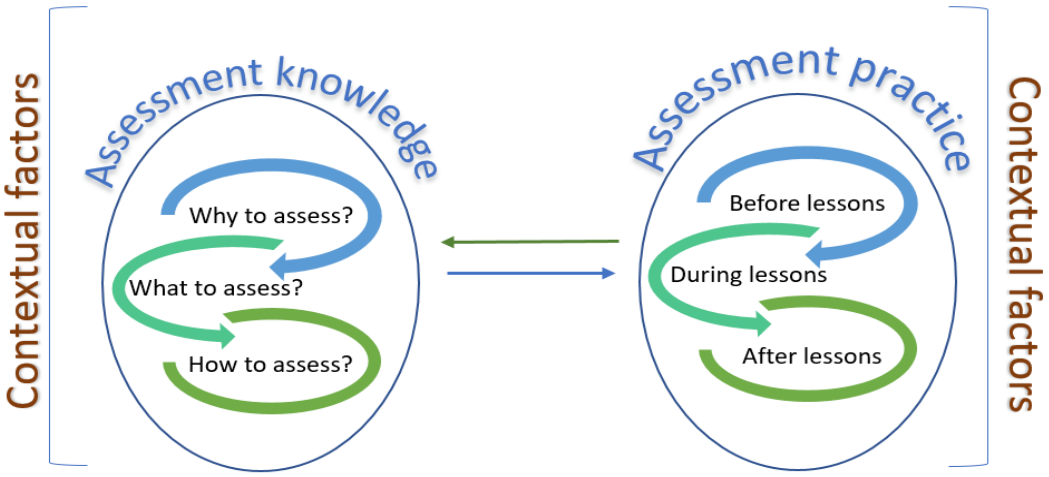

Figure 2: The framework for this study

4.3 Defining teachers' knowledge of classroom assessment

Teachers' knowledge is the first domain in this conceptual framework; initially, the discussion related to the definition knowledge is in chapter three, where it was shown that knowledge in the field of epistemology is often defined as beliefs that are true and justified. However, there were different conceptions of knowledge, which have subsequently led to a huge debate about Plato's knowledge dialogue, and how to define knowledge accurately.

Regardless of these challenges in defining the concept of knowledge, the focus in the current study revolves around forms of knowledge that are held by teachers. Indeed, there are many forms of knowledge, at least two main kinds that can be understood within the concept of knowledge. The first kind is to know what equates to theoretical knowledge, as well as possessing the knowledge of what equates to practical knowledge or tacit. Many researchers described "knowing what" and "knowing how" as two different characteristics of knowledge, whereas other researchers described knowledge as a result of the interaction between tacit and explicit knowledge (see Chapter 3).

Polanyi (2009) is widely known as the founder of tacit knowing theory, and it was stated that knowledge is a very personal aspect; not all forms of knowledge could be transferred or expressed, as individuals generally know more than what they claim. Polanyi (2009) noted that knowledge is a mental and dynamic act, while tacit knowledge is the real cause of all knowledge, which consists of two elements: cognitive and physical. Moreover, Kikoski and Kikoski (2004, p. 44) mention that "what is unsaid and unexpressed could be the reservoirs of tacit knowledge" and that personal knowledge is an individual's tacit knowledge possession. Furthermore, these authors have claimed that knowledge is integrated by a person's education, talent, and experiences. It is clear that Kikoski and Kikoski (2004) have emphasised Polanyi's (2009) notion in relation to tacit knowledge, as they have stated that all kinds of knowledge depend partly or completely on tacit knowledge.

In addition, Nonaka (1994) argueds that knowledge creation and organisation is a spiral interaction between tacit and explicit knowledge. Based on his claim, Nonaka (1994) identifies four different modes of knowledge conversion: (1) tacit to tacit, called socialisation; (2) explicit to explicit, called combination; (3) tacit to explicit, called externalisation, and (4) explicit to tacit, called internalisation.

Separately, in terms of defining knowledge, Fan (2014) provides a definition for the concept of knowledge: "a subject's knowledge of an object is a mental result of certain interaction of the subject and the object" (p. 30). Hence, based on Fan's (2014) definition, the definition of

knowledge can be limited to an individual, dynamic mental statement, together with possessing information, ideas, and understanding about a specific object. This dynamic mental statement cannot be seen by anyone, but its impact can be noticed through an individuals' behaviour or practices.

In order to provide a better understanding of “knowledge” in the current study, it is important to note that according to this definition of knowledge, the individual's information, ideas, or understanding is not always true to the object. The reason for this stems from the fact that knowledge can develop into being true or wrong, or even out of date (Fan, 2014). For example, a person may hold on to certain beliefs, even if this knowledge was later shown to be untrue.

The literature revealed that the term “teachers' knowledge” has been studied by researchers, as they have attempted to identify that specific term throughout various domains (see chapter three). Likewise, ever since Shulman’s (1986) work, the classification of teachers’ knowledge into categories aimed to provide an insight into recognising what teachers really know about teaching (Fenstermacher, 1994). Originally, Dewy (1902) predicts that teachers’ knowledge differs from one teacher to another, as he explained that teachers can know their subjects in various ways. According to Dewey’s prediction, which the current study agrees with, teachers’ knowledge is affected by many factors, such as: teachers’ personalities, education, and experiences. Furthermore, the factors that exist in the context of education may also affect teachers' knowledge.

In addition, Connelly and Clandinin (1997) point out that individual teachers' knowledge takes a moderate position between teachers' practical and theoretical knowledge, as this knowledge is a set of teachers' personal knowledge, education, and working landscape. Feldman (2002) provides the same opinion, as he determined that teachers’ knowledge and understanding is not an organised process or set of strict rules, which therefore could not be accounted as explicit or tacit knowledge. Through the previous notion, the current study corresponds with certain researcher’s views, which describe teachers' knowledge as a fundamental type of knowledge. In addition, the current study considers teachers’ knowledge as an overlapping form of knowledge, which is difficult to be determined as practical or theoretical. Accordingly, the current study defines teachers' knowledge as a mental statement that is based on their beliefs and understanding of teaching and the learning process.

Since the context of this study is classroom assessment, the assessment description is adhered to what was provided by NCTM in its Assessment standards for school mathematics, which defines an assessment as:

> "The process of gathering information about a student's knowledge of, ability to use, and disposition toward mathematics and of making inferences from that evidence for a variety of purposes" (NCTM, 1995, p. 3).

Within the boundaries of NCTM's assessment definition, it may be understood that in order to fulfil the ultimate benefits from assessment, teachers should have a sufficient understanding about the following:

1) Gathering information and evidence about students learning
2) Interpreting students' assessment results
3) Making suitable decisions in regards to students' assessment results

Similarly, Webb (2002, p. 1) provides a definition of the knowledge of classroom assessment:

> "The knowledge about how to assess what students know and can do, interpret the results of these assessments, and apply these results to improve student learning and program effectiveness".

Based on his definition, it is obvious that teachers are required to possess an adequate knowledge about the role of assessment in the students' learning, rather than just use assessment in testing or measuring what students know.

4.4 The theoretical foundation of teachers' knowledge of assessment framework

The frameworks and research studies that were concerned with knowledge of assessment were understanding what kinds of assessment knowledge teachers need to have in order to use assessment sufficiently. Based on my reflection on the evidence from the literature and the established frameworks over the past years, there were only a few studies in which researchers established a theoretical framework for understanding teachers' knowledge and skill of assessment. Accordingly, in the current study, two theoretical frameworks have been selected to be the basis in conceptualizing what mathematics teachers need to know about assessment. These two frameworks were selected because they both exclusively focused on the knowledge of classroom assessment that teachers utilise on a regular basis.

The first framework was conducted by Magnusson, Krajcik, and Borko (1999), who theorized that the pedagogical content knowledge (PCK) is a transformation of various kinds of knowledge for

teaching. These researchers have stated that PCK includes a number of components, such as teachers' knowledge of assessment, along with knowledge of students' needs, instructions, and curriculum. Magnusson et al. (1999) conceptualise knowledge of assessment as including two domains: knowledge of the important dimensions to assess, and knowledge of the methods of assessment. The first domain "refers to teachers' knowledge of the aspects of students' learning that are important to assess within a particular unit of study" (Magnusson et al., 1999, p. 108). This domain is related to how teachers understand the learning goals and the important dimensions in the lesson or unit that should be assessed. Based on this domain, in any given topic there will be dimensions that are easier to address than others. The second domain "refers to teachers' knowledge of the ways that might be employed to assess the specific aspects of student learning that are important to a particular unit of study" (Magnusson et al., 1999, p. 109). This domain includes teachers' knowledge of the instruments or activities that are used to assess important aspects in learning.

Although the Magnusson et al. (1999) framework provides a foundation of assessment knowledge that teachers need to understand, this framework is limited to only two categories of assessment knowledge: knowledge of learning goals and assessment strategies. Based on NCTM's (1995) definition of classroom assessment, I believe that the Magnusson et al. (1999) framework has not covered all assessment domains, which are needed to understand teachers' knowledge of assessment.

The second framework comes from the work of Abell and Siegel (2011) on teachers' assessment literacy. These researchers have developed a model for understanding what science teachers need to know about assessment. The core of this model is the values, beliefs, and ideas that teachers have regarding learning and assessment decisions. Abell and Siegel (2011) indicate that teachers' beliefs of what is important to be learned in science influence and guide the decisions they make regarding what, why, and how they assess their students. In Abell and Siegel's (2011) model, the teachers' view of learning interacts with four categories of teacher knowledge of assessment. The first category is knowledge of purposes of assessment, which is related to why teachers choose to assess students in science. The second category is teachers' knowledge of what to assess, which is related to what science teachers need to know about learning goals and curriculum in order to assess what they think is more important to learn. The third category is knowledge of the general strategies used to assess students' learning in a particular unit. The fourth category is knowledge of the interpretation of assessment, and the relevant actions based on assessment evidence that are about using assessment data to modify plans for instruction, as well as students' learning.

It is clear that Abell and Siegel (2011) provide four categories, which together demonstrate fully what teachers need to know about assessment. However, this model is mainly targeted at science teachers. Nevertheless, some of the assessment knowledge categories in this model seem to be very general, such as the knowledge of assessment strategies and knowledge of what to assess. According to what has been mentioned regarding the previous frameworks, it seemed that the current study needed to develop its framework in order to explore mathematics teachers' knowledge of assessment. Assessment knowledge framework in this study is grounded on the Magnusson et al. (1999) framework, and Abell and Siegel's (2011) models of teachers' assessment knowledge. Based on NCTM standards, mathematics teachers need to know how to assess students in a manner that aligns with mathematics teaching instructions and learning goals, in order to support students' learning in mathematics. Thus, teachers must consider the purpose behind using assessments, together with what aspects should be assessed and what methods should be used in assessing students.

4.5 Conceptual framework of mathematics teachers assessment knowledge

The current study developed a framework to investigate mathematics teachers' knowledge in relation to assessments. Overall, this framework consists of three main dimensions: Why should teachers assess? What should teachers assess? How should teachers assess? Each dimension includes several components, which are described, in detail, next.

4.5.1 Teachers' knowledge of why assessment should be conducted

Apart from testing and grading students, the literature indicated that many substantial purposes exist for using assessments in classrooms (e.g., Gipps and Stobart, 1993; William, 2004b). According to the NCTM's (2000, p. 1) *Principles and Standards for School Mathematics*:

> "Assessment should be more than merely a test at the end of instruction to see how students perform under special conditions; it should be an integral part of instruction that inform and guides teachers as they make instructional decisions. Assessment should not merely be done to students; rather, it should also be done for students, to guide and enhance their learning".

Therefore, teachers need to possess a sufficient knowledge of both summative and formative assessments, as well as understand the purpose behind implementing these two types of assessment; the literature has demonstrated that these are the two main forms of assessment.

Summative assessment

Summative assessment refers to the process of judging students' achievements in mathematics at a certain times throughout the academic year; the results of this assessment are often provided to both parents and school administration. The main characteristic of summative assessment is scoring students' work. Grading decisions are related to the process in which teachers collect information about students in order to provide students with marks based on the quality of what they have learned (Harlen and James, 1997; Airasian, 2000). Basically, teachers use tests or quizzes to collect particular information after finishing certain content, although classroom activities which involve students and homework could also be used to grade students, instead of purely focusing on testing. Sadler (2005) defines grading as an evaluation process of students' progress. Furthermore, Sadler (2005) distinguishes between two groups of grading models. The first grading model is "achievement of course objectives", which relates to how well students achieved learning outcomes. The second grading model is "overall achievement as measured by score total", which is also referred to as percentage grading. This grading model is broadly used in assessment, and it is based on students' grades in different tasks, which provide an overall grade for the subject or course. Hence, teachers need to be aware of the summative assessment purposes, as results are recorded and sent to the both schools administration and parents, which is crucial for students' educational future.

Formative assessment

The current study refers to the term "formative" as the assessment which is used during the process of learning mathematics, in order to help teachers better understand students' learning and to implement solutions when learning and teaching requires improvements. The main characteristics of formative assessment could be concluded based on the principles of assessment established by ARG (2002). Hence, formative assessment means:

1) Providing feedback- that is defined by Hattie and Timperley (2007) as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (p. 81). Teacher's feedback is an important component in formative assessment, which is widely considered as a tool that provides the information to modify students' performance or behaviour, as well as instructions (Sadler, 1989; Black and Wiliam, 1998a; William, 2004b). In daily classroom life, the direct feedback from teachers to students provides teachers with a clear insight of students' challenges, and thus, teachers can plan for more efficient solutions to help their students (Hattie and Timperley, 2007). Indeed, to fulfil the ultimate benefits from the feedback process, teachers need to collect specific

information regarding a specific task in order to reduce the gap between what students achieve and what teachers want them to achieve (Sadler, 1989).

It should be indicated that teachers need to understand how to provide accurate feedback, which contributes to guiding students to achieve learning targets. Moreover, students should be involved in the feedback process; Gipps (1994) states that students need to understand learning targets and assessment criteria in order to become more aware of their learning processes. Accordingly, within the classroom, written and verbal feedback are the two major forms of feedback, as teachers can provide feedback to students instantly while learning, following any assessment, and after longer periods of learning (ARG, 2002). Furthermore, Gipps (1994) notes that most research has demonstrated that students need to gain instant feedback following the practice of any task. Moreover, providing descriptive feedback in the form of oral or written comments about how students can improve is more likely to give students a hidden message that she or he has the ability to progress and improve (Black and Wiliam, 2018). Hence, feedback is the guide to improve learning.

2) Improving teaching, as during teachers' daily schedules, they encounter many situations in which they need to make decisions to modify instructions. It is clear that teachers need to know that students' results in assessments could guide them while teaching by offering valuable information in order to meet learning and teaching needs (Black and Wiliam, 1998a; Nitko, 2001). When formative assessments are embedded, teachers can ascertain enormous information; they need to elicit a basis to select suitable teaching strategies or develop teaching in general. In addition, decisions in regards to instruction could be made beforehand, during, and after instruction, which all require the ability to build teaching plans based on students' levels of achievement (Nitko, 2001).

3) Involving students in assessment, as students' reflections on their learning process helps students to become aware of their own learning (Black and Wiliam, 1998a). The discussions between the students and the teachers are one of the affective methods in helping students to monitor their progress (ARG, 2002). Teachers can create the opportunity for students to take part in assessment by developing self-assessment skills. In this sense, Brown (1994) stated the importance of being aware of strengths and weaknesses while learning: "effective learners operate best when they have insight into their own strengths and weaknesses and access to their own repertoires of strategies for learning" (Brown, 1994, p. 9).

4.5.2 Teachers' knowledge of what aspects should be assessed

The decision of what aspects to assess is an important step for teachers' assessment competency, as assessments should reflect a clear insight into students' learning (Stiggins, 2009). The knowledge of what should be assessed in classrooms is an initial phase in planning for an assessment, which needs to be established based on in-depth understanding of the nature of mathematics content and students' behaviour. According to Wragg (2001), the main aspects of the formulation of assessing children's learning are:

1. Knowledge and understanding – factual information, concepts, names, ideas, theories, applications, connections, relationships, structures;
2. Skills – techniques, mental and physical dexterity, specific competence in particular fields, craft expertise, interpersonal skills, ability to link knowledge, understanding and skill;
3. Attitudes and values – about learning, beliefs, subject knowledge, people, society;
4. Behaviour – social relationships, personal characteristics, competence at carrying out, fulfilling potential.

In addition, NCTM (1995) states that assessing students' knowledge in mathematics, their abilities to used mathematics and their dispassion toward mathematics are the three main areas in which mathematics teachers could use assessment. Accordingly, the current study divides the aspects of mathematics that teachers should assess into two domains: cognitive and affective.

Cognitive domain

As with other subjects, mathematics' cognitive domain is multi-dimensional, according to the well-known Bloom's taxonomy of cognitive domain, which consists of six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Popham, 2014). Furthermore, Popham (2014) states that cognitive assessment aims to assess "intellectual operation" for students, such as solving problems or making decisions. Yet, since understanding mathematics has a special nature, many researchers have analysed mathematics cognition in various ways (Yoong and Kaur, 2011). For example, the Trends in Mathematics and Science study (TIMSS) (2003) provides a specific framework of the mathematics cognitive domain that classifies cognitive aspects into three domains. Firstly, cognitive domains consist of facts and concepts. Secondly, cognitive domains consist of knowledge implementation, understanding of concepts, and solving problems. Thirdly, cognitive domains consist of mathematical reasoning. The current study considers the cognitive domain through mathematical concepts, facts and skills that students are required to achieve based on the learning goals.

Affective domain

Bloom's taxonomy consists of five categories: receiving, responding, valuing, organising, and characterising (Popham, 2014). Furthermore, an affective domain refers to learners' emotions and manners, which include: attitudes, feelings, motivations, values, and interests (Smith and Ragan, 2005). Moreover, according to Popham (2014, p. 89), affective assessment targets are those that "deal with students' attitudes and values, such as a student's self-esteem, risk-taking tendencies or attitudes toward learning". Hence, classroom teachers also need to consider the assessment of students' attitudes, values, motivations, and interests toward learning mathematics.

4.5.3 Teachers' knowledge of how assessments should be conducted

According to the *Standards for Teacher Competence in Educational Assessment of Students* introduced by AFT, NCME and NEA (1990), teachers should understand how to develop or select the most suitable assessment methods, which identify the purpose of using assessments. This requires teachers to possess adequate knowledge about the different types of assessment methods, and when and how to use them to collect the desired information. Thus, there are two main types of assessment method: traditional and alternative (Russell and Airasian, 2012; Popham, 2014). A traditional assessment refers to an objective assessment that measures students' achievement or lower-order thinking skills (Russell and Airasian, 2012). According to Popham (2014), traditional methods could be divided into two groups:

1) Selected-response tests, such as multiple-choices, matching, and true or false.
2) Constructed-response tests such as essays, and short answer tests.

An alternative assessment is mainly based on the students' performance; O'Malley and Valdez (1996) state that "alternative assessment consists of any method of finding out what a student knows or can do that is intended to show growth and inform instruction" (p. 1). Additionally, it also refers to different forms, such as authentic assessment, performance-based assessment, and constructivist assessment (Russell and Airasian, 2012; Popham, 2014).

The target of using the alternative assessment method is to provide students with the opportunity to show their performance based on what they have learned. More specifically, alternative assessment is focusing on students' performances, which provides teachers with a more complete scope of the students' responses and abilities (Popham, 2014).

According to Wiggins (1993), authentic assessment tasks provide the opportunity for students to practice various activities, such as writing, designing, and presenting, as such activities could serve students' critical thinking skills and help teachers to be more flexible in instruction. Wiggins (1993)

further states that authentic tasks should mainly be designed to meet students' needs and offer real life skills, which they will need throughout their future. While traditional assessment is simple to formulate and structure in terms of grading, using alternative assessment is quite challenging for teachers to judge students' tasks, and hence, teachers should know how to develop the criteria to guide the assessment process (Hamayan, 1995).

A number of educators have classified various types of alternative assessment methods (e.g. Hamayan, 1995; Russell and Airasian, 2012; Popham, 2014). The following is the most commonly used alternative assessment in classrooms:

1) Portfolios are a set of selections of the students' work. Popham (2014) describes portfolios as "a systematic collection of one's work" (p. 181). He considers portfolios to connect the assessment, learning, and instruction, while using portfolios to demonstrate both students' improvements and achievements, whereas tests only focus on the students' achievements.
2) Self-assessment is an assessment method where students assess themselves. More specifically, self-assessment helps to gather information about students "through their self-reviewing, self-reflecting, and self-reporting about their students" (Fan, 2011, p. 276)
3) Peer-assessment refers to an assessment method where students can assess their peers, which is usually popular with group work. Formative peer assessment is specially implemented to stimulate students' higher-order skills by sharing ideas, reflecting and collaborating (Strijbos and Wichmann, 2018).

In addition, knowing about assessment implementation is not just knowing about assessment strategies, but also includes the actions that teachers normally take regarding the evidence they collect about their students. Based on Abell and Siegel's (2011) model, the critical part of assessment knowledge is teachers' understanding regarding how to interpret assessment information and take actions based on these interpretations. Abell and Siegel (2011) state that when teachers know how to use assessment data, they could enhance students' learning and use assessment evidence to modify their plans for future teaching.

4.6 Defining teachers' practices of classroom assessment

Before identifying mathematics teachers' practices of assessment in this study, a brief discussion about the concept of practice is introduced. This concept was originally introduced by Aristotle, who considered morals in his Nicomachean Ethics as important factors in human acts (May, 2010). Aristotle stated that "every craft and every enquiry and every action and pursuit, is thought to aim at some good" (cited in Husain, 2002, p. 80). Moreover, Aristotle noted that the position of

actions is to achieve the best of human behaviour. According to him, these actions are different, due to the fact that “good” is different; he explained human behaviour as a natural ambition to attain “virtues” (Husain, 2002). Aristotle claims that every human activity has some specific aim, which equates to humans acting everything in order to attain certain desired targets (May, 2010). Hence, according to Aristotle's perception of human acting, it could be concluded that the diversity of human practice refers to the diversity in human goals and desires. In fact, many thinkers were influenced by Aristotle's notion of practice, where every practice requires a rule.

On the other hand, in the mid-1970s, a number of social scientists sought to investigate practice theory, as some writers refer to practice as individual activities that create cultural specific forms, which output daily life (Winthrop, 1991). Turner (2000) criticises practice theory advocators, as he argued that practice theory is merely a general concept. Turner (2000) linked practice with tacit knowledge, as he stated that tacit knowledge is the basis of any practice; he mentioned that through Kant's practice definition: "an activity seeking a goal" (Turner, 2000, p. 8). Furthermore, he stated that "by 'a practice' I will mean an activity that requires its genuine participants to have learned something of this tacit sort in order to perform" (Turner, 2002, p. 23). As a result, it seems that Turner agreed with the Aristotelian concept of practice, which describes practice as an activity based on a set goal.

Separately, in the field of teachers' practices, some researchers have identified the term “teachers' practice” as teachers' actions or behaviour in the classroom. For example, Boaler (2002) states that practice is "the recurrent activities and norms that develop in classroom over time, in which teachers and students engage" (p. 3). Therefore, it appears that thinkers and researchers have regarded practice in two different domains: the social setting, and individuals’ activities and norms.

The current study considers teachers' assessment practices as their usual daily activities and behaviours in implementing classroom assessments. It seems that more complete benefits from assessments will be achieved as long as an assessment is implemented efficiently in classrooms. According to Black and Wiliam (1998b), "one strong reason for giving teachers a greater role is that they have access to the performance of their pupils in a variety of contexts and over extended periods of time" (p. 147). Hence, teachers need to be skilled in choosing or designing appropriate assessments, and collecting assessment information, together with using assessment information to improve learning and teaching, while also reporting assessment results.

For this study, I refer to teachers' practices of assessment as all activities that teachers do to gain evidence concerning what an individual student has learned and can do in mathematics before, during, and after lessons (NCTM, 1995; Black and Wiliam, 1998a).

4.7 Conceptual framework of mathematics teachers' practices of assessment

Classroom assessment is presented as a cycle that is divided into of a number of stages (NCTM, 1995). NCTM established a model for classroom assessment, which described four phases for conducting assessment, namely: planning the assessment, gathering the information, interpreting the information, and using the results (NCTM, 1995). These phases of the cycle of assessment are interactive and strongly interrelated. The classroom assessment cycle provided by NCTM is adopted in this study as the foundation for practicing assessment before, during, and after mathematics lessons. In the following conceptual framework, I elaborate on the implementation of the classroom assessment cycle.

Assessment before lessons

It is understood that assessment targets primarily support learning, and thus, before starting any new lesson, teachers need to think carefully about learning objectives and assessment standards. Setting a daily plan for an assessment, based on what teachers are required to assess and how they will assess it, would seriously promote assessment quality, rather than let the assessment take place in classrooms without planning in advance (McMillan, 2001). Brookhart (2005) states that teachers need to provide explicit recognition of what kind of information they are looking for, and what the most suitable assessment method is that should be applied to obtain this information. In this sense, Brookhart (2005) suggests that assessment plans should be a part of the planning for the whole course. Consequently, planning for assessment should go beyond the plan for the next lesson. It is important to consider planning for collecting information that investigates students' performance by using either grading tasks or formative activities.

Assessment during lessons

Through this phase, teachers gather information in regards to students' learning while teaching. The collection evidence could be conducted by applying a variety of assessment activities suitable for primary classrooms, such as: observing students' progress, communication between students and teachers, written tasks, group discussions, self and peer assessment, and quizzes. In particular, teachers should adopt either traditional or alternative methods to collect evidence when they are making decisions about selecting the appropriate method based on a learning situation and the appropriate measurement tool (Popham, 2014).

In primary classes, spending time on assessing students should be the first aim of monitoring and diagnosing students' learning, which will ultimately help teachers to analyse their students' difficulties through the learning process (Bachor and Anderson, 1994). By asking students diagnostic questions before starting a new lesson, teachers will be provided with the opportunity to discover their students' knowledge, skills, strengths, and weaknesses, which is an important mission for teachers. There is no doubt that the diagnostic purpose of an assessment keeps teachers informed throughout their students' progress, as well as their emotions and motivations (Gipps, 1994; Airasian, 2000).

A diagnostic assessment involves gathering information about students, which is subsequently used to assist teachers in planning for suitable instruction and fulfil learning goals. This is used for learning, as it will alert teachers to what they need to do in order to provide significant learning environments for their students. The diagnostic information may be gathered in many different ways; for instance, it is possible to implement an informal method of collecting diagnostic information, which involves the daily interaction between teachers and students through questioning and observation (Gipps, 1994; Nitko, 2001). Separately, formal collecting involves short tests in order for teachers to analyse students' responses to the test, which requires their prior knowledge or strengths, while different areas require special care (Nitko, 2001). Black (2001, p. 79) describes diagnostic interaction by stating that:

> "With better interaction in the classroom, teachers will be in closer touch with their students' progress in understanding, students will become more active and responsible …… all this should lead to enriched learning and students in the future".

Asking oral questions and pen and paper tests are considered to be the two most common methods of collecting information during lessons, as they consume less time than other methods (Airasian, 2000). Furthermore, Airasian (2000) states that during instruction, teachers should interact with students by asking either "closed" or "opened" questions, since such questioning serves different levels of students' cognitive function and development. Questions during lessons could help teachers identify students' level of understanding and difficulties, as well as monitor their progress during classes, which together provide a good opportunity to reform instruction (Brookhart, 2005). Comparatively, Sadler (1989) and Black and Wiliam (1998a; 1998b) argue that assessment activities during lessons should be followed by written or verbal feedback and comments relating to students' responses function as a monitor for what students understand.

Assessment after lessons

At this stage, it is increasingly likely that teachers may gain extensive information in regards to the students' performances, which ultimately needs to be interpreted and used to enhance both learning and teaching (Black and Wiliam, 1998a). In order to interpret collected information, teachers need to use desirable assessment standards, which are either norm-referenced or criterion-referenced assessment standards (Sadler, 2005; Popham; 2014). Norm-referenced assessment relates to comparing students' achievements to other students who are within the same class or school (Popham, 1992; 2014). As such, the norm-referenced interpretation demonstrates the difference between high and low performance.

In contrast, criterion-referenced assessment helps determine students' achievements in knowledge and skill-based learning goals (Popham, 1992). As such, criterion-referenced interpretation measures students' achievements in a specific area, and the scores are reported to students in the form of a percentage (Popham, 1992). Furthermore, it is important to note the differences between norm- and criterion-referenced interpretation, as formulated feedback and grades rely on the type of standards being used in interpreting gathered information (Airasian, 2000).

When teachers have gathered assessment evidence, this does not mean they have reached the end of the assessment process. In fact, certain actions should follow the outcomes of assessment (Black and Wiliam, 1998a). These actions focus on instructional decisions, which involve a revision of assessment activities and instructional interventions (Airasian, 2000). From assessment data, teachers could get feedback about how well they taught and plan their teaching and assessment activities based on this feedback (Gipps, 1990). In addition, providing students with feedback is a key factor in classroom assessment (Sadler, 1989). When teachers get assessment results they can provide feedback information to individuals, groups, or the entire class in relation to what students needed to achieve through the learning goals (Gipps, 1990, Popham, 2009).

4.8 The relationship between teachers' knowledge and practices

This study has a focus on the knowledge base of mathematics teachers about classroom assessment. It is also designed to examine teachers' use of classroom assessment and the relationship between what teachers knew and what they did in their classes regarding assessment. The complex interaction between knowledge and practice has roots in the constructivist view of knowledge, which considers knowledge to be a result of human actions in order to adapt with the environment in various conditions. Within cognitive constructivism theory by Piaget, knowledge is generated and shaped from individuals' experiences and their ideas

(Piaget, 1977). Therefore, Piaget's theory suggested that knowledge is always connected with people's practice; people's knowledge is not emerging from subject or object, but from the interaction between these two factors.

On that point, the primary premise behind this study is based on Donald Schon's (1983) explanation of knowledge implicit in action for participators including teachers. Schons' work insisted that teachers' actions are based on what they know, without separating teachers' knowledge from their practice. In order to show the nature of "knowing-in-action", Schon (1995, p. 29) assumes that we:

> "Cannot say what we know. When we try to describe it, we find ourselves at a loss, or we produce descriptions that are obviously inappropriate. Our knowing is ordinarily tacit, implicit in our patterns of action and in our feel for the stuff with which we are dealing. It seems right to say that our knowledge is in our action".

Similarly, the works of researchers, such as Elbaz (1981, 1983), Clandinin and Connelly (1987) and Connelly and Clandinin (1997), have all emphasised that the knowledge of teachers is full of their experiences and normally expressed in their actions. Through an understanding of these theoretical perspectives, which outright linked practitioners' knowledge and practice, it is expected that explaining teachers' implementation of assessment in their classes would contribute to providing profound insight into teachers' theoretical knowledge of assessment.

As long as assessment is considered to be a part of effective teaching, Clark and Peterson's (1986) model of teaching, which was simply concerned about teachers' thoughts and actions, also influenced the connection between knowledge and practices. This model assumed that teachers' actions are substantially determined and affected by teachers' cognitive processes. The authors argued that the process of teaching consists of two connected domains: teachers' cognition process and teachers' actions and their visible effects. Hence, teaching processes will be perfectly understood only when examining teachers' cognitive processes, and their actions in connection with each other. That is, the model depicts teachers' cognitive process as a domain that includes teachers' planning, teachers' decisions and interactive mental process, and teachers' theories and beliefs. These three categories are unobservable and take place inside teachers' brains; in contrast, teachers' actions are able to be observed and measured (Clark and Peterson, 1986).

Consequently, the current study stemmed from a similar assumption that the classroom assessment knowledge base of mathematics teachers can influence and be influenced by their assessment practices, given the study positioned itself within cognitive constructivism and knowledge in action perspectives.

4.9 Contextual factors

Literature about classroom assessment predominantly investigates teachers' practices of assessment (e.g. Shepard, 2001; Sadler, 2005; Popham, 2009); the relationship between teachers' knowledge of assessment and their practices has not been sufficiently understood (Gavin, Iris and Kelvin, 2015). According to Gavin, Iris and Kelvin (2015), understanding the potential gap between teachers' knowledge and practices could help in developing teachers' assessment practices. These authors define contextual factors to be a broad range of factors in the educational context that possibly influence teachers' knowledge and practices of assessment. In this sense, Kozma (2003, cited in Gavin, Iris and Kelvin, 2015) suggests three levels that influence teachers' understanding and practices of teaching:

1) The first level consists of the factors that exist in the context of classrooms, such as the number of students. These factors could have an immediate influence on teachers' practices.
2) The second level consists of the factors that exist outside of the classroom that affect teachers' knowledge and their practices, such as support from school leaders.
3) The third level includes the factors that exist beyond the school, for example, students' parents or community.

For the current study, I adapt Kozma's work as a guide in investigating the contextual factors that may affect what teachers know about assessment and their practices in classrooms.

4.10 Summary

This chapter has presented the conceptual framework that directs the current study in order to attain its objectives. The current study's framework was established based on the literature findings, which have been conducted in similar fields. Moreover, this chapter has provided a definition of the two main concepts within the boundaries of this study: "knowledge" and "practice". As described in this chapter, the conceptual framework presents teachers' assessment knowledge in three main dimensions: what to assess, why to assess, and how to assess. In addition, this chapter highlighted teachers' assessment practice framework that subdivided into three phases: before lessons, during lessons, and after lessons. This chapter also discussed the link between knowledge and actions, and the factors in an educational context that may affect this relationship.

Chapter 5: Research Design and Methodology

5.1 Introduction

This chapter addresses the research design and the methodological approach underpinning this study. The chapter begins with a discussion of the philosophical assumptions in terms of ontology and epistemology and the paradigm of the current study. Then, the chapter highlights the rationale of the research methodology approach and the design of the study. This is followed by a justification and description of the instruments employed in this study and the conducted pilot study. In addition, the population of the study and the sampling strategy are addressed. This is followed by a description of the data collection procedure, and the analysis techniques used are provided in detail. Ethical considerations that guided the study are then highlighted, before closing with a summary of the chapter.

5.2 Research philosophical assumptions and paradigm

The term “paradigm” was first used by Tomas Kuhn (1970) in order to provide a theoretical research framework that could be shared by a community of scientists to help in examining and solving problems. A paradigm is defined as a set of philosophical assumptions, beliefs, and world views that guide the researcher’s thinking and practice regarding the research (Creswell and Plano, 2018; Willis, 2007). A paradigm is also seen as an integrated system of thinking that involves values, structures, and framework in conducting research (Collins, 1996; Neuman, 2011). In another view, some scholars such as Guba and Lincoln (2004) and Creswell (2014) describe paradigms by using the word ‘‘worldview’’, which expresses the researcher’s orientation towards things in the world. Therefore, thinking about the research paradigm helps the researcher to reflect on the research questions, the type of data he or she wants to collect, and the suitable research methods.

In order to clarify the appropriate paradigm, the researcher needs to discuss the different research philosophies regarding the 'reality'. According to Guba and Lincoln (2004), the research paradigm is informed by philosophical assumptions such as ontology, epistemology, and methodology; the difference among these philosophical assumptions is how they view the truth and nature of reality. Thus, these philosophical perspectives guide the researchers' view towards reality, which strongly influences the way the researcher investigates the phenomenon being studied.

Based on philosophical foundations, various paradigms have been raised during the past century in social science research. In this manner, Guba and Lincoln (2004) recognise four major paradigms of thinking about research philosophy: positivism, post-positivism, critical theory, and interpretivism/constructivism. That being said, the most popular paradigms to be used in social sciences research specifically could be classified into four other categories, namely post-positivist, constructivist, transformative, and pragmatic (Creswell, 2014).

Accordingly, the variety of paradigms makes selecting the right paradigm for a study not always an easy task for the researcher to do to. In this sense, Grix (2004, p. 68) states that the role of researcher is:

> "Setting out clearly the relationship between what a researcher thinks can be researched (her ontological position) linking it to what we can know about it (her epistemological position) and how to go about acquiring it (her methodological approach)."

Considering the philosophical assumptions that influence the researcher's selection of the appropriate paradigm for the study, the following sections illustrate the current study's position regarding these assumptions

5.2.1 Ontology

Ontological assumption is a reflection of reality and its nature (Cohen et al., 2011). It could be defined as "the study of being. It is concerned with 'what is', with the nature of existence, with the structure of reality as such" (Crotty, 2015, p. 10). In social sciences, ontology answers questions like "what is the form and nature of reality? What is there that can be known about it?" (Guba and Lincoln, 2004, p. 108). Ontology is concerned with understanding the reality of phenomena and investigating facts about what exists. There are different assumptions about the nature of reality; therefore, ontology in a positivist theory paradigm emphasizes that knowledge of reality is objective, and it exists independent of human behaviour (Guba and Lincoln, 2004). On that point, Cohen et al. (2011) state that "knowledge is based on sense experience and can be advanced only by means of observation and experiment" (p. 9). Therefore, the ontological positivist researcher investigates the causes and effects or tests hypotheses by applying the same quantitative methods that are used in natural sciences research.

On the other hand, the interpretivist/constructivist researcher emphasizes that understanding a particular phenomenon is based on how individuals experience it (Bryman, 2012; Cohen et al., 2011). In other words, the ontological assumption in constructivist/interpretivist research views

the need to observe and understand the social phenomenon by looking at it through the participants' sights and feelings (Cohen et al., 2011). Listening to participants' voices means that the researcher is dealing with multiple realities (Guba and Lincoln, 2004).

The constructivist orientation believes that knowledge depends on an individual's mind; thus, different individuals may create different meanings regarding the same thing (Crotty, 2015). The reality is an output of individuals' experiences, which are constructed based on individual social action. As a result, an interpretive researcher can get different results from the observation. This means interpretive researchers also need to share the information with participants in order to construct a deeper understanding regarding the phenomena being studied.

To this end, this study seeks to explore teachers' knowledge of assessment and to understand how they use this knowledge in practice; the ontological stance of this study is interpretivist/constructivist. To explain the rationale behind my choice, I should say that ontological constructivism provides the researcher with the ability to access teachers' cognitive processes by observing and listening to teachers' expressions. In addition, I believe that teachers' knowledge about assessment is not a definite object, since every teacher has his/her own way to manipulate and construct their knowledge. Hence, even having identical circumstances does not always result in similar knowledge for all teachers. That means the researcher is dealing with multiple realities based on teachers' responses, views, or justifications, as well as understanding and interpreting these responses. Therefore, the important role of the researcher is to interpret what was read and felt from participants' words and actions. In that respect, creating meaning is possible through the interpretation of realities from the teachers we are studying

5.2.2 Epistemology

Epistemology concerns the basis of knowledge by explaining 'how we know what we know' (Crotty, 2015, p. 3). Epistemological assumptions are concerned with questions about what type of knowledge we can acquire and how we become a knower (Guba and Lincoln, 2004). Objectivist epistemology views the knowledge of reality as facts that exist apart from the operation of the consciousness, which could be tested by gathering only quantitative data (Crotty, 2015; Bryman, 2012).

In contrast, epistemology in an interpretivist/constructivist theory paradigm believes in investigating knowledge in several ways, which can result in different interpretations of the social phenomena. The followers of epistemology in a constructivist paradigm assume that knowledge is constructed by involving the self in social activities that shape individual experiences (Crotty, 2015; Creswell, 2014). In this sense, Crotty (2015, p. 11) further states that knowledge is "the

product of processes by which social actors together negotiate the meanings for actions and situations."

Epistemological perspectives focus on the social actions of people; thus, to understand realities, they cannot be studied isolated from their context (Guba and Lincoln, 2004). Based on this epistemological view, Guba and Lincoln (2004) state that interpretivist/constructivist research is objectivist where there is no objective knowledge, but a subjective interpretation of the interaction between the human and the world.

The epistemological stance of my study is social constructivism because I believe that knowledge cannot be of independent people thinking, but is constructed through the interactions between people and the social context, which shapes their experiences (Crotty, 2015). The philosophy of epistemological social constructivism regarding realities helps me to understand teachers' knowledge and practice from their point of view by giving meaning subjectively. Additionally, I believe that these realities could not be understood without being a part of the teachers' world.

5.2.3 Selecting the research paradigm

To study a social phenomenon, the researcher needs to dig deep to understand the complexity of human cognition and behaviour. On that point, this study applies a mixed method approach by combining both qualitative and quantitative strategies to address the research questions. Pragmatism emerged as a research philosophy for the mixed methods approach. This philosophy is described as a set of beliefs about ontology and epistemology that can place pragmatism in a different position than the philosophy of positivism and interpretivism (Tashakkori and Teddlie, 1998; Morgan, 2014). Morgan (2014) states that Dewey's pragmatism replaced the emphasis on ontology and epistemology with the question about human experiences. Dewey's pragmatism referred our understanding of the world to our interpretations of actions and experiences; therefore, pragmatists reject the notion that there is only absolute truth for all (Morgan, 2014). Pragmatism is a new paradigm where truth and realities could be objective and subjective; as Denzin (2012) states, pragmatism is a new way of thinking that refuses the differences between positivism and constructivism as a research approach, but focuses on social context as a sort of social action.

It could be said that the pragmatic paradigm opens up researchers' minds to apply appropriate methods that can serve the purposes of the study rather than limit the research methods to only qualitative or quantitative approaches (Tashakkori and Teddlie, 1998; Creswell, 2012, 2014). Pragmatism provides various ways for the researcher to "think about the object of our knowledge", which considers as the tools of human action where different tools result in different

action (Biesta and Burbules, 2003, p. 108). In this sense, Tashakkori and Teddlie (1998) argue that Pragmatists avoid having the researcher get involved in the concepts of truth and realties, rather than focusing on studying what they think is valuable enough to be investigated.

Accordingly, the current study aligns with pragmatists, as they give priority to the inquiries about the purpose of study in order to ensure the research methods are the best fit for the research questions (Snape and Spencer, 2003). When considering the research questions associated with the current study, pragmatism seems to provide a practical way to collect the data from teachers by using quantitative and qualitative tools. This study adopted the pragmatist approach because it provides me, as a researcher, with the freedom to use a variety of instruments from different approaches to obtain a greater understanding of social actions, instead of committing to one philosophy of reality (Creswell, 2014). An additional rationale for the adoption of a pragmatist paradigm for this study is that I believe truth could not be determinant as an absolute identity; hence, teachers' knowledge and practices could change from time to time or according to specific contexts. Moreover, I align with Dewey's viewpoint that knowledge cannot be separated from action (Morgan, 2014). Thus, this study explores teachers' practices in order to learn about how teachers are able to make use of their knowledge and put it into practice. In this sense, without adopting a pragmatist paradigm, I would not be able to investigate the realities of the positivism and interpretivism standpoints in this study. Collecting data that could be converted into numbers helped me to involve a large number of teachers and investigate their views, which could not be done by adopting an interpretivist paradigm. At the same time, interpretivist/constructivist theoretical perspectives helped me in understanding teachers' knowledge and practice by listening to the inside voices of the teachers. Indeed, involving the use of mixed methods enhances the validity of the research findings, which supports the adoption of the pragmatist paradigm.

5.3 Research methodology

Research methodology determines the researcher's selection of the methods to be used in order to accomplish the research aims (Crotty, 2015). In this sense, the research methodology must be suitable for the research in order to provide the information needed to respond to the research questions and to gain a complete exploration of the study (Cohen, Manion, and Morrison, 2011). Furthermore, the research approach used in a study depends on the researcher objects from conducting the research (Crotty, 2015). With the aim of investigating the aspects of teachers' knowledge of assessment and how teachers' practices are related to their knowledge in a mathematics context, this study was directed by the notion that understanding complex concepts such as knowledge and practices requires in-depth and rich data, which can be collected by

applying different methods (Creswell, 2014). Hence, this study employs both qualitative and quantitative approaches, which means the current study utilizes a mixed-method approach.

In the following subsections, I will explain quantitative and qualitative approaches, as well as the mixed-method approach, including the rational reasons behind the selection of such approaches.

5.3.1 Quantitative approach

The quantitative research maintains the assumptions of the positivist paradigm for creating new meanings and developing knowledge (Creswell, 2014). Quantitative research is defined by Aliaga and Gunderson (2002) as the research that is "explaining a phenomenon by collecting numerical data that are analysed using mathematically based methods in particular statistics" (cited in Muijs, 2011, p. 1). Thus, quantitative research applies methods, such as experiments and surveys, which are built upon predetermined theories (Creswell, 2014). It could be said that the main aim of quantitative research is to determine the phenomena, explore the relationship between two or more factors, and translate it into numbers (Gay, 1996).

It is clear that the quantitative approach can be used with such research questions that are concerned with describing events and collecting numerical data about these events. In this sense, the researcher who needs to adopt quantitative research is looking for "explanations and predictions that will generate to other persons and places. The intent is to establish, confirm, or validate relationships and to develop generalizations that contribute to theory" (Leedy and Ormrod, 2014, p. 102).

Muijs (2011) mentions that we could know whether the quantitative approach is the best choice for the study by looking at the types of research questions and desired data. He highlights some of these types of research questions; two of these types are as follows: 1) when research questions demand numerical answers; for example, how many mathematics teachers are there in primary schools in Saudi Arabia? 2) When the research is concerned with explaining phenomena or describing the characteristics of issues; for example, what knowledge do mathematics teachers have about classroom assessment? How do mathematics teachers practice classroom assessment in primary schools in Saudi Arabia?

The quantitative research approach is classified into three main categories: descriptive, experimental, and causal comparative (Leedy and Ormrod, 2014). In the current study, I employed the descriptive research approach, as it examines the phenomena within its real life context and seeks to explore the correlations associated with the phenomena. Therefore, the rationale for using a quantitative approach in this study is the nature of the research questions, which require

an examination of the teachers in order to describe their knowledge and practice of classroom assessment in a mathematics context. Since questionnaires are a popular method in quantitative descriptive research that provide information about the events and produce numerical data (Cohen et al., 2011), this study designed a questionnaire to gather the quantitative data that is necessary to answer the research questions.

5.3.2 Qualitative approach

The qualitative approach is described as an approach that enables the researcher to create meaning based on constructivist or participatory perspectives (Creswell, 2014). Qualitative research can also be described as a research that occurs in the natural setting of the participants (Creswell, 2014). It also has been defined by Burns and Grove (2003) as "a systematic subjective approach used to describe life experiences and situations to give them meaning" (p. 19). According to these authors, qualitative research focuses on social events that emphasize understanding and interpretation of people's experiences and feelings.

Accordingly, qualitative approach is used in research to investigate the phenomenon based on the participant's viewpoint. In order to recognize whether the qualitative approach is the best choice for the study, Creswell (2013) suggests considering the following factors: 1) the research questions are in "how" or "what" form, rather than "why"; 2) The researcher wants to focus on studying a complex situation or phenomena in depth and; 3) The researchers are concerned with investigating people in their natural situations.

There are several different methods of conducting qualitative research, including observations, case studies, and interviews, which usually provide data in non-numerical forms like words or pictures (Creswell, 2014; Dawson, 2007). These methods are supposed to meet different requirements according to the research aims and questions. In this sense, Creswell (2014) states that qualitative research uses strategies of inquiry such as narratives, phenomenologies, ethnographies, grounded theory studies, or case studies. The object of "phenomenological study" is to understand the event or situation from the participants' perceptions of experiences (Leedy and Ormrod, 2014). Based on that point, I position my study in the application of "phenomenological study", since the focus is people's interpretations of their understanding (Leedy and Ormrod, 2014).

Therefore, in regards to the rationale for using a qualitative approach to address the three research questions in this study, it is my intention to understand in depth "what" knowledge about assessment mathematics teachers have and "how" they practice assessment in their classes, along with the influence of context on teachers' knowledge and practice. The form of the

study questions, “what” and “how”, support my decision in using a qualitative methodology. The methods of collecting data in this study are through classroom observations and teachers' interviews, which were suggested as the best methods in the case of “phenomenological study” (Leedy and Ormrod, 2014).

5.3.3 Mixed-method approach

The mixed-method approach emerged in the late 1900s and has become increasingly popular in social sciences research (Teddlie and Tashakkori, 2010). Several definitions exist; for example, Jonson and Onwuegbuzie (2004) define mixed-method research as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (p. 17). Another definition by Greene, Caracelli, and Graham (1989) state that mixed-methods research is the research that is comprised of at least one quantitative method (designed to collect numbers) and one qualitative method (designed to collect words).

With the mixed-method approach to research, the researcher tends to employ strategies of inquiry that provide data in which to best understand the study (Creswell, 2014). Regarding the data collection, Creswell further states that it "also involves gathering both numeric information (e.g., on instruments) as well as text information (e.g., on interviews) so that the final database represents both quantitative and qualitative information" (Creswell, 2014, p. 18). That is, researchers not only analyse numerical data for quantitative research, but also the norm data for qualitative research, in order to gain more understanding of the social phenomenon (Jonson, Onwuegbuzie, and Turner, 2007). Applying the mixture of qualitative and quantitative methodology could be conducted in one or more phases by using a variety of methods (Creswell and Plano, 2018). For example, the researcher could collect and analyse data by distributing a survey and conducting interviews in the same study. Creswell (2014) explains that using different methods can be conducted either with equal weight of quantitative and qualitative methods or with more emphasis on one approach over the other. The weight of quantitative or qualitative methods in research is determined according to research objectives and the research nature.

It could be concluded that there are several reasons behind combining qualitative and quantitative research methods in a single study. I consider the main reason to be the benefit of having features from both approaches. The fact is that each approach or method has its weaknesses and strengths, and this combination could thus help to minimize the weaknesses of each method, as opposed to using them separately (Bryman, 1988; Jonson and Onwuegbuzie, 2004). In addition, Bryman (1988) states that quantitative and qualitative approaches could

answer the same research questions and, in this case, using different methods to address the same issue or phenomenon could provide confirmation and validity for the research results. Similarly, Tashakkori and Teddlie (1998) claim that a balanced analysis of qualitative and quantitative data helps the researcher to obtain in-depth insight into a phenomenon.

Furthermore, the concept of “triangulation” is one of the advantages of applying a mixed-method approach in this study. “Triangulation” is based on the notion that the use of one single method in a research study is not always adequate to solve the problem (Denzin, 2017). According to Greene, Caracelli, and Graham (1989), triangulation could be attained when the researcher applies more than one method to collect data, regarding the same research question, in order to obtain the convergence and corroboration of the findings. In fact, the technique of triangulation provides balanced data between the qualitative and quantitative methods, which also helps to verify and cross-check the research findings (Creswell, 2014; Denzin, 2017).

As a result, this study combined the quantitative evidence (questionnaire) and qualitative evidence (observation and semi-structured interview) because collecting a variety of types of data will help the researcher to achieve the ultimate understanding of the phenomenon under study (Creswell, 2014). Since this study deals with humans, the researcher intends to get various pictures and ideas about the study from different methods in order to explore and describe the complexity of human cognition and actions. Applying triangulation would promote the accuracy of the findings and increase the validity of conclusions, as there is no an optimal method that can alone provide 100% precise information (Kumar, 2011; Bryman, 2006; Collins et al., 2006). The research questions in this study were addressed by collecting a combination of quantitative and qualitative data; in this sense, it is likely to overcome the possible weaknesses, which could exist from applying only one method in the study. Minimising the limitations of each method will increase the confidence of the credibility level of the study findings.

5.4 Research design

According to Denzin and Lincoln (2005), the research design involves "a flexible set of guidelines that connect theoretical paradigms; first, to strategies of inquiry followed by methods of collecting empirical material" (p. 22). The research design thus consists of all the research phases to achieve the research outcome. It provides the researcher with a clear framework of how to conduct the research and get reliable and valid data for analyses and interpretation.

A large number of designs have been classified within the mixed-method approach; however, there are four major types of mixed-methods designs including triangulation, embedded, explanatory, and exploratory (Creswell, 2014). This study applies a mixed-method approach that

particularly fits a triangulation design. The reason for this decision is that the convergence model in triangulation design is presented as the best choice among mixed-method designs for when the researcher needs to compare and contrast the quantitative findings with the qualitative data in order to develop a complete understanding of the research (Creswell, 2014; Denzin, 2017). It is also suitable when the researcher seeks to confirm the validation of the research result or, in other words, to corroborate the findings from different methods regarding the same phenomenon (Creswell, 2014).

Creswell (2012) mentions that triangulation design procedures in the mixed-method approach is a one stage process in which the researcher applies the quantitative and qualitative methods in order to gather data about the same topic.

Within the triangulation mixed-method design, Creswell (2013) identifies four models: convergence, data transformation, validating quantitative data, and the multilevel model. Creswell's classification of these models is based on the timeframe of collecting, analysing, and interpreting quantitative and qualitative data with the respect of the researcher way in integrating the data. In convergence design, the researcher first is collecting quantitative and qualitative data regarding the same phenomenon. After that, the researchers analyse independently the quantitative and qualitative data. At the last stage, the researcher compares and contrasts the findings while interpreting them (Creswell, 2013).

For the current study, the process of collecting and analysing the quantitative and qualitative data was conducted separately in one phase. The questionnaire was used to collect quantitative data. The classroom observation and semi-structured interviews were used to collect qualitative data. Figure 3 has been developed to illustrate the research phases. In addition, the decision of which method will have priority in answering the research questions is an important matter for the researcher to consider. Regarding priority in mixed methods research, Creswell (2014) states that the priority decision, whether qualitative or quantitative will have equal priority or one will be greater than the other, is based on the theory that guides the research (e.g., positivism, constructivism, pragmatism). As mentioned in the previous section, this study is driven by pragmatism paradigm; thus, I utilize both quantitative and qualitative approaches equally. According to Johnson and Onwuegbuzie (2004), the equivalent status design is applied when the researcher needs various ways of looking at the research questions to understand the phenomenon being studied. The three methods in this study, questionnaire, observation, and semi-structured interview, were all used to provide balanced, mixed data to address the research questions in the study.

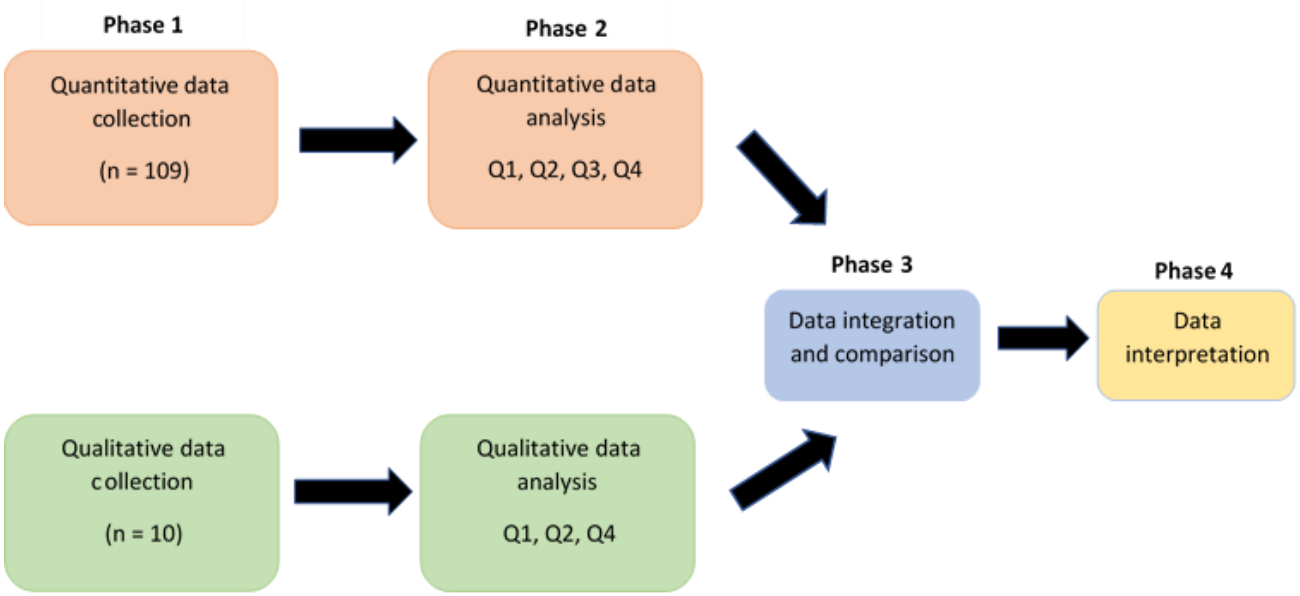

Figure 3: Research design for the study

5.5 Research questions

This study explores the knowledge of assessment that female mathematics teachers have and how these mathematics teachers practice assessment. This study also investigates the relationship between teachers' practices and their knowledge of assessment. In addition, this study focuses on the role of context in mathematics teachers' knowledge and practices of assessment. To achieve the current study objectives, the study is guided by four research questions, as follows:

1. What knowledge do mathematics teachers have about classroom assessment in Saudi Arabian primary schools?

2. How do mathematics teachers practice classroom assessment in Saudi Arabian primary schools?

3. How do mathematics teachers' practices of classroom assessment relate to their knowledge in Saudi Arabian primary schools?

4. What contextual factors influence mathematics teachers' knowledge and practices of classroom assessment in Saudi Arabian primary schools?

As mentioned in the previous section, this study applies a combination of quantitative and qualitative methods in order to answer the research questions. The methods used to investigate each research question and the data analysis are presented in the below table.

Research questions	**Methods of data collection**	**Data analysis**
What knowledge do mathematics teachers have about classroom assessment in Saudi Arabian primary schools?	A questionnaire, Semi-structured interviews	Means, Standard Deviations, Frequencies, and Percent/ Deductive and inductive thematic
How do mathematics teachers practice classroom assessment in Saudi Arabian primary schools?	A questionnaire, Observation, Semi-structured interviews	Means, Standard Deviations, Frequencies, and Percent/Deductive and inductive thematic
How do mathematics teachers' practices of classroom assessment relate to their knowledge in Saudi Arabian primary schools?	A questionnaire	Correlation
What contextual factors influence mathematics teachers' knowledge and practices of classroom assessment in Saudi Arabian primary schools?	A questionnaire, Semi-structured interviews	Means, Standard Deviations, Frequencies, and Percent/ Deductive and inductive thematic

Table 7: Research methods used for investigating the research questions and data analysis

5.6 Research instruments

The research questions of the current study are guided by the methodology, which also determines the appropriate instruments for answering these questions. The instruments employed in this study are presented in detail in the following subsections.

5.6.1 Questionnaire survey

A questionnaire is the most widely used instrument in the social sciences, as it provides quantitative descriptions of a study's participants' opinions, understandings, experiences, or

feelings about a specific topic (Babbie, 1990). Some of the major advantages of questionnaires are that they provide inexpensive and convenient results in a short amount of time, as well as allowing the researcher to collect data from a large number of participants (compared to other instruments), which helps researchers in generalising the findings of the study (Creswell, 2014).

On the other hand, questionnaires also have some disadvantages; for example, it is not possible to explain statements or answer participants' questions regarding unclear statements. Furthermore, the researcher cannot ask in-depth questions to gain a better understanding of the study (Kumar, 2011). In order to reduce questionnaire disadvantages, the current study conducted a pilot study to explore any ambiguous statements before the main study. Moreover, classroom observations and interviews were also used for this study.

The main reason for using questionnaires in this study is the lack of research in Saudi Arabia about teachers' knowledge and practices of assessment. Accordingly, this instrument helps in investigating a large sample of teachers in a short time. The large sample provides some generalisations to the findings, which may help further research in the same field.

In this study, the questionnaire was developed and used by the researcher to collect the required data to answer the research questions.

5.6.1.1 Design of the questionnaire

According to Creswell (2012), reviewing the research objectives is the starting point of designing a questionnaire. Thus, the researcher should consider the objectives of the study, and then read and understand the relevant literature to the study. Actually, the design of the questionnaire in this study went through several stages. The first stage was developing the questionnaire's items in English. The second stage was the revision of the English version of the questionnaire. The last stage was translating the questionnaire from English to Arabic. These three stages will be explained in detail, next.

Items development of the English version of the questionnaire

In this study, the questionnaire includes items to explore teachers' knowledge of assessment, teachers' practices of assessment, and the contextual factors affecting teachers' knowledge and practices of assessment. The questionnaire's items were selected to cover a broad range of these areas. Moreover, it was kept in mind to include a limited number of items in the questionnaire so as to not prevent teachers from participating in the questionnaire.

Concerning the demographic data of the participants, the first section in the questionnaire asked the participants to indicate their professional specialisation, highest qualification, kind of

qualification, years of experience teaching mathematics, and assessment training in the last three years.

In order to determine a suitable survey instrument for teachers' knowledge of assessment, a number of related studies were reviewed, such as Plake and Impara's (1993) study that designed a multiple-choice questionnaire for teacher assessment literacy. The questionnaire measures teachers' understanding of the concept of the educational assessment and the use of various classroom assessment methods. The second study was conducted by Zhang and Burry-Stock (2003) that measured teachers' use and skills. In this study, two scales were designed: one for measuring teachers' use of assessment, and the second being a self-perceived scale for assessing teachers' confidence in their abilities to perform classroom assessment from 1 (not at all skilled) to 5 (very skilled). Furthermore, the researcher has referred to the Teachers' Conceptions of Assessment (TCoA) Likert scale ranging from 1 to 5 which was widely used by Brown and colleagues in many studies conducted in New Zealand, Australia, Hong Kong, the Netherlands, and China. Although the previous studies examined teacher competency and understanding of classroom assessment in depth, no single instrument was found to serve the purpose of exploring teachers' knowledge of assessment. Therefore, it was decided to design a teachers' knowledge of assessment scale, which reflects the three domains of the knowledge of assessment mentioned in the conceptual framework of this study. Hence, the scale included items to explore mathematics teachers' knowledge of the purpose of assessment, the aspects of assessment, and the implementation of assessment. It should be noted that the items on the teachers' knowledge of assessment scale were developed through an extensive review of the literature.

Similarly, to determine a suitable scale for teachers' practices of assessment, the researcher reviewed the related literature. Along with the studies mentioned earlier, a number of instruments were found, which were developed to measure teachers' practices of assessment. In this sense, McMillan, Myran, and Workman (2002) designed a 34 item questionnaire to explore primary school teachers' practices in grading, types of assessments used, and the cognitive level of assessments. Another useful study was conducted by Alkharusi (2010), who developed a Likert-type scale to measure teachers' assessment practices and the use of traditional and alternative assessment; analysis of assessment results, assessment communication, assessment standards and criteria, and student-involved assessment; and non-achievement grading factors. However, none of these instruments adequately reflected the aim of exploring mathematics teachers' practices of assessment in this study. The researcher used the previous studies as a valuable source in designing a teachers' practices of assessment scale. Thus, this scale was self-designed to measure teachers' practices of assessment before lessons, during lessons, and after lessons.

In addition, the last scale in the questionnaire was used to assess the factors in the contexts that impact teachers' knowledge and practices of assessment. This scale was developed based on the theoretical framework described in the study conducted by Gavin, Iris, and Kelvin (2015).

Revision of the English version

After designing the items of the questionnaire as presented above, one open-ended question was added to the end of the questionnaire in order to provide the participants with the opportunity to add any additional information related to the study. This version of the questionnaire was reviewed by my supervisors, who provided some comments and suggestions. Based on this feedback, three items were deleted because of a repetition issue and some items were improved. The first draft of the questionnaire was given to two postgraduate students, who were mathematics teachers studying at the University of Southampton, to get their suggestions and to estimate the time needed to complete the questionnaire. The time needed was about 15 minutes, which was acceptable based on the number of items. Furthermore, my colleagues provided two suggestions: to modify some words that were unclear and to give clearer instructions on the cover page of the questionnaire.

Based on the given suggestions, another revision was done as the main changes were about improving the instructions for completing the questionnaire and changing the ambiguous words. Accordingly, the cover page of the questionnaire provided participating teachers with a general explanation of participants' privacy, the questionnaire sections, and the answer key to each item in the questionnaire.

Translating and validating the translated questionnaire

The translation process of the study's instrument from English to Arabic is a very important stage since the study will take place in the Al Ahsa region in Saudi Arabia, where Arabic is the language spoken. It is well known that the Arabic language is entirely different from English; accordingly, several steps should be conducted to make sure that the Arabic version of the questionnaire accurately reproduces the meaning of all items in the English version.

Primarily, the researcher translated the questionnaire into Arabic. The next procedure was to ensure the validity of the translation; the researcher handed out two versions of the questionnaire to two Arabic native speakers, who were Ph.D. students in education at the University of Southampton. Both students were asked to check the correctness of the translation, compare the two versions, and provide further feedback. After modifying unclear statements based on the feedback provided, the researcher sent the Arabic version of the questionnaire to a specialist in Arabic language to check the accuracy of the questionnaire's language. It should be

noted that the specialist was working in the education department in the Al Ahsa region under the supervision of the Ministry of Education. After employing the specialist's suggestions, the initial Arabic version of the questionnaire had been modified and completed. As a final step, both the Arabic and English versions were sent to a Saudi assistant professor in evaluation and assessment, who is fluent in English, in order to check the validity of the linguistic concepts. Receiving suggestions from different experts to modify the Arabic version of the questionnaire was very essential for the study to ensure that all participants understood the content of the study's instruments. The process of developing the questionnaire is presented in Figure 4.

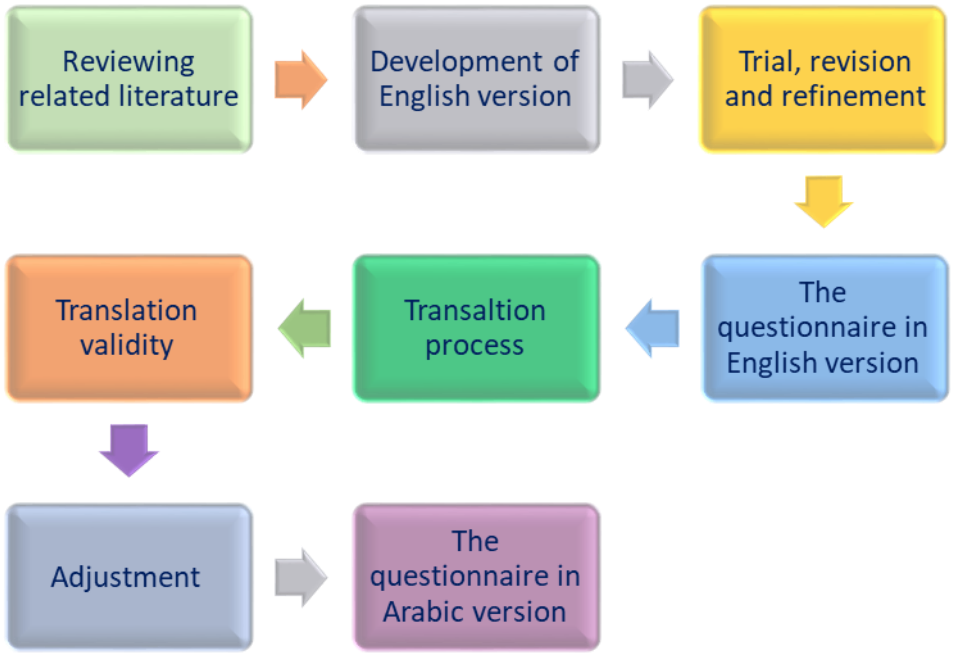

Figure 4: The process of developing the questionnaire

The selected response format

The questionnaire consists of five sections, including 61 items and one open-ended question. The first section aims to address the background of teachers and contains five items: professional specialisation, highest qualification, kind of qualification, years of experience teaching mathematics, and assessment training. The Likert scale format was used in the questionnaire as it is widely implemented in survey design, where the five-point Likert scale is the most commonly used.

Accordingly, the second section is a measurement scale, implemented to investigate teachers' knowledge of classroom assessment. This section consists of 23 items that were categorised into three parts: teacher's knowledge of the purposes of assessment, teacher's knowledge of assessment aspects, and teacher's knowledge of implementing assessment. The five-point Likert scale, strongly disagree (1), disagree (2), neutral (3), agree (4) or strongly agree (5), was utilised to evaluate participants' agreement or disagreement with the statements in this section.

The third section aims to identify teachers' practices of classroom assessment and consists of 24 items. The items in this section also were classified into three parts: teacher's practices before lessons, teacher's practices during lessons, and teacher's practices after lessons. In addition, a five-point Likert scale, never (1), seldom (2), occasionally (3), often (4) or very often (5), was used to evaluate the frequency of the participants' practice of each statement in this section.

The fourth section aims to address any barriers that teachers might face when implementing assessment in mathematics classes. This section consists of 9 items that demonstrate the challenges of assessment knowledge and practices. This section used the same five-point Likert scale that was used in section two, where items take values from 1 (strongly disagree) to 5 (strongly agree).

5.6.1.2 Validity of the questionnaire

Having validity in a questionnaire means that the questionnaire items measure what they are designed to measure (Cohen et al., 2011). This section highlights different types of validity addressed in the literature, such as face, content, criterion-related, and construct validity.

The content validity is based on the extent to which a measurement represents all facets of the specific intended domain of content (Cohen et al., 2011).

To ensure that the questionnaire led to the collection of the desired data, the content validity of the questionnaire was established by referring to the experts who could decide whether the questionnaire items reflected what was intended to be measured. Toward this end, five specialists in the field of assessment and mathematics education (see Table 8) were asked to evaluate the validity of the questionnaire's items. Experts were requested to indicate their agreement or disagreement that the items in the questionnaire measured the subject at hand. To make sure the experts had a clear vision about the study, they were provided with the research project and in-depth detail about the conceptual framework of the study. The experts were provided with the Arabic version of the questionnaire, and they were asked to write comments directly on the pilot questionnaire. The results of the content validity was checked after summarising the experts' comments. To ensure validity of the questionnaire's items, any item

remaining in the questionnaire had achieved at least four out of five of the experts' approvals. It should be noted that only one item related to teachers' practices of assessment was deleted due to the disagreement of the experts, and four items related to teachers' knowledge of assessment were paraphrased as suggested. After this final evaluation, the questionnaire was then ready to pilot with actual classroom teachers.

Position	**Specialisation**	**Degree**
Assistant Professor	Evaluation and assessment	Ph.D.
Assistant Professor	Evaluation and assessment	Ph.D.
Assistant Professor	Mathematics education	Ph.D.
Educational supervisor of mathematics	Mathematics education	Master's
Educational supervisor of mathematics	Mathematics education	Bachelor’s

Table 8: **The questionnaire content validators**

5.6.2 Classroom observation

Collecting qualitative data using observation is a very common technique in the field of education. Observation is affirmed as a systematic and powerful method that focuses on observing activities, behaviours, or events while they are in progress (Kumar, 2011). Furthermore, Kumar (2011) states that observation is a way to get initial information about individuals that cannot be obtained by questioning them. Observation is a tool to collect social data in a natural situation; as Corbetta (2003) states, the principle of observation is "gathering data on non-verbal behaviour" (p. 235), where the researcher is directly involved in collecting information about the subject of the study. Many researchers have classified observation into different types based on the degree of researcher participation in the study activities. For example, Kumar (2011) distinguishes between participant observation and non-participant observation. According to him, participant observation refers to the degree of researcher involvement in the activities of the people being studied, whether they know that they are being observed or not. In non-participant observation, the researcher does not participate in the individual or group activities but instead silently observes the situation.

Accordingly, the current study conducted non-participant observation in order to collect data about teachers' practices of assessment on a daily basis. Using observation enabled the researcher to explore and describe teachers' assessment practices, as they existed. The

observation protocol (see Appendix B) was designed by the researcher in order to aid in focusing on teachers' behaviours regarding classroom assessment practices during the observed lessons. Moreover, the observation protocol entailed taking notes while observing, which provided the researcher with guidance in making the observations more accurate. It should be noted that the protocol consists of four sections: the first and second sections are regarding general information about the school, the class, and the observed teacher; the third section is about classroom context; and the fourth section is about the proceeding lesson, focusing mainly on assessment. According to the lesson time, the observation was estimated to be approximately 45 minutes.

5.6.3 Interview

Conducting the interviews was important for gaining information from teachers face-to-face, since using only a questionnaire was insufficient for gaining an in-depth understanding of the study problem. Kumar (2011) states that an interview is a verbal interaction between the interviewer and interviewee, which is often conducted face-to-face in order to collect information or opinions from the interviewee. The interview method has recently been very widely used to collect qualitative data in social studies, since it provides the researcher with an opportunity to gather information such as ideas or beliefs that could not be gained by observation or surveys (Cohen et al., 2011). Furthermore, Corbetta (2003) defines an interview as a conversation that has special characteristics; for example, "it is elicited by the interviewer; interviewees are selected on the basis of a data gathering plan; it is guided by the interviewer; it has a cognitive objective and it is based on a flexible non-standardized pattern of questioning" (p. 285). Accordingly, the qualitative interview is not like an ordinary dialogue, since the interviewer guides the dialogue with regard to the particular topic under study.

In addition, most researchers have classified interview methods into three types: structured, unstructured, and semi-structured interviews. This classification is based on the interviewer's questions (Kumar, 2011):

- Structured interviews: Standardised interviews require the interviewer to ask the same series of predetermined questions with the same wording to all interviewees (Corbetta, 2003; Kumar, 2011). This kind of interview aims to compare interviewees' answers (Corbetta, 2003).
- Unstructured interviews: Non-directed interviews where the interviewer has the freedom to start with some point related to the topic without any need to prepare an exact question (Patton, 2002; Kumar, 2011). The aim of this kind of interview is to encourage participants to discuss a given topic in-depth (Patton, 2002).

- Semi-structured interviews: This is a flexible type of interview where the interviewer needs to cover questions that are prepared in advance; however, she/he does not have to follow the questions strictly, as they can change the questions according to the interviewees' responses (Berg, 2007). According to Corbetta (2003), in semi-structured interviews, "the interviewer is free to conduct the conversation as he thinks fit, to ask the questions he deems appropriate in the words he considers best, to give explanation and ask for clarification if the answer is not clear" (p. 207).

Accordingly, the current study used face-to-face semi-structured interviews, since this type of interview allowed the researcher to build a conversation about the study topic and probe deeply into the answers (Patton, 2002). Furthermore, the researcher could paraphrase questions as well as answer participants' questions, which encouraged them to express their ideas about the given topic (Corbetta, 2003; Berg, 2007).

Semi-structured interviews were used to ask teachers key questions related to classroom assessment in order to investigate teachers' knowledge of assessment and how they implement assessment in their classes (see Appendix D). In addition, the interview aimed to address any obstacles that teachers face while applying assessment in mathematics classes. Participants were provided in advance with a sheet of information about the study in order to help them understand the study objectives before starting the interview. The interviews with teachers were conducted face-to-face in a convenient location in their schools. It should be noted that the researcher followed up the classroom observations with the interviews in order to explore teachers' actions regarding classroom assessment. Moreover, there was audio recording during the interview process, so the researcher could collect and analyse data accurately.

5.7 Pilot study

A pilot study is known as a pre-testing of the procedure of the study. It is a mini version of the major study so, it could be said that it is a trial done in preparation for the main study (Baker, 1999; Cohen et al. 2011). Piloting can also be conducted after the researcher has a whole vision about the study in order to test all research techniques and instruments (Baker, 1999). It is a useful way to get feedback on adequacy of the research instruments and to identify any logistical issues that might occur when using the research methods (Oppenheim, 2000; Cohen et al. 2011).

The pilot study of the current study was used to identify any logical problems which might happen before conducting the major study. Furthermore, the pilot study was also conducted to check the validity and reliability of the instruments used in this study, and to determine the correct

implementation of the instruments. Given that this study used a mixed-methods approach, the piloting targeted both quantitative and qualitative methods. The procedure for the pilot study is illustrated in the next subsections.

5.7.1 Piloting the questionnaire

The participants were 16 teachers in Saudi Arabian primary schools in the academic year 2015/2016. The sample of the pilot study was a convenience sample since the participants were selected based on the convenience of the researcher. According to Cohen et al. (2011) the sample considered convenience when it is selected from people who are easy to reach. The researcher emailed the questionnaire to one of her colleagues, who is an educational supervisor, and asked her to moderate the questionnaire. This was to ensure that the items of the questionnaire were well expressed and could be fully understood by the participants. The reliability of the questionnaire's items was determined using Cronbach's Alpha test. This type of reliability test provides the internal reliability, that is, "the correlation of each item with the sum of all other items" (Cohen et al., 2011, p. 506). More specifically, the value of Cronbach's Alpha checks whether there is internal consistency among the questionnaire's items. To achieve reliability, Cronbach's Alpha value was calculated for each scale in the questionnaire. It should be noted that the value of coefficient reliability lies between 0 and 1, and some researchers suggest that the value of 0.67 and above are acceptable (Cohen et al., 2011). The three scales in the questionnaire were examined separately and the results are presented in the below table.

Scales	Cronbach's Alpha	Number of items
Knowledge of assessment	0.71	23
Practices of assessment	0.79	24
Contextual factors	0.81	9

Table 9: Reliability test of the questionnaire

It was found from the results presented in the above table that the three scales had acceptable internal consistency and could be considered as reliable. Therefore, none of the items in any of the scales were excluded.

5.7.2 Piloting the observations

The classroom observations protocol was piloted in order to test how the researcher would conduct the observations during the main study. Piloting the observations also aimed to train the researcher to be more focused on recognizing any activities related to students' assessment. The piloting was conducted by observing two mathematics classrooms in primary schools prior to the main study. After the piloting, the researcher decided not to add specific categories about assessment in the observation protocol, so that the researcher's judgment would not be influenced by these categories. The categories in the observations protocol were kept as a general guide for assessment practices that the researcher needed to explore.

5.7.3 Piloting the interviews

Piloting the interviews was conducted by interviewing two primary mathematics teachers who were also the observation participants in the pilot study. The aim of piloting the interviews was to estimate the time needed to conduct the interview, and moreover, to check the interviews' questions. The suggestions regarding the interviews were as follows:

1) Increase the interview's time from 30 to 45 minutes to provide the participant with sufficient time to express their ideas, particularly for the questions about teachers' knowledge and practices of assessment and the factors in contexts which impact teachers' knowledge and practices.

2) Along with explaining the study's objectives at the beginning of the interviews, inform the participants about semi-structured interviews as a research method, since some of participants might be not familiar with expressing their thoughts to someone else.

3) In order to get accurate data about the contextual factors, modify the following interview question, "can you tell me about the challenges you face in classroom assessment?" to become two interviews questions, as follows: "what is the impact of context on your knowledge of classroom assessment?" and, "what is the impact of context on your practice of classroom assessment?"

5.8 Description of population and sample

This section provides a description of the population of the current study and the methods employed in sampling.

5.8.1 Identification of the population

The population of a research study is a set of people, events, or objects that conform to particular standards and to which the researcher wants to generalize the research results (McMillan & Schumacher, 2010). The target population of this study was all employed female teachers who were teaching mathematics across Saudi Arabian public primary schools, in Al Ahsa educational province, during the 2015 – 2016 academic year.

Al Ahsa province was selected as the location to conduct the current study as it is the largest province in Saudi Arabia, which occupies approximately 20% of the kingdom's size (see Figure 5).

Figure 5: The location of the study

The reason for involving only female teachers in this study is because the schools in Saudi Arabia are still carrying out sex segregation (see Chapter 2), and access to male schools is unattainable for a female researcher. In addition, the teachers in this province are diverse in their years of teaching experience and educational qualifications, which could support the objective of the study. In addition, the researcher has worked for the general administration for education in Al Ahsa as an educational supervisor of the department of mathematics, and she has the intention to return to the same career after completing this degree. Thus, conducting the study in this area

would help in providing the researcher with a deeper understanding of mathematics teachers' knowledge and practice, which might contribute to improving the researcher's career. The accessible population and familiar, large area where the study was conducted were helpful in facilitating the researcher's mission to collect the required data in a short time.

Based on the information provided by the general administration for education in Al Ahsa, the sample frame for this study was 572 female mathematics teachers working in 168 primary schools (Statistic Department, 2015). It should be noted that the general administration for education in Al Ahsa comprises three education directorates: Al Hafuf city, Al Mubaraz city, and rural areas. Accordingly, the sample frame numbers were distributed according to mathematics teachers' prevalence in each of these education directorates. Table 10 illustrates the distribution of research population by location.

The educational directorates	Female mathematics teachers	Percentage of total teachers	Primary schools
Al Hafuf city	240	42%	59
Al Mubaraz city	224	39%	73
Rural areas	108	19%	36
Total	572	100%	168

Table 10: The distribution of the research population according to the education directorates

5.8.2 The sample

A sample is a subset of the population that is selected in order to investigate a phenomenon (Bryman, 2012). Cohen et al. (2011) claim that the quality of research increases not only by preparing the research methods or instruments, but also by drawing a suitable sample for the research nature. Thus, drawing a sample that represents the population fairly is an essential stage in generalising the findings of the study. Mostly, there are two main types of samples: probability and non-probability samples. In probability samples, every element in the population has an equal chance to be selected for the sample. In this sense, according to Kumar (2011), the random selection of the probability sample makes the sample more representative of the population; hence, this type of sample is substantial for the researcher who aims to generalise the findings of the study. Accordingly, for the purpose of conducting this study, a probability sample had to be drawn from the sample frame, as it was more likely to represent the whole population.

Determining a sufficient sample size is one of the challenges that the researcher must take into consideration due of the limitation of resources such as time, cost, and effort. According to Kumar (2011), the size of the sample is one of the requirements to get a merit sample, which is reliable, flexible, and represents the population of the research. However, scholars within the fields of social sciences, like Bryman (2012) and Cohen et al. (2011), state that there is no decisive answer for the question: what is the right sample size? Every study has its purposes, nature, and population. Indeed, there are a number of techniques available to help decide on an adequate size for the probability sample in quantitative research. For example, some researchers claimed that applying the sample fraction of 1:10 is considered to be a satisfactory sample size (McMillan and Schumacher, 2010). On the other hand, other researchers take into account the level of confidence and the sample errors to obtain a reliable result, so they calculate one of the reliable mathematical formulae to determine the sample size (McMillan and Schumacher, 2010).

In this study, the aim of calculating the size of the sample is to determine an adequate sample size, which can allow the study findings to be generalised for the population with an acceptable level of precision and confidence level. For the quantitative part of this study, the size of the sample was determined by calculating Yamane's (1967) formula, which is highly recognised among researchers in the field of social science. Yamane suggested a simple equation to calculate an adequate sample size for a 95% level of confidence, where the ratio of population characteristics available in the sample is 50%. Thus, the formula given below was used in the current study to determine the sample size:

$$n = \frac{N}{1 + N\left(e^2\right)}$$

Where, N is the population size and e is the level of precision.

Based on the previous equation, 85 was be the minimum number of responses needed in order to keep a 95% confidence level and a 10% precision level.

Since this study was designed to use a mixed-methods approach, the researcher considered the determination of sample size in the qualitative part of this study. According to Bryman (2012), the sample size in qualitative research should not be too small to gain the needed information or too large to conduct analysis in-depth. Qualitative research basically requires a smaller sample compared to quantitative research due to the required analysis (Creswell, 2013). Within this

respect, Creswell (2013) recommends a number between 5 and 25 as sample size to study a phenomenon using qualitative methods. Hence, the smallest accepted sample size in the qualitative part of this study was 6 teachers to be interviewed and observed.

5.8.3 Sampling methods

For the qualitative part of this study, a probability sampling method was employed. Participants were selected randomly as every teacher in the sample frame had the chance to be selected. The type of probability sampling method applied was simple-random sampling and cluster-random sampling. With the simple-random technique, every unit from the sample frame had the same chance to be included in the sample (Bryman, 2012). The cluster-random sampling technique was chosen to select schools from the three education directorates in Al Ahsa province. In this method of sampling, the population could be divided into units or groups called a cluster of sampling (Bryman, 2012). This method could be used when the sample is drawn from a population that is widely distributed geographically (Bryman, 2012; Creswell, 2013). Therefore, this type of probability sampling would suit this study since it was conducted in the largest province in Saudi Arabia, as mentioned in the previous section. In this case, the study's cluster sample was selected to represent 20% of schools in the study population. This percentage was chosen because this ratio is accepted by many researchers. Furthermore, choosing this ratio of schools was expected to achieve the minimum accepted number of responses according to Yamane's (1967) formula for sample size. To this point, the sampling method that was employed in choosing the schools was the simple random sampling method, by using a table of random numbers. A random number table was used to prevent the researcher's bias in selecting schools.

At the second stage of sampling in the quantitative part of the study, the researcher invited all mathematics teachers in the cluster sample (N= 141) to participate in the study. The number of teachers who provided their consent to participate in this study was 113. According to the discussion in the previous section, the minimum acceptable number of responses was 85. On that point, the researcher considers the number of 113 responses to be an acceptable number in the current study. The following table illustrates the distribution of the sample and the sample size.

The educational directorates	Population size	Cluster sample (schools)	Sample size (teachers)
Al Hafuf city	240	12	60
Al Mubaraz city	224	15	55
Rural areas	108	7	26
Total	572	34	141

Table 11: Distribution of mathematics teachers in the sample

For the qualitative part of the study, the researcher invited the participants from the quantitative part of the study to take part in the observations and interviews. Since the participants' information was anonymous, the researcher provided the sample schools with her contact details. Subsequently, the researcher was contacted by 10 teachers who provided their consent to participate in the qualitative part of the study. All of those teachers were observed and interviewed.

5.9 Data collection procedure

In this study, the type of collected data was both qualitative and quantitative. Accordingly, the questionnaire was used to collect data in the quantitative part of the study. Qualitative data was collected by classroom observation and semi-structured interviews, as well as the last question in the questionnaire, which was an open-ended question.

Before conducting this study, the researcher obtained the official approval for the collection of data from the University of Southampton and the Ministry of Education in Saudi Arabia. The fieldwork of this study lasted for six weeks from May 1st until June 9th, 2016. The timeline of the data collection is displayed in the table below.

<table>
<tr><th>Weeks</th><th>Quantitative data</th><th colspan="2">Qualitative data</th></tr>
<tr><td>Week 1</td><td rowspan="3">Questionnaire distribution and collection</td><td></td><td></td></tr>
<tr><td>Week 2</td><td rowspan="3">Classroom observation</td><td></td></tr>
<tr><td>Week 3</td><td></td></tr>
<tr><td>Week 4</td><td></td><td rowspan="3">Teachers' interviews</td></tr>
<tr><td>Week 5</td><td></td><td></td></tr>
<tr><td>Week 6</td><td></td><td></td></tr>
</table>

Table 12: The timeline of the data collection

5.9.1 Quantitative data collection

When the piloting process of the questionnaire was completed, the researcher distributed the final version of the questionnaire to the sample schools of the study. For confidentiality and anonymity purposes, the invitation to participate in the study and the consent form, as well as the questionnaire, were sent to all mathematics teachers in the sample schools in closed, official envelopes. Finally, after the completion of the questionnaire, the participants were asked to return completed questionnaires in the same official envelopes, which were collected from the schools by the researcher herself.

Based on the sample size of the current study, the questionnaire targeted 141 mathematics teachers within the selected primary schools; the returned questionnaires totalled 113. In addition, four questionnaires were excluded as they were returned without completing most of the items in the questionnaire. Accordingly, the total number of completed and returned questionnaires was 109.

5.9.2 Qualitative data collection

The qualitative data was collected from a sample of 10 teachers who had expressed their intention to participate in the follow-up classroom observation and interviews. In addition, the participants' responses to the optional open-ended question in the questionnaire was considered as a secondary source of qualitative data. The procedures for collecting classroom observation and semi-structured interview data are presented as follows:

5.9.2.1 Classroom observation procedure

Observation was the initial source of qualitative data that concerned the practices of assessment in mathematics classes, and how these practices might verify or dispute what teachers had indicated in the questionnaire, as well as the interviews. Once the researcher received the teachers' endorsements to participate, the consent form was provided to them together with a sheet of information about the study. The researcher observed two mathematics instructional classes for each participant, regardless of the grade levels or the content of the lessons. Accordingly, the total number of conducted observations was 20 instructional classes held throughout the second semester of the 2015/2016 academic year. The duration time for each observed class was 45 minutes, based on the school's session time in Saudi Arabia. In the field and throughout the observation, the researcher chose to sit in the back corner of the classroom, where she could see and hear and attempt to understand as much as possible about every assessment episode in the class.

Furthermore, the researcher avoided interacting with both the teacher and the students and attempted to not disturb them. She also focused on any opportunities for assessment while teachers and students were engaged in teaching and learning. As a part of the observation procedure, the researcher collected most of the documents that were related to the written comments about assessment, including teachers' written plans for lessons and students' work. The researcher also took note of the verbal interactions between teachers and students and, as an integral part of this verbal interaction, she recorded the physical actions as well, such as head movements or facial expressions.

In addition, the researcher audio recorded all observations, as well as took written field notes according to the items included in the observation schedule. Such information provided the researcher with insight into assessments in mathematics classes that were conducted in primary schools.

5.9.2.2 Semi-structured interview procedure

In this study, the semi-structured interviews were an essential source of qualitative data, since it allowed the researcher to communicate with the participants. The semi-structured interviews were conducted after the second observation for each teacher took place, so participants could reflect on their use of certain assessment practices during the observed lessons. The interviews' questions were guided by the conceptual framework of this study. In this sense, these interviews were designed to provide in-depth information about teachers' knowledge and practices of assessment, along with the potential challenges that mathematics teachers encounter regarding classroom assessment. All interviews were conducted individually at the participants' schools in a convenient room that was chosen by the participant. The range of the interviews' durations was from 35 to 45 minutes, as the duration was based on how the interviewee provided her responses. All interviews were audio recorded and manually transcribed by the researcher. Since the interviews were in Arabic, the researcher translated the transcripts from Arabic into English. The symbols (T1, T2…T10) were used in the transcription to keep participants' names anonymous, since the main aim of this study is to provide a general picture of classroom assessment. The whole process for conducting the semi-structured interviews lasted for 3 weeks (see Table 12).

During the interviews, teachers were asked in-depth questions regarding their knowledge of classroom assessment. Furthermore, to understand how teachers' practices related to their knowledge, teachers were asked questions about their practices of assessment in mathematics classes. Finally, the participants were asked questions, which investigated assessment, challenges that teachers face and the reasons behind their responses.

During each interview, the researcher was keen to encourage participants to provide in-depth responses. Thus, questions such as 'can you explain your answer?' or 'what do you mean?' were asked to participants when needed. In order to elicit both explicit and implicit information, the researcher was conscious to take in mind participants' voice tone and emphasis on words or ideas about mathematics assessment knowledge, practice, and challenges.

5.10 Data analysis procedure

After highlighting the sources of data and how the data was collected, this section illustrates the data analysis procedure. On that point, the data analysis in the current study was determined according to the nature of the research questions. The details for quantitative and qualitative data analysis are presented next.

5.10.1 Questionnaires data analysis

The quantitative data from the questionnaires were analysed in two main steps. These involved organising and analysing the data. Firstly, for organising and preparing the data, the researcher used the Statistical Package for the Social Sciences (SPSS), version 21 because it is a solid statistical program used for analysing data. Then the researcher coded the data by assigning a numeric value to every response on the questionnaire statements. For example, for the statement 'Kind of qualification', the researcher assigned the values as: Educational=1, Non-Educational= 2. The last stage for preparing the data is transferring the responses of the participants to a file in the SPSS database.

Secondly, quantitative data analysis was conducted by applying descriptive statistical techniques, such as means and standard deviations, along with frequency and percentages of participants' responses with regards to the questionnaire statements. To obtain the purpose of quantitative interpretation, central tendency measures (in this study, mean and frequency) were used to provide an overall picture of what knowledge participants had about assessment, how they practiced assessment in mathematics classes, and the role of context on participants' knowledge and practice. In addition, the spread of distribution (standard deviation) was used to show the extent to which the participants' responses are spread over the range of responses. This is because the measure of the spread of data values tells us how much the mean represents the data, as well as helping the researcher to understand the data. Furthermore, the correlations was calculated in order to investigate the relationship between knowledge and practice.

Open ended questions data analysis

There was one optional open-ended question in the questionnaire. The aim of this question was to provide the participants with the chance to write anything they thought that was related to classroom assessment. The responses were analysed qualitatively under the umbrella of inductive thematic. The inductive coding of the data shows that all responses regarding this question could be categorised in one emerged theme, which was 'the impact of context'.

5.10.2 Qualitative data analysis

The qualitative analysis was conducted to analyse data that was collected from the observations and semi-structured interviews. The analysis was carried out manually, which was useful for the researcher in order to be more familiar with the data and more focused on the analyses, by writing notes on the data transcripts.

The findings from the semi-structured interviews and non-participant observations were analysed qualitatively in two stages. In the first stage, the deductive approach was applied, and in the second stage, the inductive approach was applied.

Deductive analysis

As mentioned, the analysis was conducted manually by first going through the process of transcribing the semi-structured interviews and the observation. Then the transcript was translated from Arabic to English. During these processes, the researcher was keen to read the transcript as much as possible and take some notes regarding some of the responses. After completing the translation and transcription processes, the participants' words and sentences were highlighted for the initial coding. It should be mentioned that the researcher started the observation and interviews coding with predetermined themes from the research questions and the conceptual framework of the study (see Figure 6).

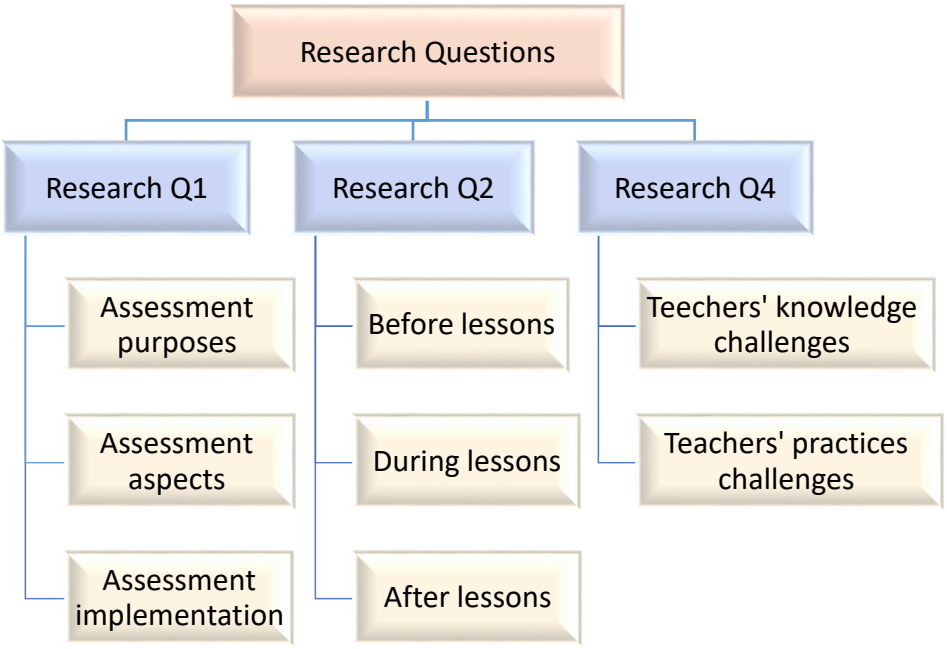

Figure 6: Predetermined themes for the analysis of the interviews

Inductive analysis

The inductive analysis was conducted in the second stage of the qualitative analysis. In this stage, the researcher referred to the transcript as a final check in order to make sure that there was not any missing words or phrases related to the study. During this reading of the transcripts, some teachers' responses about students' assessment have found to not be coded under any of the determined themes. For example, the theme 'sharing assessment criteria' has emerged from the observation data (see Chapter 7).

5.11 Validity and reliability considerations

The validity of measurements refers to "the ability of an instrument to measure what it is designed to measure" (Kumar, 2011, p.166). In order to quantify the validity of the instruments, researchers can use different criteria, including content (Pittenger, 2003; Kumar, 2011). Pittenger (2003, p. 46) states that content validity refers to "the degree to which the measurement technique samples the behaviours relevant to the construct". He further states that experts in the field should review the test content to determine its validity.

To ensure the validity of the instruments in the current study, the researcher checked the validity of the questionnaire by seeking the content validity by sending the questionnaire to five specialists in the fields of educational assessment and mathematics education. Based on the specialists' comments, amendments were made to the questionnaire. In addition, a pilot study was conducted so, the participants' responses to the questionnaire and interview questions have appraised to ensure that the questions were clear and elicited valid information.

According to Kumar (2011), reliability refers to the consistency and stability of measurement. Pittenger (2003) states that a reliable instrument produces the same results each time it is used to measure the same event. In order to measure the reliability of the questionnaire in this study, the researcher have used Cronbach's alpha test as a measure of internal consistency, since it is commonly used to check the reliability of five-point Likert scales (Cohen et al., 2011).

Whether validity and reliability can be tested is debatable for qualitative research, alternate criteria are needed (Kumar, 2011). One of these criteria is credibility, which refers to the internal validity or trustworthiness of the research results (Golafshani, 2003; Kumar, 2011). Golafshani (2003) suggests triangulation as a strategy for confirming the credibility of qualitative research. Thus, this study have employed three methods of data collection. These are a questionnaire, semi-structured interviews and classroom observation. The three instruments have promoted the validity of the findings.

Dependability is a further criterion in the assessment of the quality of qualitative research; this concept is similar to reliability in quantitative research (Kumar, 2011). To enhance the reliability of the research findings, the researcher uses an audit trail that defines as transcript descriptions of the study process from the start of the study to the finding report (Lincoln and Guba, 1985). In this sense, I have provided written descriptive details of all phases of the study, which provide me with a chance to reflect on the research process, interpretations, analysis and findings. Furthermore, my supervision team were a second party to audit the study interpretations, analytical processes, findings and conclusions in order to verify the finding of the study, which resulted in confirming the reliability of the findings.

5.12 Ethical considerations

Consideration of ethical issues is an important part of any research project that involves humans. It is essential to ensure that the research does not harm the participants. Mertens (2010, p. 12) states, "ethics in research should be an integral part of the research planning and implementation process, not viewed as an afterthought or a burden".

According to the British Psychological Society (BPS, 2010) the ethical aspects that should be considered in any research that includes human participants are the potential distress and harm to the participants, informed consent, confidentiality, and deception in any part of the research. Consequently, the current study considers several ethical issues.

Permission to conduct the study

The current research was approved by the Ethics Committee at the University of Southampton (see Appendix E). Furthermore, the researcher sought approval to conduct the study in the Al Ahsa region primary schools by sending an email to the General Directorate of Education for the AL Ahsa region. To support this request, the researcher attached the research aims, plan and instruments.

Informed consent

Informed consent refers to providing participants with adequate information about the study to ensure that they fully understand it before they participate (Pittenger, 2003). Accordingly, in the cover letter, the researcher provided information about the researcher's background and described the aims of the study and the questionnaire content. An explanation was also given to the participants about how to convey their responses to each item in the questionnaire. Further, the participants have been informed that they could withdraw by returning the unanswered questionnaire to the researcher at any point without any penalty, otherwise they could indicate their consent to participate in the study by completing the questionnaire.

As the project continues, and before conducting the observation and interviews, the researcher has provided participants with an information sheet about the study, to ensure that they fully understand the nature of the research and how they will be involved. Participants have been provided with the researcher's contact number and email address, in case the participants have questions about the study. At the beginning of the interview, participants have been informed that they have the right to withdraw from the interview and the study at any time and are under no obligation to explain their reason(s). Each teacher has been asked to sign an informed consent form that confirms she is participating voluntarily, understands the study process and is aware of personal rights.

Confidentiality

According to Mertens (2010, p. 342), confidentiality in research ensures that "the privacy of individuals will be protected, in that the data they provide will be handled and reported in such a way that they cannot be associated with them personally". The current study has confirmed in the

questionnaire cover letter that the participants' privacy has been maintained, that the questionnaire is completely anonymous and that all answers have been kept strictly confidential. Moreover, before starting the interviews, the participants have been assured that the information they provide will be treated confidentially by the researcher and her supervision team, and will be used only for research purposes.

Anonymity

Anonymity refers to the fact that "no uniquely identifying information is attached to the data and thus no one, not even the researcher, can trace the data back to the individual providing them" (Mertens, 2010, p. 342). Thus, to fulfil anonymity in this study, the researcher has not requested the participants to write their names or identify their schools. In the observations and interviews, the researcher das coded participants by letters, which means their responses have presented in the study by the given letters.

Finally, the researcher has provided participants with the contact numbers of the Head of Research Governance at the University of Southampton, to be used in case they have concerns or complains about the study or the researcher's behaviour during the study.

5.13 Summary

This chapter has presented in details the methodology employed for this study. It started with a discussion of the ontological and epistemological assumptions guiding the study. Then, the methodological stance and the instruments used. This was followed by a description of the study sample. The procedure of the data collection was then provided in details. The analysis of quantitative and qualitative data carried out in the study were then explained. Then the validity and reliability of the study were discussed and the ethical considerations.

Chapter 6: Quantitative Data Analysis Results

6.1 Introduction

This chapter reports the results of the data collected from the questionnaire. One hundred and nine mathematics teachers responded to the questionnaire, gathering the required data to answer the four questions of the study. The chapter begins with a presentation of the demographic information and background of the questionnaire's participants. Then this chapter provides an interpretation of the mean scores. Moreover, the chapter presents the analysis of the first scale in the questionnaire regarding teachers' knowledge of assessment, and it consists of three sub-sections: knowledge of assessment aspects, knowledge of assessment purposes, and knowledge of assessment implementation. The following section presents the analysis of the second scale in the questionnaire regarding the teachers' practices of assessment, and it consists of three sub-sections: assessment practices before lessons, assessment practices during lessons, and assessment practices after lessons. Then this chapter presents the analysis of the relationship between teachers' knowledge and practices of assessment. Furthermore, the chapter presents the analysis of the third scale in the questionnaire, the factors that affect teachers' knowledge and practices of assessment. The last section in this chapter summarises the chapter as a whole.

6.2 Demographic information

This section reflects the data collected about the participants' backgrounds. The data is presented based on the following demographic characteristics: participant's professional specialisation, the highest level of obtained qualification, the kind of qualification, the number of years of teaching mathematics, and the number of assessment trainings within the last three years.

6.2.1 Professional specialisation

The results of the questionnaire showed that of the teachers participating in this study, 68.8% (N= 75) were specialised in teaching mathematics; therefore, 31.2% (N= 34) of the participants were specialised in different majors. The following Table 13 represents the participants' professional specialisations.

Professional specialisation	Frequency	Percentage
Mathematics	75	68.8 %
Others	34	31.2 %
Total	109	100 %

Table 13: Descriptive statistics for participants' professional specialisation

6.2.2 Qualifications

The participants were asked to state the highest level of degree they had attained. The data showed that the majority of teachers, 89% (N= 97), had obtained a bachelor's degree. The second group of teachers, about 9 % (N= 10), had obtained a diploma. The remaining participants, 1.8% (N= 2), stated that they had attained a master's degree. The results of participants' qualifications are presented in table 14.

Highest qualification	Frequency	Percentage
Diploma	10	9.2 %
Bachelor's degree	97	89 %
Master's degree	2	1.8 %
Total	109	100 %

Table 14: Descriptive statistics for participants' qualifications

6.2.3 Kind of qualification

The participants were required to state whether they obtained a degree in education. The data showed that the majority of participants in this study, 90.8% (N= 99), had educational qualifications. However, the remaining group of participants, 9.2% (N= 10), stated that they did not have educational qualifications. The following Table 15 represents the kind of participants' qualifications.

Kind of qualification	Frequency	Percentage
Educational	99	90.8 %
Non-Educational	10	9.2 %
Total	109	100 %

Table 15: Descriptive statistics for kind of participants' qualification

6.2.4 Teaching experience

The participants' responses regarding the number of years of teaching experience they had revealed that the majority of participants, 35.8% (N= 39), had teaching experience ranging from six to ten years. The second group of participants, 28.4% (N= 31), indicated that they had teaching experience ranging from one to five years. The third group of participants, 17.4% (N= 19), had teaching experience ranging from 16 to 20 years. The fourth group of participants, 11.9% (N= 13), indicated that they had teaching experience ranging from 11 to 15 years. The fifth group of participants, 4.6% (N= 5), had teaching experience of more than 20 years, while the last group of participants, 1.8% (N= 2), stated that they had less than one year of teaching experience. The results of participants' teaching years of experience are presented in Table 16.

Years of teaching mathematics experience	**Frequency**	**Percentage**
Less than 1 year	2	1.8 %
1 to 5 years	31	28.4 %
6 to 10 years	39	35.8 %
11 to 15 years	13	11.9 %
16 to 20 years	19	17.4 %
More than 20 years	5	4.6 %
Total	109	100 %

Table 16: Descriptive statistics for participants' teaching years of experience

6.2.5 Assessment training

The participants were requested to state if they had received classroom assessment training within the last three years. The data showed that 38.5% (N= 42) of participants had taken more than one training program or workshop in assessment. The second group of participants, 33% (N= 36), indicated that they had only received one training program or workshop in assessment. However, 28.4% (N=31) of participants had not taken any training programs in assessment. The results of participants' assessment training are presented in Table 17.

Assessment training received in the last three years	Frequency	Percentage
no training	31	28.4 %
one training program/workshop	36	33.0 %
more than one training program/workshop	42	38.5 %
Total	109	100 %

Table 17: Descriptive statistics for participants' assessment training

6.3 Mean scores

The mean values are calculated of each item and scale of the questionnaire. The range of the mean scores is (R= 4). This range has been divided by the number of choices in each scale (n=5). Hence, five categories are identified to interpret the mean scores as follows:

1 to 1.80 : very low

1.81 to 2.60 : low

2.61 to 3.40 : modest

3.41 to 4.20 : high

4.21 to 5 is : very high

6.4 Analysis of classroom assessment knowledge scale

In response to the first research question, “what knowledge do mathematics teachers have about classroom assessment in Saudi Arabian primary schools?”, the researcher used descriptive statistics to calculate frequencies, percentages, means, and standard deviations of participants' responses on assessment knowledge sections of the questionnaire. The items in this section were listed under the following sub-sections, which are attributed to these knowledge of assessment domains: assessment aspects knowledge, assessment purposes knowledge, and assessment implementation knowledge. Table 18 shows the mean and standard deviation values of teachers' knowledge of assessment over all sub-sections.

Sub-sections	Average mean	Average Std. Devi.
Knowledge of assessment aspects	3.33	0.84
Knowledge of assessment purposes	3.25	1.02
Knowledge of assessment implementation	3.15	1.02
Average	3.24	0.96

Table 18: Mean of the overall teachers' knowledge of assessment sub-sections

From the data presented in the above table, the mean value of the participants' responses in the three sub-sections was between 3 and 4 on a Likert five point scale. This result demonstrated that mathematics teachers generally have a fair knowledge regarding the three domains of classroom assessment. The result also showed that the teachers' knowledge of assessment aspect had the highest average (M = 3.33) and the lowest standard deviation (SD = 0.84) among the three sub-sections of the assessment knowledge scale. On the other hand, knowledge of how to implement assessment had the smallest average (M = 3.15) among the three sub-sections with a standard deviation of (SD = 1.02). It is clear that there was not a major difference in the mean values among the three sub-sections (see Figure 7).

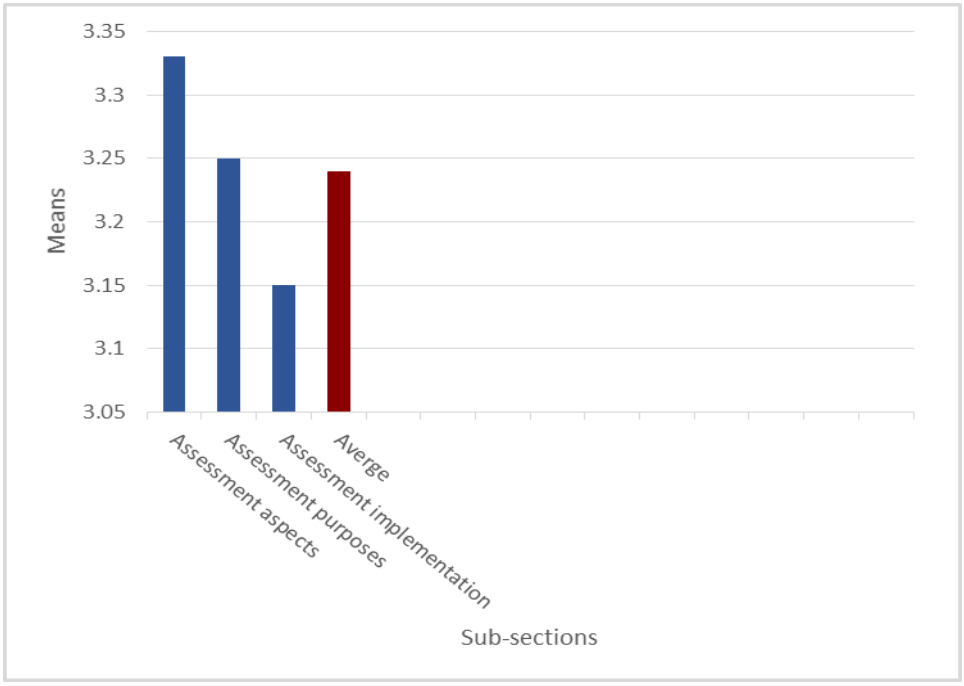

Figure 7: Means of teachers' knowledge of assessment sub-sections

The analysis results of the sub-sections of the teachers' assessment knowledge scale are presented in the next sections with details item by item.

6.4.1 Descriptive analysis of the knowledge of assessment aspects

The knowledge of assessment aspects scale consists of three items that aim to measure teachers' knowledge of what aspects should be assessed in mathematics. The descriptive statistical analysis presented in Table 19 shows frequencies, percentages, means, and standard deviations of the participants' levels of agreement regarding the knowledge they had in relation to the aspects of assessment.

From Table 19 it could be noticed that the mean value of mathematics teachers' agreement on this scale items is (M = 3.33) and the standard deviation is (SD = 0.84), which reflects a moderate awareness of the aspects of assessment.

Items	Frequency and Percent					Mean	Std. Devi.
	SD	D	U	A	SA		
6. I know what levels of mathematics knowledge to be assessed	4	10	43	44	8	3.39	0.89
	3.7%	9.2%	39.4%	40.4%	7.3%		
7. I know what students' traits to be assessed in mathematics	4	11	49	41	4	3.28	0.82
	3.7%	10.1%	45%	37.6%	3.7%		
8. It is important to assess student motivation/interest toward mathematics from time to time	5	7	47	49	1	3.31	0.80
	4.6%	6.4%	43.1%	45%	0.9%		
Average						3.33	0.84

Note: (SA)= Strongly agree; (A)= Agree; (U)= Neutral; (D)= Disagree; (SD)= Strongly disagree

Table 19: Frequency, percent, mean, and Std. deviation of teachers' knowledge of assessment aspects

From the table, it could be noted that a number of respondents, 47.7% (N=52) (with 40.4% of participants agreeing and 7.3% strongly agreeing), were found to agree that they know varied levels of mathematics should be assessed in their classes. This item achieved the highest value mean of 3.39 and it had the greatest level of variance (SD=.89), which demonstrated a wide range of responses on this item.

It appears from the above table that 45% (N = 49) of participants could not decide if they knew which student traits needed to be assessed in mathematics; this item had a mean of 3.28 (SD = 0.82), which indicated the lowest average score in this sub-scale. That being said, about 41% (N = 45) of participants agreed or strongly agreed that they knew the types of characteristics that should be assessed in mathematics.

In addition, the participants were asked about the importance of assessing affective aspects, and the results showed that about 46% of respondents (with 45% of participants agreeing and 0.9% strongly agreeing) were found to agree that it is important to assess students' motivation to learn mathematics, while about 43% (N = 47) of respondents neither agreed nor disagreed in response to this item. Moreover, this item (SD = 0.80) had the minimal level of variation in this sub-scale.

Figure 8 illustrates the mean values of the three items on aspects of assessment sub-scale. It could be recognised that although item 6 ("I know what levels of mathematics knowledge to be assessed") had the highest mean value, there was not a significant difference in the mean values of the items on this sub-scale

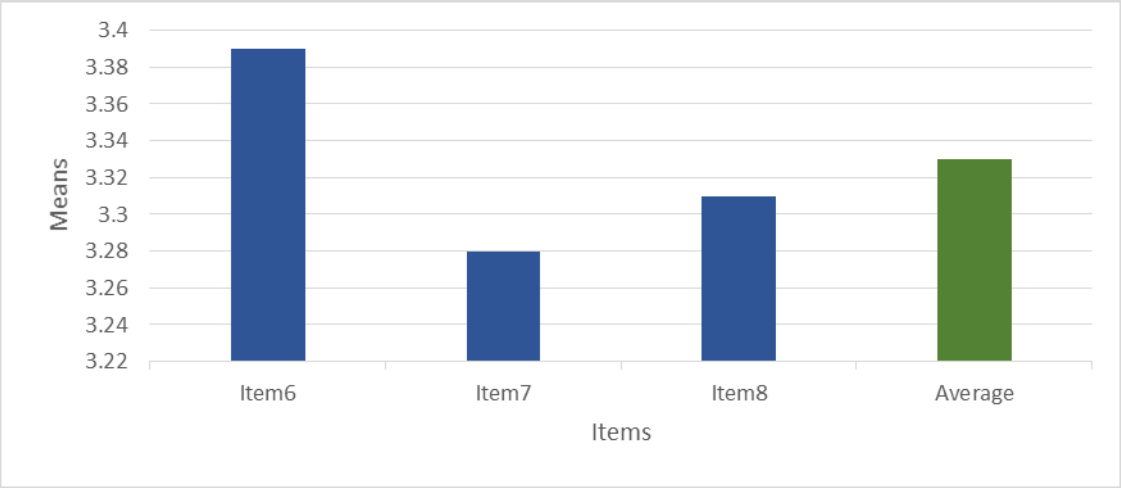

Figure 8: Means of teachers' knowledge of assessment aspects

6.4.2 Descriptive analysis of the knowledge of assessment purposes

The knowledge of assessment purposes scale consists of seven items measuring teachers' knowledge of why assessment should be conducted. Table 20 shows the frequencies, percentages, means, and standard deviations of participants' responses to the items of this scale.

It could be noticed from the table below that the mean value of the participants' agreement on the items is (M =3.25) and the standard deviation is (SD = 1.02), which demonstrates a medium level of awareness about the aspects of assessment.

Items	Frequency and Percent					Mean	Std. Devi.
	SD	D	U	A	SA		
9. Assessment can help improve student learning	14	16	29	47	3	3.08	1.10
	12.8%	14.7%	26.6%	43.1%	2.8%		
10. Assessment should focus only on preparing students for tests	21	30	36	17	5	3.41	1.11
	19.3%	27.5%	33%	15.6%	4.6%		
11. I know the purpose of formative assessment	7	15	55	13	19	3.20	1.09
	6.4%	13.8%	50.5%	11.9%	17.4%		
12. I know the purpose of summative assessment	3	5	13	57	31	3.99	0.92
	2.8%	4.6%	11.9%	52.3%	28.4%		
13. Assessment helps me identify my students' strengths and weaknesses	9	10	38	47	5	3.27	0.99
	8.3%	9.2%	34.9%	43.1%	4.6%		
14. Assessment can improve teaching	18	38	21	30	2	2.63	1.11
	16.5%	34.9%	19.3%	27.5%	1.8%		
15. Assessment should help students to reflect on their learning	9	5	55	40	0	3.16	0.85
	8.3%	4.6%	50.5%	36.7%	0.0%		
Average						3.25	1.02

Note: (SA)= Strongly agree; (A)= Agree; (U)= Neutral; (D)= Disagree; (SD)= Strongly disagree

Table 20: Frequency, percent, mean, and Std. deviation of teachers' knowledge of assessment purpose

The results in Table 20 show that more than 45% (N=50) of the respondents (with 43.1% of participants agreeing and 2.8% strongly agreeing) were found to agree that assessment could help in improving students learning. Relatedly, approximately 47% (N=51) of respondents (with 27.5% of participants disagreeing and 19.3% strongly disagreeing) were found to disagree that

assessment should focus only on testing students. On the other hand, 33% (N=36) of participants reported they neither agreed nor disagreed with this item.

When participants were asked if they knew about formative assessment about 50% (N= 55) of participants reported they neither agreed nor disagreed on this item. Moreover, the same percentage has been scored regarding the item, "assessment should help students to reflect on their learning". It is clear that this item has received the smallest standard deviation (SD= 0.85) among the items in this scale, which indicated a narrow range of participants' responses.

In addition, the results showed that a total of 47.7% (N= 52) (with 43.1% of participants agreeing and 4.6% strongly agreeing) of respondents were found to agree on the item, "assessment helps me identify my students' strengths and weaknesses". With regard to summative assessment, more than 80% (N= 88) of participants reported they either agreed or strongly agreed that they knew the purpose of using summative assessment. It is clear that this item received a mean of 3.99, which reflects the highest result in this sub-section.

The results also showed that the majority of respondents, 51% (N=56) (with 34.9% of participants disagreeing and 16.5% strongly disagreeing), were found to disagree on the item "assessment can improve teaching", with the lowest average score of 2.63. Moreover, this item (SD= 1.11) showed the greatest variation in teachers' responses. Figure 9 shows the mean values of the seven items on this scale. It could be noticed that item 12, "I know the purpose of summative assessment", is the most evident item in the knowledge of assessment purposes scale.

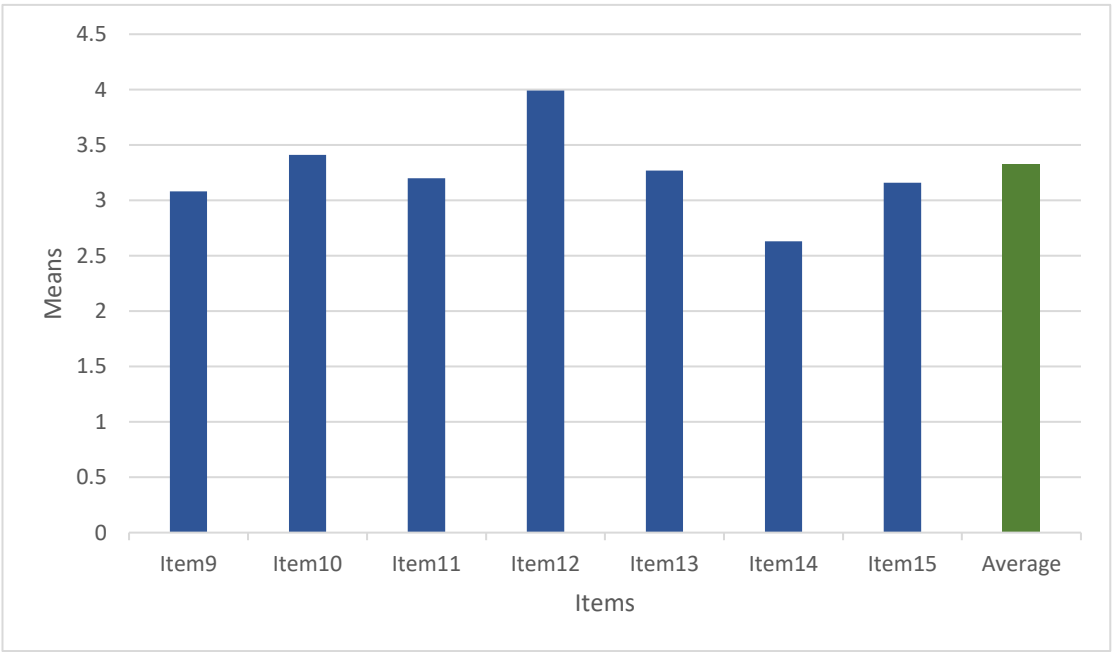

Figure 9: Means of teachers' knowledge of assessment purposes

6.4.3 Descriptive analysis of the Knowledge of assessment implementation

The knowledge of assessment implementation scale consists of 13 items measuring teachers' knowledge of how assessment should be conducted. The descriptive statistical analysis presented in Table 21 shows frequencies, percentages, means, and standard deviations of the participants' level of agreement about their knowledge of how to apply assessment.

From the table below, the mean value of the participants agreement on the items is (M= 3.15) and the standard deviation is (SD = 1.02), which shows a modest level of the knowledge about how to apply assessment.

Items	Frequency and Percent					Mean	Std. Devi.
	SD	D	U	A	SA		
16. I know the difference between traditional and alternative assessment methods	12	23	50	13	11	2.89	1.08
	11%	21.1%	45.9%	11.9%	10.1%		
17. I know how to assess student higher order thinking skills	11	16	30	38	14	3.26	1.17
	10.1%	14.7%	27.5%	34.9%	12.8%		
18. I know how to assess students using different methods of assessment	21	39	18	27	4	2.58	1.17
	19.3%	35.8%	16.5%	24.8%	3.7%		
19. I know how to let students assessing themselves	20	29	35	22	3	2.62	1.09
	18.3%	26.6%	32.1%	20.2%	2.8%		
20. I know how to let students assessing their peers	1	1	24	52	31	4.02	0.80
	1.9%	1.9%	22%	47.7%	28.4%		
21. I know how to benefit from portfolios in assessing students' progress	12	16	60	15	6	2.88	0.97
	11%	14.7%	55%	13.8%	5.5%		
22. I know how to assess my students using group projects	35	42	8	15	9	2.28	1.28
	32.1%	38.5%	7.3%	13.8%	8.3%		
23. I know how to benefit from classroom discussion in assessing students learning	4	6	19	55	25	3.83	0.97
	3.7%	5.5%	17.4%	50.5%	22.9%		

24. I know how to assess my students using classroom observation	2	6	15	53	33	4	0.91
	1.8%	5.5%	13.8%	48.6%	30.3%		
25. I know how to benefit from students' results in teaching	4	5	69	26	5	3.12	0.76
	3.7%	4.6%	63.3%	23.9%	4.6%		
26. I know how to give my students sufficient feedback	5	16	26	44	18	3.5	1.08
	4.6%	14.7%	23.9%	40.4%	16.5%		
27. I know how to interpret qualitative information collected from assessment	35	38	27	3	6	2.15	1.08
	32.1%	34.9%	24.8%	2.8%	5.5%		
28. I know how to interpret quantitative information collected from assessment	2	6	23	54	24	3.84	0.89
	1.8%	5.5%	21.1%	49.5%	22%		
Average						3.15	1.02

Note: (SA)= Strongly agree; (A)= Agree; (U)= Neutral; (D)= Disagree; (SD)= Strongly disagree

Table 21: Frequency, percent, mean, and Std. deviation of teachers' knowledge of assessment implementation

By looking at the results presented in the previous table, it could be noticed that about half of participants, 50% (N=50), responded that they neither agreed nor disagreed that they knew the difference between traditional and alternative assessment. Moreover, more than half of participants, 55% (N= 60), neither agreed nor disagreed that they knew how to use portfolios in assessing students.

While the results revealed that about 48% (N= 52) of respondents (with 31.2% of participants agreeing and 29.4% strongly agreeing) were found to agree that they knew how to assess students' higher order skills, the results also showed that 55% (N= 60) of respondents (with 35.8% of participants disagreeing and 19.3% strongly disagreeing) were found to disagree that they had knowledge of how to assess students using different methods of assessment.

In addition, about 45% (N=49) of respondents (with 26.6% of participants disagreeing and 18.3% strongly disagreeing) were found to disagree that they had knowledge about using students' self-assessment. The results revealed that the item, "knowing about peer assessment" had received

the highest mean of 4.02, since 76% (N=83) of participants showed their agreement on this item (with 47.7% of participants agreeing and 28.4% strongly agreeing).

On the other hand, the majority of respondents, about 71% (N=77) (with 38.5% of participants disagreeing and 32.1% strongly disagreeing), were found to disagree that they had knowledge of how to assess group projects. It was noticed that this item had the greatest variation (SD=1.28), which indicated a wide range of responses.

The results showed that participants felt they generally had knowledge of assessing students using classroom discussions (74% (N=80) agreed) and with assessing student using classroom observation (79% (N=86) agreed).

It should be noted that about 63% (N=69) of participants were undecided in whether they agreed or disagreed that they knew how to benefit from students' results in their teaching, with standard deviation of 0.759, which revealed a minimal range of responses.

Regarding analysing assessment data, about 57% (N=62) of respondents (with 40.4% of participants agreeing and 16.5% strongly agreeing) were found to agree on the item, "I know how to give my students sufficient feedback". The majority of respondents, 67% (N=73) (with 34.9% of participants disagreeing and 32.1% strongly disagreeing), were found to disagree on the item "I know how to interpret qualitative information collected from assessment". This item had the lowest average score of 2.15.

On the other hand, some participants (N= 78) also felt that they generally had knowledge about how to interpret quantitative information collected from assessment, with a high agreement rate of 72%. Figure 10 illustrates the mean values of the 13 items on this scale. It could be noticed that item 20, "I know how to let students assessing their peers", and item 24, "I know how to assess my students using classroom observation", are the most apparent items in the knowledge of the implementation of assessment scale.

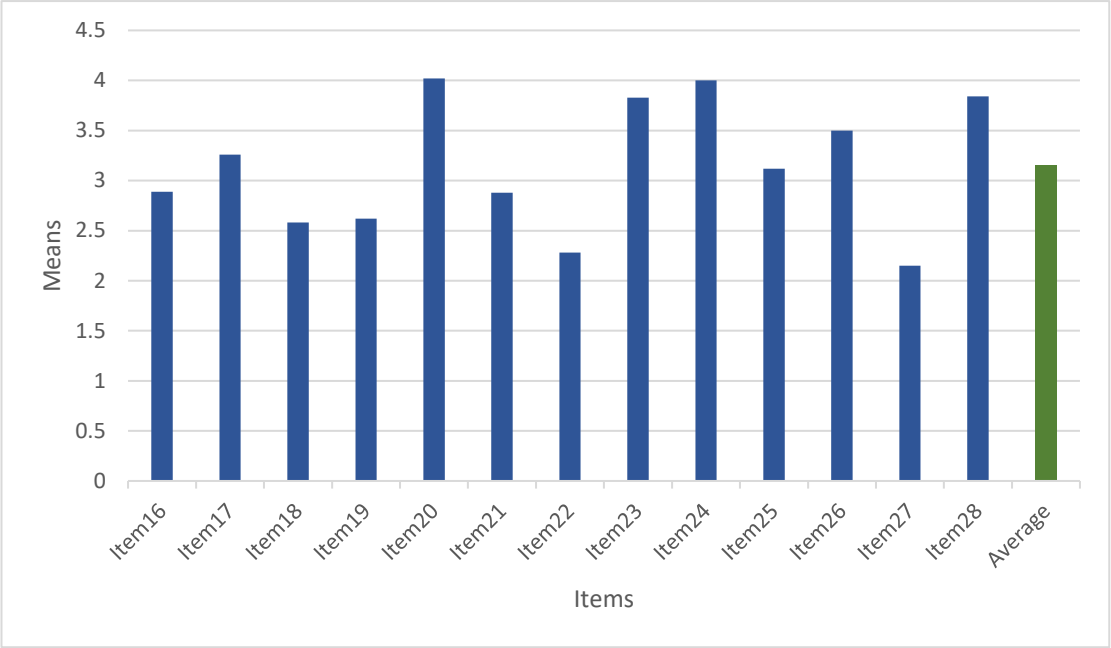

Figure 10: Means of teachers' knowledge of the implementation of assessment

6.5 Analysis of assessment practices scale

In response to the second research question, "how do mathematics teachers practice classroom assessment in Saudi Arabian primary schools?", the researcher used descriptive statistics to calculate frequencies, percentages, means, and standard deviations of participants' responses on the practices of assessment sections of the questionnaire. The items in this section have been listed under the following sub-sections, which are attributed to theses phases of practicing classroom assessment: assessment before lessons, assessment during lessons, and assessment after lessons. Table 22 shows the average and standard deviation values of teachers' practices of assessment over all sub-sections.

Sub-sections	**Average mean**	**Average Std. Devi.**
Practice assessment before lessons	3.36	1.10
Practice assessment during lessons	3.37	1.13
Practice assessment after lessons	3.53	1.14
Average	3.42	1.12

Table 22: Mean of the overall teachers' practices of assessment sub-sections

The data presented in the above table shows that teachers' practices of assessment during lessons achieved the highest average of 3.37 among the sub-sections. On the other hand, practices assessment before lessons had the smallest average of 3.36 among the sub-sections of practice assessment scale (see Figure 11).

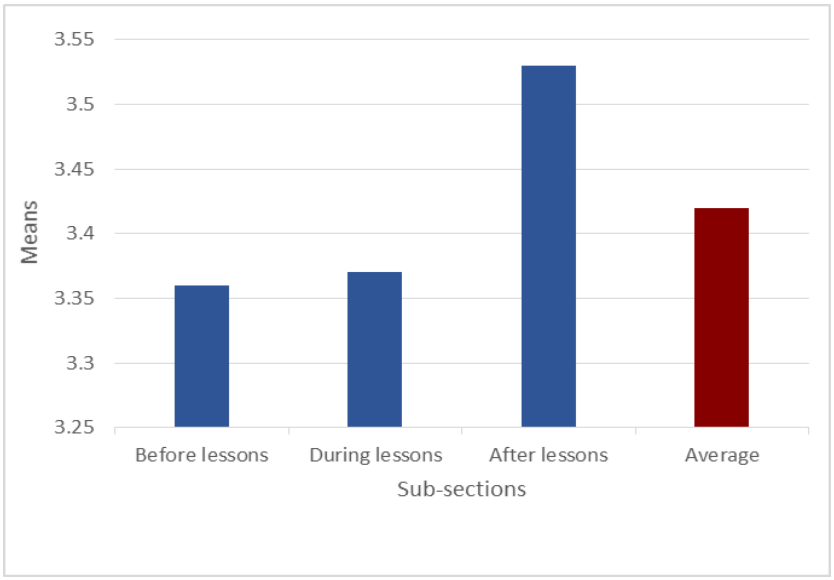

Figure 11: Means of teachers' practices of assessment sub-sections

The analysis results of assessment practices sub-sections are presented in detail next.

6.5.1 Descriptive analysis of practices of assessment before lessons

The assessment before lessons scale consists of five items concerned with determining teachers' practices of assessment before lessons. The results in Table 23 show the frequencies, percentages, means, and standard deviations of the participants' responses to the items within this scale.

It could be noticed from the table below that the mean value of the participants' agreement on the items is (M =3.36) and the standard deviation is (SD = 1.10), which indicates medium levels of practicing assessment before lessons.

Items	Frequency and Percent					Mean	Std. Devi.
	N	S	O	F	V		
29. I design/select appropriate assessment based on lesson learning objectives	7	4	41	40	17	3.51	1.02
	6.4%	3.7%	37.6%	36.7%	15.6%		
30. I estimate the time required to conduct assessment activities	3	2	35	38	31	3.84	0.95
	2.8%	1.8%	32.1%	34.9%	28.4%		
31. I use homework to identify students' learning strengths and learning weaknesses	7	9	27	32	34	3.71	1.18
	6.4%	8.3%	24.8%	29.4%	31.2%		
32. I create a written assessment plan	9	13	27	33	27	3.51	1.22
	8.3%	11.9%	24.8%	30.3%	24.8%		
33. I plan for assessment based on students' needs	33	40	21	10	5	2.21	1.11
	30.3%	36.7%	19.3%	9.2%	4.6%		
Average						3.36	1.10

Note: (N)= Never; (S)= Seldom; (O)= Occasionally; (F)= Often; (V) = Very often

Table 23: Frequency, percent, mean, and Std. deviation of teachers' assessment practices before lessons

It could be realized from the data that more than half of participants, 52% (N=54) (with 36.7% of responses often and 15.6% very often), reported that they selected assessment tasks based on the objectives of lessons. In fact, the majority of participants, 63.3% (N=69) (with 34.9% of responses often and 28.4% very often), stated that they estimated the time needed to conduct assessment activities. The results also showed that this item, "estimate the time required to conduct assessment activities", ranked as the highest mean among the items on this scale at 3.84 and the smallest standard deviation at 0.95.

In addition, the results showed that about 60% (N=66) of participants (with 29.4% of participants often and 31.2% very often) indicated they used homework to identify students' learning strengths and weaknesses. Furthermore, about 55% (N=60) of participants (with 30.3% of responses often and 24.8% very often) indicated they created a written assessment plan. It is

important to note that the item, "I create a written assessment plan" received the greatest standard deviation of 1.22, reflecting a wide range of responses on this item.

The responses on the item, "I plan for assessment based on students' needs" showed the lowest average score of 2.21, since the majority of participants, 67% (N= 73) (with 36.2% of responses seldom and 30.3% never), stated that they likely did not plan for assessment based on the needs of their students.

Figure 12 illustrates the mean values of the five items on this scale. It could be noticed that item 33, "I plan for assessment based on students' needs", is the least apparent item in the practice of assessment before lessons scale.

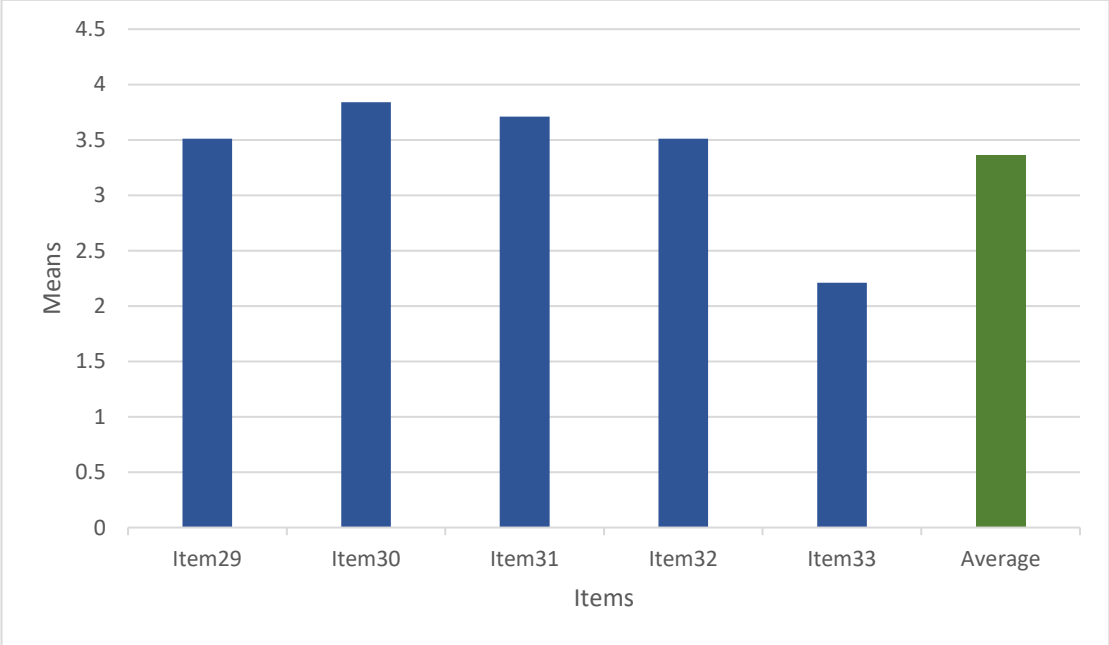

Figure 12: Means of teachers' practices of assessment before lessons

6.5.2 Descriptive analysis of practices of assessment during lessons

The assessment during lessons scale consists of 12 items measuring teachers' practices of assessment during lessons. Results in Table 24 shows the frequencies, percentages, means, and standard deviations of the participants' levels of practice of assessment during lessons.

From the table below, the mean value of the participants' agreement on the items is (M =3.37) and the standard deviation is (SD = 1.13), which reflects a modest level of practicing assessment during lessons.

Items	Frequency and Percent					Mean	Std. Devi.
	N	S	O	F	V		
34. I share lessons goals with student	24	32	21	21	11	2.66	1.30
	22%	29.4%	19.3%	19.3%	10.1%		
35. I assess students' experiences before teaching	9	4	21	26	49	3.94	1.24
	8.3%	3.7%	19.3%	23.9%	45%		
36. I ask questions that require a yes/no answer	4	10	34	34	27	3.64	1.08
	3.7%	9.2%	31.2%	31.2%	24.8%		
37. I use pen and paper tests to assess student learning	4	3	30	34	38	3.91	1.03
	3.7%	2.8%	27.5%	31.2%	34.9%		
38. I ask questions that encourage students to think	3	2	35	36	33	3.86	0.97
	2.8%	1.8%	32.1%	33%	30.3%		
39. I use student self- assessment	30	36	32	7	4	2.26	1.05
	27.5%	33%	29.4%	6.4%	3.7%		
40. I use portfolios based on lesson goals	18	22	28	21	20	3.03	1.34
	16.5%	20.2%	25.7%	19.3%	18.3%		
41. I provide students the opportunity to assess their own work with their peers	6	17	29	40	17	3.41	1.10
	5.5%	15.6%	26.6%	36.7%	15.6%		
42. I discuss the progress of group projects regularly	34	37	20	11	7	2.27	1.19
	31.2%	33.9%	18.3%	10.1%	6.4%		
43. I use classroom observation to assess students	8	9	35	36	21	3.49	1.12
	7.3%	8.3%	32.1%	33%	19.3%		
44. I offer instant feedback that helps students to know how to improve their weaknesses	6	5	23	39	36	3.86	1.10
	5.5%	4.6%	21.1%	35.8%	33%		

45. I motivate students to learn (e.g., reward, praise, etc.)	4	1	21	35	48	4.12	1.00
	3.7%	0.9%	19.3%	32.1%	44%		
Average						3.37	1.13

Note:(N)=Never; (S)= Seldom; (O)= Occasionally; (F)= Often; (V) = Very often

Table 24: Frequency, percent, mean, and Std. deviation of teachers' assessment practices during lessons

The results reported in Table 24 revealed that more than half of participants, 51% (N=56) (with 29.4% of responses seldom and 22% never), stated that they generally do not share lesson goals with students. From the table, the majority of participants, 68.9% (N=75) (with 23.9% of responses often and 45% very often), claimed they assessed students' experiences before teaching. Furthermore, a number of participants, 56.1% (N=61) (with 31.2% of responses often and 24.8% very often), indicated that they ask yes/no questions.

In addition, about 66% (N= 72) of participants (with 31.2% of responses often and 34.9% very often) stated that they assess student with pen and paper tests. The results also revealed that about 63% (N=69) of participants (with 33% of responses often and 30.3% very often) indicated that they ask questions that encourage students' thinking. It should be noted that the item, "I ask questions that encourage students to think" received the smallest standard deviation (0.97) among the items on this scale.

Approximately 60% (N=66) (with 33% of responses seldom and 27.5% never) of participants claimed they likely did not let students assess themselves during classes. This item had the lowest average score of 2.26.

Regarding the use of other assessment methods, such as portfolios, about 37% (N=41) of participants stated they often or very often use portfolios based on lesson goals. However, about the same percentage of participants, 36% (N=40), stated they never or seldom apply this tool, with the greatest standard deviation (1.34) among the items on this scale.

The responses on the item, "I provide students the opportunity to assess their own work with their peers" revealed that more than half of participants, 52% (N=57), indicated that they used peer assessment (with 36.7% of responses often and 15.6% very often). The results showed that the majority of participants, 56% (N=71), claimed they never or seldom discussed the progress of group projects.

In addition, more than half of participants, 52% (N=57) (with 33% of responses often and 19.3% very often), stated they used classroom observation to assess students. About 68% (N=75) of participants stated they provided feedback to improve students' weaknesses (with 35.8% of responses often and 33% very often). Finally, the item, "I motivate students to learn" had a mean of 4.12, which reflected the highest average score in this scale; the majority of participants, 76.1% (N=83), stated they often or very often motivate their students to learn. Figure 13 illustrates the mean values of the items on this scale.

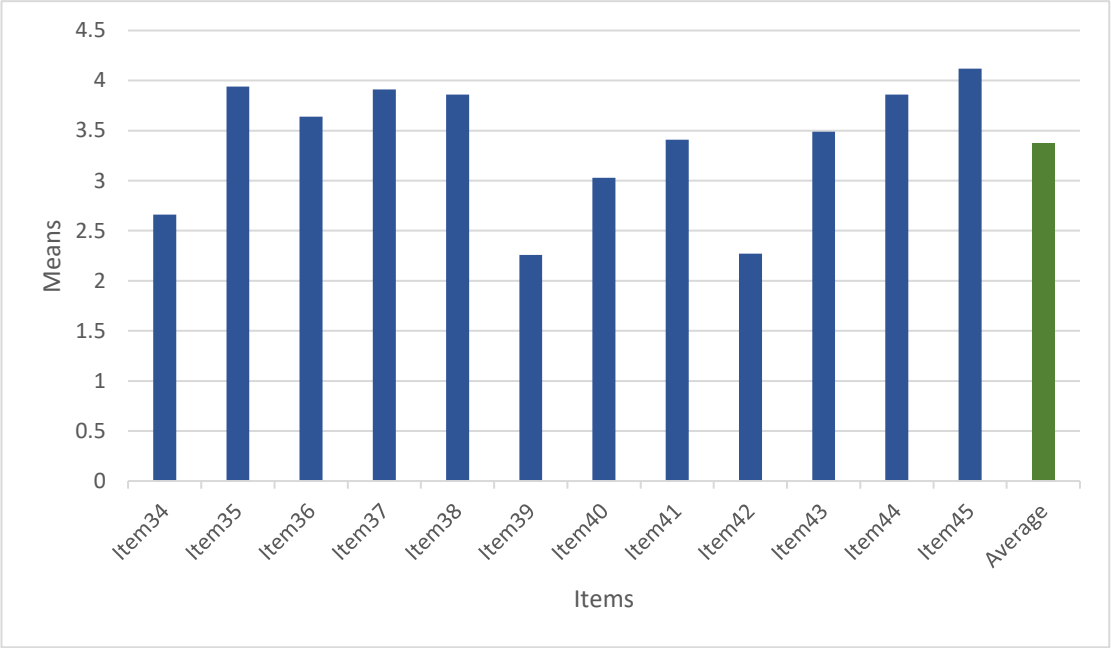

Figure 13: Means of teachers' practice of assessment during lessons

6.5.3 Descriptive analysis of practices of assessment after lessons

The assessment after lessons scale consists of seven items measuring teachers' practices of assessment after lessons. Results in Table 25 show the frequencies, percentages, means, and standard deviations of participants' level of practices of the items in this scale.

From the table below, the mean value of the participants' agreement on the items is (M =3.52) and the standard deviation is (SD = 1.14), which shows a modest level of practicing assessment after lessons.

Items	Frequency and Percent					Mean	Std. Devi.
	N	S	O	F	V		
46. I use student assessment results when planning a new lesson	19	34	17	23	16	2.84	1.34
	17.4%	31.2%	15.6%	21.1%	14.7%		
47. I use assessment results to improve daily teaching	25	30	23	17	14	2.68	1.33
	22.9%	27.5%	21.1%	15.6%	12.8%		
48.I use assessment results to improve students' daily learning	5	4	24	45	31	3.85	1.03
	4.6%	3.7%	22%	41.3%	28.4%		
49. I use assessment results to design remedial plan for students who are facing difficulties in mathematics	5	7	21	49	27	3.79	1.04
	4.6%	6.4%	19.3%	45%	24.8%		
50. I discuss assessment results with students individually	2	9	27	40	31	3.82	1.00
	1.8%	8.3%	24.8%	36.7%	28.4%		
51. I report students' assessment results to their parents	4	4	15	33	53	4.17	1.04
	3.7%	3.7%	13.8%	30.3%	48.6%		
52. I report assessment results to school leaders	8	14	33	25	29	3.49	1.22
	7.3%	12.8%	30.3%	22.9%	26.6%		
Average						3.52	1.14

Note:(N)=Never; (S)= Seldom; (O)= Occasionally; (F)= Often; (V) = Very often

Table 25: Frequency, percent, mean, and Std. deviation of teachers' assessment practices after lessons

It appears from Table 25 that about 48% (N=53) of participants (with 31.2% of responses seldom and 17.4% never) indicated they generally do not use student results when planning a new lesson. This item reserved the greatest standard deviation of 1.34.

The results also revealed that more than 50% (N=55) of participants (with 27.5% of responses seldom and 22.9% never) reported they likely did not use assessment results to improve their teaching; this yielded the lowest value mean of 2.68.

In addition, the majority of participants, about 70% (N=76) (with 45% of responses often and 24.7% very often), stated they used assessment results to improve students' learning and to design remedial plans for students facing difficulties. The results also showed that 64% (N=71) of participants (with 36.7% of responses often and 28.4% very often) indicated they discussed assessment results with students individually. This item reserved the smallest standard deviation of 1.00 in this scale.

The results showed that the item, "I report students' assessment results to their parents" reserved the highest mean of 4.17 in this scale, as more than 78% (N=86) of participants (with 30.3% of responses often and 48.6% very often) indicated they communicate with students' parents regarding their results. Finally, about 46% (N=54) of participants stated they report students' results to school leaders (with 22.9% of responses often and 26.6% very often). The mean values of the items on this scale are illustrated in Figure 14.

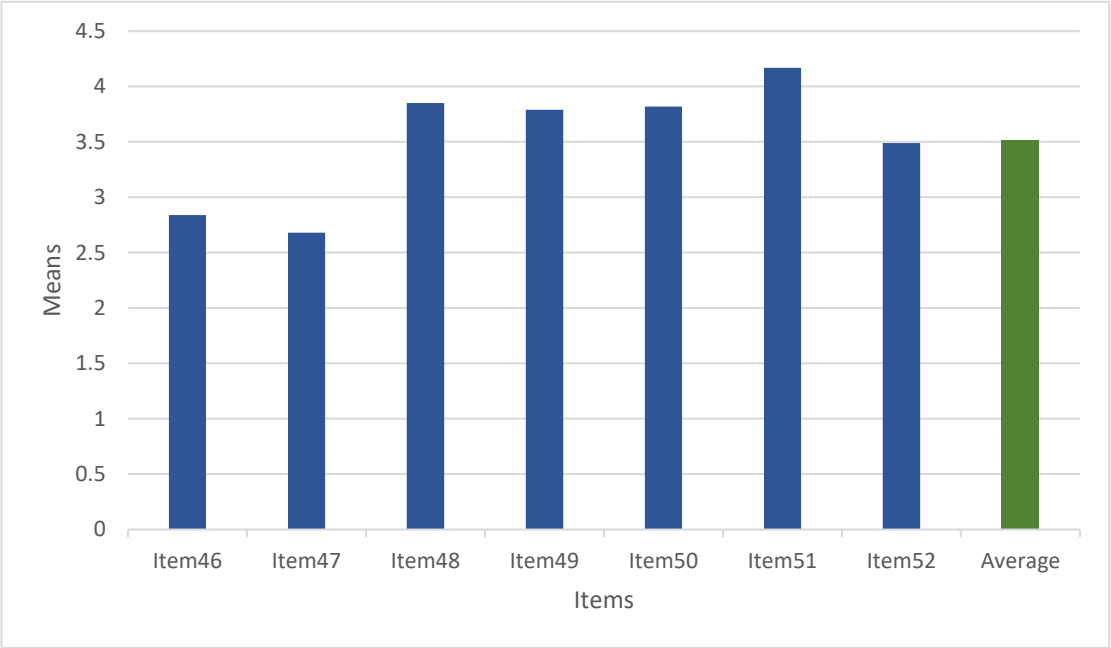

Figure 14: Means of teachers' practices of assessment after lessons

6.6 Analysis of the relationship between knowledge and practices

In order to answer the third research question, "how do mathematics teachers' practices of classroom assessment relate to their knowledge in Saudi Arabian primary schools?", this section explores the relationship between the general knowledge about assessment held by mathematics teachers and their practices.

To make sure that the data of the study could be analysed using Pearson's correlation, an assumption should be tested before running the correlation test. Failure in considering the normality of the data may result in distorting the relationship tests (Field, 2013).

Assumption: The distribution of the data is normal.

Normality of distributions can be assessed by two approaches, either graphical or statistical (Tabachnick and Fidell, 2007). The graphical method uses frequency histograms of variables to test visually whether the data looks normally distributed. As shown in Figure 15 and Figure 16, the distribution of teachers' knowledge and practices appeared to be reasonably normally distributed.

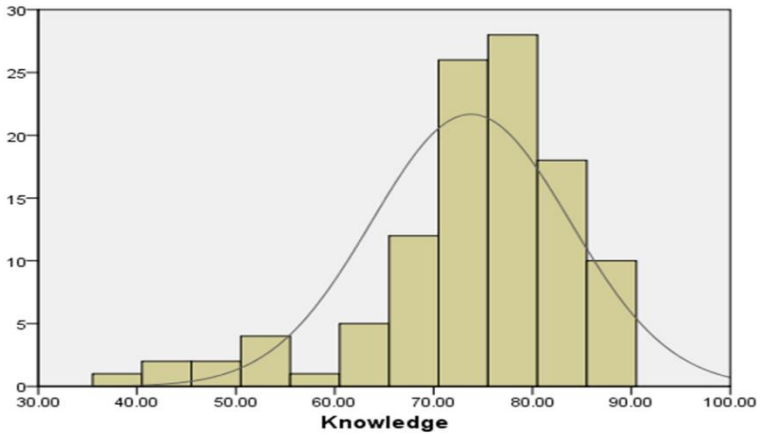

Figure 15: Distribution of Saudi primary schools mathematics teachers' level of assessment knowledge

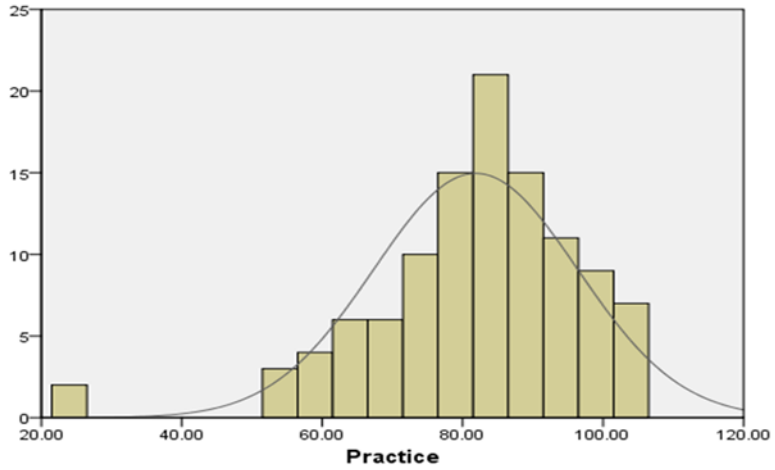

Figure 16: Distribution of Saudi primary schools mathematics teachers' level of assessment practices

In order to apply a statistical method to assess the normality of distribution, the Kolmogorov-Smirnov test is the most appropriate approach when the sample size is over 50 (Field, 2013). The results for the two independent variables were above the .05 level, which indicated the normality of the data.

Based on the result of the past assumption, conducting the Pearson Correlation Coefficient test is appropriate to explore the linear relationship between the two continuous variables in this study. In this sense, Muijs (2011) suggests the strength levels of the relationship as follows: Less than 0.1 is weak, less than 0.3 is modest, less than 0.5 is moderate, less than 0.8 is strong, and equal to or more than 0.8 is very strong. The result of the correlation is presented in Table 26.

Correlations			
		Knowledge	Practice
Knowledge	Pearson Correlation	1	.44**
	Sig. (2-tailed)		.00
	N	109	109
Practice	Pearson Correlation	.44**	1
	Sig. (2-tailed)	.00	
	N	109	109
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 26: Correlation between teachers' knowledge and practices of assessment

The values displayed in the above table demonstrated that the correlation between teachers' knowledge and teachers' practices of assessment is significant and the strength level of this relationship could be described as moderate.

6.7 Analysis of the contextual factors

In response to the fourth research question, "'what contextual factors influence mathematics teachers' knowledge and practices of classroom assessment in Saudi Arabian primary schools?" Descriptive analyses were completed to calculate frequencies, percentages, means, and standard deviations of participants' responses on nine items attributes to the factors in the contexts that may influence the knowledge and practices of assessment.

Items	Frequency and Percent					Mean	Std. Devi.
	SD	D	U	A	SA		
53. Lack of instructions from educational supervisor	26	19	34	18	12	2.73	1.30
	23.9%	17.4%	31.2%	16.5%	11%		
54. Lack of sufficient knowledge about assessment types/ methods	14	21	33	28	13	3.05	1.21
	12.8%	19.3%	30.3%	25.7%	11.9%		
55. Teachers have a lot of work to do	7	2	10	24	66	4.28	1.13
	6.4%	1.8%	9.2%	22%	60.6%		
56. Lack of training programs on assessment	2	10	32	24	41	3.84	1.09
	1.8%	9.2%	29.4%	22%	37.6%		
57. Class time is not enough time to practice assessment	5	9	21	24	50	3.96	1.19
	4.6%	8.3%	19.3%	22%	45.9%		
58. There are a lot of mathematics topics to teach	3	3	15	31	57	4.25	0.99
	2.8%	2.8%	13.8%	28.4%	52.3%		
59. There are a large number of students in classroom	7	6	12	27	57	4.11	1.20
	6.4%	5.5%	11%	24.8%	52.3%		
60. Parents only trust pen and paper tests	3	8	17	30	51	4.08	1.08
	2.8%	7.3%	15.6%	27.5%	46.8%		
61. Lack of learning resources (e.g., learning equipment, computers, internet,…)	6	9	18	23	53	3.99	1.22
	5.5%	8.3%	16.5%	21.1%	48.6%		

Note: (SA)= Strongly agree; (A)= Agree; (U)= Neutral; (D)= Disagree; (SD)= Strongly disagree

Table 27: Contextual factors influence teachers' knowledge and practices of assessment

By inspecting Table 27 it could be realised that about 41% (N=42) of respondents (with 17.4% of participants disagreeing and 23.9% strongly disagreeing) were found to disagree on the lack of instructions from educational supervisors. It should be noted that this item received the lowest mean of 2.73 and the greatest standard deviation of 1.30.

The results also showed that about 38% (N=41) of respondents (with 25.7% of participants agreeing and 11.9% strongly agreeing) were found to agree that they did not have a sufficient knowledge about assessment.

In addition, the majority of respondents, 83% (N=90) (with 22% of participants agreeing and 60.6% strongly agreeing), were found to agree that they had a large workload. This item reserved a mean of 4.28, reflecting the highest average score. Moreover, the majority of participants, 67.9% (N=74), reported they either agreed or strongly agreed that class time was not enough time to practice assessment. Participants also found that, generally, the number of students in classrooms is high, with 77.1% (N=84) of participants in agreement.

The results also showed that approximately 81% (N=88) of respondents (with 28.4% of participants agreeing and 52.3% strongly agreeing) were found to agree that mathematics topics are laborious to teach. This item reserved a standard deviation of 0.98, which demonstrated a minimal variation in participants' responses.

More than half of participants, 60% (N=64) (with 22% of participants agreeing and 37.6% strongly agreeing), reported that there was a lack of training programs on assessment. In addition, the majority of respondents, 74.3% (N=81) (with 27.5% of participants agreeing and 46.8% strongly agreeing), were found to agree that parents only trust pen and paper tests. Finally, about 69% (N=76) of respondents (with 21.1% of participants agreeing and 48.6% strongly agreeing) were found to agree that there was a lack of learning resources in schools. The mean values of the items on this scale are illustrated in Figure 17.

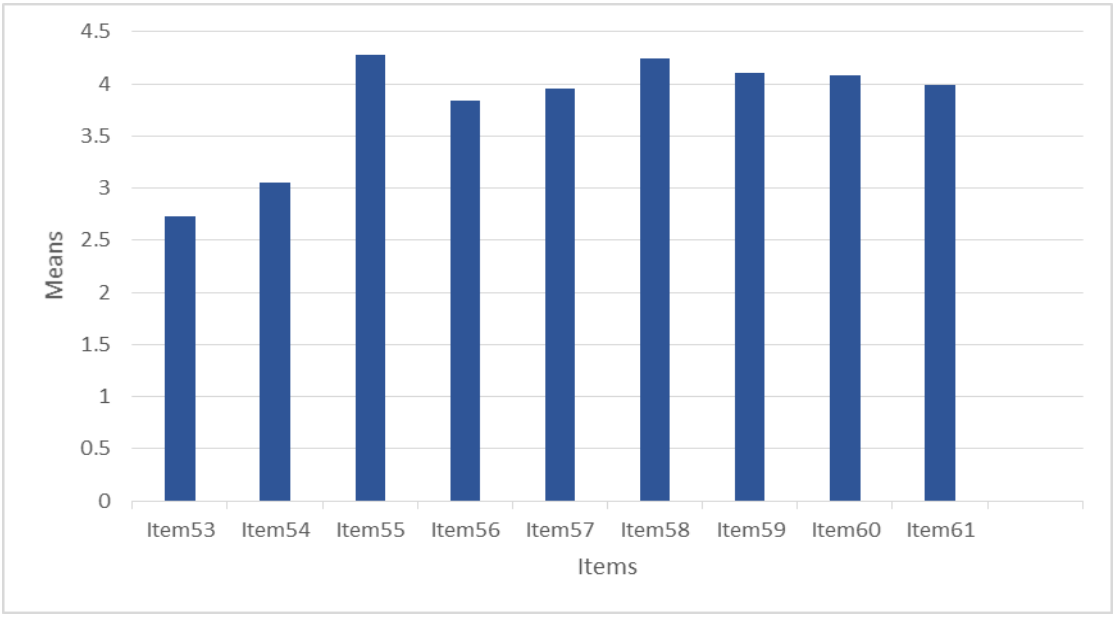

Figure 17: Means of the contextual factors

6.8 Summary

This chapter has presented the analysis of the quantitative data collected from 109 mathematics teachers employed in the primary public schools in Saudi Arabia. The analysis of the questionnaire

began with a description of the demographic information, in order to shed light on the characteristics of the study sample. The statistical analysis of the questionnaire provided a wide range of information relevant to the three domains of assessment knowledge and the three phases of practicing assessment. Moreover, the analysis showed a number of factors in the contexts, which likely influenced what teachers knew about assessment and the way they practiced classroom assessment. The quantitative analysis revealed a moderate relationship between what teachers knew and did regarding assessment in their classrooms.

Chapter 7: Qualitative Data Analysis Results

7.1 Introduction

This chapter presents the analysis of qualitative information regarding ten mathematics teachers. The qualitative data aims to delve more deeply into teachers' knowledge and practices of classroom assessment and the role of context on teachers' knowledge and practices of assessment. The qualitative data presented in this chapter were obtained using two types of instruments: classroom observations and semi-structured interviews. In this chapter, the findings from the two instruments are presented separately in order to provide an obvious picture of the original data. Accordingly, the current chapter presents firstly, an overview of observed classes and the analysis results of the classroom observations. Secondly, an overview of the interview analysis and the analysis results of the teachers' interviews will be discussed. Finally, the summary of the chapter will follow.

7.2 Overview of observed classes

The observational data were collected to provide this study with the evidence concerning assessment implementation during mathematics classes. The collected evidence from the observation could verify or dispute the data collected by other methods in this study. The primary schools that I observed were located in both towns and villages. Most of these schools looked similar as they were large buildings, which consisted of two to three floors. However, I found few schools that were in small buildings with narrow corridors and tiny classrooms. The average class size was 35 students; however, I observed some classes where the number of students reached up to 45. The teaching session length was 45 minutes and the total time of the observation was 90 minutes for each participant. As the school day in Saudi Arabia starts at 7:00 AM, most of my observations were between 7:15 AM and 9:30 AM; in most cases, mathematics sessions were conducted within the first three sessions before the break and the final four sessions. (The number of sessions per day is six to seven).

The layout of the observed classrooms was almost traditional, where students’ desks were facing the teacher and the whiteboard. The desks in these observed classes were arranged either in rows or groups (see Figure18).

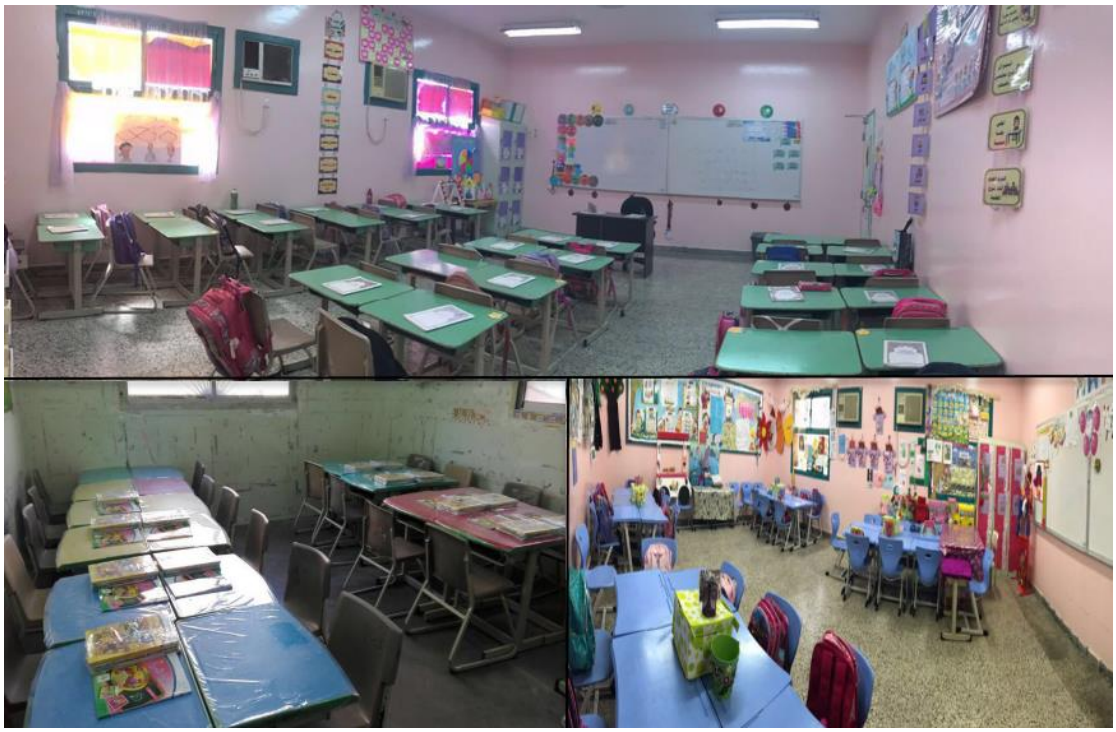

Figure 18: Picture of observed classrooms

7.3 Analysis of classroom observations

Since the interaction between teachers and students in learning and assessment activities is a complicated process, I attempted to present what I had observed in 20 mathematics sessions, in relation to teachers' practices of assessment. The findings from the observations are organised under predetermined themes and the themes that have emerged from the field notes.

In this sense, the four predetermined themes are; teachers' goals of assessment, teachers' assessment strategies, assessment tasks and teachers' feedback. Whereas, the emerged themes are; sharing assessment criteria and evidence interpretation. The findings from are presented in the following sub sections.

7.3.1 Sharing assessment criteria

Observations showed that nearly all teachers presented the learning objectives on the side of the board before starting the new lesson or unit. It was also seen that when teachers had plenty of time before the end of the session, they would summarise the learning objectives of the current lesson in order to remind students about what they had been taught. Communicating learning objectives to students makes them aware of the assessment criteria. In this sense, a number of observed teachers explained some assessment criteria to students while they are solving assessment tasks. For example, I recognised teachers talked about the quality of performance and

how the students will be graded. Moreover, the majority of teachers guided students to find the correct answers, and eventually, to achieve the best level in mathematics. There was evidence that teachers were very aware of the students' ages; thus, assessment criteria were presented to the students in a very simple words. For example:

> "I want you solve the following challenge questions: what is the value of x-y when x=5/6 , y=7/10 ? The full grade for today will be given to the students who can provide accurate answer in a very short time." (Teacher T4, observation 1)

7.3.2 Teachers' goals of assessment

During my observation, I noticed that every time teachers intended to gather assessment evidence, they used different ways to assess students based on the goals they needed to accomplish. It seemed assessing learning was the main goal of all mathematics teachers. I realised from my observation that this concern about assessing mathematic cognition and skills is to help children in learning mathematics. Moreover, it should be noted that nearly all assessment episodes that I observed in the classes were for formative purposes.

It was seen from observed classes that before starting the lessons, all teachers asked students quick questions about the prior learning, which took three to six minutes of each session's duration. On that point, the teachers were keen to conduct this routine assessment activity by asking students questions before starting the new lesson, aiming to identify what students had learned previously. It was also noticed that at this stage of lessons that the majority of teachers mostly asked oral questions in order to assess the level of their students' understanding and whether they had already mastered the basic knowledge and skills in the previous lessons. Moreover, still some teachers were found to ask students to answer a written question on the board or on their notebooks for the same purposes.

It should be noted that when teachers asked oral questions before starting the lesson, the type of question asked was generally a simple yes or no question. The following is a useful example of the observed teachers:

> "Who can remind me how to calculate the area of a rectangle?" (Teacher T8, observation 1)

> "We learned how to add similar fractions, who can tell me that?" (Teacher T4, observation 2)

Based on the previous examples, it was clear that the intention of the majority of the teachers at this stage was to get the right answers from students after electing them randomly to answer. Hence, only a few students had the opportunity to take part in answering this type of question. I also found that the majority of teachers used the assessment of students' prior learning as the basis to present the new lesson.

As mentioned earlier, the majority of assessment activities were targeted at assessing the academic aspects. Thus, the observed teachers constantly asked the students different types of questions to assess their progress and to identify any misunderstandings during the lesson. During my observation, I found that, mainly, teachers' questions assessed the lower level of mathematical knowledge, whereas a minority of teachers provided their students with assessment tasks in the form of solving mathematical problems.

In addition, a group of teachers was found to apply assessment that serves affected objective. This observation revealed that this group of teachers assessed both positive and negative aspects of the children's behavior. I noticed such practices of assessing these affective aspects when teachers would notice any lack of interest or boredom in their students and instantly take remedial action, such as changing their voice level or modifying their teaching; additionally, I found some teachers invited their students to join in physical activities like changing seats or gathering in groups. So far, the observational data also showed the majority of teachers to assess psychological aspects like anxiety and confidence. In this sense, I noticed the majority of teachers encourage shy or less confident students to raise their voices or to lead a group of students during an activity. Moreover, the observation showed that some teachers provided positive comments, either verbally or written, as an instant action in relation to the assessment of the students' psychological aspects.

7.3.3 Teachers' assessment strategies

The observation showed that the teachers applied various strategies to collect evidence about their students' learning. However, it seemed that the subjects, time, and the circumstances of the classroom environment affected teachers' selection and implementation of the assessment strategies. Notably, it was observed, in one small classroom with a high number of students, that the teacher had difficulty walking around the class and following up with all the students' work. Accordingly, that teacher tended to limit large groups activities, which required the space to organise tables for group work.

Within the typical classroom routine, it seemed that using questioning was the most common and obvious method used to elicit evidence about students. Actually, it was found that questioning

could be implemented at any stage of the lesson. For example, at the beginning of any lesson, teachers would ask questions to evaluate their students' past learning; however, at the end of the lesson, teachers asked questions aiming to assess their students' current learning. It was clear that during the lesson, teachers interacted with students by creating oral or written questions, which were asked to an individual student or to the whole class in order to enhance the discourses between the teacher and student.

In addition, the most frequent strategy that I noticed during mathematics classes was teachers' observations of students' cognitive and behavioural aspects. In all observed classes, teachers permanently monitored students' progress and provided help when needed. Nevertheless, teachers also seemed to ask questions and provide comments and explanations based on their observations of students. When teachers carried out an observation, I found that almost all teachers provided individual comments to students while they worked to solve a given task. Similarly, when students got involved in group work, teachers were keen to walk around the groups' tables and observe their work.

In many observed classes, students had significant opportunities to get involved in the assessment process via many activities. In other words, all teachers seemed to feel positively with regard to the implementation of peers' assessment strategies. For example, teachers frequently asked children to assess their peers' classwork or textbooks exercises. Thus, the children's roles as assessors were to correct their peers' answers, and based on my observations, they mostly put tick marks next to the right answers. It could be noticed that the process of peer assessment was conducted in mathematics classes as a mechanical process, since the main goal was to identify to what extent the answers were correct. It was rare to ask students to provide reasons for their marking or to encourage students to explain their answers to peers.

In addition, evidence from the observation showed that the majority of teachers provided students with a chance to assess themselves. In most cases, when self-assessment was conducted, students corrected their mistakes either by comparing their work to peers or to the answers which were written on the board. For example:

> "Teacher Asked: who did not get the right answer? Some students raised their hands. The teacher said, I am sure you had just a smile errors in some steps so you could not get it right. To know your mistakes compare your answer to the students next to you who get the correct answer." (Teacher T4, observation 1)

The above highlights the teacher's use of self-assessment during their interaction with students. It was treated like a mechanical process used to get the correct answer. Self-assessment should

rather be conducted in a way which lets the students reflect on their thinking to become a more sufficient assessor. Nevertheless, in peer assessment, assessor students would rarely share ideas with peers and discuss their decisions regarding their peers' work.

The data also revealed that the majority of teachers employed oral or written presentations in order to evaluate their students' learning. The most frequent scene that I noticed in the mathematics classes was the teacher walking around the class to check students' work. During that time, teachers followed up with students' work to examine their abilities in solving a given mathematical task. Then, some students were chosen to present their work either verbally or written on the board and explain to their classmates how they solved the task. At this stage, I noticed some teachers wrote comments in their notebook about the students' performances. Accordingly, when a student presenter explained their answer and showed any misunderstanding, the teachers corrected any mistakes they noticed or they invited another student to do so. In addition, other than the basic assessment exercises, I found only two teachers presented students' projects and discussed with the class the strengths and weaknesses of the project and how it could be improved.

It should be noted that during the observations the majority of teachers applied quizzes as a strategy of assessment. Observed teachers provided quizzes either before instruction or at the end of the session. Normally, students were given less than 10 minutes to complete the quiz and then handed their paper back to the teacher. It should be noted that teachers were concerned about using quizzes to assess students' performance in the higher grades (such as grades 4, 5, and 6) in contrast to the lower grades. At the end of a session, it was noticed that the majority of teachers were keen to ask oral or written questions regarding the learning outcomes to sum up what had been achieved in the current lesson.

The last assessment strategy l recognised during the observation was homework tasks. All teachers were seen picking out some tasks from the students' textbook or workbook and asking the students to bring their answers to the next session. Basically, homework tasks were given to assess students' ability to apply the main information of a lesson. Teachers were also found to review students' homework answers at the beginning of the session.

Overall, from the data, it was clear that mathematics teachers have implemented a variety of assessment strategies, which mainly served formative purposes. Table 28 summarises the teachers' assessment strategies that were implemented in the mathematics classes.

The stage	The aims	Teachers' assessment strategies
Before instruction	Assess prior learning/ diagnose learning	- Written and oral questioning - Homework - Pen and paper quizzes
During instruction	Elicit evidence of student learning	- Written and oral questioning - Observation - Peer and self assessment - Written and oral Presentations - Projects
After instruction	Make decisions regarding students' learning	- Written and oral questioning - Pen and paper quizzes

Table 28: Observed teachers' assessment strategies

7.3.4 Assessment tasks

It was recognised from the data that the majority of questions were asked by teachers; however, it seems that opportunities for students to ask questions while being involved in learning or assessment activities were very limited. It should be noted that nearly all teachers' questions were dealing with cognitive matters. It was also seen that most of the cognitive assessment questions were made to assess lower order thinking, in which teachers aimed to test either students' past learning or actual knowledge. I have mentioned such questions to assess lower order thinking since the vast majority of these questions were in the form of closed questions where the students needed to give one answer. I realised that the teachers' need to ask closed questions is for two reasons: firstly, they have to monitor students' progress while teaching, and secondly, they need to collect basic information about students' learning. Furthermore, it was found that the majority of observed teachers still had the chance to provide higher order thinking questions in order to encourage students to think individually or in groups.

However, I have noticed that the teachers' questions targeted all students despite their abilities in mathematics. For example, when teachers decided to give a task in the form of problem solving, which is categorised as a higher order thinking question, they ask all students to solve the same task regardless of the differences in students' abilities to solve mathematics problems.

In addition, the data revealed that teachers were keen to provide assessment tasks that informed them about students' learning; however, during the observation, there was very limited room to ask students questions about how they got the answer, for example, 'Can you explain your answer?' or 'How do you know your answer is correct?' Actually, I noticed that the majority of the written assessment tasks provided to students had been taken from the students' textbook tasks. Although observed teachers mostly adhered to the textbooks regarding assessment tasks, they were noticed to depend on their own tests or quizzes. Teachers were seen to adapt their own tests based on the objectives they wanted to assess.

On the other hand, it was noticed from the observation of the classes that a small group of teachers did not follow what they had planned regarding assessment tasks. That was exemplified in the following excerpt:

> "Teacher T1: Please open your textbook and work individually on the following task " find the missing numbers: 234, 345,…..,567,……?" After few seconds teacher T1 said: Please I think this task is too easy to be solved. Can you move to the next task? At that time students 1 said: I already solved it. Also another student 2 said: Me too Teacher T1: good, please move to the next question." (Teacher T1, observation 1)

The above excerpt showed that the teacher at this part of lesson was not exactly sure about what task was to be selected since she changed the task after a few seconds; however, some students seemed to have already found the answer. Although I noticed such practices only two times during my observation, it still indicated some lack of preparation for assessment activities; being prepared saves teachers time and helps them to be more focused on achieving assessment aims.

7.3.5 Teachers' feedback

From the observations, it was recognised that the participants used particular methods for giving feedback. The result of analyzing observations showed that overall, participants provided feedback on students' work in a written and oral format. It became evident that oral feedback was the most frequently used format by teachers in order to give feedback during the learning process. The feedback that was noticed during the observation of the classrooms could be categorised into two types of feedback: evaluative and descriptive.

Written and oral evaluative feedback was used by teachers to tell students how well they were learning mathematics. This feedback was recognised during all observed classes since teachers gave brief comments that summarised students' performance on a specific part of the lesson or a certain assignment. The following are examples from the field notes:

"At the end of lesson, the teacher said to all students: Excellent! I am very satisfied with the way your performance in solving the tasks that I gave you." (Teacher T3, observation 2)

"The teacher said to the student: Wrong answer, try again." (Teacher T7, observation 1)

"The teachers was checking groups work and she put a tick mark or 'well done' on the right answers." (Teacher T9, observation 2)

The previous examples demonstrated that words and phrases such as 'good' or 'try again' were used by teachers to indicate whether students' work was correct or incorrect. As well, teachers employed marks and symbols to fulfill the same purpose.

Moreover, it was noticed that the majority of teachers used their body language, such as hands, face, and head motions, in order to show their agreement or disagreement on students' work or answers. The following is an example from the field notes:

"The teacher nodded her head in order to encourage the student to carry on when the students hesitated to finish the task." (Teacher T8, observation 1)

Generally, it was clear that teachers used their body language as a sort of evaluative feedback with students who had a lack of confidence while solving tasks or struggled in answering teachers' questions.

Descriptive feedback was the second type of feedback that was identified in the analysis of the classroom observation. The majority of teachers provided descriptive feedback in oral format, which fundamentally aimed to guide students while learning and teach them how to improve. This was evident in the following observation note:

"The teachers wrote the following task: If three apples contain 180 calories, how many apples contain 300 calories? Then she asked the students to start solving the task in groups. The teachers checked groups' answers and shared some information that targeted some groups who could not answer either quickly or correctly. The teachers helped some groups by providing verbal suggestions to improve their work by creating the right equation to solve the question." (Teacher T6, observation 1)

"Students were asked to work in pairs to solve a task from the textbook. The task was about estimating the area of a square and rectangle. Some students worked on calculating the area directly by multiplying the width and height. At that time, the teacher advised all students to read the question carefully since it was about estimating

the area. The teacher further said to some students that they do not need to get the exact figure but they need to give a reasonable number." (Teacher T8, observation 2)

The above examples illustrate that during the observed lessons teachers provide oral descriptive feedback to identify what needs to improve while learning.

In addition, during observed lessons the majority of teachers delivered descriptive feedback in written format, which targeted students' performance and resolutions in solving tasks. Teachers mostly applied this type of feedback by writing on the board for all students. For example:

"The teacher said to students we need to know about the right steps to calculate the size of cube. I noticed some errors during your work." (Teacher T3, observation 2)

It should be noted that during the observation, the majority of teachers mainly gave oral descriptive feedback. Descriptive written feedback was needed at some points in the lessons. The following examples are from the observation:

"The teacher asked students to write a description for the pattern of given numbers. The teachers provide written comments to three students. However, some students could not solve this task since they did not receive teacher' help." (Teacher T2, observation 1)

With regard to the timing of providing feedback, from my observation I noted that regardless of the type of feedback, the majority of teachers gave immediate feedback to their students.

It should be said that all teachers' feedback targeted students' learning; however, I noticed nearly all teachers adjusted their teaching or provided more examples when they felt that students were facing difficulties in the current lesson.

7.3.6 Evidence interpretation

During my observation, I found in every classroom that the observed teachers interpreted the evidence they had collected about students with reference to three main standards. The first standard was 'criterion referenced' assessment for interpreting students' performance. In this case, the teachers' approach was to compare students' attainments to a predefined standard. It seemed that students were assessed based on the national standards of predetermined mathematical cognition and skills. Teachers were seen to be very strict on using the set of assessment standards in primary schools, as they worked to help students achieve acceptable levels of mastery. An example from the observation is as follows:

"At the end of the session, the teacher said to all students: you have to master the main skills in this chapter by the end of this week. I am going to test you. In case I find the majority of you did not master the core skills I will assign a session to review the most difficult parts." (Teacher T10, Observation 2)

It also seemed that assessment criteria had a cognitive nature since all teachers attempted to promote students' learning and cognitive skills. Moreover, teachers were keen to use logs during the class and they regularly wrote comments and records based on students' mastery of specific skills.

The second standard that was noticed in the mathematics classes was 'norm referenced'. During lessons, nearly all teachers were seen comparing a student's ability to solve a particular task or master a piece of knowledge to the performance of other students in the class. In one class, for example:

"The teacher asked one student to show her textbook to the class as she managed to draw a picture that illustrated a given fraction." (Teacher T1, observation 2)

The above example demonstrates that the majority of teachers were found to implement norm referenced assessments in such a way. In this sense, teachers were often comparing different groups' work as well as students' behaviour to their peers in the class. Comparison among students was often practiced and also seemed to be one of the teachers' techniques to encourage students, particularly low ability students, to improve.

The last standard that I noticed during my observation was 'self-referenced'. In this case, teachers compared the students' performance with their own previous achievement. I recognised this through teachers' verbal comments to students:

"The teacher said to one student you should be able give the right answer. Your grades in last test was great" (Teacher T5, observation 1)

In addition, I noticed some written comments on students' textbooks such as:

"Well done. Keep going." (Teacher T3, observation 1)

"Very pleased with your progress. Move forward." (Teacher T9, observation 2)

It is evident from the above excerpts that the teachers care about students' previous performance and considered it a reference for interpreting assessment evidences regarding students' new work.

7.4 Overview of interview analysis

The interview data gathered from the participants aimed to investigate in depth what teachers know and do regarding assessment and how context impacts their knowledge and practices. Hence, the findings of the interviews are presented in three sections as follows: knowledge of assessment domains, classroom assessment practices, and the impact of context. The approach used in analysing the interview data was in two stages. The first stage was analysing the data in a deductive way, or by using a 'top down' approach (Braun and Clarke, 2006). The predetermined units and themes involved in the deductive analysis were based on the conceptual framework and the research questions of the study. The second stage was analysing the data in an inductive way, or a 'bottom up' approach (Braun and Clarke, 2006). This was done in order to not miss any data.

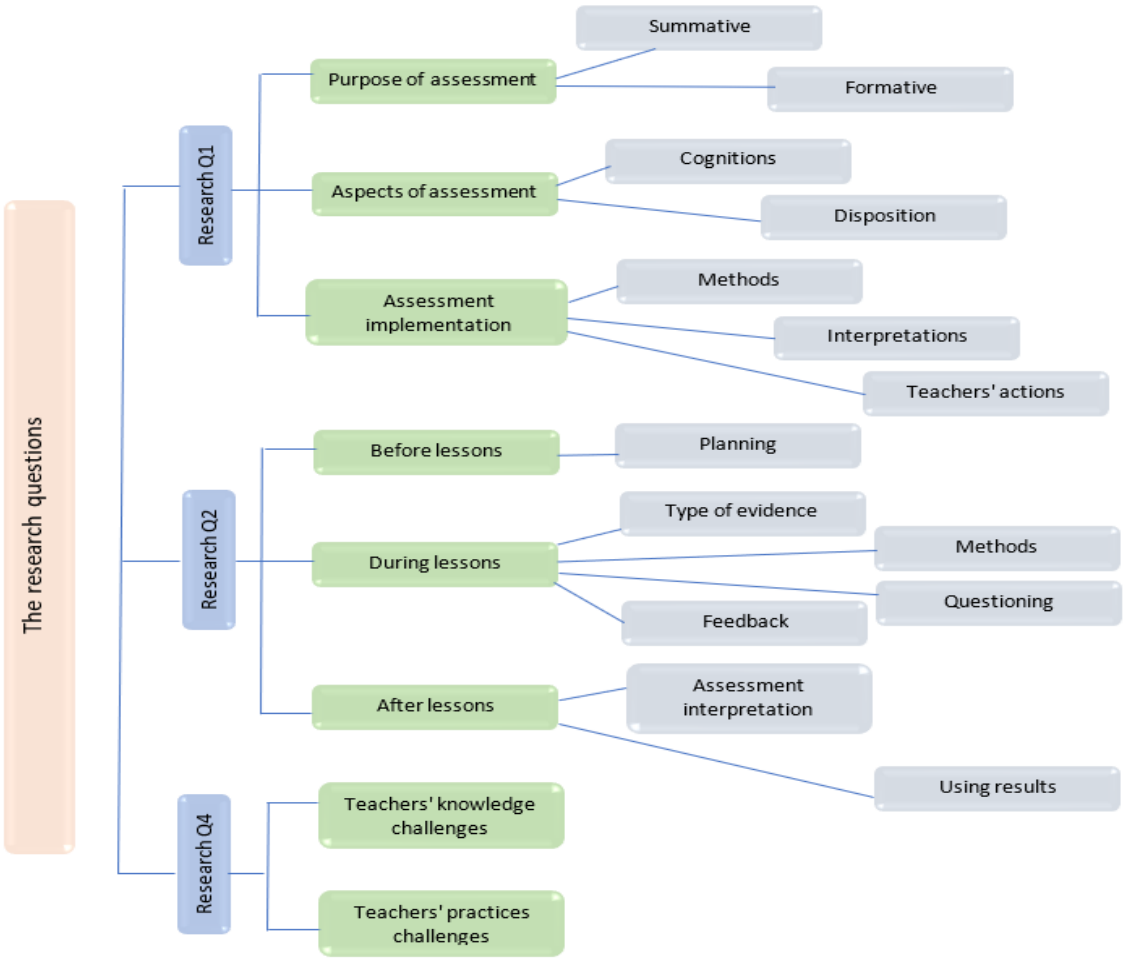

Figure 19: Units and predetermined themes of analysis

Figure 19 represents an overview of the units used in the analysis, which related to the research questions and the predetermined themes, which in turn linked to the interview questions.

Accordingly, many themes and sub-themes have emerged under every predetermined theme. The following sections represent the interview findings.

7.5 Analysis of assessment knowledge domains

Mathematics teachers' knowledge of assessment were analyzed through three domains. These three domains were identified based on the conceptual framework of the current study (see Capter 4). Accordingly, the collection of the data about teachers' knowledge of assessment started from the following interview questions: ‘Why assess students in mathematics?’ ‘What is assessed in mathematics?’ ‘How do you conduct assessments in mathematics classrooms?’ The qualitative outcomes of the knowledge of assessment are presented in the following sections under the following subtitles: purposes of assessment, aspects of assessment, and assessment implementation. In addition, under every subtitle there are a number of predetermined themes and variety of emerged themes.

7.5.1 Purposes of assessment

In order to investigate teachers’ knowledge regarding why they assess and how they understand the purpose of using an assessment every time they assess their students. I started with the teachers by asking them to provide their own definition of classroom assessment and the purposes for using assessments. More specifically, teachers were asked to describe how they understood summative assessment and formative assessment. In addition, teachers were asked to provide more information about their own aims when they apply summative and formative assessments. The results of the teachers' responses are illustrated through the following predetermined themes: summative assessment and formative assessment.

7.5.1.1 Summative assessment

Teachers' knowledge of summative assessments was investigated by the following interview questions: What do you know about summative assessment? What are the purposes of this assessment? Examining the data showed that the participants expressed various ideas in order to

describe their own awareness of summative assessments. Four themes have emerged from the data, which are presented in Figure 20.

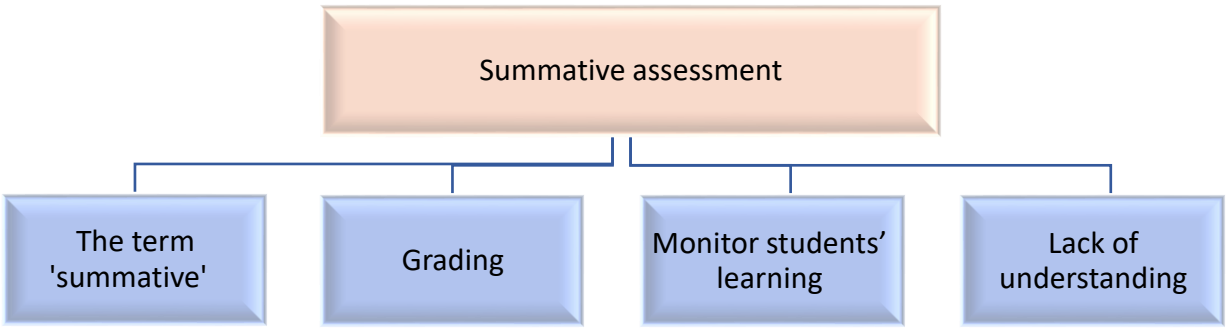

Figure 20: Emerging themes from the knowledge of summative assessment

Emerging theme 1: The term 'summative'

The comments from participants revealed that the majority of interviewees were able to define summative assessment in terms of its aims and when it should be used in their teaching. The following comments were indicative:

> "Summative is the final assessment. I mean it is conducted at the end of terms or academic year to judge students achievement." (Teacher T4)

> "Summative assessment is the one that we apply the after learning in order to evaluate the students' achievement." (Teacher T3)

> "Summative assessment takes place at the end of units, chapters, and terms for measuring students' learning." (Teacher T6)

Moreover, the small minority of participants indicated that summative assessment is implemented to evaluate learning goals. For example, teacher T10 stated:

> "It is the one that should be use to know about learning objectives I mean in order to know that students have achieved these objectives."

Emerging theme 2: Grading

All participants stated that they understood summative assessment as a tool that is used in order to provide students with grades regarding their achievement or, in other words, to measure students' achievement. For example, teacher T2 stated:

> "I understand that kind of assessment is just to measure students' performance and give them grades based on their performance in the test. From students' grades, I can decide how much information they have learned."

Similarly, teacher T 4 stated:

> "Summative assessment always aims to measure students' learning."

Two teachers indicated how summative assessment helped them to record students' grades by saying:

> "Summative assessment used to keep evidence about students' learning in the form of numbers. Parents respect numeric records and students as well since it show their performance in a reliable way."

Emerging theme 3: Monitor students' learning

A majority of participants indicated that they find summative assessment results inform them about students' progress and their growing understanding of what they have learned. In this sense, teacher T7 mentioned that she valued using tests to explore students' performance in mathematics:

> "Without summative assessment I mean measuring students' learning, it is difficult to determine whether they are progressing and understanding what I am teaching them."

Another teacher T2 stated that:

> "The main feature of summative assessment is informing me about students' learning over a period of time. By reviewing students' results I can know about the students' achievement regarding the learning goals."

In addition, a number of teachers indicated that summative assessment helped them predict student performance in mathematics. As teacher T1 claimed:

"I assess my students just to know about their achievement levels in mathematics. Grads reflect their achievement not just during a specific period of time but in future too."

In addition, all interviewees claimed that they used summative assessment in order to know about their students' needs in the future. In this sense, teachers pointed out that they found summative assessments allowed them to understand students' individual differences and students' weaknesses and strengths in mathematics. For example, teacher T7 claimed:

"This assessment aims to discover students' weaknesses and that teacher could set a plan based on students' results to treat these weaknesses."

Similarly, teacher T5 stated:

"Summative assessment results tell me about the difference among students in learning mathematics."

Emerging theme 4: Lack of understanding

A small minority of interviewees were uncertain about when to apply a summative assessment. For example, teacher T1 said:

"Summative assessment is conducted just at the end of every class to make sure that my students have understood have been taught in this session."

Furthermore, one teacher claimed that summative and formative assessments are similar, as she attributed this to the nature of mathematics lessons in primary schools. This teacher T2, stated that:

"There was no difference between formative and summative assessment, as normally mathematics lessons in primary schools consist of one main idea."

7.5.1.2 Formative assessment

Teachers' Knowledge of formative assessment was investigated by the following interview questions: What do you know about formative assessment? What are the purposes of this assessment? After investigating the data, four themes emerged (see Figure 21). These emerging themes were identify the main them 'formative assessment' since the participants' responses revolving around them.

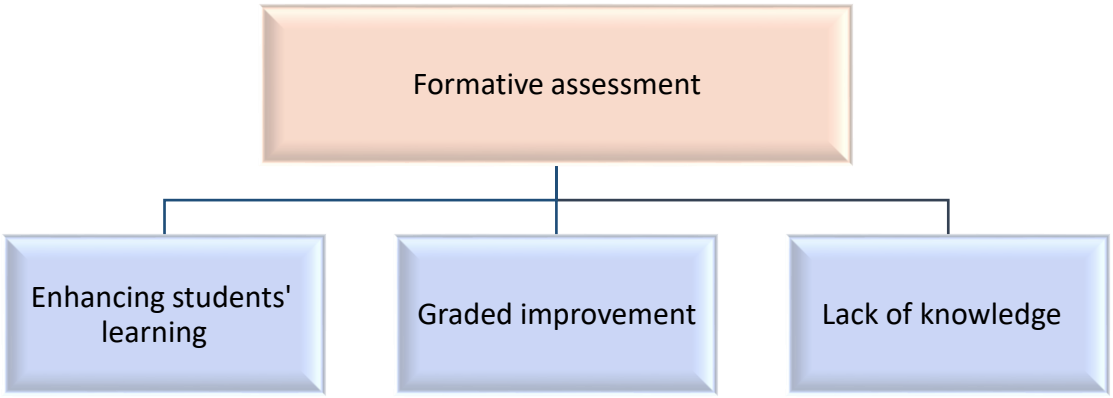

Figure 21: Emerging themes from the knowledge of formative assessment

Emerging theme 1: Enhancing students' learning

In most interviews, teachers confirmed that formative assessment is an important tool to improve students' learning by providing comments on students' performance. In this sense, teacher T9's comment was indicative as:

> "Formative assessment could improve students' learning as the teacher must be aware not to move from point to another before making sure that all students have understood."

Similarly, teacher T7 stated:

> "Provide comments to students regarding their results is the aim behind using formative assessment"

Teacher T5 made mention of the importance of recall in that:

> "Assessment tasks could improve students' achievement by helping them to remember what they have learned."

Moreover, the participants indicated that formative assessment is an effective tool in correcting students' mistakes; thus, students' achievement could be improved by correcting students' work. For example, teacher T6 stated:

> "Whenever there was a wrong idea that I realised after assessing my students, I immediately correct that idea for them so, I make sure that my students have achieved an accurate information. I mean they understood the lesson and became very good at solving mathematical problems or mathematical skills."

Other participants included the same idea regarding formative assessment. For example teacher T8 stated:

"After assessing students, I can get to understand students' mistakes in this case; I will be able to teach them how to avoid these mistakes. By doing so, I could notice improvement in their performance."

It should be noted that only one teacher indicated the role of students in formative assessment and how students learn through their reflections. This teacher (T7) stated:

"When I have time I use formative assessment to let students think about their mistakes while learning. I consider students' reflections on what they are doing is a good feedback on their own learning. Students become more responsible and conscious of their learning and mistakes"

Emerging theme 2: Graded improvement

Some participants indicated that formative assessment could improve students' learning through improving their grades in tests that could be conducted by retesting students. On that point, teacher T3 argued:

"It helps me in exploring students' mistakes then I can work in improving students' grades to boost their achievement."

It seems that such teachers considering retesting students in order to improve their marks is one of formative assessment's targets.

Emerging theme 2: Improving teaching

A number of comments from the interviews indicated that teachers benefited from students' assessment results, as they provided feedback on their performance. Teachers considered this assessment information as a basis upon which they could improve their teaching plans or change their practices in classrooms. One participant, teacher T1, stated:

"Assessment tells me whether I am able to deliver the information to my student or whether they could learn from me."

Another teacher (T10) talked about selecting teaching strategies based on assessment, as they noted:

"It makes me changing my strategies with students when needed, not just with the current students this year. But, it gives me the chance to reflect on my teaching to improve it in general or in the next academic year."

A small minority of teachers mentioned the term ‘self-evaluation’ as they considered assessment results an indicator to their success in teaching. For example, teacher T7 noted:

> "I mean I can evaluate my work as a teacher based on my students' performance results.”

About half of teachers pointed out that they find assessments help them in facing any challenges while teaching. As teacher T4 stated:

> "It helps me in exploring the challenges in each lesson and to what extend I manage to achieve the goals of the lesson.”

Emerging theme 3: Lack of knowledge

Interviewees' answers showed that just a minority of teachers were able to provide a definition of formative assessment or express their understanding regarding the term ‘formative’. For example, teacher T6 stated:

> “Formative assessment is an activity that takes place during teaching and learning.”

Two teachers emphasised the importance of formative assessment in providing a comprehensive vision of student learning during lessons. As teacher T9 claimed:

> “Formative assessment is the process of seeking evidence about students’ learning during mathematics sessions. This assessment confirms me that the students have understood.”

Although the majority of teachers knew when to conduct formative assessments in their classes, they seemed unclear as to why formative assessment should be conducted. On this point, teacher T5 noted:

> “I apply formative assessment during classes as it helps me to assess students' understanding of the previous lessons or what they have previously learned.”

Another teacher pointed out that formative assessment is a learning activity. Teacher T5 claimed:

> “Learning activates during sessions are types of formative assessment. I keep asking students oral questions before move from point to another in the lesson to make sure they have understood.”

Consequently, the majority of participants indicated that they knew little, if anything, about formative assessment, like Teacher T3 claimed:

"I cannot tell you precisely about formative assessment as I feel my knowledge about it is very limited."

Thus, most teachers in this study showed some understanding about formative assessment but they could not demonstrate coherent ideas about the meaning of formative assessment.

7.5.2 Aspects of assessment

To address this domain of assessment knowledge, teachers were asked to respond to the following question: what are you assessing in mathematics classes? I have received a variety of responses from the participants, as they expressed their understanding in relation with the student traits that need to be assessed in mathematics. Teachers' comments were mainly focused on assessing mathematical cognition and skills which are in accordance with learning expectations that are outlined in the national curriculum standards of primary schools. During the semi-structured interviews, I asked teachers further in-depth questions about their awareness of the different aspects of assessing students in mathematics. The results are presented through the following predetermined themes: mathematical cognition and mathematical disposition.

7.5.2.1 Assessing mathematical cognition

In examining the assessed mathematics, participants were asked the following interview question: What do you assess in mathematics? Most of the participants talked about the mathematical concepts they want students to understand. Participants' responses regarding said question have been categorised into three emerging themes, which are presented in Figure 22.

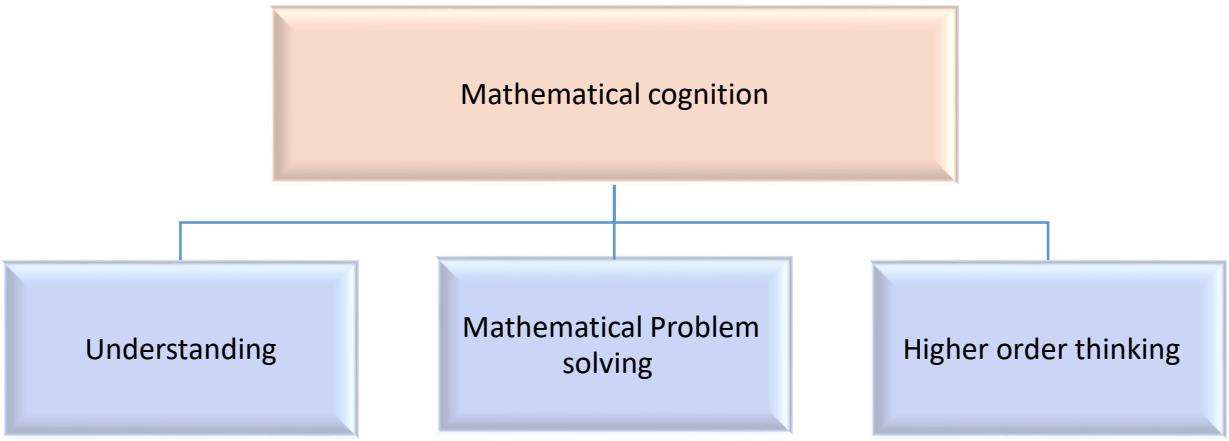

Figure 22: Emerging themes from assessing mathematical cognition

Emerging theme 1: Understanding

All teachers stated that they basically ask their students questions that reflect the most important mathematical concepts for students to understand. Teachers in this study also stated they always tend to select assessment activities that assess students' ability to apply the new mathematical knowledge. For example, teacher T5 pointed out:

> "At the initial stage in every mathematics classes, teachers should first keen to provide students with tasks that reveal students understanding of the basic skills or information in the lesson."

In addition, all teachers have mentioned the basic types of mathematical knowledge and intellectual skills, which are based on the lower order of Bloom's taxonomy. Accordingly, teachers noted that they paid more attention to assessing these levels of knowledge than the higher order ones in their daily performance of assessing students in mathematics. In this sense, teacher T6 stated:

> "I think lower order thinking are very important skills for all children to be mastered. I consider understanding and applying a new information the key factor and the starting point of assessing students."

Likewise, some teachers argued that the weight of assessing different levels of mathematics should depend on students' age. The teachers further claimed that assessments should assess the students' strengths and weaknesses in mathematical foundations that they should have at this level. For example, teacher T9 stated:

"I teaches children so my main concern is how they master the core subjects in which mathematics one of these subjects. With younger assessing lower-order thinking in mathematics has to become more significant."

Emerging theme 2: Mathematical Problem solving

The majority of teachers mentioned that they provide students with tasks, aiming to assess students' ability in solving mathematical problems, when they have enough time during the lessons. Some teachers also stated that solving mathematics problems requires high skills; thus, assessment on the basic skills in mathematics such as remembering or understanding will not help students to improve in solving problems. For example, one teacher talked about solving mathematics problems as a high cognitive skill that should be included in assessment activities. For example, teacher T4 stated:

"Solving mathematical problems is one of the main goals in teaching mathematics. In this sense, every teachers should not ignore this skill. Although assessing students' ability to solve mathematical problems is a time consuming, I personally provide my students with such tasks."

Another teacher (T10) stated that:

"I believed in applying some ways in order to enhance students' performance in mathematics such as providing challenge tasks to know how they are good at solving mathematical problems."

Emerging theme 3: Higher order thinking

A number of interviews expressed their awareness regarding assessing students' higher-order thinking in mathematics. This number of teachers stated that they were keen to involve their students in tasks which require higher levels of mathematics skill to be solved. Moreover, teachers also talked about getting their students familiar with tasks that assess mathematical reasoning skills and mathematical proofs in order to enhance students' higher-order thinking skills in mathematics. For example, teacher T8 mentioned this point by stating:

"There is no meaning to limit my assessment activities to lower-order thinking skills. I expect a lot from my students and I know their skills will not improve unless I give them more challenging mathematics tasks. Assessment tasks at this mathematical level build children logical reasoning ability."

Another example from the responses of the teachers:

"To be honest, I would say that the highest number of assessment tasks in my classes have targeted students' understanding. However, I understand how it is important to know about the students' higher-orders thinking. I may not apply this type of assessment takes very often, but any way I know that I have to assess this level from time to time." (Teacher T3)

7.5.2.2 Assessing mathematical disposition

Based on the conceptual framework of the current study, knowing what to assess includes both cognitive and affective aspects. In order to investigate teachers' knowledge about assessing students' affective disposition toward mathematics, they were asked the following interview question: What mathematical disposition do you assess? The collected data from the participants regarding assessing mathematical disposition have been categorised into three emerging themes, which are presented in Figure 23.

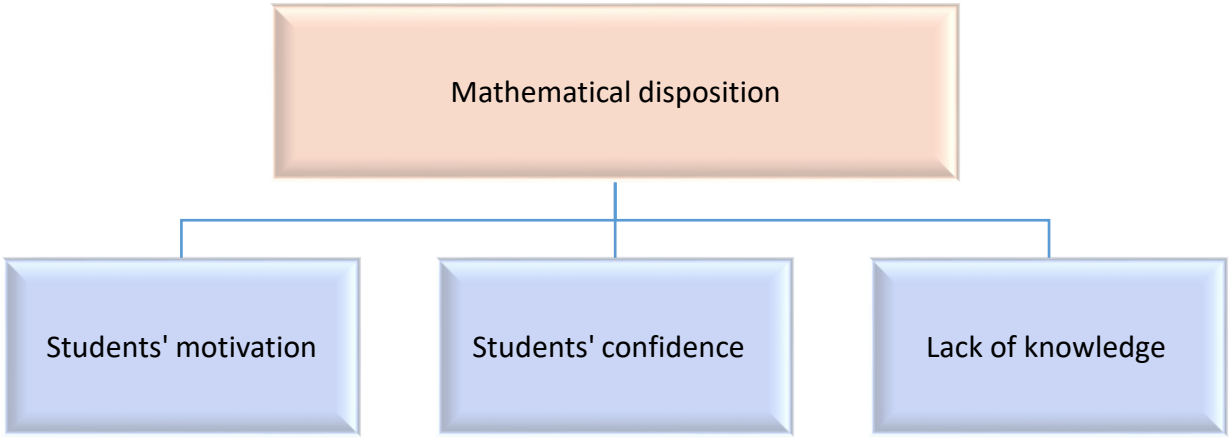

Figure 23: Emerging themes from assessing mathematical disposition

Emerging theme 1: Students' motivation

The findings revealed that it seemed important for some teachers to consider students' interest and enjoyment in learning mathematics. However, a group of teachers indicated that they could recognise whether students are motivated while learning by observing students' performance during lessons. This group of teachers further stated that there was no need to assess the affective characteristics of students, as they are unlike cognitive aspects. For example, teacher T1 claimed:

"I understand that the affective aspects such as attitudes, discipline and motivation are important to be observed when students involve in learning activities. But, I feel these characteristics should not be assessed like knowledge."

On the same point, teacher T4 stated that she was aware of students' personal characteristics and to what extent they felt mathematics was an interesting subject to learn. Although that teacher was keen to prompt her students, she also claimed that assessing disposition aspects is not necessary.

"During my daily teaching routine I know when my students are interested in mathematics topics. I could recognise that without do any assessment. Moreover, I always encourage my students by making learning mathematics more fun." (Teacher T4)

On the other hand, only two teachers showed their awareness in assessing students' motivation. One teacher emphasised the importance of conducting regular interviews with students to explore their interest toward learning mathematics. As well, this teacher indicated she was keen to apply teaching methods that boost students' learning. In this sense, teacher T7 stated:

"From time to time, I do ask my student to provide their views about my teaching just to know if I use an influential teaching the makes them like mathematics. Normally, I interview some students to give me their opinions. Moreover, I interview students to assess how much they like to learn mathematics particularly the difficult topics."

Although a minority of participants indicated they were knowledgeable regarding assessing affective dispositions, they yet did not show that they implement a clear method to assess students' motivation or interest other than their daily observation of students' learning during classes.

Emerging theme 2: Students' confidence

It was found that the majority of teachers paid attention to students' confidence in learning mathematics. Most of the teachers indicated that confidence is a huge factor in learning, since mathematics has a reputation as a tough subject to teach and learn. Hence, teachers stated that working on building students' confidence might help teachers in facing some issues in mathematics classes such as students' anxiety and behavioural problems.

In this sense, it was evident that most of the teachers were conscious about enhancing students' self-confidence when doing mathematical tasks. Similarly to what was mentioned earlier, the majority of teachers stated that they assess students' confidence in mathematics only by

observing students' performance. On that point, teacher T5 emphasised assessing the factor of confidence through observation without any need to prepare for it:

> "When dealing with mathematics tasks, it is important for me to help students' being more confidence particularly when working on solving mathematics problems. If you asked me how I assess their confidence, I would say by observe them. I think neither need to write notes nor prepare questions."

Another teacher (T9) indicated that developing students' confidence is a part of learning, but it should not be assessed like mathematical knowledge:

> "Yes, affective domain such as confidence and behaviour could not be separated from the process of learning but in terms of assessment, it should not be treated like knowledge." (Teacher T9)

Emerging theme 3: Lack of knowledge

The data also showed that the majority of teachers paid less attention to assessing mathematical affective disposition. Most teachers argued that they believe that the affective domain was a valuable factor in learning mathematics. However, those teachers claimed that they did not know how to assess students' disposition, such as attitudes or motivation, in a proper way. For example, teacher T2 stated:

> "I know students have to be motivated particularly in mathematics and I do encourage them all the time. However, I have never know that I have to assess their feeling or attitudes and I have no Idea how to do such assessment correctly."

7.5.3 Assessment implementation

In order to investigate mathematics teachers' knowledge regarding how to conduct assessments, they were asked to respond to the following question: 'How do you assess your students in mathematics classes?' Since the question was quite general initially, teachers have tried to explain their actions with students in relation to mathematics assessment. In order to gain more precise information about participants' knowledge of assessment implementations, I have asked specific questions related to the predetermined themes as follows: assessment methods, assessment results interpretation, and teachers' actions. The findings of these predetermined themes are presented next.

7.5.3.1 Assessment methods

Teachers were asked the following question: 'What knowledge do you have about assessment methods in mathematics?' Remarks from the participants revealed that most teachers knew about the different kinds of assessment tools that they normally apply in their classes. The most common assessment methods that emerged from teachers' responses could be categorised under the following themes: traditional methods, alternative methods, and lack of knowledge (see Figure 24).

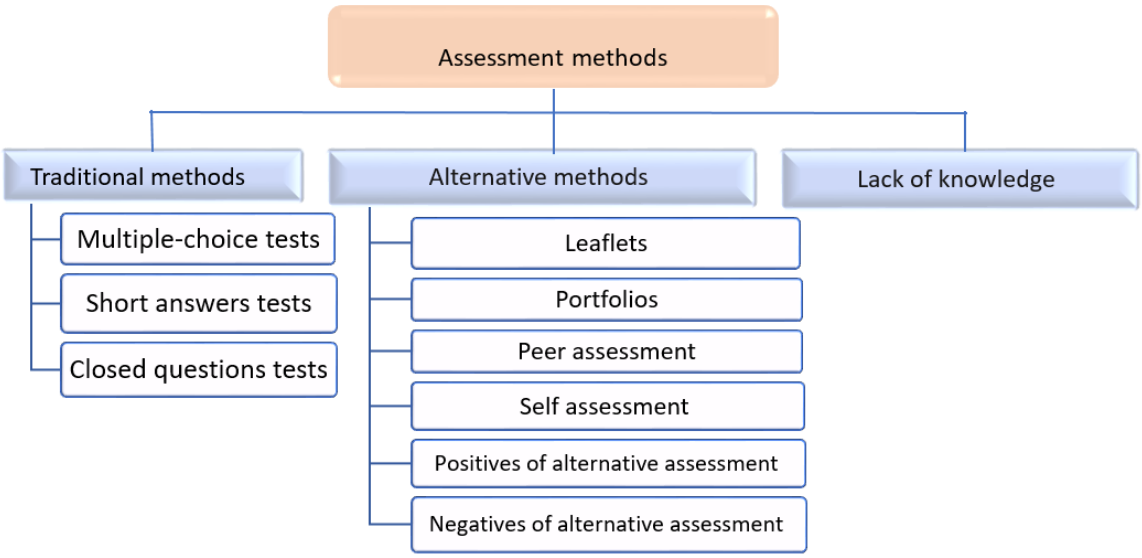

Figure 24: Emerging themes and sub-themes from teachers' knowledge of assessment

Emerging theme 1: Traditional methods

The participants talked about the types of assessment tools they know. The most common responses that emerged referred to what could be viewed as traditional assessment methods. Data suggested all teachers deemed traditional assessment tests as the classic and formal method of addressing and revealing students' achievement. For example, teacher T4 stated:

"Assessment methods in mathematics are all different types of testing."

Similarly, teacher T10 stated:

"Traditional assessment tools are based on pen and paper exams or tasks."

Many examples of traditional assessment methods have been provided by the majority of the teachers since they claimed that these methods are the most adequate to assess students in mathematics. Such examples are included the following sub-themes:

- *Sub-theme (1.1): Multiple-choice tests*

Many participants provided this example since they stated that this type of test is very common to be used with students and is fairer than subjectively scored tests. On that point, teacher T5 claimed:

> "This type of test is very reliable and the teacher need to be skilled in building such tests. Also it is easy to score."

- *Sub-theme (1.2): Short answer tests*

Some participants talked about short answer tests, where the student fills in a word or provides a precise answer where a space has been left blank in a statement. Although teachers stated they were aware of this type of test, they claimed that it is not suitable to measure some mathematical skills. As teacher T7 said:

> "Short answers tests questions should be created to accept one right answer. Normally it measures memorisation or understanding levels but not the higher levels of mathematics thinking."

- *Sub-theme (1.3): Closed question tests*

All teachers seemed to be aware of tests with closed answer questions. According to the teachers, in mathematics, closed question tests or quizzes were easy to design and to score, as well. They further stated that they realised these tests were tool that could measure different types of mathematic levels. For example, teacher T6 stated:

> "Traditional assessment methods such as testing and quizzes, these methods I apply to assess my students. Nevertheless, I know there are many types of traditional tests but I always use tests with closed answers since I can assess many learning targets. They are reliable and fixable."

In general, the word "testing" was the most frequent answer in relation to assessment methods in mathematics. All of the participants stated that they considered using traditional methods in assessment as the best way to assess students, particularly in mathematics. For example, teacher T3 said:

"In mathematics, pen and paper are not only the best way to assess students but in mathematic students could not benefit from assessment without engaging in pen and paper assessment tasks."

Participants justified their statements by claiming that they trust the quantitative results of pen and paper tests since these results normally reflect what students have accomplished.

It seemed that the teachers were committed to all kinds of tests as a main tool to be used in mathematics classes.

Emerging theme 2: Alternative methods

According to teachers' remarks, the majority of teachers claimed that they understood alternative assessments, where students' performance is measured by applying various tools other than pen and paper tests. For example, teacher T2 stated:

'"Not all assessment strategies are based on normal exams."

Another teacher (T8) said:

"Assessment tools are different from tests. I apply some of these tools in my classes like peer assessment, leaflets and presentations in order to motivate students."

On that point, the most frequent tools that were mentioned by teachers included: leaflets, portfolios, and peer assessment. Accordingly, there were a number of sub-themes that emerged from teachers' responses as follows:

- *Sub-theme (2.1): Leaflets*

All teachers talked about leaflets as an assessment strategy in which they had sufficient knowledge of how to use this strategy in assessing mathematics. Most of the teachers' responses indicated that they were familiar with leaflets since primary mathematics textbooks include many examples and clarifications about how to apply leaflets in mathematics. As teacher T3 stated:

"If you ask about alternative tools of assessment I will say leaflets. I am very familiar with this tool. I frequently use it with my students since the textbook focuses on this tool."

Teacher T3's declaration about leaflets was supported by another teacher (T7) as she talked about the role of using leaflets in promoting students' performance by saying:

"The only thing about alternative assessment tools that they keep students motivated particularly in mathematics. I realised that when they particularly design leaflets."

A few teachers revealed that they mainly focused on specific tools like leaflets because they felt more confident in applying these tools than other alternative methods. For example, teacher T2 said:

"Honestly, I use mostly leaflets and peer assessment as I know how to conduct those tools very well."

- *Sub-theme (2.2): Portfolios*

Nearly all teachers deemed portfolios as one of the alternative assessment methods, which aim to collect students' work and exhibit their progress. In this sense, some teachers talked about the benefits of using student portfolios. For example, teacher T6 stated:

"Portfolios show students' mastery of skills. I consider students' portfolios as a reference tool of students' work where I can observe their performance."

- *Sub-theme (2.3): Peer assessment*

All teachers stated that they found peer assessment is a useful strategy to be used with students. In the interviews, all teachers mentioned that they felt it was important for students to get involved in assessment by assessing their peers. Some examples are given through the teachers' own words:

"What I like about peer assessment is the opportunity that have been provided to children to be active and social by assessing their peers. During mathematics lessons, many tasks should be introduced in a way, which encourage students to build both cognitive and social skills." (Teacher T6)

Teacher T1, along with teacher T4, focused more on students' role in the assessment process. Here, the understanding of alternative assessment was based on some tools which have been designed to let students participate in classroom assessment. Specifically, teacher T1 said:

"Alternative assessment means students abilities to assess themselves and their classmate."

Similarly, another teacher (T4) stated:

"It is using leaflets and projects in assessing students."

- *Sub-theme (2.4): Self-assessment*

Just a minority of teachers indicated their knowledge about the method of self-assessment. This minority stated that they sometimes ask students to reflect on their past work. Moreover, some responses revealed that some teachers deemed self-assessment not suitable to be used with young students, or at least not all students could master this method. In contrast, some participants' responses seemed to suggest that a number of teachers had no knowledge of alternative assessment tools, such as self-assessment. For example, teacher T5 stated:

> "Self-assessment that one.. mmm, I think I do not know about it so I could not use it with my students."

- *Sub-theme (2.5): Positives of alternative assessment*

Responses from the majority of teachers regarding their awareness about applying alternative assessment in mathematics classes were varied, since their comments were based on their experiences in using such assessments. However, the majority of teachers were of the view that alternative assessment tasks kept students enthusiastic while they were being assessed. Teacher T7 explained:

> "Alternative assessment tasks motivate students since they feel that they have a role in assessment process. These tasks are not like pen and paper tests where students have to remember what they have learned."

According to teacher T7, it seemed she agreed that alternative assessment strategies served in assessing different skills, not just memorisation. In addition, some teachers tried to clarify the extent to which they were able to explore their students' skills and abilities. According to these teachers, such skills could not be examined by using traditional forms of assessment. For example, teacher T8 stated:

> "Assessment tools like projects, leaflets and presentations provide me with the chance to know about my students' abilities in many aspects, whereas tests cannot show all students' skills."

Furthermore, the majority of teachers mentioned that alternative assessment tools provided students with the opportunity to draw more attention toward their learning rather than just focusing on passing tests. For example, teacher T6 asserted:

> "Definitely the positive side is that this assessment improve students' awareness of their learning so they do not only focus on passing exams. Also I wanted to indicate that

some students study just for passing exams however, alternative assessment helps them to improve learning by mastering many skills."

It should be noted that a number of teachers pointed out that they found alternative assessment to be a suitable method in promoting students' grades, in the case that students could not get the desired results they were seeking from traditional tests. For example, teacher T10 stated:

"The benefit from alternative assessment tasks is only that I could find other tasks to help my students to get better grades in mathematics."

- *Sub-theme (2.6): Negatives of alternative assessment*

In relation to the reliability of alternative assessment, the majority of participants believed that the results collected from alternative assessment methods were less reliable in comparison to the results come from traditional tests. A number of teachers stated that they could not trust such results to evaluate students' achievement. For example, a criticism of the results from alternative assessments came from teacher T8 who remarked:

"I cannot get an accurate result about students' level by using alternative assessment tools."

Another teacher T3, emphasised that alternative assessment activities could not reveal a reliable level of student achievement, specifically in mathematics:

"I confirm that in mathematics nothing like traditional tests could show me as a teacher my students' performance."

With regard to the accuracy of alternative assessment results, the majority of teachers argued that they knew how to deal with assessment results in the form of numbers. In this sense, those teachers tended to consider assessment results from such tests as more reliable. As teacher T6 claimed:

"It is not accurate as long as I cannot get the results in numbers. Grades are more trusted than any other results. No doubt tests are very reliable."

Indeed, in the interviews a few teachers mentioned that they felt some methods of alternative assessment, such as peer assessment, were inappropriate to be used with young students. This group of teachers provided a reason for their claim by saying that children do not know about the criteria needed in order to be able to assess their peers. In addition, one teacher mentioned that students were much more likely to misbehave in the class while practicing alternative assessments. Teacher T2 claimed:

"I do not like the idea of alternative assessment as it is difficult to control students' behavior while applying these strategies."

That teacher further criticised some of assessment tools like peer assessment as she stated:

"Students do not like to be assessed by their peers. They do not like their peers know about their weaknesses."

It seemed this minority of teachers had been less able to manage student behavior.

Emerging theme 3: Lack of knowledge

The interviews showed that few teachers believed that alternative assessment was related to subject-specific learning strategies. When teachers were explicitly asked about the methods of assessment, some of teachers talked about learning activities and how to apply active learning, which fosters understanding. In this sense, teacher T7 argued that alternative assessment was about seeking alternative strategies to help students to understand mathematical topics. This teacher (T5) stated:

"Alternative assessment is about finding another way to help my students to learn. I mean if the students did not understand I look for another strategy to help them in learning mathematics."

It should be mentioned that the majority of teachers seemed to demonstrate a good knowledge about some of the alternative assessment methods as they referred to various tools of alternative assessment, which they use in assessing their students. However, some teachers' own words showed a lack of a coherent knowledge of what some assessment methods actually involve. Moreover, some responses demonstrated that few teachers had a lack of confidence in applying some methods. For example, one teacher T3 indicated her limited knowledge in using the results of alternative assessment. Teacher T10 stated:

"I frequently, apply many tools of alternative assessment in my classes, but honestly I am not sure how to manage the data from some tools like projects."

7.5.3.2 Assessment interpretations

In order to explore teachers' knowledge about interpreting the information collected in the previous phases of assessment, they were asked the following question: 'What knowledge do you have regarding interpreting assessment results?' The participants' answers were categorised into two emerged themes as follows: criterion-referenced assessment and self-referenced assessment (see Figure 25).

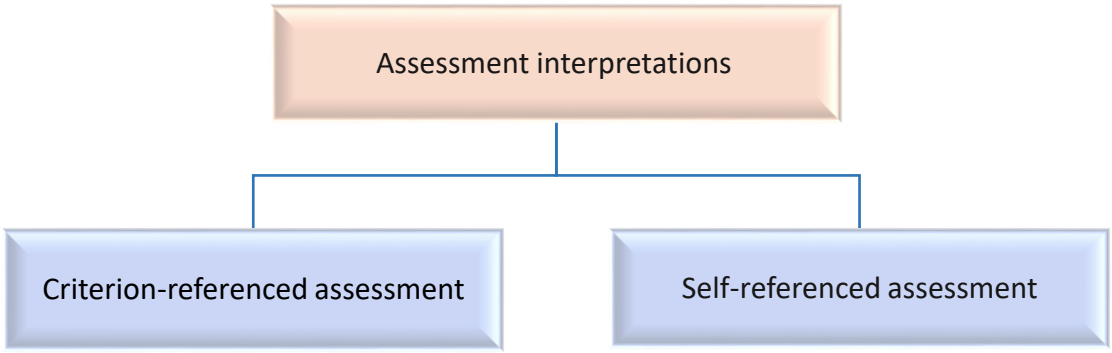

Figure 25: Emerging themes from assessment interpretations

Emerging theme 1: Criterion-referenced assessment

The responses revealed that all participants understood the basis of interpreting students' results in mathematics, which were based on pre-established performance standards. Since the content was determined, a number of teachers further mentioned that they compare students' performance to assessment standards. One of the teachers who talked about students' achievement of learning objectives stated:

> "I grade my students based on defined standards which shows the level of mastery a students must have." (Teacher T4)

In addition, the majority of teachers stated that the predefined performance standard, which they use, guaranteed the equity of assessing students by using the same criteria. For example, teacher T6 stated:

> "The provided performance standards, which based on the objectives of learning, are ideal to make sure that all students are assessed according to the same criteria. Provided equal assessment is very important in assessing students."

Emerging theme 2: Self-referenced assessment

Interview data reveals that about half of teachers talked about self-referenced criteria in interpreting assessment information. This number of teachers mentioned their awareness of monitoring students' progress as a standard of interpreting assessment. Furthermore, these teachers stated that comparing students' performance during a particular period of time was the best chance for student to improve their grades. On that point, teacher T1 stated:

> "I personally…know that I should assess students according to predetermined standards but this is not the only way to monitor students' learning. I always compare my students' results to make sure that they are progressing."

7.5.3.3 Teachers' actions regarding assessment

In daily classroom life, teachers provide various comments to students in relation to their performance. Teachers' responses were assumed to affect the process of learning and teaching. Accordingly, the following interview question addressed teachers' understanding of the actions that should be taken regarding students' learning: What actions should mathematics teachers take regarding students' assessment results? Most of the teachers' responses focused on students' performance but still some responses indicated teaching decisions. The following themes were drawn from the participants' answers (see Figure 26).

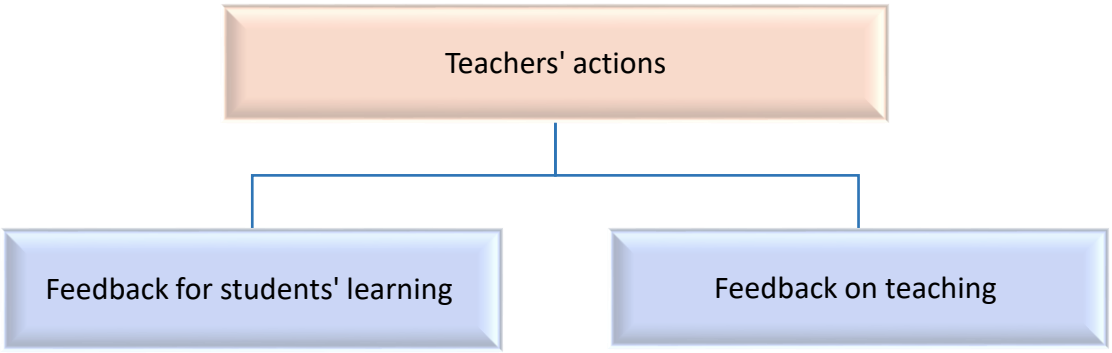

Figure 26: Emerging themes from teachers' actions regarding assessment results

Emerging theme 1: Feedback for students' learning

One of the assessment results' actions by teachers that emerged was that they provided feedback information about what and how students need to improve. Nearly all participants felt the significance of their responses regarding students' learning whether these responses were in the form of physical actions or verbal comments. A group of teachers indicated the importance of their comments on students' work in order to follow their progress. On that point, teacher T4 stated:

> "Children should receive a clear comment from their teacher to help them to understand their weakness and then they could improve. My comments whether it is written or verbal have the power of promote my students' learning and their grades as well."

Another teacher T6 declared that she considered feedback to be the identification of students' mistakes and the assistance in correcting those mistakes. In teacher T6's own words:

> "Although students care about their grades but they still value my written feedback on their papers. Since my comment guide students to the correct answerers in case they do not know. I also feel providing feedback after assessing my students a part of my work."

Emerging theme 2: Feedback on teaching

Another action taken by teachers regarding assessment results was making resolutions about teaching. According to the data, just a few teachers indicated their awareness about how students' results affected their decisions to improve their instruction. This minority of teachers have connected how well they taught to their students' results in mathematics. In addition, these teachers mentioned that assessment data reveals the strengths and weaknesses in their abilities in explaining a new topic or concept. For example, teacher T7 talked about interpreting the feedback to the teacher as whether the learning aims have been achieved. As teacher T7 said:

> "As a teacher who are always keen to improve my teaching, I should consider the data that assessment provide me about my students. These data helps me to identify my failure in meeting the learning objects. In this case I change my plan or set remedy activities."

Similarly, Teacher T10 stated:

> "When I review my students' results I treated this result as an indication of my teaching. I change or improve my instructions based on the students' results. I cannot keep using the same teaching methods when some of my students could not achieve the learning goals."

7.6 Analysis of classroom assessment practices

Mathematics teachers' practices of assessment in primary schools have been investigated within a classroom assessment cycle. This cycle was subdivided into three stages, namely: Before lessons, during lessons, and after lessons. In order to collect the data from the interviewees, I started the interview by asking a number of questions that targeted teachers' practices of assessment before, during, and after mathematics lessons. The qualitative outcomes from participants' responses provided a wide picture of how they applied assessments in mathematics classes. Based on the cycle of classroom assessment, teachers' responses are presented in the next sections under the following subtitles: practices before lessons, practices during lessons and practices after lessons.

Accordingly, under every subtitle there are a number of predetermined themes and emerged themes. The analysis of these themes is presented next.

7.6.1 Assessment practices before lessons

This section is concerned about how teachers handle assessment outside the classroom and before beginning instruction. The collected data is presented under predetermined themes.

7.6.1.1 Planning for assessment

Mathematics teachers were asked the following interview question: 'How do you prepare for classroom assessment before lessons?' Nearly all the teachers talked about planning for assessment activities; however, the data showed that teachers had dissimilar practices regarding setting a plane for assessment. Accordingly, three themes have emerged from the data, which are presented in Figure 27.

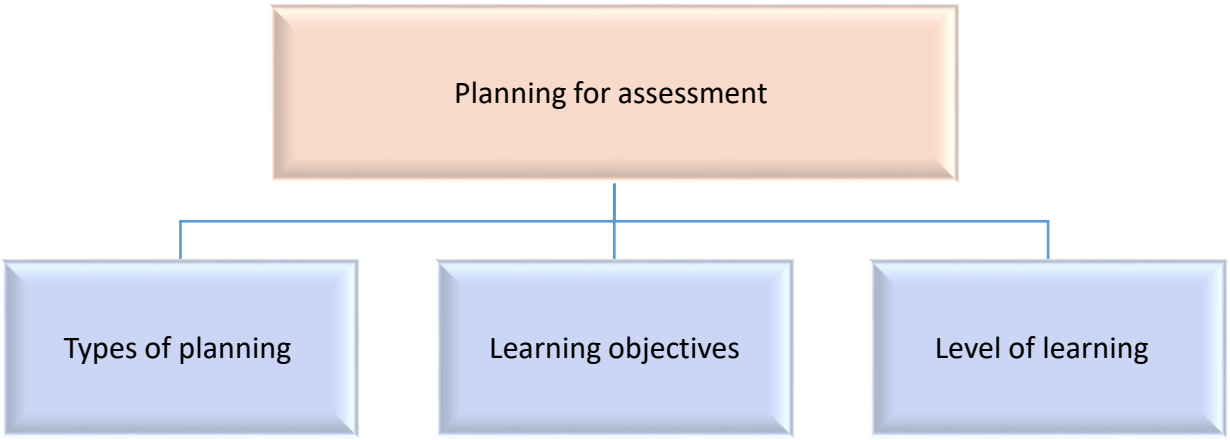

Figure 27: Emerging themes from teachers' practices of planning for assessment

Emerging theme 1: Types of planning

Planning for assessing students was mentioned by participants, since most of the comments from teachers' interviews indicated that all teachers generally set a plan to assess their students. The majority considered planning for assessments as a part of the whole planning process for lessons. Some described the significance of having a plan for an assessment before starting a new lesson:

"How may I start my lesson without preparing assessment activities? I mean the tasks that I will give my students to monitor their performance. Definitely, I consider adding assessment tasks to the lesson plan very essential." (Teacher T10)

The data showed that the majority of teachers were keen to set a written plan for assessment. For example teacher T3 stated:

"I write my plan in my regular notebook and I first consider my students level, then I design or choose assessment activities based on the information I intend to assess or the questions I need to ask."

When talking about written plans for assessment, all participants talked only about planning for the short-term, like setting a daily or weekly plan. Teachers considered that planning for the short-term helped them to be more focused in fulfilling learning objectives and students' needs. On this point, one of the participants said:

"Writing a daily plan makes my work more focused on what I wanted to do in my classes in contrast with planning for the entire term." (Teacher T4)

Although it seemed the majority of teachers were concerned about the written plan for assessment, a few teachers mentioned that they had a plan for assessments which was not written. Those teachers claimed that a mental plan was sufficient to manage classroom assessments since this group of teachers tended to assess at the venue. For example, teacher T8 stated:

"I do have a mental plan. I conduct all my planning for assessment mentally I can deal with it on the spot."

Some teachers clarified their reason for not employing a written plan for assessment, as they believed that they had sufficient experience in teaching; thus, to conduct an assessment in their classes they do not need to set a plan with much detail. For example, teacher T2 claimed:

"I know it is important to have a written plan as it is the guide to any teacher but I have a good experience in teaching so it is easy for me to set my plan mentally. I had no issues at all."

Emerging theme 2: Learning objectives

Regarding the content of an assessment plan, a number of teachers stated that they plan their assessments based on the learning objectives of every lesson.

In this sense, teacher T7 mentioned that she created a detailed plan with a specific focus on learning outcomes and students' knowledge. That teacher stated:

> "I set a written plan by considering learning objectives, students' experiences and how to link the new knowledge with what students already know. Secondly, I determine assessment tools and how to apply these tools with my students."

More teachers wrote a brief plan, as they only focused on the general outcomes of the students' assessment. For example, teacher T6 provided her reasons for not putting so many details in the assessment plan by saying:

> "I write the general points as I plan for the main ideas without details. But I cannot set all details in my plan because at the class co many things might happed which make me change my plan."

It seemed that although some teachers plan for assessment based on learning goals, they were still able to change that plan based on what happened inside the classroom.

Emerging theme 3: Level of learning

The data revealed that the majority of teachers deemed students' levels in mathematics an important element in planning assessment activities. This small minority of teachers stated that they likely reflected on what students can currently do and what is truly important for students to be able to do. Such considerations were the basis of these teachers' selection of assessment activities. For example, teacher T6 stated:

> "I need my students to be able to think mathematically. So, I set assessment tasks that inform me about students' higher order thinking skills. According to students' results I can set a remedy plan to achieve my goals with students."

7.6.2 Assessment practices during lessons

The term 'during lessons' is used in this section to address teachers' assessment practices during teaching and the learning process. Accordingly, teachers were asked questions aimed at investigating how teachers collect assessment evidence during mathematics classes. Teachers' responses have been categorised into the following predetermined themes: type of assessment evidence, assessment methods, questioning, and feedback.

7.6.2.1 Type of assessment evidence

Teachers have been asked the following interview question: 'When conducting assessments in your class, what assessment evidence do you collect about your students?' Examining the data showed that the participants collected many types of evidence; however, the vast majority was intellectual evidence. The themes that have emerged from the data are presented in Figure 28.

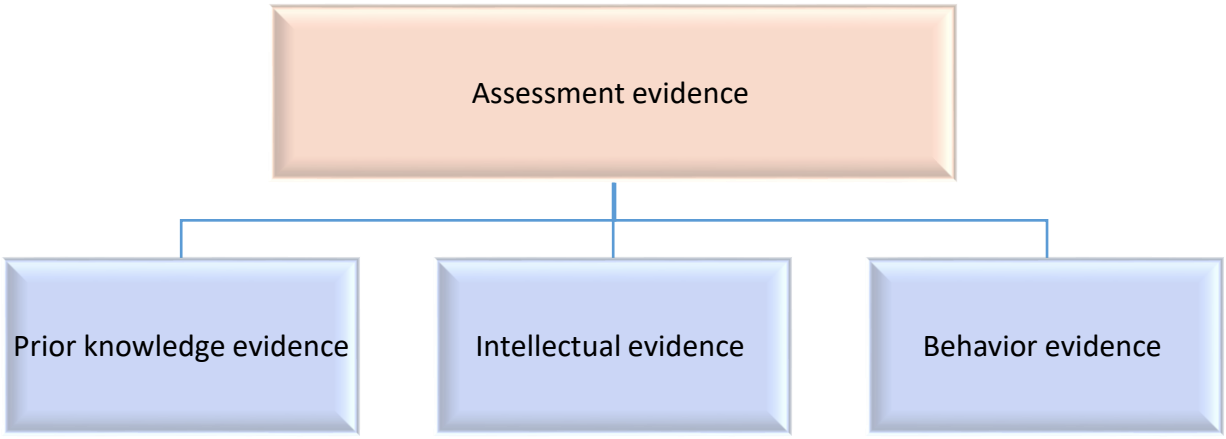

Figure 28: Emerging themes from the types of assessment evidence

Emerging theme 1: Prior knowledge evidence

The majority of teachers stated that they ask students some questions at the beginning of the lesson in order to evaluate students' prior learning and recap previous lessons. In this sense, teacher T5 stated:

> "It is important for me as a mathematics teacher to know what my students have achieved from past lesson before presenting any new information."

The same idea stated by another teacher T9 by saying:

> "Learning mathematics like constructing a building you cannot move forward without make sure that every students have the minimum knowledge to progress. Dedicating sometime on introducing the new knowledge by asking and communicating with students will ease the rest of lesson."

Teachers' comments in the interview revealed that they considered this stage as a good start for any new lesson, but it must be conducted in a prompt action. For example, teacher T3 stated:

"The ultimate purpose of assessing students before starting instruction is to grab students' attention and to know from where you should start. Frankly, I always ask quick closed questions and expect to get quick responses."

Emerging theme 2: Intellectual evidence

The data revealed that all teachers stated that they primarily conduct assessments in order to collect evidence about students' learning. Assessing students' level of achievement in mathematics both formally and informally was frequently mentioned during the interviews. The data also revealed that the teachers gathered a wide range of academic evidence in order to serve many purposes such as diagnostic, formative, and summative information. For example, teacher T7 said:

"Assessing students is a part of any lesson. So, I mainly ask questions and communicate with students to know about their learning not only in the past lessons but the new lesson too. Moreover, assessing for grading is a part of teaching and learning process."

Furthermore, the majority of teachers mentioned that their most frequent practices were to assess students' comprehension and application of mathematical knowledge. Teachers also stated that when they had the chance, they provided questions to assess higher level objectives. It should be noted that the data also showed that a few teachers stated that they feel all levels of knowledge are important to be assessed, and they prepared assessments to inform them about both lower and higher-order thinking. For example, teacher T10 stated:

"I choose assessment questions to tell me about my students' abilities in mathematics. I never focused on lower level like memorisation or comprehension. Normally I divided my questions to cover all levels of knowledge."

Emerging theme 3: Behavior evidence

From teachers' responses, it was clear that the majority of teachers said they usually assess students' behavior during lessons. These teachers stated that children have to learn how to behave kindly with other children and with teachers, as well. For example, teacher T2 said:

"Children need a lot of control. Then need to learn how to stay calm and respect the class. It is important to write reports about children manners and send these reports to parents regularly."

7.6.2.2 Assessment methods

In order to explore mathematics teachers' use of assessment strategies in collecting assessment evidence, they have been asked the following interview question: 'How do you assess students in mathematics?' The data revealed that teachers assess students using a number of methods. The data emerged are presented in detail next (see Figure 29).

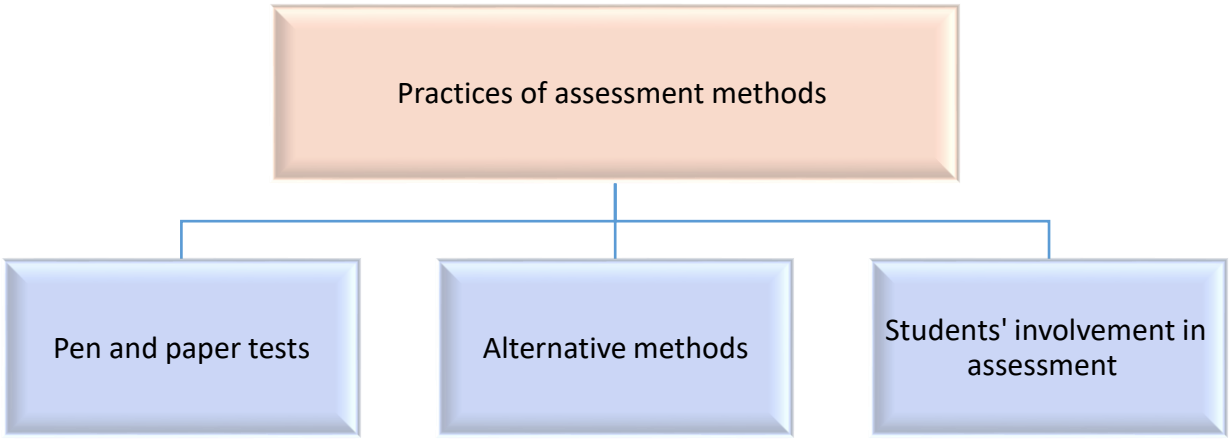

Figure 29: Emerging themes from teachers practices of assessment methods

Emerging theme 1: Pen and paper tests

All teachers expressed their views about applying assessment tools in mathematics classes. All teachers agreed that they used tests to collect evidence about student achievement, since they considered tests as the most reliable tool to reflect students' levels of achievement, specifically in mathematics. Many examples were given by teachers to show the importance of testing students. On this point, teacher T3 stressed:

> "How may I know about students' achievement in mathematics without testing them? I can use many tools to assess my students but in the end, I only trust the result when it comes in a form of numbers."

Similarly, teacher T5 was in agreement and stated:

> "From my experience, using paper based exams in mathematics are the best way to assess students. Other tools may help during learning processes."

Some teachers considered tests an essential factor that encouraged students to study and parents to follow up with their children. For example, teacher T8 claimed:

> "We do encourage parents to pursue children at home but, some parents normally do not deal with it seriously till assessment time. Exams should boost children to devote more effort on studying."

Emerging theme 2: Alternative methods

In addition, apart from using traditional tests, the majority of teachers mentioned that they had used a variety of assessment tools during mathematics classes; these included leaflets and peer assessment. Other forms included projects and self-assessment. According to the participants, the purpose of using such assessment tools was mainly for monitoring student learning during lessons. As teacher T6 stated:

> "I try to apply many methods to follow up my students learning. However, I use mostly leaflets and peer assessment. These tools do not consume the lessons' time. Occasionally I use projects about one or two projects during the term as they need an extra time to conduct and assess."

However, a group of teachers specified that they have used a number of alternative assessment tools with low ability students in order to improve their final grades. Also, these participants claimed that presentations as an assessment tool was only appropriate with high achievement students. They believed that not all students should be assessed in the same way. Sample comments included the following:

> "As a teacher, I provide assessment methods to my students based on their level of achievement. I mean some students could not get a good grades on tests in this case I assess them with different ways just to support them and help them to improve." (Teacher T1)

> "I let high achievement students present some parts of the lesson. I use this method with only such students. Other students can learn from their colleagues' presentations. Some assessment activities could not be used with low performance students." (Teacher T4)

Emerging theme 3: Students' involvement in assessment

Comments from the teachers indicated that they had provided their students with the opportunity to get involved during mathematics classes.

Typically, students had the chance to assess their peers' work. For example, teacher T5 stated:

> "The most common way for me to let my students taking part in assessment, is assessing their classmates."

However, the majority of teachers stated that they employed this strategy for assessment only with high achievement students. In this sense, most participants claimed that only such students were capable of using this strategy. Thus, these teachers explained their reasoning by stating high achievement students were aware of how to assess more than other students. For example, teacher T6 claimed:

> "I provide students with the chance to be a young teacher or assessor, but I only let high performance students to assess other students. The reason is that I am quite sure they know how to assess their peers. I trust them based on their performance in mathematics."

Similarly, teacher T10 confirmed:

> "My students get involved in assessment by practicing peers assessment however, I let high achievement students doing that with their colleagues. Then I check students' work."

A number of teachers mentioned group assessment, as teacher T7 claimed:

> "I let high achievement students assess either peers or groups, then I discuss with the class how she assessed."

Only a minority of teachers indicated that all their students had the opportunity to assess themselves. Teacher T9 stated:

> "I let students assess their peers and most importantly when students assess their own work, I always ask students to become an assessor to themselves."

Another teacher (T3) noticed that she seldom used self-assessment since it is not suitable to be used with children, as she explained:

> "I do not use this tool with my students. It is difficult to explain for children how to correct their errors or to be a self-assessor."

7.6.2.3 Questioning

Teachers were asked about the questions they use in collecting assessment information by asking the following question: 'What type of assessment questions do you apply in your classes?' The themes that have emerged from teachers' responses are presented in Figure 30.

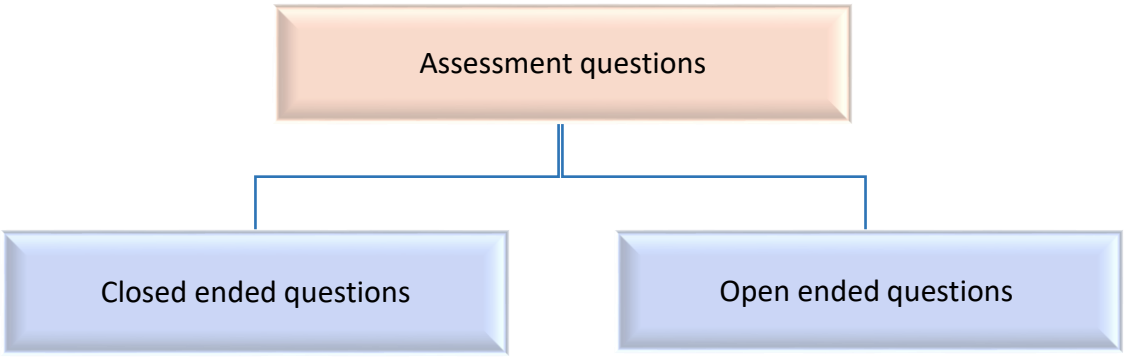

Figure 30: Emerging themes from teachers' assessment questions

Emerging theme 1: **Closed ended questions**

All teachers seemed to use closed ended tasks for assessment, either oral or written, for assessment purposes. In the interviews, all teachers mentioned that they regularly apply oral closed questions to encourage students to interact with the teacher. Some teachers further stated that by using such questions they could observe whether students understand what had been taught. One teacher (T3) stated:

> "Questions that have only one correct answer is my main way in asking questions to assess students in different stages in the lesson. This kind of questions is appropriate in mathematics."

Similarly, the majority of teachers stated that they often asked students to answer questions in the form of routine closed mathematical problems.

Emerging theme 2: Open ended questions

Based on teachers' responses, it seemed more than half of teachers stated that they used open ended questions in assessing students' knowledge about some concepts in the lessons. However,

these teachers stated they used this type of question only in formal assessments for summative purposes. On that point, one teacher (T9) stated:

> "In students' textbooks many open ended tasks I use these questions to challenge students and to know their understanding level. I never use these tasks in final assessment."

7.6.2.4 Feedback

Teachers have been asked the following interview question: 'How do you provide your students with feedback?' Examining the data showed that the participants provided feedback in many ways. The themes that have emerged from teachers' responses are presented in Figure 31.

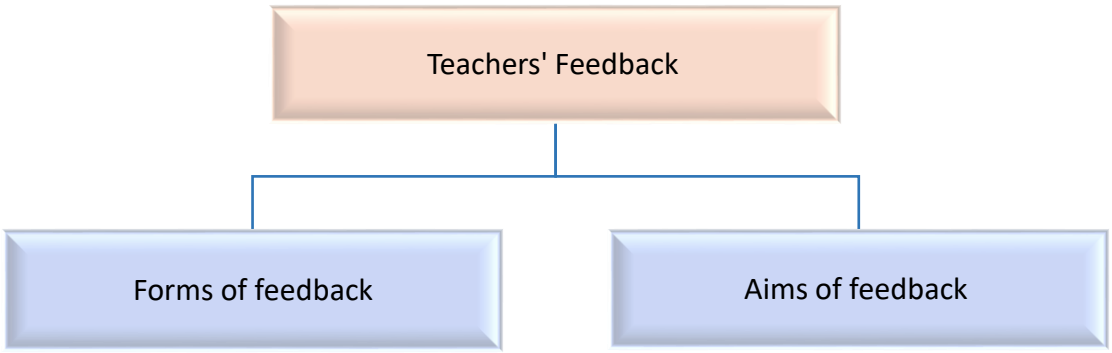

Figure 31: Emerging themes from teachers' feedback

Emerging theme 1: Forms of feedback

The majority of teachers pointed out that they mostly provided their students with feedback in a written format. In this sense, one teacher talked about the importance of giving written feedback, particularly for children, as she stated:

> "Usually children need written sentences to describe either their work or weakness. It is a very helpful way to students' parents too, as they can refer to these comments when needed. Moreover, that helps parents to know about students' progress. By doing so, I make sure that my comments will be benefiting my students." (Teacher T7)

The teacher accordingly highlighted the role of written feedback in keeping parents conscious of their children's learning. Likewise, another teacher supported the value of written feedback in teaching mathematics as she stated:

"I deem feedback particularly written feedback a part of my teaching strategies. I combine written feedback with my teaching according to the nature of mathematics." (Teacher T10)

Similarly, teachers' responses in the interviews showed that a number of teachers provided oral descriptive feedback in order to observe students' learning during the classes. The teachers clarified that the oral comments were given specifically when they recognised any lack of understanding. For example, teacher T5 stated:

"I walking around the class and provide my help when I realised any students need it. I give students a feedback to boost them while learning. A little oral comments sometimes help."

Another clarification provided by a number of teachers was that they normally wrote some comments on the board at the end of the class for all students regarding their performance. For example, teacher T2 claimed:

"Writing comments on the board is a very suitable technique to let students know about their mistakes."

The same teacher talked about writing the right answers of the tasks on the board, as a way of providing a written feedback on students' classwork. In this sense, teacher T4 said:

"In order to give a feedback, I write the answers of challenging questions on the board and then, let students check their answers. I think that way keeps students aware of the right answers before the end of the class."

With regard to the descriptive feedback, several teachers' responses showed that they gave much time to writing comments on students' homework in order to help them to understand. For example, teacher T9 stated:

"In general, for a written feedback I care about writing my comments on the homework. I believe that is the best way to provide feedback to the children since these comments help them to improve."

The majority of teachers' responses in the interview revealed that they considered oral feedback right after exams as one of the best ways to help students to progress and learn from their mistakes. For example, teacher T1 said:

"I always review exams with my students, right after they get their grads. So students know the correct answers and they become more keen to improve."

Emerging theme 2: Aims of feedback

On analysis of the data, it became evident that most feedback provided by teachers aimed to promote students who were working in groups or individually. All teachers agreed that the main aim of providing feedback was to encourage students to improve learning or to get the right answer. On the other hand, just a small minority of teachers mentioned that students' results also provided feedback on the teachers' performance. On that point, teacher T10 said:

> "I reflect on student interaction during lessons when I noticed any problem that provide me with an indication to change my way."

7.6.3 Assessment practices after lessons

In order to explore teachers' practices of assessment after lessons, they have been asked questions regarding how they interpret and use assessment results. The following sections represent the analysis of the teachers' responses.

7.6.3.1 Interpreting assessment information

In examining how mathematics teachers interpret assessment results, participants were asked the following interview question: 'How do you interpret collected assessment evidence?' All participants have talked about the standards they use and the kind of data they refer to. Teachers' responses have been categorised into two emerging themes, which are presented in Figure 32.

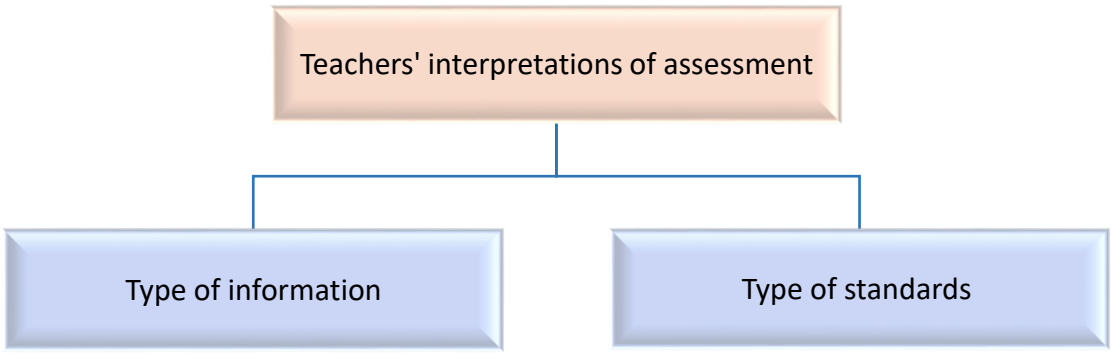

Figure 32: Emerging themes from teachers' interpretations of assessment

Emerging theme 1: Type of information

The majority of teachers confirmed that the main source of assessment data was traditional tests. Thus, those teachers stated that they only analyzed quantitative data in order to determine the achievement level of students. For example, teacher T1 stressed:

> "Although I use many activities in my classes, still traditional tests are the best way to evaluate students particularly in a subject like mathematics."

There were many comments from teachers to clarify the reasons behind the use of quantitative evidence only, despite the fact that they already collected quantitative information. It was apparent from these comments that teachers had little knowledge about how to analyze qualitative data. In this sense, teacher T3 stated:

> "I have no experience on analyzing qualitative data. I prefer to deal with numbers."

Another teacher (T5) said:

> "I have never been trained in how to use qualitative data. So, I cannot evaluate students based on this evidence."

In addition to issues of knowledge, teachers viewed qualitative data as less trustworthy than quantitative data. These teachers stated that they did not want to spend time on analyzing information that did not accurately reflect students' level of achievement. For example, teacher T6 explained:

> "I collect qualitative evidence about my students but I believe that data does not always show students' levels of achievement. Some students provide a good leaflet or project, but then they performed poorly on tests."

However, only two teachers indicated that it was useful for them to analyze qualitative data. One teacher T7 further stated:

> "Both data were essential to analyze in order to draw a conclusion about my students."

Emerging theme 2: Type of standards

All teachers stated that they have to follow the standards provided by the Ministry of Education to interpret students' results. Teachers further stated that they refer to provided assessment criteria in case they were about to provide the final grades to the students. On the other hand, teachers stated they regularly observed students' performance over the academic term since this

helped them to know whether the students' performances were improving. For example, Teacher T10 stated:

> "I evaluate students based on predetermined standards. However, I regularly follow up my students' achievement and write notes about students' results and from time to time I talked with students in case they need any remedy plan."

7.6.3.2 Using assessment results

In order to investigate mathematics teachers' use of assessment results, they were asked the following question: 'How do you use students' assessment results?' Teachers' responses have been categorised into two emerging themes, which are presented in Figure 33.

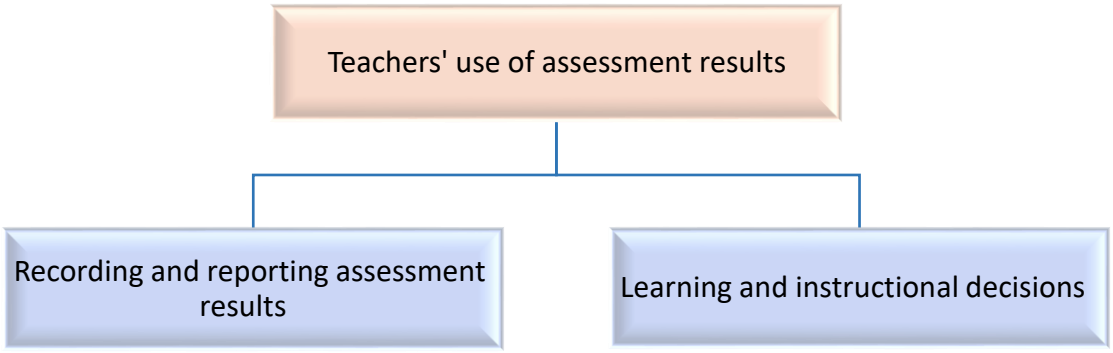

Figure 33: Emerging themes from teachers' use of assessment results

Emerging theme 1: Recording and reporting assessment results

Most of the comments from participants about using assessment data showed that they preferred to record quantitative data. The majority of teachers pointed out that they mostly record the best grades the students achieved on the same skill. Some teachers clarified the rationale behind recording best grades, as teacher T4 stated:

> "I conduct many tests to assess my students in one or two lessons. Then, I normally record the best grades for students. That motivate students to learn mathematics."

On the other hand, a number of teachers believed that recording best grades was not a valid way to evaluate students' achievement. Those teachers instead stated that they recorded students' grades after calculating the average of the grades. For example, teacher T7 claimed:

"I think it is not fair to choose the best grades for students. We need to provide students with fair grades. The average grades in tests that assess same skills is the right solution."

Most teachers mentioned that they retained students' qualitative information in the students' logs. However, a number of these teachers admitted they did not have such logs for all students. For example, Teacher T8 indicated:

"Students' logs used only for high or low achievement students. It is good to hold students work like leaflets in logs. I honestly focus on high or low achievement students to have logs as these students need more care than other students need."

Teachers' responses showed that all teachers communicated with schools leaders and parents to provide reports about students' learning results. This included the results after every learning phase.

Moreover, the participants were asked about communicating with parents in terms of reporting students' performance during the learning process. Most of the comments revealed that the majority of teachers regularly sent reports in order to engage parents in the assessment process. For example, teacher T9 said:

"It is important to inform the parents about their children performance during the term. As a teacher, I need parents' help at home without involving them in assessment they cannot follow up their children."

Another teacher T3 stated:

"Sometimes I do not have time to write report but I communicate with parents by phone or I ask to meet them."

However, a number of teachers indicated that they only communicated with low achievement students' parents in order to provide them with a picture of their children progress. In this sense, teacher T1 said:

"There is no need to communicate with all students parents only when students facing challenges or problems in learning."

Emerging theme 2: Learning and instructional decisions

In general, all teachers pointed out that they used students' results in supporting student achievement level. A group of these teachers' comments showed that they strongly focused on

improving students tests grades in order to enhance students' general achievement. For example, teacher T9 stated:

> "Students' grades on tests are very important to either the student or me. Based on students result I can set a plan to improve their performance."

On the other hand, a minority of the teachers indicated that they considered students' results a real signal to their teaching. These teachers talked about how they worked on changing instruction strategies after reporting students' results. In this sense, teacher T7 stated:

> "Every term and after reporting students' results, I review these results. Then I think about my practices during the term. I do not set a plan for perfecting my instruction but I record the main points that I need to work on."

7.7 Analysis of the impact of context

The data has pointed out the role of contextual factors in classroom assessment. Some of these factors affected both teachers' knowledge and implementations of assessment in mathematics. The following is the analysis of the data regarding the impact of context.

7.7.1 The impact of context on teachers' knowledge of classroom assessment

The participants were asked the following interview questions: 'Can you tell me how you learned about classroom assessment?' 'What contextual factors do you feel have an impact on your knowledge of classroom assessment?' The participants referred to the role of institutional contexts in their knowledge about assessment. The data revealed a number of issues, which have been categorised into the following emerging themes: lack of support from educational supervisors, lack of collaboration among teachers, and lack of training programs (see Figure 34). The following analysis will describe what participants mentioned about these obstacles. The following analysis will describe what participants mentioned about these obstacles.

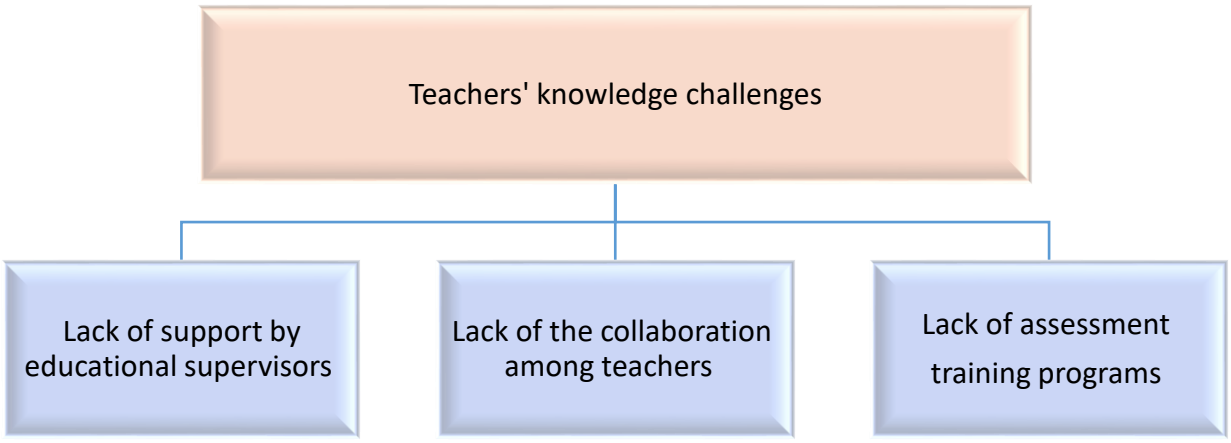

Figure 34: Emerging themes from the impact of context on teachers' knowledge of assessment

Emerging theme 1: Lack of support by educational supervisors

The findings indicated that a few teachers considered the lack of support from educational supervisors an impact factor on these teachers' knowledge of assessment. Although this is a relatively small minority of participants, they still raised this issue, which clearly needed to be considered. These teachers stated that they have received a sufficient support by their educational supervisors regarding teaching methods and learning activities; however, they had less support in relation to classroom assessment. For example, teacher T3 stated:

> "Since I started teaching mathematics, I had a lot of help form my supervisors. However, the main concern was teaching and learning so I have a good experience about the teaching of mathematics. I mainly count on pen and paper test not because I trust this method in assessing students but I feel need to know more about assessment."

In addition, teachers claimed that they needed more advice about how to apply some methods of classroom assessment, specifically in mathematics, not just about the regulations of assessment in primary schools. On that point, teacher T1 said:

> "Personally, I conceder assessing students by using methods other than traditional tests quiet challenging. That because we received a lot of information about the regulations and rules of assessment. It would be helpful if my supervisor provide with some information about other assessment activities."

In much the same vein, another teacher (T8) indicated that she needed to share the knowledge about assessment with the educational supervisor. Teacher T8 commented:

"When the supervisor visited me and made her observation, she asked the students some questions to assess their performance. It would be very helpful if I could share some knowledge about how to use various assessment along with the traditional methods."

It seemed that this group of teachers found that the major instructions from their supervisors were about the new regulations and the criteria of assessment which was recently reformed in primary schools. For example, teacher T1 said:

"My supervisors regularly talked with me how to follow the criteria and checked some students' results just to make sure that I am grading students correctly."

Emerging theme 2: Lack of the collaboration among teachers

The findings also showed that two teachers indicated the lack of support from other teachers who had experience in teaching mathematics. As one teacher (T10) said:

"I understand that my knowledge could be promoted when some teachers who have had good experience about teaching and assessment exchange their knowledge with me. However, some teachers are not supportive."

The other teacher (T2) reported the interaction among teachers plays an important role that contributes to the knowledge of mathematics assessment. This teacher (T3) commented:

"At the most event, teachers do not discuss with each other any matter regarding teaching. If any collaborations and interaction have been done we could learn from each other and then we could address any challenges we may have for example, assessment."

Emerging theme 3: Lack of assessment training programs

The fact is that the majority of teachers mentioned that the lack of training programs in classroom assessment has contributed to their insufficient knowledge regarding assessment. Based on most of the participants' responses, they had the sense that if they could have had a sufficient training related to classroom assessment they would have a better knowledge. From an interview with teacher T9:

"We need a regular training in order to learn about any new strategies in teaching and assessment. However, not many training in the field of classroom assessment."

Furthermore, a number of teachers stated that they have attended many training programs in different aspects of teaching, but nearly none of those programs were targeted at classroom

assessment. In this sense, teacher T7 claimed that all knowledge she had was according to her reading:

> "I can say that I have a little knowledge about assessment as I never attended training programs on assessment. All my information about assessment was based on self-learning."

Similarly, teacher T8 referred to her previous education; she stated that she only studied one course in assessment in university. Accordingly, teacher T8 mentioned the need for more workshops in assessment:

> "During my academic years I studied one module in assessment. It is not enough so why did not the educational department support the teachers by providing workshops in assessment. I know we received some training but the majority of this training is not about assessment."

7.7.2 The impact of context on teachers' practices of classroom assessment

In order to investigate the role of context in teachers' practices of assessment, they have been asked the following interview question: 'What is the impact of context on your practice of classroom assessment?' The participants have mentioned various challenges in conducting classroom assessments in mathematics. According to the data, five themes have emerged as follows: workloads and curriculum length, time barrier, classes size, lack of equipped classrooms, and the role of students' parents (see Figure 35). The analysis of the emerged themes is presented next.

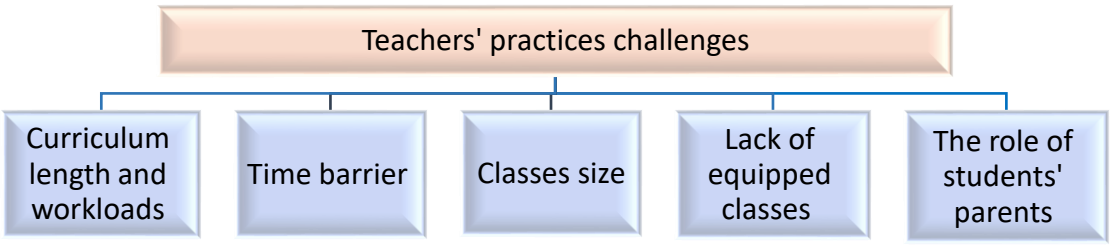

Figure 35: Emerging themes from the impact of context on teachers' practices of assessment

Emerging theme 1: Curriculum length and workloads

The intensity of the mathematics curriculum was one of the challenges mentioned by teachers. This included the number of topics in mathematics' textbooks, which needed to be taught each term. On that point, teacher T3 talked about how the teachers have to follow the textbooks, as they do not have the right to choose what topics to teach. In teacher T3's own words:

> "I have to teach every page in the textbook. Honestly, the new textbook are very intensive which put an extra load on me. Most of the time I apply traditional assessment for that reason."

Similarly, one group of teachers believed that the number of examples and exercises in the current mathematics textbooks was way too high. In relation to that issue, these teachers proposed a reduction in curriculum intensity, as that would save them some time during the classes to apply different assessment methods. Some indicative comments included:

> "Students' textbooks are full of topics and exercises also; we do have students' workbook. I do not have enough time to cover all that content. Thus, I focus on traditional and alternative assessment but this is put me under alt of pressure." (Teacher T5)

> "The new textbooks are good but there are a lot of lessons that could be combined in one or two lessons to save time and effort so I could practice assessment in many ways." (Teacher T8)

> "Mathematics syllabus is very heavy, as a teacher I have to follow the syllabus." (Teacher T2)

Accordingly, the length of the curriculum has a role in the dominance of traditional assessments in mathematics.

Furthermore, a number of teachers claimed that the high number of weekly mathematics teaching periods compared to other subjects was an additional workload issue. For example, teacher T4 said:

> "The average of teaching periods is 20-24 a week, it is difficult with mathematics."

Emerging theme 2: Time barrier

One group of teachers mentioned the issue of the time limits for finishing assessment work during the school day. It was stated that they sometimes had to complete such work at home, which they saw as a burden on them and their personal lives. For example, teacher T7 claimed:

"Some days I forced to take students' work with me home to correct and write comments. I have been asked to do many tasks besides teaching during the day so time is very limited."

In addition, a minority of the teachers mentioned that low students' level of achievement might affect their abilities as assessors, and this can be time consuming, too. They further clarified that some students in the higher grades (such as grade 5 or 6) did not have the sufficient skills in mathematics for that level. As a result, teachers concentrated on such students during classes, which consumed their time to use different methods of assessment. For example, teacher T10 explained:

"I teach grade 6 some students cannot remember core skills that they studied last year like multiplying numbers or fractions. I have to work on them, which affect my time in the new lessons."

Emerging theme 3: Classes size

Intensive school workload was identified as one of the challenges teachers faced concerning classroom assessment. Specifically, the majority of teachers talked about the large number of students in classrooms. Teachers also reported how it was difficult to apply different methods of assessment in such large classes with a subject like mathematics. For example, teacher T2 stressed:

"I am teaching one of the most difficult objects to learn. With more than 37 child in one room, it is tough to apply many tools to assess students."

The issue of class size was also considered as a serious issue that may affect teachers' practices of assessment and prevent them from using some assessment strategies. For example, teacher T1 commented:

'The distribution of students' seats sometimes restricted my strategies' in assessment. I mean in small classes it is difficult to conduct and manage some activates."

Emerging theme 4: Lack of equipped classes

As regards equipped classes, during the interview a number of teachers indicated that there was a lack of learning resources in their schools. According to these teachers, technical equipment in the classroom was insufficient to enable teachers to apply different methods of learning and assessment. For example, teacher T 4 stated:

"I would like to benefit from learning resources, but my school is very poor in learning equipment."

This view was supported by teacher T5:

"Technical equipment such as projectors, TV sets and computers were very important materials to enable teachers use these tools with students either learning or assessment."

In addition, all responses that I have received regarding the open ended question in the questionnaire were about the lack of equipment in classes and the extent to which this problem may limit teachers' practices of teaching and assessment. As one teacher wrote:

"The shortage of technical tools was clearly noticed in the classrooms that I teach. I consider this one of the challenges in assessment." (questionnaire's Participant).

Emerging theme 5: The role of students' parents

The majority of the teachers indicated that some students' parents also affected their practices of assessing students in mathematics. Teachers further stated that some parents did not want their children to be assessed with methods other than the traditional methods. The lack of trust in using some assessment tools from some parents forced these teachers to assess their students traditionally in order to provide parents with evidence about their children. In this sense, teacher T1 clarified this problem by saying:

"Some parents believe only in tests. They cannot realise that their children could be assessed in many ways. They keep asking me for tests results."

Another teacher T8 talked about the same point:

"When I use peers assessment or projects assessment some parents still need a traditional test specially, when they did not like their children grades. They keep asking about the reason of getting such grade and in the end, they claimed that was not a reliable grade. Thus, I graded my students traditionally."

From the findings above, it is clear that students' parents play an influential role in teachers' current practice of mathematics assessment.

7.8 Summary

In this chapter, I have presented the qualitative analysis of the findings based on the classroom observations and teachers' interviews. The data was collected from 10 mathematics teachers in primary schools in Saudi Arabia. The findings showed that current knowledge of assessment held by mathematics teachers appears to be varied in terms of the purpose aspect and the implementation of assessment. The findings also revealed various practices of assessment during the cycle of classroom assessment. The findings also mentioned a number of factors that affect teachers' knowledge and practices of assessment in mathematics classes.

Chapter 8: Discussion

8.1 Introduction

This chapter aims to provide profound insight into the results of the study based on the objectives of the study. This chapter is divided into six sections based on the research questions. The chapter starts with an introduction, then it presents a discussion of Saudi Arabian mathematics teachers' knowledge of classroom assessment in primary schools. The chapter then presents a discussion of the teachers' practices of assessment in mathematics classes, followed by a discussion of the relationship between teachers' practices of assessment and their knowledge. This chapter also presents a discussion of the factors in contexts which may influence teachers' knowledge and practices. The last question in this chapter presents a summary of the findings. In this chapter, the discussion of the findings, which were obtained from both quantitative and qualitative data, is presented in a way which provides the most analysis and synthesis. Then, the results of the current study will be compared to the findings of the existing, relevant literature. Finally, a reflective interpretation regarding the findings of the study.

8.2 Mathematics teachers' knowledge of classroom assessment

The knowledge of assessment held by mathematics teachers in primary schools was explored quantitatively by using a questionnaire to gain a general view about teachers' knowledge regarding classroom assessment, through the responses of a large sample. In addition, the different forms of teachers' assessment knowledge was explored qualitatively by using semi-structured interviews with a smaller sample to obtain a better understanding and more in-depth information. This answered the following research question:

What knowledge do mathematics teachers have about classroom assessment in Saudi Arabian primary schools?

The discussion of both quantitative and qualitative results is presented by the following domains of classroom assessment knowledge: the purposes of assessment, the aspects of assessment, and the implementation of assessment.

8.2.1 Knowledge of the purposes of assessment

The data obtained from the questionnaire in relation to teachers' knowledge of the purpose assessment showed that the participants' overall average score on the knowledge of 'why to

assess' scale was (M= 3.25, SD= 1.02), reflecting the second highest mean among the three domains of classroom assessment knowledge. Consequently, the value of the mean demonstrated that, in general, mathematics teachers had a fair knowledge about the purposes of classroom assessment.

In fact, it is significant to point out that the majority of mathematics teachers generally were able to distinguish between the two forms of assessments, summative and formative, in terms of timing. It was stated by Torrance and Pryor (1998) that the amount of time involved in conducting an assessment is the main difference between summative and formative assessments.

With regard to summative assessment, quantitative results evinced that a majority 80% of teachers were aware of assessment for summative purposes. This result was confirmed by the results collected from the interviews, in which nearly all teachers in this study showed an adequate understanding regarding the general meaning of summative assessment, and why and when it should be conducted in mathematics classes. At the basic level, all of the interviewees' responses described summative assessment as an evaluation of students' work in order to summarise their achievements at the end of units, terms, or any other major academic time period.

Nevertheless, just a small minority of participants defined summative assessment with reference to learning objectives. From the findings, it could be recognised that the majority of mathematics teachers have restricted the term 'summative assessment' to evaluate either students' understanding or achievement, rather than to fulfil the learning objectives. According to Glaser (1990), assessments should collect the necessary data that teachers and policy makers need to know about students. A possible reason for this is the mathematics teachers’ concern for students' grades. This worry about achieving good grades in mathematics is prevalent in Saudi society. However, learning objectives enclose both cognitive and affective aims (Rowntree, 1987). Additionally, teachers in this study stated that they evaluate their own teaching based on their students' grades in mathematics. That may justify why teachers care a lot about their students to get high grades in mathematics.

It should be noted that, during the interviews, teachers mentioned various purposes for using summative assessment, such as grading and evaluating, which underlined the majority of mathematics teachers' understanding of this form of assessment. This finding is in line with Harlin's (2012) views regarding why teachers should use summative assessment. Accordingly, this result provided good indications for this study, as it confirms that teachers had sufficient knowledge about assessment for summative purposes. It seems it is not surprising to find that mathematics teachers are familiar with the term 'summative' and the aims of applying this form

of assessment. It looks as if knowing about assessment is knowing about the whole process of instruction (Airasian, 2000; Popham, 2014). In other words, assessment is something that teachers use every day; as Earl (2013) claims, assessment is a common process in teaching and learning and it is a part of the daily routine of any teacher.

On the other hand, the qualitative findings of the study showed that a number of participants claimed that summative assessment is about monitoring students' learning and knowing about students' need. However, many researchers have suggested that summative assessment cannot be efficiently applied in enhancing students' learning (Black and Wiliam, 1998a; Taras, 2005). According to McMillan (2008, p. 7):

> "Formative assessment is designed to extend and encourage learning; summative assessment is used to determine how much students have learned, with little or no emphasis on using results to improve learning"

Furthermore, the qualitative findings showed still that a small minority of interviewees were not sure about the type of assessment that they normally applied at the end of every class. These teachers were undecided on whether to consider such assessment summative or formative. The result from the questionnaire confirmed this finding, as just less than 7% of respondents indicated their disagreement with the statement, "I know the purpose of summative assessment". Although this result has been demonstrated by a small number of participants, it yet indicates that this minority had a low level of knowledge in relation to classroom assessment.

In addition, the data collected from the questionnaire revealed that about half of participants were aware that assessment could be used as a tool that could serve many aims in mathematics classrooms, other than testing students or writing reports. This result also reflected on the majority of participants' responses during the interview, since they have mentioned other purposes of using assessment in mathematics classes. What teachers mentioned was mainly concentrated on improving students' grades in mathematics and addressing any difficulties in which students may face.

Furthermore, it was interesting to find that although the majority of teachers were able to distinguish between summative and formative assessment, they showed different levels of knowledge about formative assessment. On that point, it was found that a number of teachers during the interviews could not articulate their understanding of the term 'formative assessment'. For example, when teachers were asked how they understand formative assessment, a number of teachers asked to clarify or repeat the question. In other words, participants in this study had contradictory knowledge either about the term 'formative assessment' or its role played in the

process of learning and teaching. This result has been confirmed by the findings of the quantitative part of this study, since 50% of respondents were unable to either agree or disagree that they knew about the purposes of formative assessment. Significantly, the majority of the teachers had little knowledge about the meaning of formative assessment. These results are consistent with some studies in Saudi Arabian contexts, which found teachers' understanding of formative assessment is likely limited (Al-rumaih, 2009; Alaudan, 2014; S. Alghamdi, 2015).

Qualitatively, it is noticeable that the majority of participants use the words 'grade', 'correct errors' and 'performance' rather than the word 'learning'. These conceptions regarding formative assessment was also mentioned by Hargreaves (2005) who found that a group of teachers frequently used the word 'performance' rather 'learning' in order to define assessment for learning. Black and Wiliam (1998b) states that formative assessment is the process of collecting evidence in order to be used by both teachers and students to decide how far the students are from the learning objectives and what they need to achieve these objectives.

In addition, most of the participants thought that there was no relationship between teaching and assessment. This was demonstrated by the quantitative findings as only 29% of participants indicated they agreed that assessment could improve teaching. Moreover, the findings from the interviews showed that only a minority of participants felt that they could modify their teaching based on their students' results. Numerous researchers have indicated the importance of assessment, as it is an essential process that enable teachers to use assessment evidence to improve learning and teaching (Stiggins, 2009; Popham, 2014).

To consider another aspect regarding participants' knowledge on formative assessment, about half of responses from the questionnaire showed that participants agreed that assessment helps them in identifying students' strengths and weaknesses. Qualitatively, the majority of teachers seemed to consider enhancing students' learning as one of the main purposes of formative assessment. However, it was noticed from the interviews that some participants admitted that though they recognised the importance of formative assessment in learning, they still voice it through the principals of summative assessment. Since, the qualitative findings revealed that the words 'grade' or 'mark' were frequently used by the majority of participants to describe assessment. In this sense, Popham (2009) states that many teachers do not have a good knowledge about assessment since they understand assessment as tests.

In relation to utilising assessment to promote learning, the quantitative findings of the study demonstrated that about half of participants were undecided on if they knew assessment should allow students to reflect on their learning. This result was confirmed by the qualitative findings as none of the participants mentioned this purpose of assessment. It has been suggested that

formative assessment should involve students in assessment by reflecting on what they have learned and achieved and how they could improve (Torrance and Pryor, 1998).

In general, both quantitative and qualitative findings suggested that traditional assessment still remains dominant in teachers' knowledge of assessment. This is despite the shift from traditional assessment, which is based on tests to continuous assessment, which aims to promote teaching and learning in primary education in Saudi Arabia (Ministry of Education, 2007).

8.2.2 Knowledge of the aspects of assessment

The analysis of the questionnaire responses of mathematics teachers on assessment aspects knowledge revealed that they held a decent knowledge regarding what to assess in mathematics. The assessment aspects mean (M= 3.33, SD= 0.84) yielded the highest result among the three domains of assessment knowledge. Although the results from the questionnaire showed slight differences in the mean values among the three domains of assessment, they still indicated that the participants were aware of the cognitive and non- cognitive aspects that should be assessed in mathematics somewhat better than the other two domains of knowledge of assessment. This result regarding what primary schools teachers should assess in mathematics could be justified by the recent series of reforms in primary education in Saudi Arabia, which targeted the implementation of a new mathematics curriculum. The ultimate aim of these reforms was to underline students' acquisition of mathematical knowledge and skills and to use mathematics effectively as well as to think critically (Ministry of Education, 2008; Alsadaawi, 2010).

The quantitative findings also revealed that the teachers in this study had different levels of knowledge about which student traits to assess in mathematics, with the lowest mean value (M= 3.28, SD= 0.84) of responses on this scale. It should be noted that all of the interviewees indicated that the most popular student traits they were keen to assess were problem solving, understanding, and higher-order thinking. Most of these mentioned traits would fall under mathematical cognition aspects. However, a few teachers mentioned students' behaviors as affective characteristics to be assessed. There is also evidence from the literature that primary teachers assess both cognitive and affective aspects (e.g., Airasian, 2000; Black and Broadfoot, 1982; Ginsburg, 2009; Siegfried, 2012), but still the majority of mathematics teachers considered cognitive aspects as the most substantial to assess compared to affective aspects (Collison, 1992; Siegfried, 2012).

It was interesting to find from the questionnaire that about half of the teachers' responses showed they were aware of the various levels of mathematics knowledge in which they have to assess. However, the findings from the questionnaire also left about 40% of respondents who

were unable to either agree or disagree on this item. The interviews also evidenced that the most common responses about what to assess in mathematics were based in emphasizing the assessment of students' understandings. Accordingly, all teachers' comments indicated they felt that providing evidence about students' learning is the basis of any classroom assessment. Teachers' responses mainly focused on mathematical knowledge, which aligned with the recent reform of mathematics assessment in primary schools. This reform was based on NCTM's (1995) *Assessment Standards for School Mathematics*, which recommended assessment to reflect the mathematics that all students need to know and be able to do.

In addition, all teachers appeared to insist the importance of children mastering the basics in mathematics. In particular, teachers stated that they tended to focus their assessment on the lower level of mathematics objects, such as understanding, in order to provide the opportunity to students at this age of obtaining mathematical knowledge. In fact, according to mathematics curriculum in primary schools, the core mathematical skills are provided more often than other skills (Ministry of Education, 2008).

In any case, all teachers stressed the assessment of the basics in mathematics; however, still the majority of teachers in this study also feel it is important to assess other skills in mathematics. On that point, most of the teachers indicated that they agreed that assessing student' abilities in solving mathematics problems may promote students' learning. Overall, two main points can be drawn. First, the teachers' assessment activities targeted lower levels of Bloom's educational objectives and second, the majority of teachers focused on assessing higher levels of mathematics objectives, such as problem solving. This appears to support the findings reported by other researchers (e.g., Firestone, Winter, and Fitz, 2000; Lithner 2008; Webb, 2007), which showed that classroom assessments mostly focused on the content of lower levels of mathematics and the basic mathematical skills to solve problems.

Moreover, it was found that when teachers were asked about other characteristics to assess, like affective disposition toward mathematics, about 46% of participants agreed they were knowledgeable about assessing affective aspects. Generally, it could be said that during the interviews, teachers indicated their interest regarding assessing mathematical disposition, since they mentioned students' motivations and confidence in mathematics as significant aspects to observe. Children's productive disposition toward mathematics was described by Kilpartick, Swafford, and Findell (2001, p. 131) as the:

> “Sense in mathematics, to perceive it as both useful and worthwhile, to believe a steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics”

On the other hand, about 43% of participants could not determine if they were knowledgeable in assessing mathematical disposition. Similarly, it was found that the majority of mathematics teachers during the interviews honestly admitted that they felt less confident about their knowledge of assessing other student traits such as affective dispositions. Nevertheless, the majority of teachers seemed to seriously not appreciate using any methods to assess mathematical disposition other than observing students' performance during lessons.

It seemed important for the majority of teachers to consider such affective information, so they could also encourage students to use mathematics confidently while solving mathematics problems. Nevertheless, most of the teachers prioritized the cognitive domain in classroom assessment over the disposition domain. This finding is in line with what was stated by Ginsburg (2009), that teachers mainly need assessments that inform them about children's performance, knowledge, and thinking.

8.2.3 Knowledge of the implementation of assessment

The findings from the questionnaire showed that the overall mean score for teachers' knowledge of how to conduct classroom assessment was (M= 3.15, SD= 1.02), reflecting the lowest mean value among the domains of assessment knowledge. Although the mean value of participants' responses was the lowest, it still indicated that the participants had a moderate knowledge of implementing assessments.

It may be seen from the quantitative results that about 50% of mathematics teachers neither agreed nor disagreed about their awareness of the difference between traditional and alternative assessment. However, the majority of interviews showed something slightly different from the questionnaire result; it seemed that the majority of teachers were able to confidently identify both traditional and alternative assessment. From my discussions with the teachers during the interviews, I could conclude that all teachers at least were able to recognize how traditional tests were different from other methods of assessment in terms of their formats.

In addition, when questioned about teachers' knowledge of how to assess students using different methods, about 55% of participants indicated their disagreement regarding their knowledge about using various methods. The researcher believes this result can be justified by pointing out that all teachers during the interviews asserted that they paid more attention to traditional tests. The data suggest that the reason for this was likely that these teachers seemed to consider traditional tests results more trustworthy, particularly in mathematics. These findings are quite comparable to those of Webb (1992) who has claimed that traditional tests are

important in providing quantitative, valid results; however, he also claimed that traditional tests possibly do not provide the whole picture of a student's learning.t

On the other hand, the teachers surveyed in this study indicated their awareness of the use of several alternative assessment methods, and they were most knowledgeable in some areas, including classroom discussions, observations, and peer assessment. For illustration, the items on the questionnaire related to the previous methods (item 20, item 23 and item 24) scored a higher percentage of agreement among than the items related to the knowledge of assessment methods. This could be a sign that the participants were knowledgeable about several forms of alternative assessment, as they indicated they used them as daily assessment methods.

Some other alternative methods such as portfolios, projects, and self-assessment seem to be the methods that mathematics teachers are less aware of. This is shown in the results of item 22 and item 21, since over half of the respondents indicated that they disagreed or were neutral regarding having knowledge about using portfolios and projects. Moreover, about 44% of teachers disagreed with the statement that they were knowledgeable about using self-assessment. The findings from the interviews showed that teachers valued using leaflets, and they acknowledged their advantage as they stated that this tool was well explained in students' textbooks. This finding reflects that mathematics teachers adhere to the text books.

The findings from the interviews confirmed that teachers were aware of both traditional and alternative assessments, in terms of methods and formats. Moreover, the majority of teachers emphasized the advantages of using alternative assessments with students, which reflects the mathematics teachers' awareness of using a wide range of methods of assessing students' learning. The data suggest that mathematics teachers were likely to understand alternative assessment methods as an activity to be used specifically for formative purposes. That being said, some teachers were satisfied with the evidence they gathered from alternative methods to be used for summative purposes; however, this was only done with lower achieving students in order to provide them with the chance to get better grades.

It should be noted that alternative assessment has been given more attention since the last reform of classroom assessment in Saudi Arabia (Ministry of Education, 2015). However, the interviews' findings showed various levels of understanding regarding alternative assessment; for example, few teachers stated that they were knowledgeable about alternative assessment tools but they did not know how to deal with the student responses collected from these tools. Another group of teachers claimed that alternative tools do not offer a true level of achievement in mathematics. It seems likely that this finding is derived from the teachers' reflections of their

past experiences with traditional assessment, since they were students when traditional assessment dominated the educational system in Saudi Arabia (Alhareth and Aldighrir, 2014).

On that point, it is essential to note that knowing how to use something does not always mean one has the ability to utilize it sufficiently (Weick, 1995). This point leads the researcher to the fact that a group of teachers showed a fair awareness of alternative assessment tools, but they talked about these tools as learning strategies, which they applied when they teach some challenging topics in order to encourage students to be more active when learning mathematics.

It is quite clear from the interviews' findings that the minority of teachers advocated the need for using balanced methods in assessment in order to benefit from all types of assessment tools. This finding aligns with the views of Birenbaum and Feldman (1998) and Harlen (2012), who recommend gaining assessment evidence from the balanced implementation of traditional and alternative methods.

Knowledge about assessment implementation also includes the awareness of using assessment evidence in students' learning and instructions (Abell and Siegel, 2011). In this sense, the findings from the questionnaire showed that more than half of participants agreed they were knowledgeable about providing adequate feedback to students. The findings from the interviews were compatible with statistical results because the majority of teachers were able to express their actions regarding assessment results. All teachers indicated they normally considered feedback to be a part of the learning process, which was given not only in written or verbal forms, but in physical actions, too. Teachers seemed to know different ways of providing feedback, which has been suggested in the literature (e.g., Tunstall and Gipps, 1996; Alexander, 2000). However, what could be found from teachers' responses in the interviews, is that teachers' feedback normally targeted correcting students' mistakes and improving grades. It should be stated that the effective forms of feedback are those which are conducted with the aim of closing the gap in learning and promoting students to think about their work (Sadler, 1989; Black and Wiliam, 1998a). Regarding this matter, Black and Wiliam (1998b, p. 140) describes the aims of summative feedback by stating "look for the ways to obtain the best marks rather than at the needs of their learning which these marks ought to reflect".

A further quantitative finding, with respect to teachers' actions regarding assessment evidence, is that about 63% of participants could not decide whether they agreed or disagreed about benefiting from assessment results in teaching. Again, the same was found through the interviews, since few teachers seemed to know that assessment results could speak to the efficiency of their teaching. It should be indicated that this finding is in line with the studies by Al-rumaih (2009) and S. Alghamdi (2015) who pointed out that primary teachers in Saudi Arabia

were more likely to deem assessment an independent process from teaching. Hence, these findings may suggest that further attention is needed to ensure that teachers are able to understand how to conduct assessments which enhance both learning and teaching. In this regard, it is expected that teachers use assessment results in modifying instructional processes, which drive the integration of teaching and assessment (Black and Wiliam, 1998a; Shepard, 2001; Airasian, 2000; Wiliam, 2011).

In addition, the outcomes of the interviews showed that all teachers were knowledgeable in interpreting students' responses based on given criteria of assessment, which were determined by the Ministry of Education. In this sense, criterion-reference of assessment provided the formal guide for teachers to make consistent inferences about students' responses in assessment, particularly in some methods of alternative assessment (Popham, 2009; 2014). These results confirmed the results from the questionnaire, as more than 70% of participants agreed they were knowledgeable in interpreting qualitative evidences. On the other hand, about 66% of responses on the questionnaire were in disagreement on their knowledge in relation to interpreting qualitative results. These findings affirmed what the teachers had stated in the interview regarding their knowledge concerning how to make use of the information collected from alternative assessment methods.

The findings of this study also showed that all teachers seemed to be aware of the most typical way of interpreting assessment information, called self-referenced assessment, particularly in primary schools. Examining the improvement in students' achievement over a certain time period was mentioned by all teachers. Despite teachers' comments indicating that self-referenced assessment was more significant in recognizing students' progress towards the learning goals, it was also noted to be time consuming. This supports Airasian's (2000) claim that self-referenced assessment is quite challenging for teachers, as the grades are based on students' progress over time.

8.3 Mathematics teachers' practices of classroom assessment

This section discusses findings related to assessment practices in mathematics classes in primary schools, which were investigated quantitatively and qualitatively via the following research question:

How do mathematics teachers practice classroom assessment in Saudi Arabian primary schools?

Practicing classroom assessment consists of three main phases: before lessons, during lessons, and after lessons. The discussion of both quantitative and qualitative results is presented through the following sub-sections.

8.3.1 Assessment practices before lessons

With regard to teachers' practices of assessment before lessons, the overall average score of the participants on the questionnaire was (M= 3.36, SD= 1.10). This result showed the lowest mean value among the three sub-scales of teachers' practices of assessment. It could be concluded from such a result that mathematics teachers tended to pay less attention to planning and selecting assessment activities before lessons.

The qualitative findings of this study also showed that more than 50% of teachers were found to agree that they either often or very often selected assessment activities based on the learning objectives. The findings from the interviews came to confirm this result as a number of teachers related their selection for assessment tasks to the learning goals. This result might be due to the dominance of assessment of learning over assessment for learning. On that point, assessment is considered formative when its design is based on the learning outcomes to promote students' learning. Additionally, assessment activities can enhance learning when it can give feedback on students' learning (Black et al., 2004).

The majority of responses on the questionnaire, about 63%, stated that teachers normally estimated the time needed for assessment activities before starting a lesson. However, still 32% of participants seemed to occasionally care about specifying the time for assessment activities before lessons. In this sense, the findings from the observation demonstrated that nearly all teachers seemed to be well organized in terms of time when they provided assessment activities as a normal part of classwork. This is in spite of what had been confirmed by the results of the interviews, where many expressed that they prepared only a brief plan without specifying the time needed. That being said, mathematics teachers appeared to manage the time during their lessons effectively. This finding corresponds with the results of a study by Abdulkader and Atwan (2015) which showed that 73.8% of primary mathematics teachers were skilled in managing a lesson’s time in relation to planning, organization, observation, and addressing challenges.

Quantitatively, the results showed that about 60% of participants often used homework to identify students’ learning strengths and weaknesses. It was also found from the questionnaire that about 55% of participants often or very often created a daily written assessment plan. Furthermore, the results from the interviews revealed that all teachers mentioned setting a plan for assessment as a part of the whole planning process for lessons. The literature suggests that

assessment occurs within a series of interrelated processes with teaching; accordingly, a coherent assessment plan is one that is created within the big picture of learning and teaching teachers (Mavrommatis, 1997).

However, not all teachers showed their interest in creating a written plan for day-to-day assessment strategies. Interestingly, a few teachers found that writing a plan for an assessment was not important, as they felt that they had the experience to manage assessment efficiently. There are some studies in the literature that support this finding. For example, Arzt and Armour-Thomas (1999) investigated seven novice and seven experienced mathematics teachers in relation to their knowledge, goals, and practices and found that the goals and intentions of experienced teachers were focused on students' learning more than the procedure of learning or coverage of the content.

In addition, when teachers were asked in the questionnaire about planning assessment tasks based on students' needs, 67% of participants stated that they seldom or less often plan for assessments based on the needs of their students. This finding was complemented by the qualitative result in which the minority of interviewees deemed students' levels of achievement as something to be considered while planning for assessment. This appears to support the findings by Black et al. (2004), as they argued that many teachers do not plan their lessons or conduct classroom discourses in ways that could assist students while learning.

8.3.2 Assessment practices during lessons

It may be seen from the quantitative results that the practices of assessment during lessons scored (M= 3.37, SD= 1.13). This result suggests that, generally, mathematics teachers practice assessment during lessons to a moderate degree. Practicing assessment during lessons implies gathering assessment information and providing feedback.

In regards to learning objectives, about half of participants in the quantitative part of the study indicated that they less often have shared the lesson’s goals with students. On the other hand, it was found from the observation that each participant was keen to present the learning goals on the board at the beginning of a new lesson. It is important to note that the 10 teachers shared learning goals with students. However, the majority of teachers rarely referred to learning goals during instruction or discussed the learning goals in a simple way with the children, particularly when doing assessment activities. Communicating learning goals with students was acknowledged by most of the literature in formative assessment since it has been recommended in order to build children's skills and maximize learning (Black and Wiliam 1998a; 1998b; Stiggins, 2008).

Actually sharing learning goals with students is more than just writing these goals on the board; as Moss and Brookhart (2012, p. 9) state:

> "The most effective teaching and the most meaningful student learning happen when teachers design the right learning target for today's lesson and use it along with their students to aim for and assess understanding".

The results from the questionnaire also showed that about 68% of participants very often assessed students' prior learning before teaching. Similarly, the qualitative results found that the 10 observed teachers spent a few minutes collecting some information about the children's prior learning. Furthermore, the majority of teachers' responses during the interviews showed that they likely deemed assessment a diagnostic function, in which they could gather evidence regarding students' prior experiences. Research has suggested the significance of assessment in diagnosing students' strengths and weaknesses (Gipps, 1990). This finding of the study provides a good indication that mathematics teachers in primary schools are dealing with mathematics in their classes as a construct more than a function (Ernest, 1991).

In addition, the findings of the qualitative part provided more details about assessment information collected in mathematics classes, as these findings showed the participants assessed various levels of mathematics. Firstly, all teachers indicated that assessment should primarily target the children's comprehension of the basics in mathematics. Secondly, the vast majority of teachers claimed that they regularly assessed students' higher order thinking skills, but they indicated collecting such evidence was time consuming. This finding is consistent with other findings from previous international studies that mathematics teachers have collected various intellectual evidences about students (e.g., Barnes, Clarke and Stephens, 2000; Mohamad, 2013). In this study, teachers' practices of assessing various levels of mathematics might be justified, as they abide by the Ministry of Education guidelines in assessing mathematics and work in line with the mathematics education goals in primary stage (see Chapter 2).

Overall, the interviews showed that the majority of mathematics teachers used assessments for classroom controlling in order to assess students' behavior during lessons. It is important to note that none of the interviewees had indicated assessing mathematical disposition; however, the observation revealed that about half of observed teachers assessed students' dispositions toward learning mathematics, and the majority of teachers assessed children's psychological aspects, such as anxiety and confidence during observed lessons. This raises a question regarding teachers that did not talk about collecting such evidence during the interviews, but have been observed to assess students' disposition in their classes. The answer could be that teachers likely did not consider psychological aspects as information that they needed to know. This finding suggests

that teachers may need to reflect on their assessment practices, which may help to make their practices in the classroom more oriented towards all aspects of assessment. In this sense, teachers need to work in parallel with the tendencies, attitudes, values, and goals in mathematics education in primary stage (see Chapter 2), as well as with the standards documents from NCTM (1989, 1995, 2000) which suggest that students should be active in exploring mathematics and teachers should play a crucial role in shaping students' confidence while learning mathematics.

With regard to the strategies used in collecting assessment evidences, the large majority of teachers said in the questionnaire that they often or very often assess students with traditional tests. Moreover, it was found from the interviews that all teachers considered pen and paper tests to be the best method in assessment to provide reliable information about students. All participants claimed that they used test-based assessments because they found that such methods were easy to score and offered tangible evidence about students' learning, which could be presented in students' reports. Teachers' claims regarding test-based assessments were likely to have come from their own experiences as students with teachers who taught mathematics traditionally, before the reforms in the mathematics curriculum in Saudi primary schools. This result is in line with previous research that has shown that most mathematics teachers value using pen and paper tests in assessment (Alkhozam, 2006; Alduwairi, 2013; Mohamad, 2013). According to Mohamad (2013), test-based assessments, which involve quizzes and tests, were conducted to assess students' proficiencies in mathematics, since mathematics teachers were likely to trust these strategies. He further suggested that many factors might shape teachers' selections for assessment tools such as teachers' own experiences.

In addition, the quantitative results of this study showed that about half of participants often collected assessment evidence by using classroom observation. Nevertheless, interviews with mathematics teachers revealed that the 10 participants did not mention classroom observation as one of the assessment strategies. Additionally, the qualitative findings in this study showed that observation was the most frequent strategy to be used during mathematics lessons in order to assess students' academic performance, as well as students' behaviour. Based on this result, the majority of mathematics teachers did not consider observing students as an assessment strategy. Continuous observation has been mentioned in the literature as assessment tool to be applied particularly with children (Brady and Kennedy, 2012).

It was found from observed mathematics classes that the majority of teachers' oral questions were in the form of closed questions. Similarly, all teachers during the interviews claimed that closed questions were widely used in their classes. This result came to be confirmed by what has been found from the quantitative part of the study: about 63% of participants stated they often

ask yes/no questions. All teachers claimed this type of question helped them in assessing students' lower order thinking skills. Furthermore, it was indicated by 63% of the questionnaire sample that they often or very often asked students higher order questions, which enhance students' thinking and reasoning skills. From the qualitative part, it seemed half of participants showed interest in using open ended questions with students, whereas one group of participants seemed to use this type of question only for formative assessment activities. From the teachers' responses, it was clear that they valued the use of different types of questions, with more emphasis to the role of oral and written closed questions in building children's abilities to interact with their teachers.

The observation data suggested that the majority of questions during mathematics classes were asked by the teachers; however, the data showed that the chances for students' to ask questions seemed to be limited during mathematics classes. Moreover, during mathematics sessions it was very rare to see students being asked to justify their answerers or reflect on their mistakes.

On that point, Black and Wiliam (1998b) claims that students' questions provide a valuable chance for students' learning (compared to the questions asked by teachers) as students' own questions make them talk and think about what they are learning and what they have understood. In a Saudi Arabian context, providing students with all opportunities to develop their abilities in being an active student and using the mathematical concepts and skills effectively was one of the general goals in mathematics in primary schools (Ministry of Education, 2008). It seemed that mathematics teachers had the willingness to assist children in gaining mathematical knowledge. The findings indicated that the majority of the participating teachers needed to train students on how to reflect on their learning, as well as ask questions, which enhances learning. Similar findings were suggested by some international research, in which teachers need to be skilled in asking questions and provide students with the time to ask questions that supporting their learning (Black et al., 2004; Taras, 2005).

The findings from both quantitative and qualitative parts of the study also revealed that students have been provided with the chance to be involved in the assessment process. For example, more than half of respondents indicated they often asked students to assess their peers. In fact, from the interviews it seemed that teachers were in agreement with the notion that students should have a role in classroom assessment. However, the vast majority of teachers indicated that they at most involved students in assessment through peers assessment. When asked in the interviews, teachers said that they often encourage high achieving students to assess their peers, as they are able to practice such task comparing with other students. Moreover, it was found that mathematics teachers frequently used peer assessment in their classes by asking students to

exchange textbooks and correct the mistakes. However, the students' practice of this strategy in assessment was mainly to check their peers' answers, as it was very rare to see children share their ideas about their performance in the assessment tasks or discuss how to get the right answers. The data suggested that students seemed to be not skilled enough in assessing their peers, which supports what was indicated previously regarding the lack of the teachers' role in training students to improve their skills to become reflective of their own learning.

According to interview data, the majority of teachers indicated they seldom use self-assessment tasks with students. Moreover, few teachers noted self-assessment to not be suitable for young students. This claim could be justified by considering the impact of society and culture on teachers' values and intentions, since children in Arabic countries are usually provided with less opportunities by their parents to learn how to be responsible for themselves (Abdullkhalek, 2011).

This result has been confirmed by the findings from the questionnaire, as 60% of participants agreed that they seldom let their students assess themselves. However, what was found from the observation slightly contradicts this result, as in most cases, the majority of teachers were found to let students correct their own answers. Usually, this was conducted by asking the student to check the right answer from the board or by comparing his answer with another student in the class.

However, the evidence from the literature indicated that self-assessment is more than just checking the final answer; teachers should allow students to judge their performance and assess any possible gap in their learning (Sadler, 1989; Broadfoot, 2007). Therefore, to engage efficiently in assessment activities for formative purposes, teachers may need to have positive views towards a social constructivist paradigm in learning where students play a more active role in assessment activities. From these findings, it is suggested that the lack of practice in involving students in assessments effectively is the result of a lack of assessment training for teachers.

With respect to alternative assessment, it could be suggested that the quantitative outcomes showed that just 15% of participants stated they often or very often used projects for assessing students. Furthermore, 37% of participants indicated the same level of use for portfolios. The findings from the interviews confirm this result, as just a minority of participants mentioned such strategies. Nevertheless, participants stated that they used projects in just special cases, for example, when they intend to provide students with the chance to get better grades for summative purposes. The findings are supported by the research highlighted by Aldosary (2014), where he found mathematics teachers in primary schools occasionally use portfolios with their

children. I believe that a major reason for this is the lack of time and training. It is hoped that these findings may shed light on teachers' skills and needs in relation to classroom assessment.

A further finding of the study relates specifically to the students' individual abilities. Qualitative findings indicated that all observed teachers provided the same assessment tasks to all students regardless of their level of achievement or abilities (Gipps, 1990). Moreover, it could be recognized from a number of participants' comments that they considered that some alternative assessment strategies, such as presentations and self-assessment, did not suit all students, and therefore they suggested to use such strategies with only distinctive students. Such an approach of practicing assessment may work against the learning goals in Saudi Arabia (see chapter 2). Nevertheless, Saudi Arabian classrooms are mixed in ability, which reflects the intention of Ministry of Education to provide equal chances for learning for all students.

The current study investigated teachers' practices of providing feedback during mathematics classes. Generally, the findings from the questionnaire demonstrated that about 68% of participants often or very often provided feedback in order to improve students' weaknesses. Statistical results also demonstrated that more than 76% of participants considered using expressions aimed to motivate students to be a "very often" practice. The interviews and observations revealed nearly the same findings since both methods suggested a number of feedback types used by mathematics teachers. Based on the study context, it would appropriate to use the classification of feedback by Tunstall and Gipps (1996), who distinguish between evaluative and descriptive feedback that is provided by teachers to young students. In the current study, evaluative feedback was provided by teachers either verbally or in a written format during the observed classes. Since this type of feedback is aimed at judging students' work, the findings from the study suggested that all participants regularly used expressions such as 'good', 'that is all right' and 'excellent' to inform students of how well they are doing. Moreover, using grades was the most frequent evaluation feedback provided by teachers in mathematics classes. Additionally, evaluative feedback that provides negative judgment seems to discourage children (Black et al. 2004); this was not found in any observed classes. On the other hand, it was notable that the majority of teachers did not justify their expressions or grades to students. It was suggested by Tunstall and Gipps (1996) that good feedback is when students think about their learning.

Descriptive feedback is that which gives students much information in order to inform students about their performance; nearly all teachers provided this kind of feedback during classes. Interestingly, most of the participants did not provide the descriptive feedback in oral form. Teachers claimed that young students do not read the written feedback; hence, they give such feedback verbally. The interviews showed that when teachers provided a written feedback, they

primarily intended to inform parents about the students' performance. In fact, these findings seemed to be in line with some research, which suggested to provide oral feedback to children; it is more effective since children might face difficulties in reading teachers' comments (Brookhart, 2008; Ewens, 2014). The qualitative data also demonstrated that most of the feedback was given instantly. It seems likely that teachers wanted to help students to hear the comment and use it at the same time (Brookhart, 2008). In the study, the individual and group feedback were mainly targeted learning purposes; nevertheless, the findings demonstrated that a number of participants practiced feedback by providing the right answer either verbally or written on the board. That being said, feedback does not promote learning processes or encourage students to think when it is limited to correcting students' errors or providing words of encouragement. The literature on formative assessment considers feedback to support learning when it tells students exactly how far they are from achieving the learning objectives (Sadler, 1989; Black and Wiliam, 1998a).

While all teachers in the current study provided different types of feedback, the main concern is more so the quality of the feedback. The data has suggested that the majority of provided feedback was likely focused on conventional feedback, which is about the correcting of errors rather than highlighting students' weaknesses and strengths.

8.3.3 Assessment practices after lessons

The overall mean score of mathematics teachers' responses on assessment practices after lessons was (M= 3.53, SD= 1.14). This result showed the highest mean score among the three phases of assessment practices. Accordingly, mathematics teachers had good skills in practicing assessment after lessons, which included interpreting assessment results and using assessment information in teaching and learning.

Just as an assessment gives students feedback on how well they are learning, an assessment also contributes to providing feedback on how well teachers have taught. The qualitative findings indicated that 45% of participants appear not to use assessment information to plan their next teachings. Similarly, 50% of responses on the questionnaire showed that participants either never or seldom adapted their teaching based on students' results. Furthermore, the evidence from the interviews confirmed that just a minority of participants admitted that they considered assessment information as feedback on their instruction.

On the other hand, the evidence from the observation showed that nearly all participants gained some feedback during their interaction with students; hence, they were noticed to modify their teaching instantly. In general, teachers were noted to remediate or modify their teaching during

the class time to help students while learning, but it seemed they did not use students' previous results to plan or improve their teaching in general. Consequently, these findings provide an indication that mathematics teachers in primary schools rarely use assessment to track their own performance in order to improve their teaching according to students' needs. In this regard, mathematics teachers may need to shift from the traditional practices in teaching, which separate teaching from assessment, to a coherent approach that integrates assessment and teaching (Shepard, 2000; Moss and Brookhart, 2012). It is important to indicate that one of the standards proposed in an NCTM document for school mathematics teaching states that teachers must use assessment to monitor the quality of their teaching and to adapt their instruction to provide better learning for students in mathematics (NCTM, 1991).

In addition, the data obtained from the questionnaire showed that the vast majority of participants (about 70%) indicated that they very often use assessment to take the responsibility of improving students' achievement or designing remedial activities. Similarly, all of the comments from participants during the interviews demonstrated that teachers used assessment not just to grade students' achievement, but also to help them to improve learning. This result provides a good indication regarding teachers' use of assessment data in which they benefited from assessment results in developing children's abilities in mathematics.

The information about interpreting assessment information that was provided by participants in the interviews demonstrated that they collected evidence about students' learning with reference to two standards: criterion-referenced and self-referenced. This study's qualitative data suggested that using criterion referenced aims to focus on assessing students' performance by describing their performance based on range of levels (Brown, 1988). These criteria should be related to the learning objectives. In this sense, Harlen (2012) suggests when using summative assessment teachers should apply the same criteria for all students. This finding is supported by Pegg's (2003) claim that the assessment based on standards rather than other references help students to know how they have been assessed. However, Pegg (2003) further sates that the link between students' learning in mathematics and the standards assessment seemed to remain weak.

Furthermore, observational data provided additional findings as nearly all teachers had interpreted some form of collected data using norm-referenced assessment. Although comparing students' performance to their peers seemed to be employed in the mathematics classes, it was not mentioned by teachers during the interviews. Accordingly, this finding suggests that teachers in the study did not consider all kinds of reference in interpreting assessment results. It is important to note that comparison among students was occasionally conducted in mathematics classes, despite the transformation to cooperative learning in Saudi Arabia. In this sense, the

literature indicates that most norm-referenced classroom assessments are used to encourage the whole class, but not to improve learning (Rowntree, 1987; Airasian, 2000).

Communicating assessment information to students' parents seemed to be a high concern, as 78% of participants indicated that they very often send written reports to parents. In addition, most teachers argued that they use grades very often to record assessment evidence. Although observed teachers seemed to use marks and grades all the time, they likely neglected conducting a systematic recording of assessment information instead of a few brief notes or marks.

8.4 The relationship between mathematics teachers' knowledge and practices of classroom assessment

This section discusses the relationship between what teachers know and what they do regarding classroom assessment in mathematics. This relationship was explored quantitatively by the following research question:

How do mathematics teachers' practices of classroom assessment relate to their knowledge in Saudi Arabian primary schools?

Statistically, the study revealed that the correlation value between teachers' general knowledge about assessment and their practices was (0.44). The correlation value demonstrated a moderate strength level of this relationship (Muijs, 2011). A few studies have focused on the relationship between teachers' understanding and practice of assessment, either directly or indirectly. The findings of these studies were mixed; for example, in a Saudi Arabian context, a study conducted by Alotaibi (2011) found that there was a constant relationship between what teachers understood about assessment and what they actually did in classrooms. Contrastingly, another international study by Ogan-Bekiroglu and Suzuk (2014) found that while teachers demonstrated their understanding of assessment theory, they had difficulties translating this understanding into practice, indicating a weak relationship between theory and practice.

As previously discussed, looking across both qualitative and quantitative data sets indicate that, generally, mathematics teachers were able to demonstrate modest levels of the key aspects of knowledge and practices of classroom assessment. However, for a better understanding of the relationship between what teachers knew and did, more reflection is needed on the findings of the first two questions in this study. By discerning both quantitative and qualitative findings, three cases could be recognized regarding the relationship between teacher knowledge and classroom practice.

In the first case, it could be noticed from the findings of the study that when teachers practiced assessment in their classes, they did what they knew, based on their understanding of the purposes and the process of assessment. For example, the majority of participants were low in formative assessment knowledge; this may the reason behind teachers' inattentiveness regarding the use of assessment evidence in modifying instructions or involving students in assessment. It was also found that a number of participants were mainly aware of traditional assessment, which was reflected in their selection of assessment tasks or methods and the type of collected evidence. This could be evident of a constant relationship between teachers' knowledge and practices. McEwan and Bull (1991) refer to this type of relationship as when teachers transfer their knowledge to action, since what makes teachers different is their usage of what they know. From the literature, this relationship may be described as teachers' practical knowledge or, "knowledge that teachers hold and use in distinctive ways" (Elbaz, 1981, p. 47).).

Another case which highlights the relationship between knowledge and practice is when teachers had the knowledge, but did not practice what they knew. For instance, the findings showed that some of the participants in the study, who indicated that they had sufficient knowledge about alternative assessment strategies, seemed to not apply these strategies in their classes, such as through portfolios, leaflets, and projects. Teachers could not translate their knowledge into actions, which provided a sign for the lack of usability of theoretical knowledge, which could be considered as a significant issue in teachers' knowledge.

In the last case, the relationship between what is known and what is done is pointed out in the way that teachers practiced some aspects or strategies in assessment, but were not aware that they did. It is interesting that teachers were observed using some strategies of assessment to collect evidence about students, such as observation, but they did not realise it to be one of the basic strategies in assessment. In addition, participants regularly were seen to assess students' confidence and anxiety regarding learning mathematics, but they also appeared to not be aware of such practices. These are often found to be practices that teachers are typically unaware of; however, they found themselves carrying out these practices without consideration. ‘Reflection-in-action’ was suggested by Schon (1983, p. 54), as he noted, "actions, recognitions, and judgments which we know how to carry out spontaneously; we do not have to think about them prior to or during their performance".

The above three cases demonstrated the presence of a gap between theory and practice in assessment. Highlighting this gap could justify the modest relationship between teachers' knowledge and practice in this study. It should be noted that the relationship between knowledge and practice is complicated and deserves in-depth investigations, particularly in the field of

classroom assessment. The next section discusses the potential obstacles faced by teachers regarding their knowledge and practice of assessment.

8.5 Mathematics teachers' views of the role of context in their knowledge and practice of classroom assessment

This section discusses the contextual factors that may affect teachers' knowledge and practices of assessment in mathematics classes, which was investigated quantitatively and qualitatively through the following research question:

What contextual factors influence mathematics teaches' knowledge and practices of classroom assessment in Saudi Arabian primary schools?

The data largely pointed at the factors in context as a possible reason behind teachers' knowledge and use of assessment. It should be noted that this study did not explore what impact context had on teachers' knowledge and practices.

In this study, both qualitative and quantitative findings demonstrated that there were a number of factors in the context of schools that may have impacted teachers' knowledge about assessment. The most significant factor was the lack of training programs in assessment, as about 60% of participants agreed that training programs in assessment were insufficient. The qualitative findings indicated that teachers' professional development activities were inadequate when related to classroom assessment. This result is consistent with that of other studies such as Aldawood (2004), Alotaibi (2011) and Alqarni (2015). Therefore, training programs in assessment should be designed based on the teachers' needs. For example, in this study it is clear that teachers' need to be trained in implementing alternative assessment methods.

In addition, most of the interviewees disagreed they were knowledgeable about assessment, indicating they likely have not been provided with the opportunities to improve their knowledge in assessment strategies or types. Some participants reported they did not receive adequate modules regarding classroom assessment during their education. Additionally, a few teachers were found to describe their knowledge as 'stable'. Interestingly, lack of assessment knowledge was indicated by 38% of the questionnaire sample. Hence, this demonstrates how essential the 'triangulation' data is, which was collected from different sources. This finding of the study suggested that, despite the importance of assessments in education, it seemed few teachers had received special training in assessment implementations or types. The findings of the study

provide an indication to the universities in Saudi Arabia to develop teachers' preparation programs.

In addition, a few teachers mentioned that the working environment seemed to be less social, since teachers do not interact with each other in order to exchange knowledge and experiences. The collaboration among teachers in order to share knowledge seemed to be a neglected source in developing teachers' knowledge, particularly for the teachers who have less experience. The significance of collaboration among mathematics teachers has been suggested by Alolayan's (2014) study, which found that experienced mathematics teachers had a more positive attitude towards implementing alternative assessment compared to the new teachers.

It could be speculated from the qualitative findings that instructions provided by educational supervisors were mainly focused on teaching and learning, and they appeared to pay less attention to classroom assessment. Although the minority of participants (about 27%) showed their agreement regarding this statement, this result provided evidence for educational supervisors to dedicate a portion of their directive to assessment implementations. According to Alabdulkareem (2004), educational supervisors in Saudi Arabia spend much of their time on checking teachers' logs and paperwork during visits to schools.

Through teachers’ responses in the interviews, some factors could be identified in a school context, which likely affected teachers' practices of assessment. From the questionnaire, it seemed the workload during the school day and the intensity of the mathematics curriculum were the most significant factors behind teachers' implementations of assessment; the percentage of participants' agreement was 70% and 80%, respectively. More specifically, many teachers indicated in their comments that the combination of a heavy mathematics curriculum and strict assessment regulations influences their implementation of some methods of assessment. As mentioned earlier, in the Saudi Arabian context, teachers have to adhere to the syllabus content; they do not have the right to choose which lessons to teach. The focus is to complete the syllabus rather than developing students' learning. This may suggest that practicing assessment activities in a sufficient way can be slightly challenging. The findings in this study appear to support the study by Alqarni (2015), who found that the heavy workload for mathematics teachers is considered to be one of the major challenges in applying assessment.

In the context of classrooms, the size of the class seemed to be one of the obstacles in practicing formative assessment. In this sense, the majority of teachers during the interviews described the number of students in classes as a serious problem that they encounter when conducting assessment activities. Quantitatively, about 67% of responses confirmed the qualitative result. Moreover, both quantitative and qualitative data revealed that most of the classes in primary

schools seemed to be lacking in equipment, which created numerous challenges in practicing alternative methods in assessment. Reducing the number of students in the classroom and providing adequate learning resources has been recommended by various studies conducted in the context of Saudi Arabia, such as Alotaibi (2011), H. Alghamdi (2015) and Alqarni (2015). The findings of this study highlight the importance of creating an inclusive teaching and learning environment.

Other challenges that some participants encountered in practicing assessment were related to the limitations of time, based on class time and the curriculum content. This result was confirmed by 68% of responses in the questionnaire, indicating that there is not enough class time to practice assessment in a way that support students' learning. Teachers' comments during the interviews identified an additional difficulty that they suffered from: students' level of achievement in mathematics. They seemed to devote some of the class time to reviewing the mathematical skills that students were supposed to have mastered in previous years.

The study revealed that both qualitative and quantitative data confirmed the role of students' parents in teachers' selections of assessment methods. Some participants saw parents' views regarding traditional assessment as an obstacle to the implementation of alternative assessments. A number of participants admitted that most parents asked for tangible evidence about their students' achievement, which was mostly the results from traditional tests. In such cases, parents could be involved in assessment by taking the time to explain assessment processes and communicate the need to transition from just evaluating students' learning to also supporting their learning.

8.6 Summary

This chapter has provided a discussion of the findings of the current study with reference to the research questions. The findings have been integrated and considered in relation to the literature. The findings demonstrated that mathematics teachers hold a modest level of knowledge of assessment. Moreover, the findings showed various levels of practicing assessment in mathematics classes. The chapter revealed some gaps between what teachers knew and what they actually did in their classes regarding assessment. The last section in this chapter attempted to shed light on the possible challenges that teachers are likely to encounter, in the context of Saudi Arabia, in relation to their knowledge and practice of assessment.

Chapter 9: Conclusions and Recommendations

9.1 Introduction

This chapter presents a brief overview of the study and the major findings within it. The chapter starts by presenting a summary of what is involved in this study, followed by a summary of the major findings of the study. Then the chapter presents the contributions of the study to research. Moreover, the chapter provides some implications and suggestions for mathematics teachers, educational supervisors, and policy makers. This is followed by the limitations of the study and suggestions for further research. Finally, the chapter presents the researcher's final thoughts about the current study.

9.2 Summary of the study

The current study explored mathematics teachers' knowledge and practices of assessment in primary schools in Saudi Arabia and the possible contextual obstacles. The study also looked at the relationship between teachers' actions and their stated knowledge regarding classroom assessment. The purpose behind exploring teachers' knowledge and practices is the fact that understanding teachers' knowledge is limited without investigating their practices. The pragmatic nature of knowledge and practice justified the use of the quantitative and qualitative approaches to answer the research questions. One hundred and nine mathematics teachers were involved in the quantitative part of the study, where they responded to a questionnaire. In the qualitative part of this study, ten teachers were observed practicing assessment in their classes. Semi-structured interviews were conducted with these ten teachers to explore their knowledge about assessment, how they practice it, and the challenges they face in relation to classroom assessment.

The analysis of the results was based on statistical analyses for the quantitative data. Furthermore, the analysis of the qualitative data was based on the conceptual framework of the study. This approach was conducted since it was considered to be suitable to serve the aim of collecting the qualitative data, which was to validate the quantitative data and to gain in-depth information that could not be achieved by using only quantitative methods.

The findings of this study contribute to filling the gap in the literature regarding mathematics teachers' knowledge and practices about assessment in the Saudi Arabian context. Moreover, the findings of the study provided researchers with insight into classroom assessment in the context of Saudi Arabia.

9.3 Summary of major findings

This section provides a summary of the most interesting findings obtained in the current study. These findings are presented below.

Finding one: It was found that the teachers had different levels of knowledge concerning the purposes of using assessment. Both summative and formative assessment were identified by the majority of participants as the main purposes of utilizing assessment. However, just a few of the participants demonstrated a good understanding of assessment as an integral part of the daily interaction between teacher and students. In this regard, the important findings of this study lie in the fact that it has shown that the majority of teachers were not aware that formative assessment plays a major role in enhancing teaching. From the findings, it was apparent that teachers tended to use summative assessment to improve learning, despite the evidence from the literature that confirmed summative assessment plays a lesser role in improving learning when compared to formative assessment. This shows the teachers' lack of theoretical knowledge regarding why they should use assessment.

Finding two: The majority of participants in this study were able to show adequate knowledge about what they should assess. In terms of the aspects which could be assessed, both cognitive and non-academic characteristics were indicated by the majority of participants. Mathematics teachers demonstrated a sufficient understanding of assessing the academic aspects in comparison to non-academic ones. In this sense, the majority of teachers showed less knowledge in assessing affective aspects. It was interesting to find that a number of teachers knew they should assess affective aspects, but they also mentioned that they did not know how to assess such aspects.

Finding three: Nearly all participants were able to distinguish between traditional assessment methods and alternative assessment methods. It was found that teachers were able to talk about the positives and negatives of both traditional and alternative strategies in assessment. However, the majority of teachers had limited knowledge regarding some alternative assessments, particularly self-assessment. One of the important findings in relation to how assessment should be conducted is that some of the teachers had limited knowledge of how to analyze assessment information collected from alternative strategies. This implies that these teachers considered the evidence collected by traditional tests to be more reliable than other alternative methods of assessment. In addition, all teachers in this study were aware of the benefits offered by assessment evidence in promoting students' learning and providing the suitable feedback. On the other hand, just a few participants were aware of the actions they should take in modifying their teaching based on their students’ results in assessment.

Finding four: In general, nearly all teachers in this study planned for assessment before lessons. The study also showed that a number of teachers trust in their experience in teaching, and thus felt preparing a written plan for assessment to be unnecessary.

Finding five: Most of the participants were not skilled enough in implementing different types of assessment in their classes. In this sense, the majority of participants undervalued self-assessment as a tool which builds students' self-reflective skills in learning mathematics. Involving students in the assessment process helps to build assessment skills at an early age. On that point, teachers showed their interest in involving students in assessment, but it seems they only practice this through peer or group assessment. It could be said that teachers in this study had weak skills in conducting assessment to enhance learning.

Finding six: Most of the participants treated teaching and assessment as two separate events. Hence, the majority of teachers rarely reflected on their performance based on their students' results in assessment. Moreover, nearly all teachers provided feedback to students in various ways; however, the provided feedback mainly aimed to correct students' mistakes, which did not realistically serve the purposes of formative assessment.

Finding seven: All participants were confident in interpreting assessment results based on two standards: criterion-referenced and self-referenced. Furthermore, the classroom observation revealed that teachers sometimes used norm-referenced assessment to compare students' work either individually or among groups.

Finding eight: The relationship between what teachers knew about assessment and what they practiced in their classes was weak. The study showed that teachers basically acted in line with their knowledge; however, the findings also showed this was not always the case. It was noticed that sometimes teachers were not able to practice all assessments they knew of, due to the many challenges they faced during the school day. Nevertheless, it was found that a number of teachers practice some aspect of assessment automatically without reflecting on their knowledge or even indicating a sufficient knowledge of their actions.

Finding nine: The factors that exist in the context of teaching influence what teachers know about assessment. According to the participants, the most significance factor was lack of training programs in assessment. Moreover, a lack of support from educational supervisors and a lack of collaboration among mathematics teachers also play a part in level of knowledge that teachers had about assessment.

Finding ten: There were a number of factors that shaped mathematics teachers' practices of assessment in primary schools. These factors were mathematics curriculum workloads, size of

classes, lack of learning resources, insufficient time, students' achievement levels in mathematics, and the role of culture and parents.

9.4 Contributions of the study

The current study has a number of theoretical and methodological contributions in the field of teachers' knowledge and practices of classroom assessment.

9.4.1 Contributions to the body of knowledge in the field

This study attempted to fill the gap in the literature regarding the knowledge of assessment held by mathematics teachers and how assessment has been conducted in primary schools. Such points have not been explored by previous studies in the context of Saudi Arabia, particularly in terms of what teachers know about assessment implementation, what they assess in mathematics classes, and how mathematics teachers provide feedback and use assessment evidence. In fact, in the field of assessment there is still a need to conduct such research, which would shed more light on how teachers understand assessment. This need has been indicated by some researchers such as Abell and Siegel (2011) and Gavin, Iris and Kelvin (2015). Accordingly, this study not only contributes to a clearer picture of teachers' understanding and practices of assessment in Saudi Arabia, but it is hoped that this study provides a general knowledge of the topic, which is needed in the field of classroom assessment.

The current study contributed in providing a framework to explore what it means to know about assessment, which could be benefited other researchers. Also, this study contributed in bringing to light significant evidence about teachers' knowledge regarding assessment, considering the complexity of this knowledge. In particular, the evidence in this study revealed some deficiency in the knowledge of classroom assessment that was held by mathematics teachers. In addition, this study provides practical evidence that some teachers found themselves assessing students in the way that they had been assessed. Thus, this finding helps to implicitly realise the significant role of teachers' beliefs, past experience, and lack of understanding in directing teachers' practices and decisions regarding the assessment of their students.

In addition, this study makes a considerable contribution to research by exploring the relationship between knowledge and practice, which revealed a complex relationship between what teachers knew and what they actually did in terms of assessing their students. This finding also contributes to showing the need to conduct more studies in order to investigate the complexity of the relationship between knowledge and practice. Another significant contribution comes from identifying the obstacles in classroom assessment and providing participants with the chance to

suggest ways to overcome these obstacles. This also contributes to supporting the findings of previous research that demonstrated the impacts of context on knowledge and practice. Finally, this study contributes to showing how important it is to listen to teachers speak about their needs and the challenges they face.

9.4.2 Contributions to methodology

This study has also contributed to the field of research methodology. This study applied a mixed research methodology, which used both quantitative and qualitative approaches to investigate the same phenomena. The use of this design provided a clearer image of the study and helped in gaining rich data to promote deeper investigation into classroom assessment practices and teachers' knowledge. The integration of quantitative and qualitative methods was important in the case of investigating how teachers' thoughts and actions are related to their understanding. Thus, the current study contributed to the research methodology as it demonstrated the significance of using a mixed methods approach in educational research to understand the phenomena at hand in more depth.

The various instruments applied in this study have provided more validity to the findings. Therefore, the study provided evidence that using different types of instruments was essential to explore overlapping variables, such as knowledge and practice. In particular, the classroom observation in this study has contributed to look at all the different ways that mathematics teachers have delivered assessment to their students. Thereby, observing participants gives a holistic view of how assessment is being implemented in primary schools and allows the researcher to be closer to the reality of the classroom environment.

Moreover, the sample size of the study showed that employing a large sample is not always the right decision, especially when the aim is gathering more information about many aspects of the research problem. When analysing the qualitative data, there was an explicit attempt to provide more examples from the original data to allow the reader to reflect on the data and come to their own conclusions. Also, this may contribute to providing more valuable results for researchers and decision makers.

9.5 Recommendations for future practices

According to the findings of this study, there are several recommendations that could be presented to primary mathematics teachers, educational supervisors, and decision makers.

9.5.1 Recommendations for primary mathematics teachers

Since the findings of the current study revealed various levels of assessment knowledge and practices, teachers should seriously consider the lack of knowledge about assessment purposes and strategies. Mathematics teachers should seek out ways to share their own information about classroom assessment. They should also take the responsibility to look for resources to educate themselves about assessment. Along with the resources outside schools, teachers could benefit from the resources within the school context, such as asking their educational supervisor to provide more support regarding assessment implementations. In addition, teachers should pursue their professional development by working on improving their skills in teaching and assessing. This means that teachers should have a constant drive to improve and learn new things. This may be conducted by communicating with school leaders regarding the teachers' needs for training programs in assessment, as well as discussing with the educational supervisors about their strengths and weaknesses in assessment. Teachers should share with students learning objectives and assessment criteria by informing them of what is expected of them to accomplish. Also, teachers need to help their students understand the reasons for any success or failure they may experience. However, the majority of teachers in this study thought sharing goals could be conducted by just writing the lesson goal on the board at the beginning of the lesson.

Furthermore, teachers in primary schools should educate themselves about children's psychology, particularly cognitive development, in order to provide them with all the opportunities to become powerful mathematical thinkers. Teachers should teach students how to seek knowledge and monitor their own learning in order to assess themselves. To improve the quality of assessment in mathematics classes, teachers need to keep in mind the learning objectives and keep monitoring their students' progress in order to provide a descriptive feedback on their performance.

Teachers must also be interested in the child's affect, as well as cognition. The final recommendation is that teachers need to believe in children's abilities as assessors and pay more attention to providing them with equal chances to practice assessment activities regardless of their levels of achievement.

9.5.2 Recommendations for educational supervisors

According to the findings of the study, educational supervisors should encourage teachers to talk about their needs and help them to address any challenges they encounter. Additionally, educational supervisors should encourage collaboration among teachers by conducting regular meetings including both novice and more experienced teachers; teachers could learn from each other's experiences, which may inspire them to use better assessment practices.

In addition, supervisors should remember that their role is as an advisor, not an inspector. Hence, they need to pay more attention to providing teachers with advice, which supports teaching and learning processes more than checking the paper work, for example. Supervisors need to make sure that their own information is up to date by attending workshops and training programs.

Furthermore, supervisors should know what kinds training programs teachers' need, thus they could request training programs based on teachers' needs. It is important to make sure that all teachers are following assessment regulations provided by the Ministry of Education, but at the same time, more attention on assessment techniques is strongly needed. It would be beneficial if educational supervisors provided teachers with some information about the validity and reliability of assessments.

9.5.3 Recommendations for the decision makers

Based on the findings of this study, there are a number of recommendations for the decision makers in the Ministry of Education. Classroom assessment should be afforded the same attention that is given to instruction; hence, more training programs on assessment should be provided to teachers, particularly for primary mathematics teachers due to the reforms in the mathematics curriculum and the students' assessments. Training programs should be designed to give teachers the theoretical and practical knowledge about various assessment types and methods. When conducting summative and formative assessments teachers should realise that both types of assessment are equally important. It might be worthwhile to train teachers in how to conduct assessment in order to serve these purposes.

The last assessment reform in Saudi Arabian primary schools supports the shift from traditional assessment, which aims to evaluate students' learning to apply assessment that support learning and teaching. However, from the findings of the current study, the dominance of traditional assessment in mathematics classes and the overlapping understanding that teachers had about assessment purposes was realized. In order to achieve the purpose behind implementing any reform in assessment, policy makers should make sure, before any implementation, that teachers, parents, and students fully understand the new regulations and how assessments will be conducted.

Policy makers need to support teachers to ensure that they have enough time to help their students develop learning skills in mathematics. It is essential to consider removing unnecessary workload for teachers. In the case of teaching mathematics, the intensity of the syllabus was mentioned by the majority of participants. Thus, the policy makers in the Ministry of Education should determine the number of mathematics lessons within the textbooks, including the learning

activities and the exercises, based on the session time and the length of the academic term. Nevertheless, teachers should be given some freedom to decide what lessons to teach instead of abiding by the textbooks.

The obstacles in classroom assessment that have been mentioned by the participants in this study should be considered by the decision makers in the Ministry of Education. It would be beneficial to solve the issue of class sizes by reducing the number of students in the classroom and to work on improving the classroom environment in primary schools. Moreover, policy makers need to ensure that well-equipped classrooms are available for teachers and students in order to provide teachers with the chance to conduct learning and assessment activities successfully.

Finally, to improve teaching and learning, policy makers should build their decisions based on the evidence of research.

9.6 Limitations of the study

Every study has limitations and, accordingly, there are several possible limitations in relation to this study which should be noted. The first limitation was the location of the study since it was conducted in one province in Saudi Arabia. Although the researcher provides her own justifications for the selection of the study location, other regions still have their special characteristics in such a large country with a diversity of geographic nature. Moreover, the qualitative sample was drawn from a cluster of primary schools in Al Ahas. Hence, this may limit the generalisability of the findings shown in the study.

A second limitation was in reference to the practice of single-gender education in Saudi Arabia on the basis of religion and tradition. This influenced the selection of the sample for this study, as it included only female mathematics teachers, because the researcher, who is female, would not be given permission to access male schools.

A third potential limitation was the limited timeframe; the researcher was not able to spend more time at the schools observing the participants. Observing two classes for each participant might not be enough time to learn about their practices of assessment in mathematics classes. To address this limitation, the researcher asked participants to be observed in their typical mathematics classes without any previous preparation. In addition, the researcher decided to conduct the semi-structured interviews after the observation; hence, during the interviews the teachers were asked questions related to their assessment practices.

A fourth limitation was imposed by the small sample size in the qualitative part of the study. The qualitative sample was limited to the teachers who showed their interest to participate in this

study. In order to address this limitation, the researcher applied a mixed method approach, as the research question in this study has been measured qualitatively and quantitatively.

Finally, the current study was only authorized to audio record the classroom observation. In this case, the researcher could not make video recordings of teachers' and students' practices during the classroom observation. The absence of a video recording might influence the truthfulness of the qualitative data. Alternatively, the researcher used audio recording along with the observation protocol to elicit all information related to assessment practices.

9.7 Future research

The current study sheds lights on the cognitions and practices of in-service mathematics teachers regarding classroom assessment in a Saudi Arabian primary schools context. In light of the findings, the research specified some limitations where there is a need to conduct more research in order to enrich the findings of the current research. Thus, this research actually works as a starting point for conducting similar studies in other contexts, though particularly, there is a need to fill the gaps in the field of students' assessment in a Saudi Arabian context.

In addition, within the qualitative part of this study, the researcher collected information about what assessment knowledge teachers acquire and how this knowledge informs their use of assessment in mathematics classes. On that point, there is a need for studies that address the sources of teachers' knowledge about assessment and how this knowledge influences their teaching of mathematics. Further studies are needed to investigate how teachers create their own knowledge.

In terms of the research instruments, the current study provides some tools that may be used as a guideline for researchers to develop more instruments to measure teachers' knowledge and practices in the field of assessment. Additionally, the findings of the current study could interest researchers, who are keen to improve mathematics teaching and learning, to conduct further research that explores the quality of students' assessment in mathematics classes and the impact of assessment on students' performance in mathematics.

This study provides a general insight regarding teachers' assessment knowledge and practices; thus, there is a need for further studies that target the impact of teachers' characteristics, such as academic qualifications and years of teaching, on their knowledge and practices. In this sense, further research is needed to investigate what novice teachers should know about assessment and the relationship between their knowledge and practice.

9.8 Final thoughts of the researcher

The initial intention of conducting this study was to explore mathematics teachers' thoughts about classroom assessment in primary schools. After an intense reading of the literature in relation to the nature of knowledge, I became more conscious of the fact that investigating knowledge is a challenging task due to the complexity of the concept. To gain a greater understanding of what was in teachers' minds, I decided to investigate their actions regarding the assessment of students. I have the belief that a human's practices are one of the ways to express what knowledge they hold. That belief was behind my decision to investigate teachers' practice of assessment, since studying practices could open a window for me to reflect on teachers' knowledge and raise questions regarding any possible gaps between what teachers knew and what they did. In addition, my pragmatic decision was made because there was serious need to conduct studies about primary mathematics teachers' knowledge and their assessment practices.

During this study, I have learned that teachers actually do much more in their classes than they say they do. It was interesting to hear from teachers, and particularly during the interviews, I had the feeling that the participants were unfamiliar with talking to someone about their thoughts. It was interesting to learn the ways in which teachers deal with young students and how the culture of the society could affect what teachers do in their classes. Furthermore, I was keen to investigate teachers' justifications for choosing certain assessments over others. From my discussions with teachers, I recognized the importance of having sufficient knowledge in pedagogy and how the factor of time could limit teachers' practices.

In addition, what I have found from this study made me reflect on my own practices when I was a teacher. Hence, I came to the question: how could classroom assessment in mathematics be developed to allow formative and summative assessment to support each other?

Finally, this study has convinced me that teachers' needs deserve much more attention, and their effort in tackling the everyday challenges they face is highly respected.

Appendices

Appendix A Questionnaire

Teacher Questionnaire

(Ethics reference: 19362)

Dear Mathematics Teacher,

I am a PhD student in the School of Education at the University of Southampton in the United Kingdom. Currently, I am carrying out a study that is looking into mathematics teachers' knowledge and practices for classroom assessment in primary schools.

Your responses to this questionnaire are very valuable to my study, and I appreciate your decision to participate. All you need to do is answer all the items as best as you can, and please follow the guidelines provided in the questionnaire that are typed in italic form. That task should take you approximately 25 minutes, and all responses will be anonymous.

All answers will be kept strictly confidential and be used for research purposes only. Your participation is also voluntary and if you wish to withdraw, please simply return the questionnaire to me. By completing the questionnaire, you are including your consent to participate in this study.

This questionnaire consists of five sections as follows:

Section A: Background information

Section B: Teacher knowledge of classroom assessment

Section C: Teacher classroom assessment practices

Section D: Classroom assessment challenge

Section E: Further comments

The Researcher

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In the unlikely case of concern or complaint, please contact the Head of Research Governance at the University of Southampton; 02380 595058; rgoinfo@soton.ac.uk

Section A: Background information

Please read each statement and tick your responses.

1. Your professional specialization

□ Mathematics

□ Other……

2. Your highest qualification

□ Diploma

□ Bachelor's degree

□ Master's degree

□ Other……

3. Kind of qualification

□ Educational

□ Non-Educational

4. Your mathematics teaching experience

□ Less than 1 year

□ 1 -5 years

□ 6-10 years

□ 11-15 years

□ 16-20 years

□ More than 20 years

5. Assessment training received in **the last three years**

□ I received no training on assessment

□ I took one training program/workshop on assessment

□ I took more than one training program/workshop on assessment

Section B: Teacher knowledge of classroom assessment

In this section, please tell us to what extent you agree or disagree with the following statements. *Please respond to each item by circling your own answer as follows:*

(1 = Strongly disagree, 2 = Disagree, 3 = neutral, 4 = Agree, 5 = Strongly agree)

What aspects should be assessed ?						
6	I know what levels of mathematics knowledge to be assessed	1	2	3	4	5
7	I know what students' traits to be assessed in mathematics	1	2	3	4	5
8	It is important to assess student motivation/interest toward mathematics from time to time	1	2	3	4	5
What is the purpose of assessment?						
9	Assessment can help improve student learning	1	2	3	4	5
10	Assessment should focus only on preparing students for tests	1	2	3	4	5
11	I know the purpose of formative assessment	1	2	3	4	5
12	I know the purpose of summative assessment	1	2	3	4	5
13	Assessment helps me identify my students' strengths and weaknesses	1	2	3	4	5
14	Assessment can improve teaching	1	2	3	4	5
15	Assessment should help students to reflect on their learning	1	2	3	4	5
How should assessment be conducted?						
16	I know the difference between traditional and alternative assessment methods	1	2	3	4	5
17	I know how to assess student higher order thinking skills	1	2	3	4	5
18	I know how to assess students using different methods of assessment	1	2	3	4	5

19	I know how to let students assessing themselves	1	2	3	4	5
20	I know how to let students assessing their peers	1	2	3	4	5
21	I know how to benefit from portfolios in assessing students' progress	1	2	3	4	5
22	I know how to assess my students using group projects	1	2	3	4	5
23	I know how to benefit from classroom discussion in assessing students learning	1	2	3	4	5
24	I know how to assess my students using classroom observation	1	2	3	4	5
25	I know how to benefit from students' results in teaching	1	2	3	4	5
26	I know how to give my students sufficient feedback	1	2	3	4	5
27	I know how to interpret qualitative information collected from assessment	1	2	3	4	5
28	I know how to interpret quantitative information collected from assessment	1	2	3	4	5

Section C: Teacher classroom assessment practices

In this section, please tell us how often you practice the following. *Please respond to each item by circling your answer as follows:*

(1 = Never, 2 = Seldom, 3 = Occasionally, 4 = Often, 5 = Very often)

Before lesson						
29	I design/select appropriate assessment based on lesson learning objectives	1	2	3	4	5
30	I estimate the time required to conduct assessment activities	1	2	3	4	5
31	I use homework to identify students' learning strengths and learning weaknesses	1	2	3	4	5
32	I create a written assessment plan	1	2	3	4	5
33	I plan for assessment based on students' needs	1	2	3	4	5

During lesson						
34	I share lessons goals with student	1	2	3	4	5
35	I assess students' experiences before teaching	1	2	3	4	5
36	I ask questions that require a yes/no answer	1	2	3	4	5
37	I use pen and paper tests to assess student learning	1	2	3	4	5
38	I ask questions that encourage students to think	1	2	3	4	5
39	I use student self- assessment	1	2	3	4	5
40	I use portfolios based on lesson goals	1	2	3	4	5
41	I provide students the opportunity to assess their own work with their peers	1	2	3	4	5
42	I discuss the progress of group projects regularly	1	2	3	4	5
43	I use classroom observation to assess students	1	2	3	4	5
44	I offer instant feedback that helps students to know how to improve their weaknesses	1	2	3	4	5
45	I motivate students to learn (e.g., reward, praise, etc.)	1	2	3	4	5
After lesson						
46	I use student assessment results when planning a new lesson	1	2	3	4	5
47	I use assessment results to improve daily teaching	1	2	3	4	5
48	I use assessment results to improve students' daily learning	1	2	3	4	5
49	I use assessment results to design remedial plan for students who are facing difficulties in mathematics	1	2	3	4	5

50	I discuss assessment results with students individually	1	2	3	4	5
51	I report students' assessment results to their parents	1	2	3	4	5
52	I report assessment results to school leaders	1	2	3	4	5

Section D: Classroom assessment challenge

In this section, please tell us to what extent you agree or disagree with the following. *Please respond to each item by circling your answer as follows:*

(1 = Strongly disagree, 2 = Disagree, 3 = neutral, 4 = Agree, 5 = Strongly agree)

53	Lack of instructions from educational supervisor	1	2	3	4	5
54	Lack of sufficient knowledge about assessment types/ methods	1	2	3	4	5
55	Teachers have a lot of work to do	1	2	3	4	5
56	Lack of training programs on assessment	1	2	3	4	5
57	Class time is not enough time to practice assessment	1	2	3	4	5
58	There are a lot of mathematics topics to teach	1	2	3	4	5
59	There are a large number of students in classroom	1	2	3	4	5
60	Parents only trust pen and paper tests	1	2	3	4	5
61	Lack of learning resources (e.g., learning equipment, computers, internet,…)	1	2	3	4	5

Section E: Further comments

Please add any other comments you would like to make about classroom assessment

……..……
…..……
……..…….....
.....

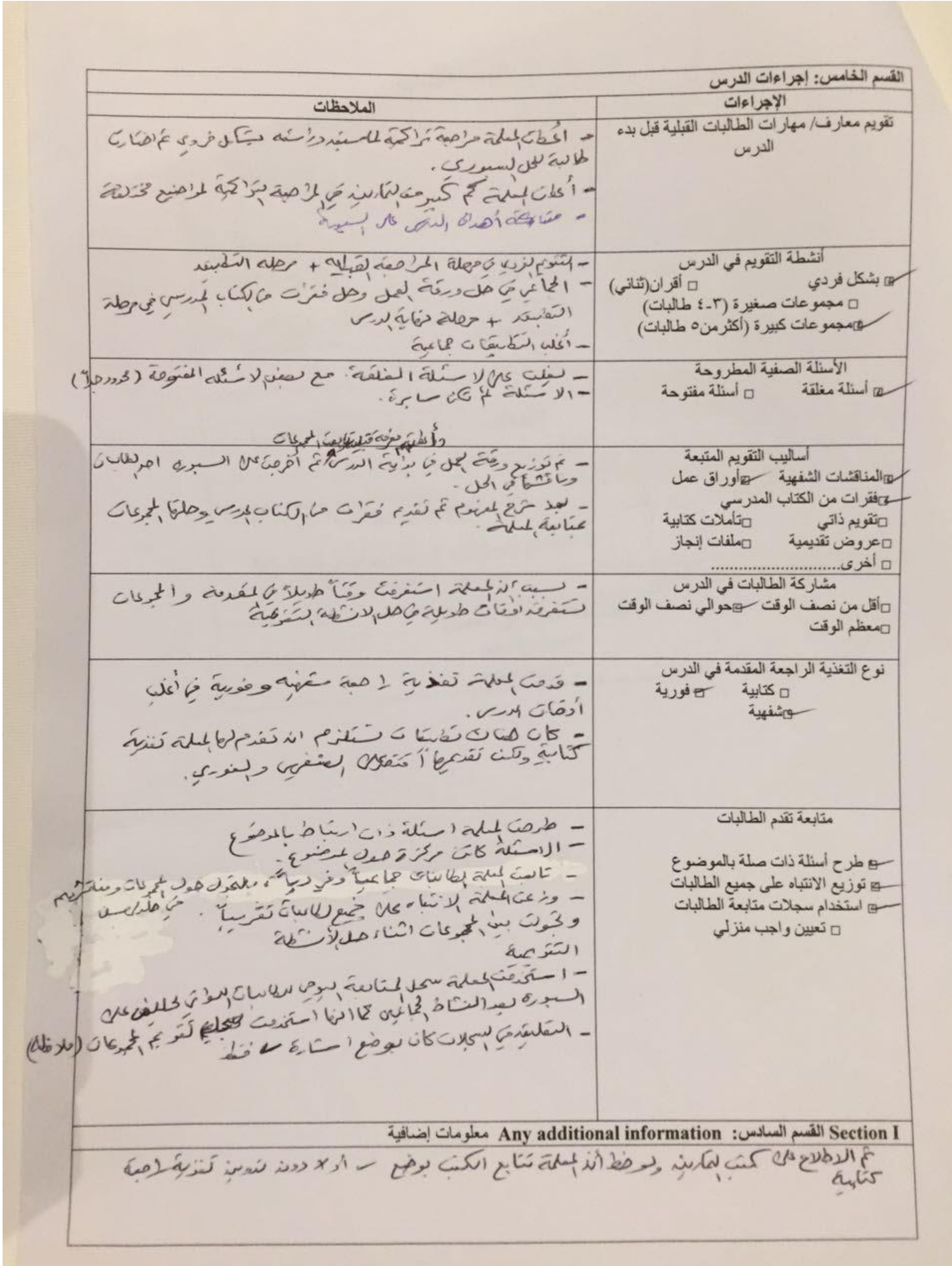
Thank you for your time and input

Appendix B Classroom observation protocol

Section A: General Information:		
Time of observation	Name of the school	Date
Number of students	Absent	Grade level
Section B: Teacher Background		
Teaching experience	Qualifications	Major
Section C: Lesson Information		
Lesson objective(s)		Topic
Section D: Classroom Context		
Classroom space □ Crowded □ Appropriate		

Section E: Lesson proceedings	
	Comments
Assessing students' prior knowledge/ skills before starting	
Assessment activates □ Individually □ Peers □ Small groups (3-4 students) □ Large groups (more than 5)	
Questions have been asked in the lesson □ Closed questions □ Open questions	
Assessment methods □ Oral discussions □ Items from the textbook □ Worksheet papers □ Reflecting writing □ Portfolios □ Presentations □ Self- assessment □ Other……..	
Students' participations in the lesson □ Less than half time □ About half time □ Most time	
Type of feedback □ Oral □ Written □ Instant	
Monitoring students' progress □ Asking relevant questions to the topic □ Providing attention to students' work individually □ Recording students' performance □ Assigning homework	
Section F: Any Additional Information	

Appendix C Sample of classroom observation



القسم الخامس: إجراءات الدرس

الإجراءات	الملاحظات
تقويم معارف/ مهارات الطالبات القبلية قبل بدء الدرس	- أعطت المعلمة مراجعة تراكمية لما سبق دراسته بشكل فردي ثم اختارت طالبة للحل بالسبورة. - أعطت المعلمة كم كبير من التمارين في المراجعة التراكمية لمواضيع مختلفة - مناقشة أهداف الدرس على السبورة
أنشطة التقويم في الدرس ☑ بشكل فردي ☐ أقران(ثنائي) ☐ مجموعات صغيرة (٣-٤ طالبات) ☑ مجموعات كبيرة (أكثر من٥ طالبات)	- التقويم الفردي في مرحلة المراجعة القبلية + مرحلة التطبيق - الجماعي في حل ورقة العمل وحل فقرات من الكتاب المدرسي في مرحلة التطبيق + مرحلة نهاية الدرس - أغلب التطبيقات جماعية
الأسئلة الصفية المطروحة ☑ أسئلة مغلقة ☐ أسئلة مفتوحة	- يغلب على الأسئلة المغلقة مع بعض الأسئلة المفتوحة (محدودة جداً) - الأسئلة لم تكن سابرة. وأعطتهم فرصة قليلة لتطبيق المجموعات
أساليب التقويم المتبعة ☑ المناقشات الشفهية ☑ أوراق عمل ☑ فقرات من الكتاب المدرسي ☐ تقويم ذاتي ☐ تأملات كتابية ☐ عروض تقديمية ☐ ملفات إنجاز ☐ أخرى............................	- تم توزيع ورقة العمل في بداية الدرس ثم أخرجت على السبورة إحدى الطالبات وناقشتها في الحل. - بعد شرح المفهوم تم تقديم فقرات من الكتاب المدرسي وحلها المجموعات بمتابعة المعلمة.
مشاركة الطالبات في الدرس ☐ أقل من نصف الوقت ☑ حوالي نصف الوقت ☐ معظم الوقت	- بسبب أن المعلمة استغرقت وقتاً طويلاً في المقدمة والمجموعات استغرقت أوقات طويلة في حل الأنشطة التقويمية
نوع التغذية الراجعة المقدمة في الدرس ☐ كتابية ☑ فورية ☑ شفهية	- قدمت المعلمة تغذية راجعة شفهية وفورية في أغلب أوقات الدرس. - كان هناك تطبيقات تستلزم أن تقدم لها المعلمة تغذية كتابية ولكن تقديمها اقتصر على الشفهي والفوري.
متابعة تقدم الطالبات ☑ طرح أسئلة ذات صلة بالموضوع ☑ توزيع الانتباه على جميع الطالبات ☑ استخدام سجلات متابعة الطالبات ☐ تعيين واجب منزلي	- طرحت المعلمة أسئلة ذات ارتباط بالموضوع - الأسئلة كانت مركزة حول الموضوع. - تابعت المعلمة الطالبات جماعياً وفردياً، بالتجول حول المجموعات ومناقشتهم في حلولهن - وزعت المعلمة الانتباه على جميع الطالبات تقريباً. وتجولت بين المجموعات أثناء حل الأنشطة التقويمية - استخدمت المعلمة سجل المتابعة لبعض الطالبات اللواتي حللن على السبورة بعد النشاط الجماعي كما أنها استخدمت [illegible] لتقويم المجموعات (ملاحظة) - التقليدي بالسجلات كان بوضع إشارة ✓ فقط

القسم السادس: Section I Any additional information معلومات إضافية

تم الاطلاع على كتب الطالبات ولوحظ أن المعلمة تتابع الكتب بوضع ✓ أو ✗ دون تدوين تغذية راجعة كتابية

Appendix D Interview questions

a) Mathematics teachers' knowledge of assessment

1. Why assess students in mathematics?

2. What do you know about summative assessment? What are the purposes of this assessment?

3. What do you know about formative assessment? What are the purposes of this assessment?

4. What are you assessing in mathematics classes?

5. How do you assess your students in mathematics classes?

6. What knowledge do you have about assessment methods in mathematics?

7. What knowledge do you have regarding interpreting assessment results?

8. What actions should mathematics teachers take regarding students' assessment results?

b) Mathematics teachers' practices of assessment

9. How do you prepare for classroom assessment before lessons?

10. When conducting assessments in your class, what assessment evidence do you collect about your students?

11. How do you assess students in mathematics?

12. What type of assessment questions do you apply in your classes?

13. How do you provide your students with feedback?

14. How do you interpret collected assessment evidence?

15. How do you use students' assessment results?

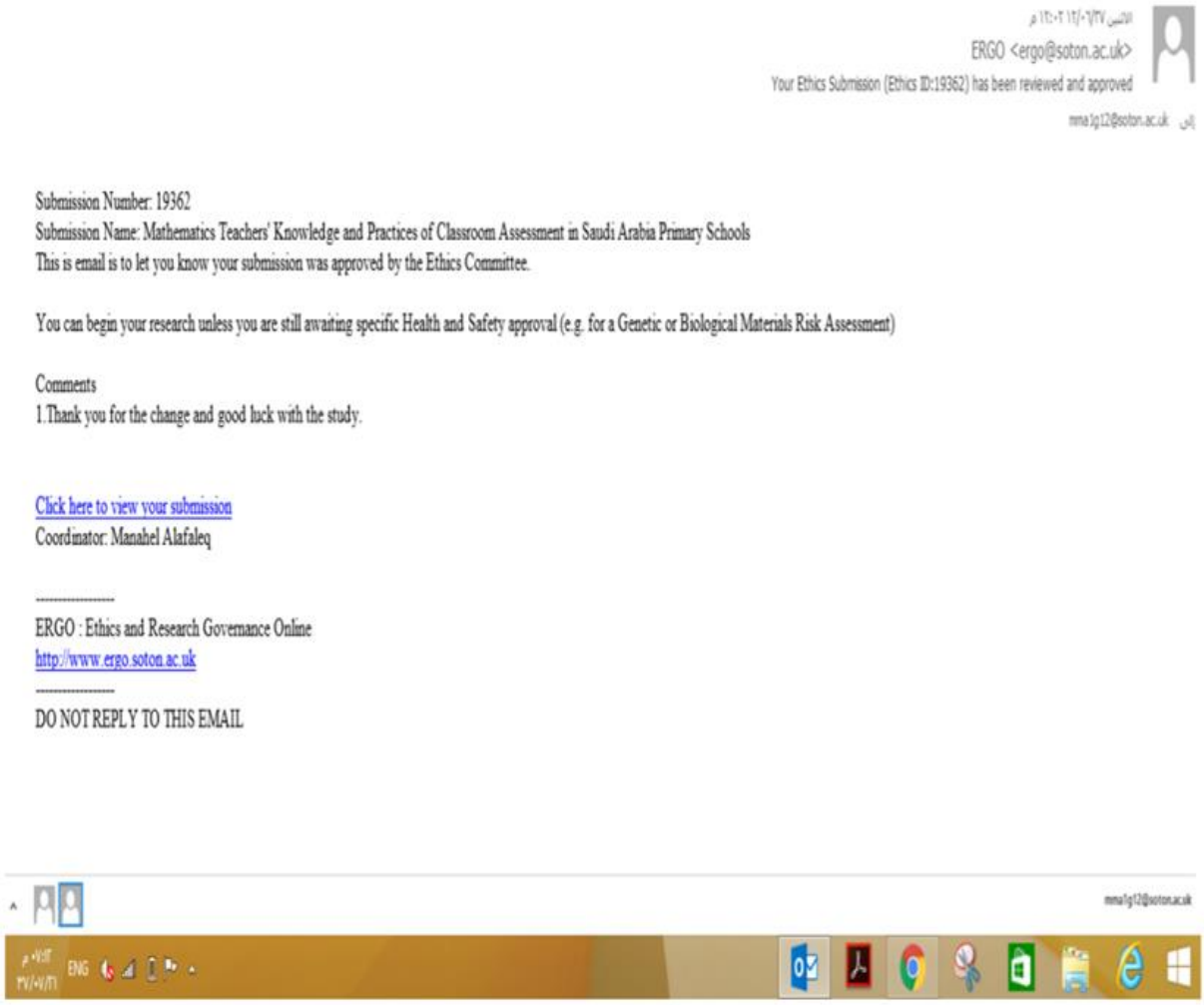
c) The impact of contextual factor on teacher' knowledge and practices of assessment

16. Can you tell me how you learned about classroom assessment?

17. What contextual factors do you feel have an impact on your knowledge of classroom assessment?

18. What is the impact of context on your practice of classroom assessment?

Appendix E Ethical approval form



ERGO <ergo@soton.ac.uk>
Your Ethics Submission (Ethics ID:19362) has been reviewed and approved
mma1g12@soton.ac.uk

Submission Number: 19362
Submission Name: Mathematics Teachers' Knowledge and Practices of Classroom Assessment in Saudi Arabia Primary Schools
This is email is to let you know your submission was approved by the Ethics Committee.

You can begin your research unless you are still awaiting specific Health and Safety approval (e.g. for a Genetic or Biological Materials Risk Assessment)

Comments
1.Thank you for the change and good luck with the study.

Click here to view your submission
Coordinator: Manahel Alafaleq

ERGO : Ethics and Research Governance Online
http://www.ergo.soton.ac.uk

DO NOT REPLY TO THIS EMAIL

Appendix F Consent letter for conducting the study

٢٠١٦/٢/١٥ البريد - meu9@hasaedu.info

استعجال رقم (١) تسهيل مهمة الباحثة مناهل محمد العفالق

meu9@hasaedu.info
الأثنين 15/02/16 10:24 ص

إلى: meu4@hasaedu.info

استعجال رقم (١)

اليوم: الأثنين
التاريخ: ٦/ ٥/ ١٤٣٧هـ

الى / مديرى مكاتب التعليم (بنين ، بنات) حفظهم الله
الى / مساعدى مديرى مكتب التعليم (بنين / بنات) حفظهم الله

السلام عليكم ورحمة الله وبركاته،،،

بناء على خطاب مدير عام التعليم بالأحساء بتاريخ ٢٢ / ٤/ ١٤٣٧هـ والمبنى على خطاب المبتعثة: مناهل محمد عبدالله العفالق بشأن تسهيل مهمتها فى جمع البيانات الخاصة ببحثها بعنوان (درجة المعرفة والممارسة للتقويم الصفى لدى معلمات الرياضيات فى المرحلة الإبتدائية)
وذلك كمتطلب للحصول على درجة الدكتوراة من جامعة ساوثهامبتون بالمملكة المتحدة، حيث ترغب الباحثة فى جمع البيانات من عينة من معلمات الرياضيات للعام الدراسى ٣٦/ ١٤٣٧هـ

عليه آمل منكم التكرم بتسهيل مهمتها فى الميدان التربوى.

.. نسخة الى مدير الادارة للاحاطة
.. نسخة الى منسقة البحوث بالادارة للمتابعة

والسلام عليكم ورحمة الله وبركاته،،
مساعدة مدير التخطيط والتطوير
حياة بنت عبدالعزيز الملحم

البندري علي الطبيلي
مسئولة البحوث التربوية - قطاع البنات
5991317

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