Exploring teaching strategies to attain high performance in grade eight Mathematics: a case study of Chungcheongbuk Province, South Korea.

By

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ABSTRACT

This study focused on teaching strategies preferred and used by grade 8 mathematics teachers, what they thought was most effective for learning mathematics as well as students' perspectives of their mathematics classroom. The aims of this study were to investigate the teaching strategies used in the South Korean mathematical classroom and to find out how they attain a high performance in mathematics, in comparison with other countries. The target population was chosen from within the Chungcheongbuk Province and ten schools were selected for the study.

In order to determine what teaching strategies are used in the South Korean mathematics classroom, a case study using both quantitative and qualitative research methods was adopted. Data collection methods included questionnaires for the students while interviews were conducted with the teachers. The questionnaire contained fifty closed-ended questions divided into different sections to obtain data on teaching strategies used, on preferred learning styles from the students and on how they felt about mathematics and the mathematical classroom. The interview consisted of ten open-ended questions to get feedback from the mathematics teachers on what teaching strategies they used in the classroom and on what they thought were the best strategies with regard to teaching grade 8 mathematics. From the ten sampled schools there were two hundred and two students who participated in this research, and six teachers were interviewed.

The results of the study showed that in the South Korean mathematics classroom a combination of direct instruction, practice and teacher guidance helps the students to learn problem-solving skills and to master mathematics. The students indicated that the teachers mostly used chalkboard instruction and that they practiced solving problems using worksheets, past exam paper questions and through homework or private study. The average student studied mathematics for about six hours a week and most attended afterschool academies for further studying mathematics. Although the South Korean students attained a high performance in mathematics it was evident that they indicated a low interest in the subject. The teachers stated in the interviews that they

thought the students needed to see examples on the chalkboard, and then the students need to practice with guidance from the teacher. It was evident that the students focus a lot on guided practice, since they study for about six hours a week. The teachers also felt that the curriculum is overloaded and that there was a gap between the better and the poorer level of students in the mathematics classroom, this gap grew bigger as students lost motivation. The responses to the questionnaire showed that 65% of the students were not interested in mathematics; in spite of this South Korea is placed among the best performing countries in the world. The teachers also indicated that mathematics was very highly valued in South Korea and that parents and universities put a lot of pressure on students to perform well in this subject.

This study provides better insight into what is happening in the South Korean mathematics classroom, what methods are used and how the students felt about the mathematics classroom and the strategies that are used. Apart from commenting on teaching strategies, there was also an indication of what teaching style the students preferred. The information in this research study can provide answers to questions regarding South Korean mathematics instructional practices and will be useful for future comparative studies regarding the teaching of mathematics in other countries.

KEYWORDS: Teaching strategies, Problem-solving skills, Direct instruction, Guided practice, Outcome Based Education

DECLARATION

I, Gerhard van der Wal, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Masters of Education at the University of South Africa, Pretoria. It has not been submitted before for any degree or examination in this or any other university.

LGvdWal

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Signed at Cheongju, South Korea

On the 25th day of February 2015

DEDICATION

THIS THESIS IS TO HELP SHARE KNOWLEDGE TO THOSE SEEKING MORE.

LIST OF ABBREVIATIONS

TIMSS	-	Trends in International Mathematics and Science Study
IMO	-	International Mathematical Olympiad
Gr. 8	-	Grade eight
NASSP	-	The National Association for Secondary School Principals
PISA	-	Programme for International Student Assessment
MEST	-	Ministry of Education, Science and Technology
OBE	-	Outcome-Based Education
OECD	-	Organisation for Economic Co-operation and Development

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CHAPTER 1

BACKGROUND TO THE STUDY

1.1 Introduction

In this chapter the researcher discusses the purpose of the study, the context of the study, the significance of the study, delimitations of the study as well as assumptions of this study.

The Trends in International Mathematics and Science Study (TIMSS) is an assessment of fourth and eighth grade students' performance in mathematics and science across the globe. Table 1 shows the results of studies that were performed on grade eight students in the past decade (Mullis, Martin, Foy, & Arora, 2012).

Table 1: Trends in International Mathematics and Science Study (TIMSS)

Year	**1995**	**1999**	**2003**	**2007**	**2011**
Country ranked first:	Singapore	Singapore	Singapore	Taiwan	
Ranking of South Korea	2	2	2	2	1
Number of countries participating	41	38	46	49	45

From the above table the ranking of South Korea draws attention to the fact that the South Korean mathematical teaching strategies may be more efficient and may promote better learning, hence research on mathematics instruction used in this country may benefit other countries. For this reason, the researcher presents a case study of the South Korean grade eight mathematics teaching strategies, to inform the teaching of mathematics in other countries. Such a study is not undertaken to provide a final 'solution' to mathematics education, but rather to provide a document that can yield

insight into alternative teaching strategies that could be of interest to countries performing poorly in mathematics.

Information was gathered from both students and teachers in South Korea to examine how the teaching strategies are implemented and to what extent the teaching strategies are used in the class. It was also important to see what the provincial education office expected of the teachers with regards to the teaching strategies that should be used. Provincial documents and curriculum guidelines give a clear indication of what is expected regarding teaching strategies in South Korea. This study was conducted in the Chungcheongbuk Province.

Although there have been much debate and significant movement away from the traditional methods of teaching, which mostly relied on the transference of knowledge from the teacher to the students, there are still schools (internationally) that use these methods and teaching strategies. Teachers often talk about improved strategies but it is also important to implement them. There are arousing needs to know how to successfully implement these strategies.

Mathematics teachers tend to place too much focus on the instructional strategy, where the teacher is the one who does the talking, while the students listen; this is still the norm in today's classrooms. The teacher spends most of the time talking and explaining when he or she should rather adopt approaches that are less dependent on transmission and more participatory (Sfard, 1998). When we talk about participatory methods most teachers associate student participation with group work, but this is not necessarily the case. There are other techniques that can be used to ensure that understanding of mathematical concepts takes place. These include getting the students to show their understanding through demonstration or verbal explanations.

"Different teaching strategies are simply different ways of helping learners to learn – that is, different ways of helping learners to achieve the learning outcomes that you have decided are important" (Killen, 2000, p.78). Killen further states that there is no single teaching strategy that is effective for all students in all situations. If the teacher wants to apply different teaching strategies then he/she needs to gradually build up his/her

teaching expertise. This will help the teacher to make the right decisions with regard to what approach and strategy to use. The teacher's planning should always begin with the important outcomes that he or she wants the students to achieve. After the teacher has identified the outcomes then he/she can start to think about the content that he/she wants to select to help students achieve these goals and the teaching strategies that the teacher might use.

It is often asked if it is really necessary to do more research about mathematics, since there is already an abundance of research available. *Why is there still a need for more research?* According to Kieren, Forman and Sfard (2003, p.14) there is a big gap between research and practice and there is no "lasting improvement in teaching and learning that the research is supposed to bring." With this in mind, it is important not to just identify teaching strategies that will help improve mathematical learning but also to look at how the teachers implement these strategies, so that teachers in other countries might follow their example. Thus this study has focused on teaching strategies used by grade eight teachers, on their practice and on the implementation of teaching and learning with regard to mathematics.

1.2 Overview of the study

This chapter provides an overview of the study. First a brief summary of the purpose of this study is given, as well as an account of the context in which it took place and of its significance for the reader. The problem is stated together with the research questions and the delimitations of the study will describe the sample used in this study. There follows a brief summary of the relevant literature, and the theoretical framework, and the aims and objectives of the study are outlined. Finally this chapter summarizes the chapter layout of the whole study.

1.2.1 Purpose of the study

The purpose of this study was primarily to explore the teaching strategies used in South Korea to attain a high performance in mathematics. It is the researcher's opinion that teachers in countries that perform poorly in mathematics can learn from the teaching

strategies used in better performing countries. However, teaching styles and strategies change frequently, thus it is important to keep searching for what works better and for what might enhance mathematics performance. Secondly, the teachers' perspectives on teaching strategies and on what works best for them will be useful for teachers from countries that perform poorly in mathematics. Thirdly, the students' perspectives on the teaching strategies used and on how they experience learning in the classroom will narrow the field down to a few strategies that might shed light on how to attain a higher performance in mathematics in South Africa and in other countries.

This study is useful for those seeking a more technical understanding of the South Korean classroom, other studies focus more on cultural differences between Asian schools and Western schools. This study attempts to provide a better grasp of what is happening in the South Korean mathematics classrooms, and to use this information to help other mathematics teachers to adapt or rethink their teaching strategies; no teaching strategy should be discarded before looking at what works best. Vigilant teachers should always strive to explore and try to implement new things in the classroom to adapt to an ever-changing modern era.

1.2.2 Context of the study

Mathematics is one of the subjects that is the focus of comparison between different countries and research is often conducted on how to improve its teaching and learning. Students compete on an international level and a country's performance is rated on a ranking list. One such example is the Trends in International Mathematics and Science Study (TIMSS). Proficiency in mathematics is essential in modern life and most universities look at students' mathematics ability before they allow those students to register for most careers.

The researcher has three years' experience as a high school accounting teacher in South Africa (2007-2009). During this period he noticed that students struggled with mathematics and that there was a need to find better ways to learn and more effective teaching strategies to improve the understanding of concepts in this subject. Since moving to South Korea as a teacher he has been intrigued by their education system

and impressed by how well their students perform in mathematics, especially at middle school level. This study focuses on gaining insight into the teaching strategies used in South Korea and on how they are implemented in teaching mathematics.

The South Korean mathematics classroom is quite different from South African classrooms. It is not the size or technology that is different; the difference lies in the teaching strategies used to teach mathematics. Often the basic principles of teaching are overlooked in South Africa, where the focus is typically on technology or culture rather than on the strategies used whilst teaching this subject. A lot of research has been done in poor or underdeveloped countries regarding the teaching and learning of mathematics, but there has been little research on the mathematics teaching strategies used in South Korea, a country that is highly rated in mathematics throughout the world. This study focused on the South Korean mathematics classroom, on the teachers' perspectives and on what the students thought about the teaching strategies used to impart this subject.

Considerable research has been done regarding mathematical instruction internationally. However, most of the studies focus on the curriculum (Vithal, Adler, & Keitel, 2005), teacher education, providing psychological or sociological perspectives on the education systems, or they focus on tuition in a second language, classroom size, resources, and other factors (Reddy, Kanjee, Diedericks, & Winnaar, 2006). To this researcher's knowledge, no study has focused on the teaching strategies currently used in the grade eight mathematics classroom. This study addressed the basic elements in the South Korea classroom that can be implemented by all teachers to obtain an improved student performance in mathematics. Most teachers think of teaching strategies as a fixed set of strategies or methods that could be implemented, but they have to consider that some strategies are often modified or combined to get better results. Vijayalakshmi (2004) asserts that there is a close relationship between teaching and learning and that it is possible to *modify*, *improve* and *develop* teaching strategies. Thus it is important to learn from how South Korea has enhanced the strategies of teaching mathematics and learn from it.

1.2.3 Problem statement

Main problem

This study investigated the teaching strategies used to teach mathematics to grade eight students in South Korea. The focus on South Korea is because of that country's excellent performance in mathematics in comparison with other countries. This research can benefit poorly performing countries and help to shed light on what teaching strategies are effective in the mathematics classroom. The Trends in International Mathematics and Science Study (Mullis, Martin, Foy, & Arora, 2012), in which schools from 45 countries participated, showed that South Korea was the top performing country in 2011.

(i) **Aims of this study**:

The aim of this study was to identify the teaching strategies that are used in the South Korean mathematics classroom.

In order to identify the strategies that are used there were a few objectives that needed to be achieved.

First was to obtain the students' perspectives of their mathematics classroom and to explore the relationship between the teaching strategies used and the students' performance. This included the students' view of classroom management, of the methods that were used in the classroom as well as of materials that were used by the mathematics teachers.

Second was to obtain the teachers' perspectives of teaching strategies and examine the strategies they applied in their classrooms and find what they thought was most effective for learning mathematics.

In order to obtain these objectives the researcher needed data from the research instruments. After the data from the questionnaires and interviews was analyzed the information was used to answer the research questions; this is briefly discussed in the next section.

(ii) **Research questions**:

1 What teaching strategies are used to teach mathematics in South Korea?
2 What are teachers' and students' preferred strategies in teaching and learning of mathematics?

The following two strategies were used to answer the research questions:

I. Explore and assess the mathematics teaching strategies used by South Korean teachers in the mathematics classrooms.
II. Obtain feedback from the students on the effect of the teaching strategies used in their mathematics classrooms.

1.2.4 Significance of the study

The 53rd International Mathematical Olympiad (IMO) was held in Mar del Plata, Argentina in 2012. The IMO was attended by 548 students representing 100 countries. At this Olympiad South Korea was ranked first with six gold medals. South Africa was ranked 56th at this Olympiad. The following year, 2013, during the 54th International Mathematical Olympiad held in Santa Marta, Columbia, South Korea was ranked second out of 97 participating countries. South Africa was ranked 58th at this Olympiad.

According to a study, Trends in International Mathematics and Science Study (Mullis, Martin, Foy, & Arora, 2012), which assessed international mathematics performance for Grade eight (Gr.8) students, it was found that South Korea was the highest performing country. "There were 50 participating countries in TIMSS 2003. The five highest performing countries in mathematics were Singapore, Republic of Korea, Hong Kong (SAR), Chinese Taipei and Japan. The five lowest performing countries were the Philippines, Botswana, Saudi Arabia, Ghana and South Africa." (Reddy, Kanjee, Diedericks, & Winnaar, 2006, p.30).

With this in mind we can acknowledge that the South Korean approach to mathematics teaching is working and their performance is excellent. Although many countries are successful in achieving high grades in mathematics, many are still struggling to improve

their performance in mathematics. It is the researcher's opinion that gaining better performance in mathematics does not require a paradigm shift in the curriculum; rather what is needed is the use of better strategies and more effective implementation.
Thus this study can contribute to narrowing the gap between high- and low-achieving countries by introducing teaching strategies that most countries can adopt to improve their performance in mathematics. This study aims to describe the teaching strategies that are used in South Korea and how they are implemented.

The study provides guidance to other countries and teachers who are in need of better ways to improve mathematical learning in their classrooms. Attaining a higher performance in mathematics is a goal for teachers and students alike. We should not focus on the culture or on the content that is being taught, but rather on what happens in the classroom and on the strategies that are used to teach mathematics.

1.2.5 Delimitations of the study

In South Korea the students' schooling is split into the elementary, middle and high schools. Elementary schools enroll students aged from 7 to 12 years, while middle school students are aged from 13 to 15; high school students are aged from 15 to 18. These ages are internationally recognised, since South Korea uses the lunar year to calculate ages. The lunar calendar is roughly 354 days, and this is sometimes referred to as a lunar year. This study is limited to grade eight students, for the purposes of uniformity and manageability. The TIMSS study focused on grade eight students and this makes comparison with other countries easier. Grade eight students are at the beginning of the process of learning mathematics in greater depth and they are more receptive to new teaching strategies and learning styles than older students.

1.3 Literature review

In the next chapter there is a review of the relevant literature; this provides some knowledge of a variety of concepts and is especially useful in providing some background knowledge of the South Korean education system and the teaching of mathematics. The literature reviewed included dealing with teaching and learning strategies. A historical perspective of teaching strategies enables an understanding of where these strategies originate and how they have been relevant in the past. This suggests what we could learn to shape the future of these teaching strategies. According to Silver, Strong and Perini (2007, p.35) a four-phase process is needed to maximize skill acquisition:

1. Modelling – the skill is modelled by the teacher, who thinks aloud while performing the skill.
2. Directed practice – the teacher uses questions to lead students through the steps and to help them see the reason for the steps.
3. Guided practice – students generate their own leading questions while working through the steps; the teacher observes, coaches, and provides feedback.
4. Independent practice – finally, students work through examples on their own.

This is important because some of the South Korean teachers use this model in their teaching of mathematics. Learning strategies are discussed next in the literature review. Some of the questions in the questionnaire were directed at the students' preferred learning styles and strategies, and this literature review provides insight into these strategies.

Teacher strategies were reviewed with regard to the problem-solving approach as well as the problem-centred approach. Both these approaches have been researched by various mathematicians such as Polya (Masingila, Lester, & Raymond, 2002, p.19) to discover which method is more effective in learning mathematics.

Finally, Korean mathematics is reviewed and discussed in relation to the history of education in South Korea and how their education system works. The national

curriculum is briefly discussed and how South Korea has performed in various research studies regarding mathematics.

1.4 Research design

This section outlines the research methodology and design of the study. The researcher decided that a case study would be used to obtain the data needed to answer the research questions. For the researcher to identify the teaching strategies data was needed on practices within the South Korean mathematics classroom; a questionnaire was designed to gather data from the students and to gain their perspectives on the strategies used in the mathematics classroom. An interview guide was also designed for the South Korean mathematics teachers focussing on the teaching strategies used. Thus this study has followed both a qualitative and a quantitative approach to the gathering of data.

The population of this study consisted of two hundred and two students from ten different middle schools in the Chungcheongbuk Province. Six teachers were willing to be interviewed and give answers regarding teaching strategies used in their classroom. They could supply information regarding the teaching strategies that could improve mathematical learning. The procedure that was followed in collecting data is discussed in the third chapter, as well as the data analysis from the questionnaires and the interviews.

1.5 Definition of terms

Middle school

In South Korea, middle school is between elementary and high school. The high schools are divided into specialist, normal or technical high schools. Thus the middle school will determine to what type of high school the student can go to. In the third grade the students have to write a high school entrance examination to apply for certain high schools. In South Korea the second grade students are 14 years old and can be compared to grade eight students internationally.

Higher performance

Higher performance relates to the scores of assessment that are generally higher than the average of the other students in the same group, such as age. The average can be seen as the sum of the scores divided by the number of students in the same group. Higher performance is comparative.

Teaching strategy

Teaching strategies refer to the methods and techniques that are used by the teacher in the classroom to teach the learning material and transfer the knowledge to the students. It is the type of principles that are used for instruction.

Pedagogical approach

This refers to certain strategies of instruction, or the strategies used in the process of teaching mathematics.

Outcome based education

This is a student-centred learning philosophy that focuses on empirically measuring student performance.

Traditional education

This is also known as direct instruction. The teacher is the main source of knowledge and transmission of the knowledge is from the teacher to the student.

Learning style

Learning style is the way that each person starts to concentrate on new academic information and then to process, internalize and retain this new difficult information (Dunn, & Dunn, 1993). Similarly the National Association for Secondary School Principals (NASSP) Task Force defined learning style as “the composite of characteristic, cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment” (Keefe, 1979, p.30).

Learning strategy

The learning strategy determines the approach that was followed to achieve the learning outcomes, to make sure that learning takes place. Oxford and Green (1996) defined learning strategies as specific behaviours that students use to improve their own learning. Learning strategies can also be viewed from the teacher's perspective as a certain set of techniques that teachers use to promote learning, such as demonstration and group repetition.

1.6 Assumptions

This study assumed that the South Korean teachers were well educated and had excellent qualifications in their field of study. They were able to identify their teaching methods and knew what was relevant in their classrooms and what worked best for them in achieving the desired learning outcomes.

This study assumed that the teachers were willing to cooperate and help in any way possible. However the language barrier proved to be a problem which interfered with their ability to express themselves. A translator was used to ensure that the conversations and interviews proceeded smoothly and that the right content was reflected in the research.

1.7 Chapter layout

Chapter 1: Provides an introduction, overview of the study with the problem statement, the aim of the study with the theoretical framework as well as the method for data collection.

Chapter 2: Gives a summary of the literature review.

Chapter 3: Deals with the research design as well as the methods and techniques (instruments) used for the data collection.

Chapter 4: Provides the analysis of the data with diagrams to represent the findings from the questionnaire.

Chapter 5: Provides the summary of the findings followed by conclusions of the study and recommendations.

In this chapter the researcher discussed the overview of the research study and gave information regarding how the study was conducted. The problems were stated and the research design of the research study was given as well as the chapter layout for this dissertation. The next chapter focuses on the literature reviewed to get background knowledge on the main terms used as well as a better perspective on teaching strategies and mathematics in South Korea.

CHAPTER 2

LITERATURE REVIEW

In this chapter the researcher presents a literature review of the teaching strategies that are used in the mathematics classroom. This literature review is divided into five main parts. The first part is a brief definition of the topic: this gives a clear view of teaching strategies used in the classroom. The second part provides a historical perspective on teaching strategies as well as a focused look at learning and teaching strategies that are relevant to mathematics. The third part presents a discussion of the Korean mathematics classroom as well as of the Asian perspective on mathematics. The fourth part looks at other relevant studies regarding teaching strategies in South Korea. The final part concludes the chapter and provides a brief summary of the first four parts.

2.1 Teaching and learning strategies

In order to make sure that learning and understanding of mathematics occur in the classroom, it is essential that powerful learning styles and strategies are identified. It is important to incorporate strategies to help the students to learn mathematics using the learning styles that they prefer; these strategies should create opportunities for the students to use their own preferences. Orlich, Harder, Callahan, Trevisan and Brown (2009) assert that as one plans to teach a subject, one must remember that the processes that students use to master the content of a lesson are just as important as the content itself. Thus, the teacher has to apply the correct strategy in order to achieve the appropriate outcome. In the following section the researcher presents (i) a historical perspective of teaching strategies; (ii) content based on learning and outcomes-based learning; and (iii) some learning strategies employed in the mathematics classroom.

2.1.1 Historical perspectives on teaching strategies

Throughout history students have learned mathematics in different ways. Effective teaching practice has often adapted as the demand for better education has increased. What was effective in the classroom twenty years ago might not be best practice for today's classrooms. Before the focus on outcome-based education, the industrial era shaped the education system according to the norms of what we know as traditional education. Teaching strategies can best be understood in relation to the education system they are used in. Different education systems bring with them different demands and expectations, so the teaching strategies used are influenced by these systems. To fully understand where we are going we have to take a look at where we are coming from, thus one starts by looking at traditional education.

John Dewey (1938, p.1-5) described the students of his era as "imposed from above and from outside": they were forced to memorize information that was "transferred" from the teacher to the students. They were obedient and most of the time the conversation was one-way. The students had to believe the answers that were given to them.

In traditional education all the students were taught the same material at the same time and they had to follow at a speed determined by the teacher. According to Beck (2009) the students who could not learn at the same speed often failed; they could not learn at their own pace. Corporal punishment was often used to manage discipline and to motivate students to study harder. Because students memorized most of the work and recited it, they were able to attain higher grades in tests by memorizing the answers. Emphasis on learning did not reinforce conceptual understanding. Learning was mostly characterized by memorization and progression from one grade to the other. Rote learning usually caused problems since students could not recall any of the memorized facts in the next grade. They also could not relate the concepts learnt to their applications and did not understand how they added to their knowledge.

A strategy used by these teachers was known as "direct instruction". "'Direct instruction' is often called 'whole-group' or 'teacher-led' instruction. Basically, the technique involves an academic focus, provides little opportunity for student-initiated activities,

tends to be large-group-oriented, and emphasizes factual knowledge," (Orlich, Harder, Callahan, Trevisan, & Brown, 2009, p.28). This teaching strategy is now considered to be outdated: it should have been replaced by newer strategies involving more group work or involving the whole class. Although this is partly true there are still many cases where direct instruction is part of the mathematics classroom: some teachers feel that the demand of the curriculum requires direct instruction, where they can relay the information faster to the students.

There are still teachers who rely on direct instruction as a useful and effective teaching strategy. Silver, Strong and Perini (2007, p.35) found that direct instruction can be useful to teach declarative content. According to this strategy there is a four-phase process to maximizing skill acquisition:

i Modelling – this is where the skill is modelled by the teacher, who thinks aloud while performing the skill.

ii Directed practice – here the teacher uses questions to lead students through the steps and helps them see the reason for the steps.

iii Guided practice – the students generate their own leading questions while working through the steps; the teacher observes, coaches, and provides feedback.

iii Independent practice – finally, students work through examples on their own.

Silver, Strong and Perini further noted that this strategy worked because teachers who spent more time demonstrating and explaining procedures and skills were more effective than teachers who spent less time doing so.

In the 1980's many countries started to move away from the traditional approach to outcome-based education (OBE). In South Africa this was part of the Curriculum 2005 programme. This programme started in the 1990s but was abandoned in 2010 as most people viewed it as a failure (Mogaki, 2010). OBE is defined as a "comprehensive approach to organizing and operating an education system that focused in and was

defined by the successful demonstrations of learning sought from each student" (Spady, 1994, p.2).

Outcome-based education is different from traditional education in the sense that it focuses on the student rather than on the resources (textbooks and other study material). The students' performance was measured using empirical evidence. The American Heritage Dictionary of the English Language (Picket, 2011) states that through observation and experimentation empirical evidence can become a source of knowledge. Thus the student should demonstrate his knowledge other than through the traditional methods of reflection and memorizing: the students had to demonstrate what they knew and what they were able to do. They had to meet the stipulated outcomes in order to progress to the next level.

The following are different approaches to Outcome-based education as distinguished by Spady (Killen, 2000, p.2):

i Emphasis on knowledge and skills in traditional subjects, which he calls 'traditional OBE'.

ii Emphasis on broad competencies such as problem-solving and using technology, which is 'transitional OBE'.

iii Emphasis on 'role performances' is his third approach; this is known as 'transformational OBE'.

Traditional OBE, as explained by Spady, can be seen as knowledge that the student acquires from the textbook and that is transferred from the teacher to the student. Transitional OBE on the other hand includes a wider range of problem-solving skills: the student needs to show that he is competent at finding solutions and needs to demonstrate his knowledge at a deeper level than just memorizing. Technology is introduced in transitional OBE and thus there are various ways to test the student (other than just testing textbook knowledge). Transformational OBE is where the student should be able to present the problem and find solutions in role performance: this creates a practical scenario where the student can solve the problems in a situation that resembles real-life experience.

Outcome-based education has met resistance from several teachers: its failure to show progress and improvement has led to its recent decline. Mogaki (2010) asserts that few South Africans will mourn the disappearance of the OBE system that was forced on students a decade ago. He further noted that the South African government had grossly underestimated the side effects and the negative impact of OBE on the teachers and students. When one considers the pressure to transform from one educational system to the next and the confusion this has caused, one can understand the damage that has been done.

Kraak (1999, p.53) asserts that the education perspectives have undergone an important shift. There has been a move away from macro-level concerns about a divided education and training system and an unequal society to a "micro-level obsession with unit standards and the minutiae of an overly prescriptive assessment model." The assessment standards were intended to create an even field of assessment and make use of rubrics which specified what knowledge the students needed to demonstrate. Assessment was no longer an area where the teacher had freedom to judge how best to assess the students; the teacher was rather told how to assess using specified material or topics. The assessment standards had to evaluate everyone on the same level, and thus the level dropped to accommodate the majority of lower-level students (in order to help them pass the grade). The reform process has changed from its original purpose, which was to unify and integrate the system; it now sought to address the problems regarding social inequalities which arise in the education and training system.

The focus of these two educational approaches, as Spady (1994) calls it, differs: the traditional or transactional approach is content-based and includes performance indicators such as tests results and completion rates. It also emphasizes academic outcomes or content. On the other hand, the second approach, the transformational (outcomes-based) approach was less definite and was usually measured in terms of what the students knew or were able to do. Table 2 illustrates a comparison of the traditional approach and the transformational approach to content-based learning and outcomes-based learning.

Table 2: Content-based Learning versus Outcomes-based Learning

Content-based Learning System	Outcomes-based Learning System
Passive students	Active students
Assessment process – exam & grade driven	Continuous assessment
Rote learning	Critical thinking, reasoning, reflection & action
Content based/broken into subjects	Integration of knowledge, learning is relevant/connected to real-life situations
Textbook/worksheet focused & teacher-centred	Student-centred: educator/facilitator use group/teamwork
Syllabus is rigid & non negotiable	Learning programmes are seen as guides that allow educators to be innovative & creative in designing programs/ activities
Teachers/trainers are responsible for learning - This depends on the personality of the teacher	Students take responsibility for their learning: students are motivated by constant feedback/ affirmation of worth
Emphasis on what teacher hopes to achieve	Emphasis on outcomes – what student becomes & understands
Content placed in rigid timeframes	Flexible timeframes-students work at own pace
Students stay in one learning institution	Students can gather credits from different institutions until they qualify
Previous knowledge & experience in learning field is ignored – Each time attends whole course	Recognition of prior learning: after assessment, students are credited with outcomes demonstrated or transfer credits from elsewhere

(Source: Spady, 1994)

The above table gives a clear indication of the differences between Content-based Learning and Outcomes-based Learning. According to Spady the students are more

passive in the Content-based Learning system and rote learning takes place. Spady further notes that students actively participate in the Outcomes-based Learning system, such that the teacher controls less of the lesson and allows the students to take responsibility and create connections between the learning material and their own experience.

The teaching strategies used in OBE, as defined by Killen (2006), are quite wide and could be incorporated in most classrooms. The strategies include:

i. Direct instruction,
ii. Discussion,
iii. Small-group work,
iv. Co-operative learning,
v. Problem solving,
vi. Research,
vii. Role play,
viii. Case study, and
ix. Writing.

These strategies will be discussed further under the heading of teaching strategies.

2.1.2 Learning styles

When one looks at a learning style one has to understand that “style” refers not to ability but rather to one’s preferred way of using this ability (Zhang, 2001). Learning styles as individualized to suit each person’s ability to acquire new knowledge originated in the 1970s and since then have made a big impact (Pashler, McDaniel, Rohrer, & Bjork, 2008).

James and Gardner (1995) state that individuals differ in the way they learn. In different learning situations each individual has a different way of acquiring and processing new information; this is called a learning style. In the classroom the teacher should identify the different learning styles of his/her students and adopt the learning material and methods that are best suited to the students’ learning style.

According to David A. Kolb (1984) there are different learning styles with different approaches that promote understanding: these are Concrete Experience and Abstract Conceptualization. There are also two other approaches that assist with transforming experience, these are: Reflective Observation and Active Experimentation. Kolb says that all of these approaches need to be used for learning to take place. An individual will, however, favour one experience-grasping approach and one experience-transforming approach. For learning to take place in the mathematics classroom the students need to transform the experience to grasp the content and to be able to use it on their own. While most students just watch the teacher in the classroom it is important that the students reflect on the content, not just observing, to fully understand and comprehend the new content. Active participation could help the students to use their current knowledge and build on it by practicing and experiencing the new content actively. The combination of the two approaches that the individual favours results in the following learning styles: Converger, Diverger, Assimilator, and Accommodator. In the mathematics classroom the students need to accommodate the new content with their existing knowledge, this could lead to the convergence of the old and new knowledge. On the other hand, students need to explore for themselves and build their own knowledge. To diverge from their current paths and seek new ways to solve problems on their own could lead the students to construct and build their own experiences and knowledge.

Another famous description of learning styles is Fleming's VARK model. Hawk and Shah (2007) explain these different learning styles. The first type of learner is the visual learner. These learners prefer to see the information, and think in pictures and use visual aids. The second type of learner is the auditory learner: these learners prefer to hear or listen to the information. The third type of learner is the kinaesthetic or tactile learner: these learners want to learn via experience - in other words by moving, touching or doing something.

When a teacher plans a lesson it is important to be aware of these learning styles so that he/she can choose appropriate teaching strategies.

2.1.3 Learning strategies

Students use learning strategies to help them understand information and to solve problems in mathematics. Each individual has a strategy or an approach to learning and absorbing information. These strategies include (i) listening, (ii) guessing or inferring, (iii) taking notes, (iv) identifying progress and (v) focusing. Oxford and Green (1996) distinguish between learning styles and learning strategies. They see learning strategies as specific behaviours that students use in order to improve their own learning, while learning styles are the broader approaches to learning a new subject or solving a problem. Thus learning strategies are more intricate and focused and are more specific to the individual and are vital for gaining new knowledge. If a student can't grasp his or her own learning strategy or lacks the knowledge to use a learning strategy then that student is likely to fail academically.

Learning strategies also include (i) cognitive, (ii) metacognitive, (iii) affective and (iv) resource management strategies (Cangelosi, 1996). Cognition refers to a cluster of mental processes that includes attention, memorizing, learning, reasoning and problem-solving. Managing these cognitive processes means that the student is able to control and use these processes to solve a problem. Metacognition can be seen as knowledge about when and how to use particular strategies for learning or for problem-solving. It means knowing about your own cognitive mental processes and using them effectively. The affective domain can be described as having the elements of "affect", "behaviour", and "cognition". To manage these three elements of the affective domain is to manage your feelings or emotions. Resource management refers to the resources that are available to the student and that enable them to order, categorize and decipher these resources to solve the problems at hand.

"Meta-cognition refers to conscious monitoring or being aware of how and why you are doing something while *regulation,* means choosing to do something or deciding to change your own thought processes" (Van de Walle, 1998, p.51). White and Mitchell (1994, p.26) further assert that training in meta-cognition improves the students' control over their learning.

When we look at learning strategies with a particular focus on mathematics, we then consider the behaviours and thoughts that affect the students' affective state or motivation; this can be seen as the way in which they select, acquire, organize and integrate new mathematical knowledge. Mathematics learning strategies according to Cangelosi (1996) are specific techniques that are used to further the progress and increase mathematics learning.

Wolters (1999, p.281) outlines six cognitive and metacognitive learning strategies. These are: (i) *rehearsal* - the degree to which students use repetition and memorization to learn material; (ii) *elaboration* - students' use of strategies to connect new material to what they already know; (iii) *organization* - students' strategies for making outlines or diagrams to organize study materials; (iv) *planning* - students set goals or think through what they wanted to get done before beginning a task; (v) *monitoring* - this is the way in which the students mentally supervise and observe their cognitive strategies and (vi) *regulation* - this is when students adjust their cognitive strategies to fit the requirements of their current task.

Familiarity with these learning strategies and understanding which strategies the students prefer can enhance mathematics instruction. This enables the teacher to adapt his or her teaching strategy to meet the needs of the students so that learning can take place. To see what teaching strategy works best, the teacher needs to first see what learning styles or strategies are used by the students.

2.2 Teaching strategies

Teaching strategies are the methods or techniques that the teacher uses to teach content knowledge in the classroom and to transfer this knowledge to the students. According to Black (1999, p.120), knowledge of the difference between rote learning and learning with understanding depends on the type of instructional strategy used in the classroom.

Killen (2006) states that since learning is the process of acquiring new information, the teacher must choose a teaching strategy that will help the students to understand and remember the information, or think about it. The teacher sets the outcomes for the

lesson and thus it is the teacher's responsibility to make sure that the information conveyed is directly aligned to the outcomes that the students should achieve at the end of each lesson.

The focus is on the student, so when teachers do their planning they should first set the outcomes and then design the instructional activities that will build on the students' previous knowledge, motivation and level of interest (Jones, Palinscar, Ogle, & Carr, 1987). They further assert that the teacher should evaluate available materials and should then choose a strategy to take the students to the level of knowledge expected of them. The most important aspect of this is that the teacher should continuously modify his/her plans according to feedback from the students; in this way the teacher can find a balance between giving the students the necessary guidance and allowing them the necessary independence. From this we can see that a teaching strategy is not set in stone: it can be altered and modified to fit the needs of the students, since each teaching situation and environment is different.

According to Killen (2006) the following teaching strategies apply to the modern classroom: (i) direct instruction, (ii) discussion, (iii) small-group work, (iv) co-operative learning, (v) problem solving, (vi) research, (vii) role play, (viii) case study and (ix) writing. Direct instruction, as discussed previously, involves the direct transfer of knowledge from the teacher to a student, with the teacher doing most of the talking. The teacher leads the instruction and the focus is on acquiring factual knowledge and this leaves few opportunities for the students to initiate activities.

Discussion can be used in any classroom environment by students to test their own ideas against those of other students. It is a good way to learn from different perspectives on the same information and it can help to guide students to understand or grasp a principle that has eluded them previously. The students can express their own opinions and can give other students their views on the topic. The teacher will facilitate the discussion and guide the discussion in the right direction if it strays.

Small-group work is an activity that focuses on the students and the teacher should facilitate and give guidance to the different groups (Killen, 2006). These groups can vary

in size, depending on the classroom and desk layout but average group sizes are usually four to six students. Students can work together to achieve their goals or outcomes and they can acquire social skills as well as factual knowledge. The main goal is to produce evidence of their understanding. Small-group work can include a wide variety of activities. These activities can include small-group discussion, completing worksheets, solving problems or making presentations. Small-group work can thus be integrated with other strategies.

Co-operative learning can take place within small groups or between two students working together. Students learn from each other and the teacher should pair students who will work effectively together. This encourages student-to-student interaction, and can help team members to establish a supportive relationship. It further gives merit benefit for both students and the teacher (Huetinck, & Munshin, 2000, p.15).

Problem-solving is a strategy that is widely used in mathematics classrooms. The students should solve the problem themselves using their prior knowledge to guide them towards a solution. Problem-solving tests the students' ability to use their knowledge and to prove that they have assimilated it by using it to solve problems. This topic will be further discussed at length under the next heading.

Research can be used as a teaching strategy to promote self-learning and allow the students to discover new information on their own. Research can take the form of an investigation or guided research using materials such as books or the internet. It can also be combined with case studies. Research can lead the student to discover new methods and information, thus giving the student a broader perspective; this will enable the student to retain new information when it is transferred from the teacher.

Role-play is effective as a teaching strategy: it helps the students to gain confidence and grasp knowledge and use it in an everyday situation. Role-play can be used to create a particular scenario and it brings a kind of realism to the classroom. This helps the students to solve problems and use the knowledge that they have acquired in a situation that resembles a real life situation. Role-play can help the students to understand information and to see its value.

Case studies provide real-life scenarios: the students can learn from these experiences to put their knowledge to use and build on their current experience. Case studies can provide useful information that is not in the textbook. A case study can be combined with research, small-group work or co-operative learning. This strategy can be used to gather data in real-life situations and to analyze the data using problem-solving methods. This can help the students apply knowledge from the classroom and analyze data to present useful information.

Writing is a good way of testing the students' knowledge and their understanding (Killen, 2006). It reveals their ability to write and tests whether they can relay information effectively. Through writing students can represent their opinions and also deal with problems that they might encounter in the mathematics classroom.

In the next section the problem-solving approach and the problem-centred approach are discussed in relation to teaching and learning of mathematics.

2.2.1 Problem-solving approach in teaching and learning mathematics

Problem-solving has been an integral part of mathematics since the 1940s and most of the work done on problem-solving can be credited to George Polya (Masingila, Lester, & Raymond, 2002, p.19). According to Polya, the problem-solving process consists of four steps, each with identifiable strategies.

i. *Understanding the problem* – become familiar with the problem.
ii. *Design a plan* – identify strategies that apply to the problem.
iii. *Carry out the plan* – implement the chosen strategies.
iv. *Look back* – review the original problem, and the process and generate new ideas to deal with the original problem.

The primary focus of learning mathematics should be on problem-solving (Cockroft, 1994, p.50). A problem-solving approach is useful to teach certain mathematical concepts and helps the student to gain firsthand experience at solving these problems. According to this approach the main focus is on teaching mathematical topics by using problem-solving methods and enquiry-oriented environments that are chosen by the

teacher to help students arrive at a deeper understanding of mathematical ideas and processes.

They can participate in by using the following steps: (i) *creating, (ii) conjecturing, (iii) exploring, (iv) testing* and *(v) verifying* (Lester et al., 1994). They state that a typical problem-solving approach includes:

i. Teachers guiding, coaching, asking insightful questions and sharing in the process of solving problems.
ii. Teachers knowing when it is appropriate to intervene, and when to step back and allow the pupils make their own way.

Problem-solving is of the utmost importance in the mathematics classroom. When the teacher wants to implement a teaching strategy it is necessary to engage the students in problem-solving activities. The teaching strategies used will incorporate the problem-solving approach, so it is necessary to understand how the problem-solving approach can be used effectively to achieve the best learning result. The next section will focus on the problem-centred approach in teaching and learning mathematics.

2.2.2 Problem-centred approach in teaching and learning mathematics

The problem-centred approach is also based on problem-solving as a way of teaching mathematics. The problem-centred approach is student-centred and it is based on the constructivist perspective. Killen (2006) noted that constructivism is based on the belief that the students should develop their own understanding while actively seeking solutions for themselves. He further states that this doesn't mean that the learning process should be left totally up to the students; the teacher should guide and motivate the students.

Borich and Tombari (1997, p.178) noted that students use "their experiences to actively construct understanding in a way that makes sense to them". From a constructivist perspective, a student-centred approach is essential: the teacher should develop and

manage a learning environment and activities that allow students to construct their own knowledge rather than simply accept what is presented to them.

Dominick and Clark (1996) assert that constructivist teaching involves getting students to figure out what they need to know by using their existing knowledge. In this type of approach it is clear that the students' interaction with the content is the most important part of the learning process. When we look at problem-centred mathematics instruction, it is important to realise that the students construct their own understanding of mathematics by solving reality-based problems. In this approach the students can see their own mathematical knowledge at work when they actively produce or solve a mathematical activity.

2.3 Theoretical framework

This study adopted the positivist's view: it was conducted to confirm the positive aspects in mathematics instruction; it used empirical evidence in a case study to ascertain what teaching strategies were used in the South Korean mathematics classroom. Empirical evidence can be collected quantitatively or qualitatively by direct or indirect observation or experience (Pickett, 2011). The evidence in this study consisted in the measurement of the students' opinions regarding mathematical teaching strategies that were used in the classroom, as well as their opinions regarding preferred strategies. Further evidence was collected from the teachers as to what teaching strategies were preferred and what they regarded as the best way to implement these teaching strategies. Positivists believe in data derived from experience. This data is based on factual knowledge (Feigl, 2014).

The mathematical object in this regard is the teaching strategy that is used in the South Korean mathematical classroom. It was the researcher's point of view that there were teaching strategies used in the South Korean classroom that enhanced mathematical learning. This study was conducted to confirm what teaching strategies could assist mathematical learning and if these strategies could be transferred to other classrooms.

2.4 Korean mathematics

“The South Korean mindset has been imbued with the belief that education and examination preparation represent the potential for social access and status selection” (Shapiro, 2002, p.1). In South Korea the status of teachers and the education system are highly regarded: the South Koreans emphasize the quality of their teachers and their teaching. In this section the education system in South Korea will be discussed as well as mathematics instruction in their classrooms.

2.4.1 Education in South Korea

Attending school is compulsory for children between the ages of six and fifteen. Elementary school consists of six years, middle school is three years long, and three years are also set aside for high school. Students normally attend their local elementary school and middle schools; they don’t really have a choice until they reach the end of their compulsory education. The South Korean national curriculum framework is provided by the Ministry of Education, Science and Technology (MEST). In elementary school the students have to follow the core subjects: ethics, Korean language, mathematics, science, social studies, physical education, music and arts. Despite the basic instruction in these core subjects, students should learn to solve problems, and appreciate their culture and traditions and their basic life habits. In the middle school phase there is a differentiated curriculum, or ability-based grouping, for some subjects. These include: mathematics, English, Korean language, social studies and science (Anonymous, 2012). Ability-based learning refers to the division of classes into two or more levels. The levels differentiate between students who perform better and those who are struggling.

These days much concern has been expressed regarding the South Korean education system. Mathematics has taken the brunt of a lot of criticism regarding private spending or so-called “private education”. Private education mostly takes the form of academies that teach the students after school. They prepare students for the examinations, they provide extra mathematical problems and they help students who are struggling. In

these academies the classroom sizes are relatively small and individual students get more attention than in the usual school classroom. Private spending consists mostly of private tutoring and lessons at these private academies. According to the National Youth Policy Institute, students in South Korea spent 49 hours a week studying; this means that they study for about 8 hours every weekday (Yoon, 2009). A national survey showed that the average middle school student (grades 7-9) spent about 10.3 hours per week on lessons, that is on extra-curricular instruction outside the school system (Kim, Yang, Kim, & Lee, 2001, p.50).

According to Choe (2003) the Ministry of Education announced a new curriculum in 1997 to reduce the burden of private education. This curriculum was called the seventh amendment of curriculum and was the first curriculum for the new millennium. The aim of new mathematics curriculum was to give attention to each student's achievement in mathematics by helping the students in the following ways:

- To understand basic concepts, procedures, principles and rules of mathematics through solving problems of everyday life in a rational manner;
- To observe and analyse the phenomena of matters mathematically; and
- To acquire interests, abilities, knowledge and skills needed to think and reason mathematically.

The curriculum in South Korea has been changed and revised seven times since its first implementation in 1946. Thus the new millennium curriculum is actually the eighth curriculum to be introduced within this period. Table 3 lists the different curriculum changes from 1946 to 2012 affecting mathematics teaching in South Korea (Choe, 2003).

Table 3: Periods of National Curricula of Mathematics in South Korea

Amendment	Period	Main Focus
0	1946 – 1954	Progressivism
1	1955 – 1962	Real-life-centred
2	1963 – 1972	Systematic-learning
3	1973 – 1981	“New Math”
4	1982 – 1988	Back to basics
5	1989 – 1994	More back to basics
6	1995 – 1999	Problem solving
7	2000 – 2012	Differentiated curriculum

The seventh curriculum, announced in 1997, was implemented in 2000 and its most important feature was to encourage students’ activity. The activity level of the students was supposed to increase so that instruction and knowledge transferred from the teacher to students were not the only activity in the classroom. Students were supposed to be more active and participate in the class by giving feedback or by actively exploring problem-solving techniques. The basic characteristic of this curriculum is that it is a “differentiated curriculum”. The essential features of the new curriculum as outlined by Choe (2003, p.77) are:

i. The implementation of a “differentiated curriculum” for grades 1-10;
ii. A 30% reduction of mathematical contents and the reconciliation of contents;
iii. The introduction of elective subjects for mathematics for grades 11 and 12; and
iv. Greater use of technology in mathematics teaching.

Choe also states that the curriculum should be implemented in stages, depending on the students’ cognitive development. Cognition, as previously discussed under the problem-centred approach, refers to a group of mental processes that includes attention, memory, producing and understanding language, learning, reasoning, problem-solving, and decision-making. In South Korea classes in the schools are divided according to years of schooling and not according to the ability of the students. “The main objective

is to promote students' learning according to their aptitudes, talents and abilities. The common course is intended to equip students with basic life skills such as the traditional three R's (reading, writing and arithmetic), foreign language acquisition, literacy in information technology and interpersonal skills" (Kim, 2002, p. 37).

According to Choi (2006, p.6) the education ministry carries out an extensive curriculum revision every five to six years, but they found that "under such a system it is difficult to adapt to new changes, and therefore switched to an 'on-demand' curriculum revision system in 2005". This system meant that they could change or revise the curriculum if there was a need for change or improvement. With regard to grade eight mathematics, this new system proved useful in adapting the curriculum more frequently and in revising minor details to ensure that the curriculum stays relevant for the students and for the changing education system. The result is that whenever there is a call for curriculum or textbook revision, an appraisal is carried out right away and the necessary changes are made. "This helps deliver knowledge that is up-to-date and alive," (Choi, 2006, p.6).

There are however many critics claiming that the South Korean education system, with regard to mathematics, is not efficient. "Up to now, the most serious problem of mathematics education is that the mathematics classrooms in schools had been conducted without much concerning of students' ability to understand the contents, affective domain interests, aptitude and attitude and other attributes of the individual students" (Choe, 2003, p.79). The affective domain refers to the experience of feeling or emotion. The students' aptitude is a part of their competence to perform certain work at the level required by the curriculum. The students' attitude and their motivation regarding the learning of mathematics should be positively influenced by the teacher and the classroom environment. The schools have been criticized for being monotonous. Woo (2003, p.2) stated that in schools the mathematical abilities of students were so diverse in a class, that only about two-thirds of the students in primary schools (grades 1-6), about half the students in middle schools (grades 7-9) and about one-third of the students in high schools (grades 10-12) understood the explanations given by teachers

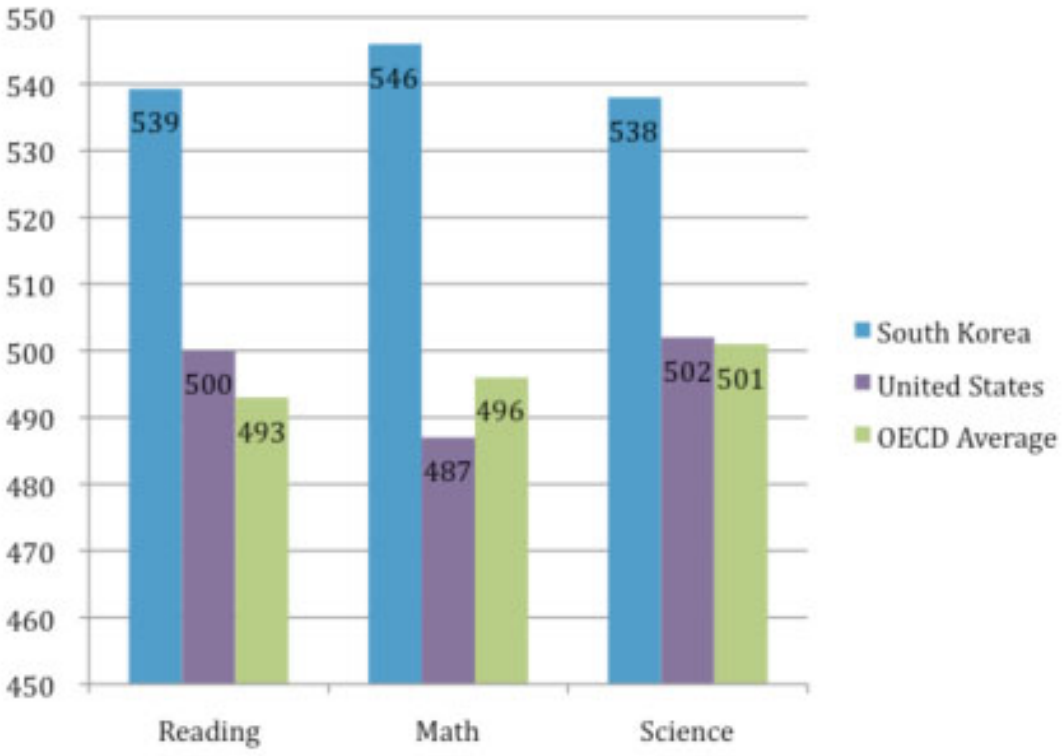
in class. As a result of this the private education market is growing, as students try to regain the necessary level of understanding of mathematics concepts.

2.4.2 Mathematics in South Korea

According to Pang (2009), many East Asian countries have teacher-dominated, content-orientated, and examination-driven mathematics instruction. Pang further says that the mathematics classrooms are characterized by whole-class teaching, large class sizes, and minimal student involvement. However when we look at the high mathematics scores that these Asian countries consistently achieve in international comparative studies (such as TIMSS), this raises the question as to why they are achieving such high standards using these poor and unfriendly student practices mentioned by Pang (2009).

According to the Programme for International Student Assessment (PISA) that is run by the Organisation for Economic Co-operation and Development (OECD) a total of sixty-five countries participated in the PISA 2009 assessment in 2009. According to this assessment South Korea was ranked overall second, second in reading, fourth in mathematics and sixth in science.

Table 4: PISA 2009 Mean Scores by Country for Reading, Mathematics, and Science



(Anonymous, 2009)

On average South Korean students attend school for 1020 hours a year once they reach the age of fifteen. The average OECD for hours a year is 902, thus the South Korean students study for about 118 hours more than the OECD average. This does not include additional time spent at private institutions or academies.

Although the South Korean students spend a lot of time in the classroom, their interest in mathematics is not high. Korean students spend eight hours and 55 minutes per week on mathematics according to the Chosun newspaper article: *Korean Youth Study Longest Hours in OECD* (Anonymous, 2009) in comparison to Finnish students who spend just four hours and 22 minutes per week on mathematics. Interestingly the Finnish scores were higher in the 2003 PISA assessment scores. Thus it can be seen

that hours spent does not necessarily guarantee a high score when it comes to mathematics assessment.

According to Leung and Park (2005), although most people think that the passive learning in South Korean classrooms is not efficient and the apparently procedural teaching is ineffective, students were actually engaged in meaningful exploration through teachers who designed learning activities that kept them interested and gave them incentives to study harder. This is in line with their negative perspective towards mathematics, although on the other hand, the positive results show that they learned and they did have sufficient incentive to study harder.

2.5 Conclusions to literature

Teaching strategies do not apply to just one subject. As Killen (2006, p.42.) says, “we should expect to be able to use similar general teaching strategies, adapting them where necessary to suit the particular demands of the content and the special needs of the students.” From the literature reviewed, it appears that in order to apply the best teaching strategies, the teacher needs to understand the different ways in which students learn, and which learning strategy or method they prefer; the teacher should plan to use the correct strategy to ensure that the desired outcomes are reached. When focusing on the South Korean classroom it is noticeable that critics emphasize many faults and problems, but it is important to not focus on what is not working, but to rather focus on what can be learned. One needs to look carefully at what lies underneath to get a better understanding of how teaching strategies influence the students’ mathematics ability and performance.

In this chapter literature regarding the Korean mathematics curriculum and the situation of South African mathematics was described. A historical perspective on teaching strategies gave some background regarding what was done in the past and how this has shaped our current system, and the need for more effective teaching strategies. Learning strategies explain how the student will best acquire new knowledge and point to what the student needs in order to learn effectively. In the following chapter the researcher presents the research design and methodology used for this study.

CHAPTER 3

RESEARCH METHODOLOGY

In Chapter 2, the literature reviewed was mostly about learning strategies, the history of teaching strategies and the problem-solving and problem-centred approach to learning mathematics. This chapter also gave further details on the South Korean education and on the teaching of mathematics in the South Korean classroom. This chapter gives an account of the research plan that was followed in this study.

This chapter starts by describing the research problem, the research questions, the purpose of the study and the research paradigm. This is followed by an in-depth description of the research design and the research method that was used to answer the research questions and an explanation of why the researcher employed these methods. There is a detailed explanation of the sample and the methods used as well as a description of the research instruments that were used. An explanation of the procedure for the data collection is provided, with an in-depth account of the data analysis; this is followed by a statement of the ethical considerations.

In order to determine what teaching strategies are used in the South Korean mathematics classroom, a case study approach was used. According to Bell (1999, p.10) “a case study approach is particularly appropriate for individual researchers because it gives an opportunity for one aspect of a problem to be studied in some depth within a limited time scale”. The resources available for this study were limited, thus the researcher opted to use a case study and analyzed the findings of the study.

In planning the case study it was necessary to keep the main focus in mind, to state the problem and basic questions clearly, to identify and implement an appropriate methodology, to design appropriate instruments to get the necessary information, to schedule the research activities, as well as to select suitable participants for this research. This chapter looks at the research design that was used and reports on the way that data was gathered and processed.

The researcher wanted to examine the methods and strategies used in the South Korean mathematics classroom; this might help other countries to improve their mathematics performance. The problem which was identified was the starting point for this study and the research questions determined the type of study to be followed. These research questions identified certain objectives that the researcher wanted to attain. The research questions for this study were:

1 *What teaching strategies are used to teach mathematics in South Korea?*

2 *What are teachers' and students' preferred strategies in teaching and learning of mathematics?*

It became evident that concrete evidence needed to be found. The researcher had to (i) explore and assess the mathematics teaching strategies used by South Korean teachers in the mathematics classrooms; (ii) he had to obtain feedback from the students and the teachers on the effect of the teaching strategies used in their mathematics classrooms. These aim and objectives are outlined and explained in more detail in section *1.2.3 Problem statement* of chapter 1.

3.1 Research design

The design in this study used a mixed-method approach, being both qualitative and quantitative in nature. Creswell (2003) defines a quantitative approach as one where the investigator uses methods such as (i) cause-and-effect thinking; (ii) the use of measurement and investigation; and (iii) the testing of theories for developing knowledge. Quantitative strategies would include experiments, surveys and data collected on predetermined instruments. On the other hand Creswell states that a qualitative approach is where the researcher makes knowledge claims based on constructivist perspectives: these include (i) the meanings of individual experiences; (ii) meanings that are socially and historically constructed with the intention of developing a theory or pattern. The qualitative approach uses strategies of inquiry such as narrative, grounded-theory studies or case studies where the researcher collects open-ended data. Since the purpose of this study was to investigate the teaching strategies that are used in the mathematics classroom in South Korean schools, a quantitative study method

was used to gather data from the students and a qualitative study method was used to get information from the teachers. This is appropriate since the teaching strategies were investigated to ascertain which strategy was most commonly used in the South Korean classroom. The study went deeper by finding data regarding personal opinions about these strategies from both the students in the mathematics classroom as well as from the teachers. What teaching strategies did they use and which did they think were most effective? The study design also intended to categorize the teaching strategies that were under investigation and to analyse each separately.

The research design was the key to determining how this study was conducted. The research design guided the case study and how the data was collected and analysed. Kothari (2006) noted that the research design helps the researcher to adopt appropriate methods for collecting data and to use the correct techniques during analysis. According to Kothari (2006, p.33) the following should be considered from Brown and Dowling (1998, p.37) when making a decision regarding the type of research that should be followed, “If the major emphasis of the study is on discovery of ideas and insights the appropriate research design is found to be exploratory while if the purpose of the study is on the accurate description of a situation the appropriate research design is descriptive.” This study sought to gain insight into which teaching strategies were used; it sought to describe what was happening in the South Korean mathematics classroom, and in this way to give an indication of the mathematics learning situation in the classroom. In the next section the population and sample are discussed as well as the sampling technique that was used.

3.2 Population and sample

3.2.1 Population

Creswell (2003) defines a population as the aggregate of individuals of interest from which the sample is drawn for the study. The office of education in the Chungcheongbuk Province provided a list of thirty-five schools that could participate in the study and each school was contacted and asked whether they wanted to participate. Of the thirty-five schools contacted, only eleven replied and from the schools that gave permission, ten schools were selected. The population for this study comprised grade eight students in those schools together with teachers. There was an average of twenty two-students per class. The students completed the questionnaires and the mathematics teachers were also interviewed. This group of students was enrolled during the 2013 academic year and they were all studying at schools in the Chungcheonbuk Province.

3.2.2 Sample and sampling method

From the above-mentioned population, ten schools were selected to give the researcher a subset of individual schools to participate in the research. This subset is known as the sample (Creswell, 2003). Since both quantitative and qualitative approaches were used the most appropriate sampling technique for this study was purposive sampling. Typical-case sampling is a purposive sampling technique that can be used if the researcher is interested in the normality or typicality of the units. This means that the researcher is able to compare the findings from a study using typical-case sampling with other similar samples. It is important to remember that the purpose of this study was to identify teaching strategies that were used in the South Korean mathematics classroom and might enhance mathematical learning. With the typical sampling technique one province was selected in South Korea. Since all the provinces followed the same curriculum, one province was deemed representative of the country. Chungcheongbuk Province is situated at the centre of South Korea and is surrounded by the other eight provinces. The sample for this study consisted of ten grade eight classes from ten different schools, chosen from the eleven schools that were willing to participate in the

study. Only six teachers from the ten schools participated in the interviews and two hundred and two students completed the questionnaires.

3.3 Research instruments

A research instrument can be seen as a device that measures a given situation and in this case the research instruments consisted of a questionnaire for the grade eight students and an interview guideline for the particular mathematics teacher of that class. These are discussed in detail in sections 3.3.1 and 3.3.2 respectively.

3.3.1 Design of the questionnaire. (Questionnaire – Appendix A)

A questionnaire is usually paper-based or delivered online and contains a set of questions for the individuals to complete (Adams, & Cox, 2008). In this study the questionnaire was developed to obtain the necessary information from the students. The questionnaire consisted of four sections and was composed of a total of fifty questions and was given to two hundred and two students.

Section one focused on retrieving information regarding the mathematics classroom and what teaching styles or methods were used in the classroom. This section consisted of twenty-four closed-ended questions where the students could choose their answers according to a five-point Likert scale. The student could indicate his/her answer with a check (√) in the appropriate column. There were five columns to choose from. The options were: “very often”, “often”, “sometimes”, “hardly ever” and “never”. Section one was further divided into three parts. The first part was about whole-class activities; the second part was about individual activities, and the last part was about small-group activities.

Section two focused on the students’ preferred learning styles. There were eleven closed-ended questions in this section and the students had to choose their answers according to a five point Likert scale. The students could indicate their answers with a check (√) in the appropriate column. There were five columns to choose from. The options were: “strongly agree”, “agree”, “undecided”, “disagree” and “strongly disagree”.

Section three focused on the teaching strategy that related to the students' learning preference as well as the strategies that the teacher used in the classroom. This section used the same code styles as were used in section two. There were eight closed-ended questions that the student had to answer.

The last section, section four, consisted of seven questions that required a "yes" or a "no" answer. These questions were designed to provide information regarding the students' mathematical background and to elicit their opinions regarding mathematics. There were two questions where the students needed to fill in a number. For example, question 44 required an indication of classroom sizes in the research sample, and question 46 required an indication of how many hours the students studied mathematics per week.

3.3.2 Design of the Interview Guide (Interview Guide – Appendix B)

An interview is usually conducted on a one-on-one basis (Adams, & Cox, 2008). It consists of questions asked by the interviewer and the interviewer has to transcribe and code the data. The interview guide was used for the mathematics teachers. This interview guide gave information regarding the teacher's own preferred teaching style/method and what teaching strategies he/she was using. Also their opinion was sought regarding the curriculum and South Korean mathematics; this suggested ways of identifying teaching strategies that could improve achievement in mathematics.

The interview guide consisted of ten questions. The first two questions were about teaching styles/methods. These questions were aimed at finding what methods the teachers used or preferred in their mathematics classrooms. Questions 3 to 5 enquired about teaching strategies. The teachers firstly were asked their opinion of teaching strategies and then they were asked to identify their preferred teaching strategy. Classroom management is the way the teacher manages the classroom to achieve the goals that he/she has set. It has a big influence on the learning environment and can either promote or prevent learning from taking place. An enquiry was also made as to how teachers managed big classes. Some questions were related to the curriculum and the work load that needed to be completed during the year. The last question dealt with

the performance of South Korean mathematics students and how the teachers explained their excellent performance in mathematics as compared to other countries. Lastly the teachers were asked to suggest what they regarded as best practice in the mathematics classroom.

3.4 Procedure for data collection

The researcher asked the office of education for permission to perform research in the selected province and this was granted. The next step was to get permission to collect data from the relevant schools. A permission form was sent to the schools on the list that was supplied by the Office of Education and the principals of the schools signed the permission sheet. Once this step was completed the mathematics teachers were informed of the study and their cooperation was sought. The teachers were given an interview guide and they were able to ask any questions regarding the research instrument. Once the teachers had given their cooperation, a date was set for each school. The students were all given an informed consent form for their parents to sign; the students would then sign the assent prompt form. A similar informed consent form was given to the mathematics teachers who were interviewed. Once all the consent forms were collected and copies were given to each student and teacher, the study could then begin. The questionnaire was transcribed from English into Korean to make sure that the students understood the questions. The students completed the questionnaire, and while they were busy with this the researcher interviewed the mathematics teachers. Once all the questionnaires had been handed back and the interviews completed, the data was analyzed. Since the answers to the questionnaires had been checked by the students, the data from the questionnaires did not need to be translated back to English, since they had not written their responses in Korean. The researcher knew in advance that some of the mathematics teachers could not speak English; therefore the researcher gave the teachers a written copy of the questions in both English and Korean to ensure that they could understand the questions. Since some of the mathematics teachers could not speak English, and gave their interview answers in Korean, a translator was used to translate their answers to English. The data collected in Korean was translated into English so that it could be analyzed. All

questions were supplied in both English and Korean and the data was received sometimes in English and sometimes in Korean. All Korean data was officially translated by a qualified translator.

3.5 Reliability and validity of the research instruments

In this study, it was important to consider the reliability and validity of the instruments. It was necessary to ensure that quality research instruments were used. Reliability refers to the consistency of the research instruments used to collect data: the same results should be obtained if the instruments were administered in a stable environment (De Vos, 2002). In this research the questionnaire and interview questions were administered under the same environmental variables. The students and teachers were given enough time to answer all the questions and none of the participants was pressured. The study was conducted in a mathematics classroom with a mathematics teacher present.

Validity refers to whether the research questions could provide answers that would be considered valid responses to the questions. According to De Vos (2002, p.166) the following two questions address validity:

(i) What does the research instrument measure?
(ii) What do the results mean?

The research instruments measured the teaching strategies used, the learning styles preferred by the students and the teachers' perspectives on what teaching strategies worked best in the mathematics classroom. The results provided the researcher with information about what was happening in the mathematics classroom with regard to the teaching strategies to the extent that the researcher would be able to assess how these strategies might assist other countries to perform better in mathematics.

Table 5 summarises the strategies used to establish trustworthiness (Krefting, 1991, p.217):

Table 5: Summary of strategies used to establish trustworthiness

Strategy	Criteria
Credibility	● Prolonged and varied field experience ● Time sampling ● Reflexivity ● Triangulation ● Member checking ● Peer examination ● Interview technique ● Establishing authority of researcher ● Structural coherence ● Referential adequacy
Transferability	● Nominated sample ● Comparison of sample to demographic data ● Time sample ● Dense description
Dependability	● Dependability audit ● Dense description of research methods ● Stepwise replication ● Triangulation ● Peer examination ● Code-recode procedure
Conformability	● Conformability audit ● Triangulation of methods ● Reflexivity

According to the first section of the above table the credibility or the internal validity of the study needed to be established. The data was collected from students and their mathematics teachers and their answers and opinions were considered to be a true account of their perspectives. The credibility of the researcher was monitored by a supervisor who was an expert in this field. The translator used to translate the Korean data into English was a qualified translator who gave a reliable account of what the mathematics teachers said in the interviews. The answers to the questionnaires were checked by the researcher to ensure that the students only gave one answer for each question.

The second section of Table 5 refers to transferability. Transferability means how the data or findings in the research can apply to groups other than the group used in the original study. The research was conducted at ten different schools. The questionnaires thus reflect ten different schools and the interviews give an account provided by six different teachers from different schools. This study makes use of different sources to enhance transferability.

The third section looks at the dependability of the study; this is related to reliability. According to De Vos (2002) this is the ability of the researcher to adapt to changing conditions and to take into account changes in design. The researcher tried to ensure that classroom conditions were similar in the ten schools when the students completed the questionnaires. The teachers who participated in the interviews could understand the questions well enough since these questions were supplied in both English and Korean; few problems arose.

The fourth section of the table refers to the conformability of the research, which gives an indication of whether the researcher was neutral during the study. The researcher did not show prejudice or influence the teachers in giving answers. The research supervisor also audited the study results to ensure the conformability of the study.

3.6 Ethical considerations

In any type of research it is important to consider the ethical principles that might be relevant to the study. In this study the schools and students participated voluntarily. The consent of the participants was respected whether they were willing to participate or not. The participants were informed that they could withdraw from the research at any time without being penalised in any way. The participants were protected from any type of physical or psychological harm that might have been inflicted upon them in the course of the research. The names of the participants were kept confidential and the participants knew that their names would be kept secret to protect their identity. Participants were also informed of the contact details of the person in charge in case they needed further information regarding the study.

3.7 Conclusion

In this chapter the research methodology was explained with regards to the research design and research methods that were used to answer the research questions. The research instruments, questionnaire and interview guide, were both explained with regard to their purpose and the nature of their design. The size of the population and sampling method gave an indication of the participants and the procedure for the data collection gave an overview of how the study was conducted.

The next chapter focuses on the data analysis of both the questionnaire and the interviews. The data are represented in diagrams with descriptions to give a clear indication of what was found in the study.

CHAPTER 4

DATA ANALYSIS

In chapter 3 the research design and methodology that were followed were discussed. A detailed description of each tool of inquiry and of the data sources was provided. In addition the data analysis process was explained. This chapter presents and discusses the results of the research. As has been explained, questionnaires and interviews were used. After acquiring the data from the research instruments, the researcher started to analyze the data and answer the research questions. In this chapter the findings of the investigation are presented, analyzed and interpreted.

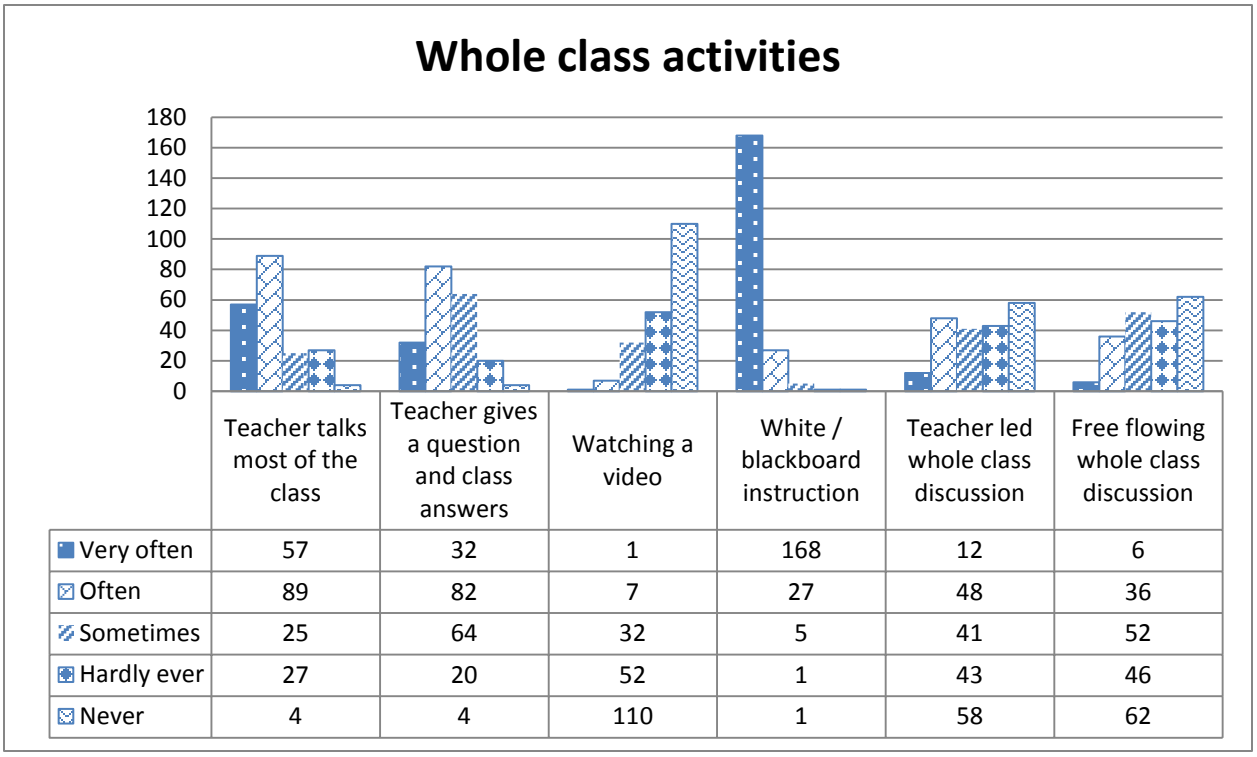
4.1 Questionnaire

Quantitative methods were used to analyse the questionnaire administered to two hundred and two grade eight students in ten schools in the Chungcheongbuk Province. The questionnaire was designed to respond to research question number one according to chapter 1 (section: *1.2.3 Problem statement*) and to give an insight into the students' knowledge of the strategies and style through which they preferred to learn. The questionnaire was divided into three sections. Section one dealt with classroom activities. This section was further divided into three parts dealing with (i) whole class activities, (ii) individual activities, and (iii) small group activities. Section two focused on the learning styles that the students preferred. Section three focused on classroom management and how the students felt about mathematics. Section four was designed to obtain information regarding classroom size and study hours. Sections one, two and three were made using a Likert scale. A Likert-type scale "requires an individual to respond to a series of statements by indicating whether he or she strongly agrees, agrees, is undecided, disagrees, or strongly disagrees. Each response is assigned a point value, and an individual's score is determined by adding the point values of all the statements" (Gay, Mills, & Airasian, 2009, pp.150-151). The five point Likert scale that the questionnaire used was organised into five columns, with the headings "very often", "often", "sometimes", "hardly ever" and "never". Sections two and three used a different

scale: “strongly agree”, “agree”, “undecided”, “disagree” and “strongly disagree” and addressed questions on learning preferences, study methods and how the students felt they could improve their grasp of mathematics.

4.1.1 Section one of the questionnaire

Figure 1 represents students’ responses to whole-class activities; Figure 2 represents only the positive and negative results of whole-class activities to give a better indication whether these activities happened in the classroom or not. From Figure 1 it can be seen that white and chalkboard instruction was the most prominent whole-class activity. In Figure 2 a similar bar is shown but in this diagram the answers were shortened by adding two bars together such as (i) “often” and “very often” and (ii) “hardly ever” and “never”. In this diagram it is easier to see if the majority of the students agreed or disagreed.



	Teacher talks most of the class	Teacher gives a question and class answers	Watching a video	White / blackboard instruction	Teacher led whole class discussion	Free flowing whole class discussion
Very often	57	32	1	168	12	6
Often	89	82	7	27	48	36
Sometimes	25	64	32	5	41	52
Hardly ever	27	20	52	1	43	46
Never	4	4	110	1	58	62

Figure 1: Students' responses to whole-class activities.

Figure 1 represents activities that took place in the mathematics classroom where the students participated as a whole group. There were six options for whole-class activities. The responses of the students are presented in Figure 1. Figure 2 shows that most of the activities in the classroom were teacher-orientated. The first column shows that 72% of the students said that the teacher talked "very often" and "often" most of the class time and that chalkboard instruction occurred for 83% of the class time. It also shows that other activities rarely took place in the mathematics classroom: most students "never" or "hardly ever" watched a video and discussions were also in the "hardly ever" or "never" range.

In Figure 2 the chart was simplified to show only the two opposing sides of “often and very often” and “hardly ever and never”. From Figure 2 it can be seen that the “teacher talks most of the time” was far more frequent than “never” and that whiteboard instruction was the most common classroom activity.

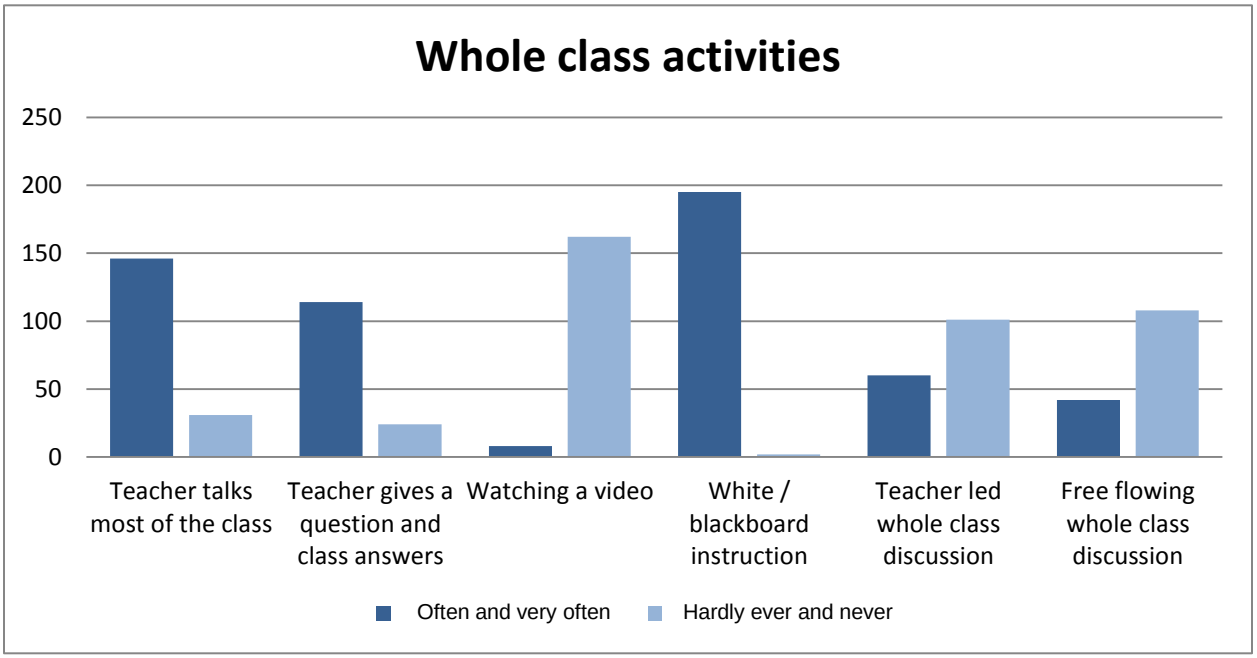


Figure 2: The positive and negative results for whole-class activities.

The next part of the questionnaire explored individual activities. Figure 3 displays the results for this section. The students' responses in this section show that exam paper questions, worksheets and homework / private study were the most common activities in the mathematics classroom. Other activities were not that common, especially demonstrations by students, practical experience or self-evaluation. Resources were basic and simple and focussed on preparing for the examination with textbook homework supplemented by extra worksheets. From Figure 3 it is evident that working on previous exam paper questions took up about 79% of the class time, worksheets about 86% of the class time and homework and private study about 77% of the class time. Another interesting fact is that regular tests were not that frequent, according to the students' responses.

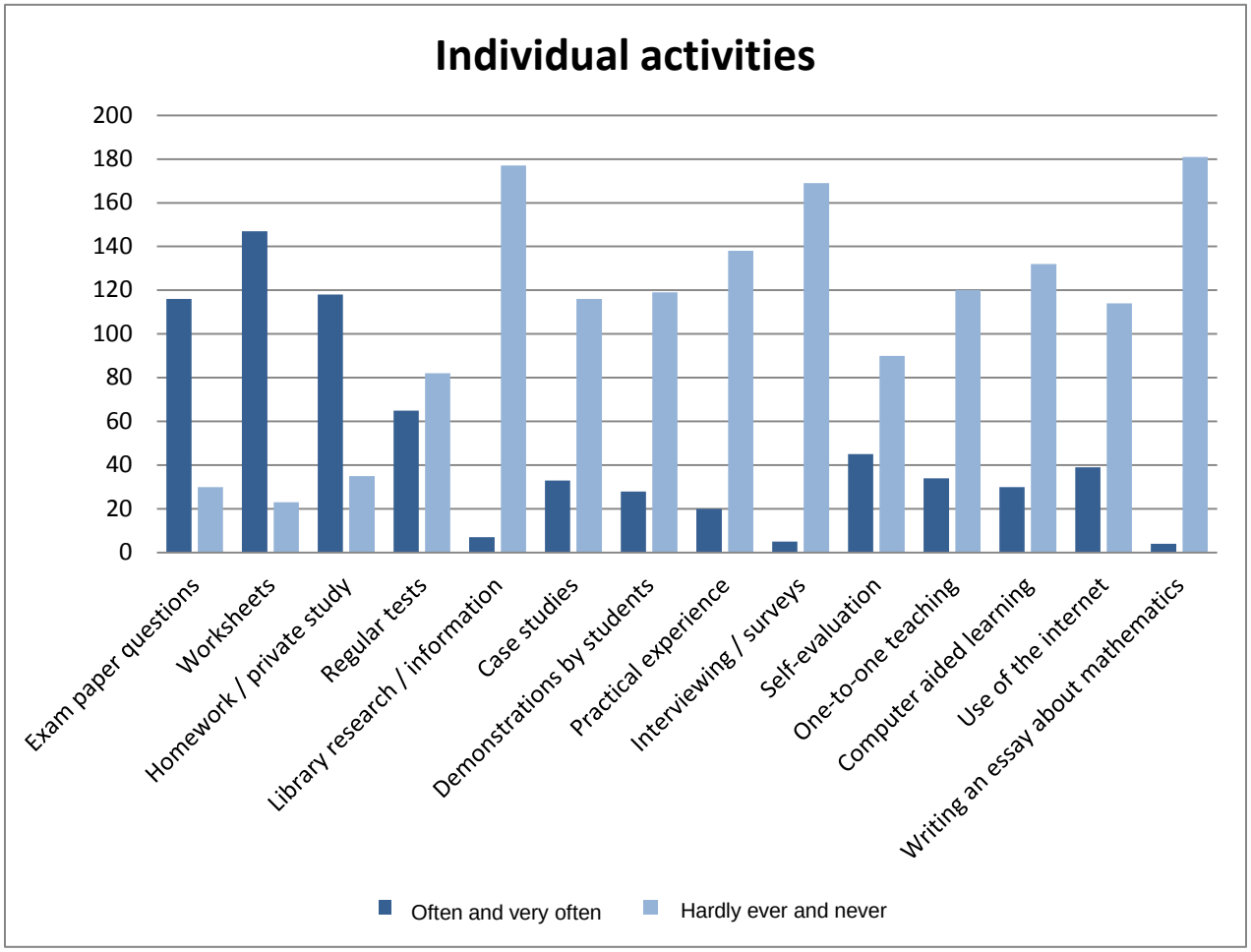


Figure 3: Students' responses on individual activities.

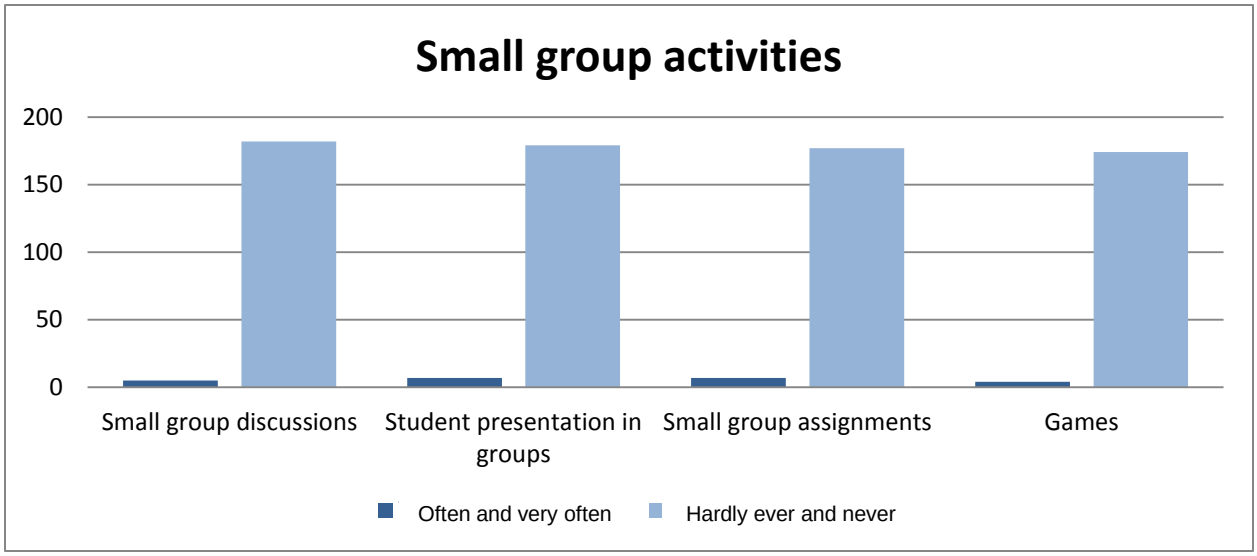


Figure 4: Students' responses to small-group activities.

The final part of section one represents small-group activities. According to Figure 4 it is clear that no such activity existed in the mathematics classroom. The responses from the students to group discussions, presentations, games or even normal assignments appeared mostly under the "hardly ever" and "never" columns. The occurrence of these small group activities can be better understood when looking at the percentages of each column. Small group discussion occurred for about 2,7% of the class time, while student presentation in groups occurred for 3,9% of the time. Small group assignments occurred for about 3,8% of the time and games in the classroom occurred for about 2,3% of the class time.

4.1.2 Section two of the questionnaire

Section two refers to the students' preferred teaching style. Figure 5 uses a combination of the four main columns to represent what the students felt strongly about or normally agreed with and what they disagreed strongly about or normally disagreed with. The green bar in the diagram is a combination of the "strongly agree" and "agree" values. The blue bar is a combination of the "strongly disagree" and "disagree" values. With these two bars it is easy to distinguish between the students' responses and to see whether they agree with the teaching styles used by their teachers.

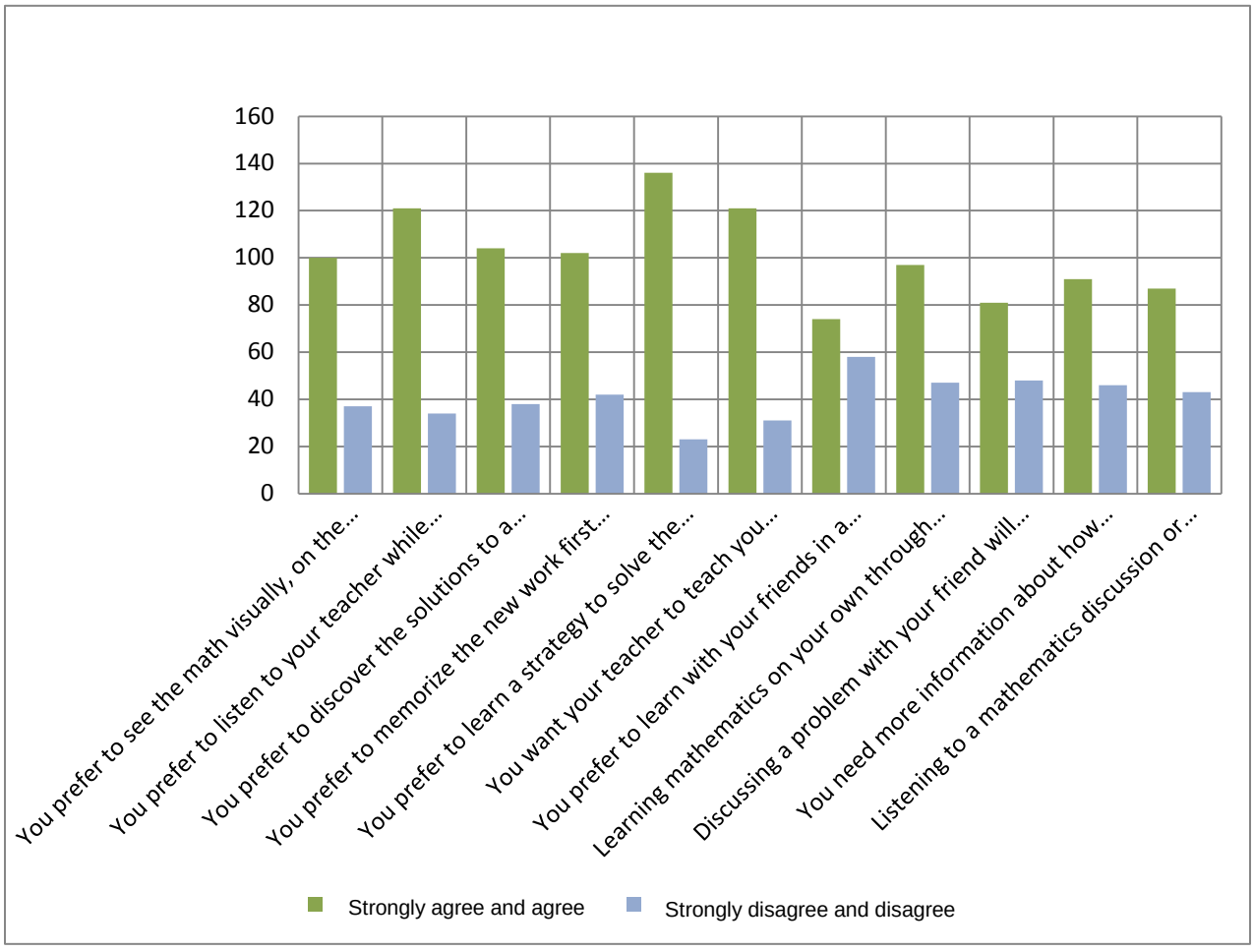


Figure 5: Students' responses to preferred learning styles.

According to their responses students preferred to learn by being introduced to a strategy to solve a given problem and then try it out themselves. According to the questionnaire responses 78% of the students said that they preferred to listen to their teacher while he or she explained the work; 86% of the students' responses showed that they wanted to learn a strategy and then try to solve the problems themselves. Of the participating students, 79,6% also indicated that they preferred to get taught individually. It can be seen that students felt less certain about working in groups with their friends. This received the lowest rating, at 56%. It can be seen that students preferred to learn mathematics from their teacher, either by listening or seeing it on the board and then by learning and memorizing the strategy and using it themselves to find a solution to the mathematical problem.

4.1.3 Section three of the questionnaire

Figure 6 represents items from section three, which focused on what the students preferred in the classroom. From Figure 6 it can be seen that students wanted there to be clear outcomes of what they were doing in the class, and they preferred to identify areas of mathematics that they needed to improve on. It also shows that students are not too eager to set their own learning goals and they didn't really want feedback about their progress from their teacher. Students knew how their teacher would evaluate them and felt that they could evaluate themselves. Students wanted the teacher to guide the class and present their learning objectives, but they felt they didn't need their teacher's feedback since they could evaluate their performance and they could identify for themselves the areas of mathematics where they needed to improve. This indicates that they were longing for opportunities to be afforded doing calculations on their own without supervision.

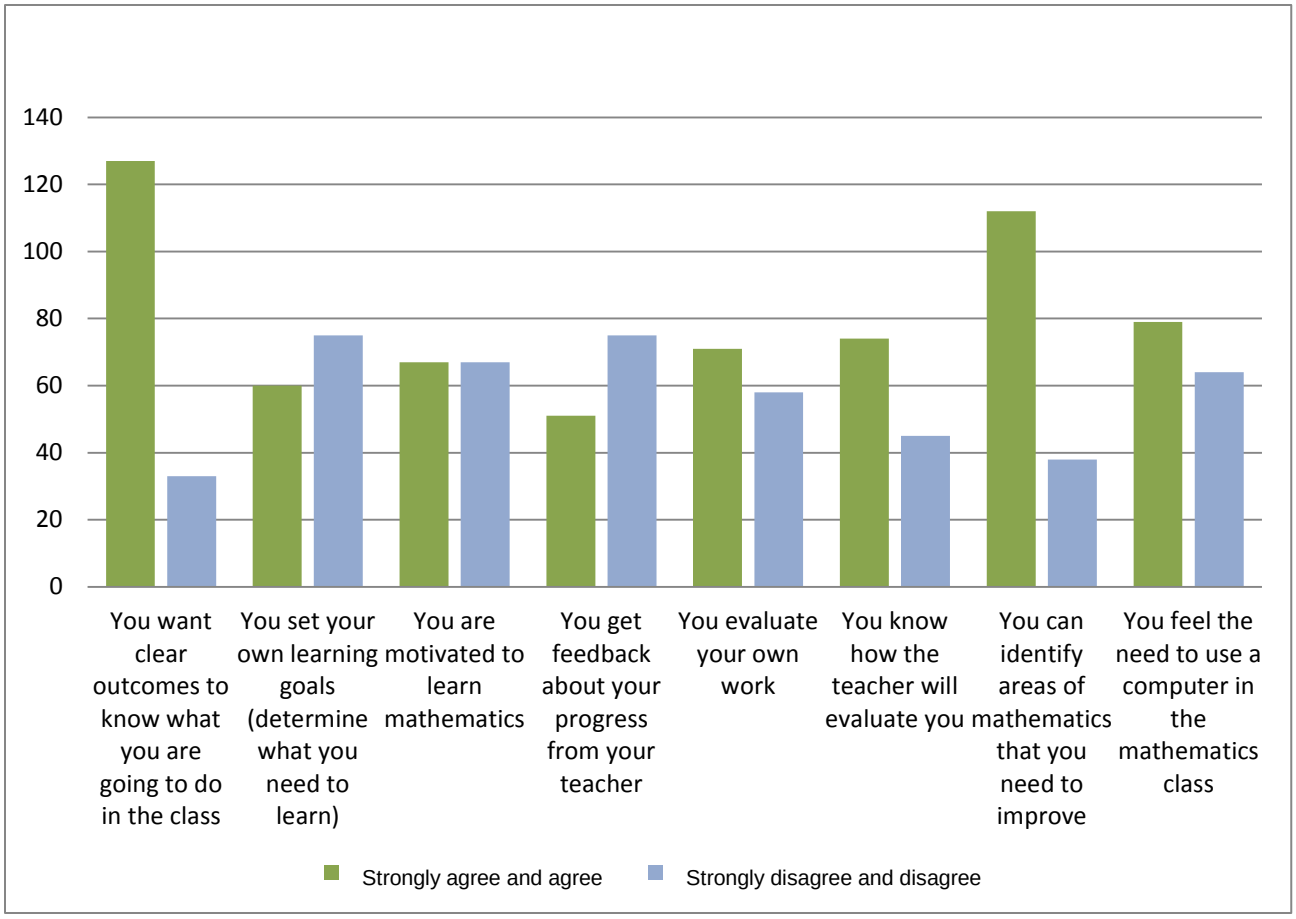


Figure 6: Students' responses to strategies used.

4.1.4 Section four of the questionnaire

Section four of the questionnaire was used to obtain details such as classroom size, how many hours a week the students studied mathematics and how they felt about mathematics. Their responses to this section yielded the following information: the average classroom size of the sampled classes was about twenty-two students. About 57% of the students went to a private institution after school to study mathematics, and they studied mathematics for an average of six hours per week. From the responses it can be seen that about 65% of the students said they were not interested in mathematics, while about 80% of the students felt that they were not good at mathematics.

4.2 Interview responses

The interview schedule consisted of ten questions. The interviews were conducted over a thirty-minute slot during breaks and six teachers participated in the study. The questions are presented below with the responses from the teachers to a particular question. The aim was to understand why teachers used various styles and strategies when teaching mathematics (this would address research question one). The interviewer normally asked one-on-one questions (Adams, & Cox, 2008). In this study the researcher was the interviewer; he posed questions to the six mathematics teachers, who were the interviewees.

Ten schools participated in the study but only six teachers were willing to be interviewed. The teachers from schools one to six were coded as T1, T2 and so on.

Question 1

Researcher: Do you prefer to lead the class (direct instruction) or do you prefer to facilitate the students so that they work on their own or in groups?

T 1: I prefer to let students learn by themselves or do group activities. It is desirable for a teacher to suggest the right direction only while giving them an opportunity to solve problems themselves and arousing their interest.

T 2: I hope students can find out solutions and understand the ideas themselves. However, in reality, direct instruction is inevitable. Due to prior learning, students rarely have the opportunity to discover something new during class.

T 3: I prefer direct instruction. The reason is that it takes a shorter time to make students understand. Of course, it may be because I learned that way when I was a student. Maybe it is a habit, or familiarity.

T 4: I prefer direct instruction, and sometimes student-initiated learning. Considering the amount of content they should learn, meeting the schedule is really important for the third grade in middle school.

T 5: Currently I teach students without dividing them according to their level of ability. Normally one class consists of 32 to 33 students. That is quite a lot so I prefer direct instruction.

T 6: I combine direct instruction and ways in which students can solve problems themselves. I try to give students as many opportunities to practice or discuss the matter as possible.

Five out of six of the teachers said that they used direct instruction. Their reasons were that the classes were too big and that they could not be divided into different levels. Other reasons are that direct instruction took less time given the amount of work that needed to be taught. One teacher answered that he/she preferred to allow the students to learn by themselves or in groups.

Question 2

Researcher: What is your preferred teaching style? Why do you prefer this style of teaching?

T 1: Reciprocal. After solving problems, students can check each other's answers and find out what is wrong.

T 2: Practice. Self-check. Guided discovery. I help students to learn principles and concepts, and guide them to practice these by themselves.

T 3: I prefer direct instruction, practice, and guided discovery. That is because I think combining these three is the most efficient. Another reason is that I have not tried the other options before, so I do not know how to use them or they have not been proven efficient.

T 4: I prefer direct instruction and practice. The reason is that it can secure enough time to follow the schedule and make students practice what they have learned.

T 5: After teaching through direct instruction, I make students practice more. From time to time I try another strategy but direct instruction is the most efficient to complete the curriculum within the given period.

T 6: I mostly use guided discovery. As there is a gap of level and understanding ability, I explain first and help students solve problems by themselves.

Of the six teachers, four favoured practice, three favoured direct instruction and three guided discovery. Direct instruction was preferred by three teachers since the available time was limited and it helped to cover more of the syllabus. Practice was the most commonly used teaching style: four of the six teachers said that practice helped the students remember the concepts and how to use them. Guided discovery was used since their classes were large and there was a gap between the students' levels of ability: the work was first explained and then the teacher helped the students to find the solutions by themselves.

Question 3

Researcher: What is your opinion about different teaching strategies?

T 1: Teachers should lead students to achieve the class aims, improve professionalism, and encourage them to study further by motivating and interesting them. Teachers can ask various questions or suggest questions to build up application ability. An appropriate amount of praise and encouragement is needed as well.

T 2: Proper teaching strategies tailored for each chapter are needed. I use both teacher-oriented and student-oriented strategies.

T 3: I studied various teaching strategies in both undergraduate school and graduate school, but have not seen them used in practice. I intend to make use of them if I have more experience with them. As of now, I have a favourable attitude toward these strategies.

T 4: Various strategies are needed depending on the contents of each unit.

T 5: Teaching strategies can vary according to the content and subjects.

T 6: To meet the class aims, differentiated education considering students' characteristics is the most idealistic teaching strategy.

In the first interview T 1's response indicated that praise and encouragement should be used to motivate students so that they can achieve the goals set for that class. Teaching strategies could vary according to the content to be taught and both teacher-orientated as well as student-orientated strategies were needed. One teacher indicated that differentiated education was needed to meet the needs of different students.

Question 4

Researcher: Do you have a preferred teaching strategy? If so, explain why you prefer it.

T 1: I present a lot of mathematical problems and make students solve them and assess their tasks themselves.

T 2: I prefer direct guidance and to bring up questions in order for students to understand the fundamentals and practice them. After students finish their part, I organize what they learned and wrap up the class. Students can master it by solving many problems down the road.

T 3: Direct instruction plus leading students to solve problems themselves.

T 4: I use both direct instruction and practice.

T 5: Questioning – I ask questions to students so that they can grasp the concepts themselves.

T 6: The bigger the class is, the less attention each student gets. I think guided discovery is the best way. Guided discovery combined with reciprocal teaching strategy can be useful in a big class.

Four of the teachers felt that they needed to present problems and teach the students how to solve them; then the students needed to practice them on their own. These strategies are in line with direct instruction and practice (both are teaching styles); the teachers did not mention group work as a teaching strategy as one would assume because of the many students in the class. One teacher felt that guided discovery was also part of a teaching strategy and could be used in the classroom.

Question 5

Researcher: What do you think is the best strategy to learn mathematics in the classroom?

T 1: Student-teacher communication is important. Teachers should try to make students feel confident and motivated while developing their own specialty.

T 2: Similar to the above answer (for question 4). One thing to be added is that the strategy should be changed according to the students' level and chapters.

T 3: Direct instruction

T 4: Student initiated: for those with high performance. Guided discovery: for those with low performance

T 5: Guided discovery.

T 6: The bigger the class is, the less attention each student gets. I think guided discovery is the best way. Guided discovery combined with reciprocal teaching strategy can be useful in a big class.

From these responses, student-teacher communication appears to be important so that the student can gain the confidence to develop his or her own speciality (strategy); that

the strategy should be differentiated according to the students' levels of ability. One teacher said that students could plan their own programme if they had already achieved a high level in mathematics but the lower-level students needed guided discovery to help them.

Question 6

Researcher: To manage a big class can be difficult. What do you find is the best way to manage a big class?

T 1: Students can handle the given tasks by doing group activities, and student presentation and discussion are also helpful.

T 2: The best way is to divide students into small groups and make them mentors or mentees to one another.

T 3: Direct instruction.

T 4: Direct instruction, practice, and reciprocal.

T 5: Direct instruction.

T 6: The bigger the class is, the less attention each student gets. I think guided discovery is the best way. Guided discovery combined with reciprocal teaching strategy can be useful in a big class.

Two of the teachers said that small-group work would be best suited for big classrooms, while three of the teachers said that direct instruction was the best. Another teacher said that guided instruction with peer work would work best in these situations.

Question 7

Researcher: Do you feel the need to rush through the work or do you have enough time to explain the work and to make sure the students understand everything?

T 1: I think the curriculum is too tight. It does not guarantee enough time to practice and master each subject, which is essential to make a firm ground of

mathematics; this is especially important as the students' grades or learning stages get higher.

T 2: I have enough time to explain concepts but there is not enough time for students to solve problems and practice them. This is left to individual study, and this is where the individual performance gap is widened.

T 3: It depends on the students' level and generally the pressure is huge.

T 4: I always feel pressure and think the curriculum is too tight. Time is running out and realistically there exist students whose performance is really poor.

T 5: I feel pressure. Thanks to after-school classes assigned to math, I meet the schedule narrowly.

T 6: There is a lot of work to do in one year, so I feel too pressured to make sure for students to understand everything and then go to the next step.

All of the teachers said that they felt pressured to complete all the content in one year. One of the teachers said that he / she managed to finish the curriculum due to after-school mathematics classes. The teachers felt that they did not have enough time to explain the main concepts, so it was up to the students themselves to solve problems and practice on their own and in their self-study time.

Question 8

Researcher: Do you think the curriculum is well suited for the students to prepare them for further studies in mathematics?

T 1: I think the general curriculum is well-developed. Reviewing what students learned the previous year is also advisable.

T 2: No.

T 4: I think the general curriculum should be cut down, and those with high performance should follow a distinct curriculum based on free quest.

T 5: It is well suited for students majoring in math in the future, but unnecessary for those who are not.

T 6: Most of the study in school is for getting a better grade, so students learn skills to get higher grades rather than to study further in the field. Educational programmes that help students to study further are desperately needed.

Two of the teachers said that the curriculum was well suited, especially for those students who wanted to pursue mathematics in the future. Another teacher said that the curriculum should be reduced, and that the higher-level students can explore mathematics more deeply on their own. One teacher said that students study in school to get better grades in the examination; this means that they don't study further in the field.

Question 9

Researcher: South Korea is known for their high achievement in mathematics. What do you think is the reason why South Korean students are good in mathematics?

T 1: Systematic education has been implemented step by step since childhood. General atmosphere in Korean society put a great importance on studying and students can get an education right for their age.

T 2: Parents' educational zeal. University entrance examination. Still-existing special treatment given to those who graduate from so-called elite universities.

T 4: The main reason is thought to be years of learning of various mathematics problem-solving skills starting in the elementary schools. Even though the general outcome is outstanding, the gap between those who are excellent and those who are not is huge.

T 5: Repeated practice

T 6: In Korea, mathematics is the subject that can decide a student's life. Korean students think they cannot enter the elite universities without studying mathematics. They study continually and patiently, investing more time in maths

than students in other countries. That explains why Korean students get better results.

The teachers' answers to this question can give us an understanding of why Korean students perform so well in mathematics. The first teacher said that systematic education since childhood helps students to develop good study habits, and they learn the importance of education. The second teacher said that the main reason is the parents' zeal and university entrance examinations, which force the students to study hard. The fourth teacher said the reason is that they learn various problem-solving skills, starting in elementary school. The fifth teacher said that it's due to repeated practice. The final teacher answered that it is due to the importance placed on mathematics in Korea: that is why the students study so hard for it and why their results are better than those students in other countries.

Question 10

Researcher: What do you think needs to change in the mathematics classroom so that the students can learn better and more efficiently?

T 1: Differentiated learning is needed for students who lag behind.

T 2: When asked why they abandon the subject of mathematics, students say that they did well in elementary school but gave up in middle school as they felt it was difficult. I suggest that the middle school curriculum be modified for students to understand and access the subject easily.

T 4: I think that students need to grow the passion to learn maths themselves first. Students with low performance need consistent guidance from childhood.

T 5: Downscaling the curriculum.

T 6: Teaching strategies or textbooks should be developed to grow thinking skills rather than to simply acquire knowledge or solve problems.

Two teachers said that the curriculum should be scaled down, to reduce the gap between elementary and middle school. Many students lag behind, thus differentiated

learning is needed. Students needed to acquire a passion for mathematics themselves (intrinsic motivation), and then they needed to be guided so that they could learn for themselves. The final teacher answered that teaching strategies or textbooks should not be focusing on acquiring knowledge or solving problems but should rather on developing the students' own thinking skills.

4.3 Summary

This chapter presented the data analysis and the discussion of results. The aim of the study was to collect data from students and their teachers regarding what teaching strategies were used in the mathematics classrooms in South Korea. The study was in the form of a mixed methods research design. From the results and findings of the study, the researcher confidently concluded that teaching strategies such as direct instruction and problem-solving were relevant to their classrooms. The results showed that small-group work, discussions, research, case studies and role-play did not really feature in the mathematics classroom in South Korea.

It also came out from the students' responses in the questionnaire that activities like using videos in the class hardly ever took place in the mathematics classroom. The most activities prominent in the mathematics classroom involved teacher-talking and the use of whiteboard instruction while sometimes minimal classroom discussions took place. It appeared though that students preferred just a little of guided instruction on a concept and then would be delighted to work mathematics problems on their own.

The next chapter, which is the final chapter of this study, summarizes the research, reviews the research questions and discusses the researcher's recommendations, the limitations of the study and possibilities for further research.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the teaching strategies used in the South Korean mathematics classroom and to find out which strategies the students and the mathematics teachers preferred in the learning and teaching of mathematics. The study focused on teaching and strategies used by the South Korean teachers in the classroom. This chapter provides an overview to demonstrate that the research questions and aims originally stated in the first chapter have been addressed and achieved. This is the final chapter in this study: it summarizes the findings, draws conclusions, highlights the limitations, and makes conclusions and recommendations.

5.1 Review of the research questions

At the beginning of the study two research questions were formulated:

1 What teaching strategies are used to teach mathematics in South Korea?
2 What are teachers' and students' preferred strategies in teaching and learning of mathematics?

In order to find answers to these questions, a specific aim (see section *1.2.3 Problem statement*) and objectives were set. These research questions were addressed by the literature review (see Chapter 2). The first research question was addressed by the literature review, and interviews using open-ended questions with six teachers. The literature review revealed several teaching strategies, and the following strategy was related to the answers from the interviews: direct instruction. From the four phases in which direct instruction is divided, (modelling, directed practice, guided practice and independent practice) it became evident from the findings that modelling and guided practice were the most used strategies by the teachers. The interviews revealed that the teachers used *guided practice*. Guided practice is the third phase of direct instruction. What is important is that the four phases should be completed. In order for the students to fully grasp the content, the teacher should not stop facilitating after the first two

phases, *modelling* and *directed practice*, but should continue to ensure that *guided practice* and *individual practice* also take place. The teachers also confirmed that *individual practice* was of utmost importance. This is the fourth phase of direct instruction. It is also similar to the final step of the problem-solving approach. In various parts of the interview the teachers' responses indicated that they used direct instruction and that, given the amount of work that needs to be taught in a year, was best suited to their classrooms. They also felt that direct instruction was best used in classrooms with many students.

Research question 2 was addressed by the questionnaire (see section *3.3.1 Design of the questionnaire* and *Appendix A*). From the responses to the questionnaire (see Figures 1 and 2), the teachers' preferred strategies could be seen and these teaching strategies were teacher-orientated since the majority of the students felt that:

i. the teacher talked most of the time in the class;
ii. the teacher used mostly chalkboard instruction to explain work; and
iii. the teacher posed questions to the class as a whole.

The resources used in the classroom, apart from the textbook being used, show how students acquired knowledge and how they practiced and acquired mathematical skills. From the results of the questionnaire (see Figure 3) the resources that the teachers preferred to use the most were:

i. past examination paper questions;
ii. worksheets; and
iii. homework or private study.

Results also indicated that in most of the classrooms there were no small-group activities, such as discussions, presentations or even assignments. Only in a few cases did some of the students indicate that these activities might sometimes occur in the mathematics classroom.

With regards to students' preferences regarding teaching strategies (see Figure 5) it was found that these were their preferences, listed in order from top to bottom:

i. They preferred to use a strategy to solve the problem and then try it themselves.
ii. They wanted their teacher to teach them individually so that they could understand the content.
iii. They preferred to listen to their teacher while he or she explained the work.
iv. They preferred to discover the solution to a problem for themselves.
v. They preferred to memorize the new work first so that they could recall it when needed.

As seen from the above, it was established that students wanted to learn how to solve a problem and then master it by themselves. Therefore, they only needed guidance from their teacher; afterwards they would practice and try out the concepts on their own.

5.2 Summary of the findings

The findings of this study provide the readers, educators and policy makers with the insights into the strategies used by South Korean mathematics teachers and the students' preferred learning styles in the mathematics classroom. This section provides a summary of literature review, the research methodology and design and the findings of the study.

5.2.1 Summary of the literature review

The aim of the study was to identify the teaching strategies that were used in the South Korean mathematics classroom. This was achieved through conducting an extensive literature review (see Chapter 2). Aspects in the literature reviewed included the historical perspective on teaching strategies such as the content-based learning system and the outcomes-based learning system. A brief history of teaching strategies showed how these strategies changed in time and how the teachers moved away from direct instruction to more conventional strategies to improve problem solving. Direct instruction was also called "whole-group" or "teacher-led" instruction.

Learning styles and learning strategies were discussed to understand how to improve the learning of mathematics. From Chapter 2 it could be seen that each student has his or her own way of absorbing information. There were five learning strategies identified in the literature review, including listening, guessing or inferring, taking notes, identifying progress and focusing. These learning strategies were part of section two and three of the questionnaire.

Teaching strategies were reviewed with regards to the problem-solving approach and the problem-centred approach. Understanding the teaching strategies that were identified by literature could give a better idea of how these strategies are used and implemented in the classroom. The four phased skill acquisition model that is related to direct instruction, proved to help the students to learn better since the teacher demonstrates and explains the work better. These phases were identified from the interview results and related to what the South Korean teachers used in their mathematics classrooms.

A deeper look in the South Korean education system and more specifically at mathematics in South Korea proved useful to understand how the curriculum was implemented. Relevant literature about their high performance gave a glimpse at their study ethic and hours spent studying mathematics. Working hard, not only in the classroom but also outside of the classroom, while doing individual practice proved to be a strong point and enhanced the South Korean mathematical performance. Completing the four phases, as mentioned earlier, from modelling by the teacher to the different levels of practice is what might benefit other countries or teachers who are not satisfied with their mathematics performance.

5.2.2 Summary of the research methodology and design

A case study was used to answer the research questions. This case study sought to identify the methods and strategies used in the South Korean mathematics classroom. The research design was a mixed-methods approach that made use of both the qualitative and quantitative methods. The quantitative method used entailed measurement. This method included a survey (questionnaire) to collect data. On the

other hand the qualitative approach focused on the meaning of individual experiences: in this case the researcher used an interview guide to gather open-ended data from the mathematics teachers.

The sample of this research was composed of the Chungcheonbuk Province and consisted of two hundred and two grade eight students from ten different schools and six teachers from those schools. All the students were enrolled during the 2013 academic year. The students participated by completing a questionnaire and the researcher conducted interviews with the six teachers to collect data for the study. Since South Korea performs well in mathematics internationally, the teaching strategies identified in this study might help other countries to perform better in mathematics.

5.2.3 Summary of the findings of the study

The findings of the investigation in this study were presented in chapter 4 and only a summary of the findings are presented in this chapter. The analysis and interpretation of data from the questionnaires indicated what learning strategies were preferred by South Korean students. The results showed that small-group work, discussions, research, case studies and role-play did not really feature in the mathematics classroom. More prominently the students preferred to learn a strategy to solve mathematics problems and then wanted the teacher to guide them while they practiced by themselves. This strategy corresponds to what was referred to in the literature as “guided practice”. The students preferred this teaching strategy and it was found from the interview responses that some of the teachers also recommended this strategy to enhance mathematics learning.

The second research question that enquired into the teachers’ preferred strategies was addressed by the interview findings. Teaching strategies were discussed in Chapter 2 and these strategies were reflected in the feedback that the teachers gave in the interviews. Teaching strategies such as direct instruction and problem-solving were relevant to their classrooms. The teachers preferred to use direct instruction and the four phases of direct instruction could be identified in their responses. The teachers used “modeling” and “directed practice” and then they facilitated the students through

“guided practice”. The fourth phase “individual practice” was left to the students to master on their own or with extra-curricular lessons.

The questionnaires showed that the students studied for an average of six hours per week more on mathematics outside of school. From previous literature reviewed, the Chosun newspaper (2009), it was found that South Korean students spent an average of eight hours and 55 minutes per week on mathematics. This is nearly three hours less than what was found in the questionnaire results. Further, the classroom sizes (at 22 students per class) were not overly large, according to the questionnaire results. This contradicted the literature review in Chapter 2, Pang (2009), that noted that the South Korean mathematics classrooms were large in size. From the questionnaire results it could be seen that 57% of the students went to private educational institutions such as after-school academies; this corresponds with the Korean literature review where it was shown that the average middle-school student (grades 7-9) received about 10.3 hours per week of extra-curricular lessons, outside the school system.

5.3 Limitations of this study

The small sample size and lack of participation from the schools were limitations in this study. Of the thirty-five schools originally contacted, only eleven of the schools replied and were willing to participate in the study. The researcher chose ten schools and this limited the study for generalizations regarding operations on mathematics teaching in South Korea. When considering the data and conclusions that the researcher came to, it could be seen that the sample size did not have a drastic influence on the outcome of this study since most of the questionnaires and interviews pointed to similar conclusions. From the ten schools chosen only six teachers were willing to participate. Some of the teachers were reluctant to answer questions in the interview since they felt that their English skills limited their conversational ability. The questionnaire and interview guide had to be transcribed from English to Korean and this took more time than the researcher anticipated.

5.4 Conclusion

This study focused on teaching strategies in the South Korean classroom, in schools with normal classroom sizes and a full curriculum that needed to be completed in a year. Teachers used a combination of three strategies, namely direct instruction, repetitive practice and guided instruction. This study revealed that the main priority was for the teacher to explain the work on the chalkboard and to instruct the students how to work with the new concepts. The teacher would then allow the students to practice the new work on their own and guide them in solving the new problems by themselves. Since the curriculum was very demanding, many students enrolled for after-school classes to practice mathematics; thus their average time spent studying mathematics was higher than that in most identified European countries according to the Chosun newspaper article: *Korean Youth Study Longest Hours in OECD* (Anonymous, 2009).

The teachers mostly used methods and concepts that would obtain best results in examinations. Some teachers felt that the students should rather study mathematics in greater depth, and not only learn skills to obtain good grades in the examinations. The pressure from society, parents and from university entrance exams, resulted in students studying more intensively. However, they were not really motivated to study mathematics or were not interested in the subject. They had no option but to study it. Most students did not like mathematics and didn't consider themselves to be good at mathematics. The teachers mentioned that there was a significant gap differentiating between the levels of ability of students in the mathematics classroom. This gap was getting bigger, with some students excelling at mathematics while others were falling behind and losing focus. The main reason for this is that the curriculum was too broad with too much work needed to be done and after-school academies that the students went to. The students who took extra classes got high grades and this gave a good impression of the mathematics classroom, many students were in fact falling behind. The students who excelled at mathematics practiced more intensively, using repetitive practice, and they made more time to prepare for the examinations.

To conclude it can be seen that there are some aspects of the South Korean education system that are working well and that the increased time spent studying mathematics

could make a big difference in enhancing mathematical learning ability. The use of “unnecessary” resources or techniques, such as group activities, watching videos or discussions, might reduce the time spent learning and practicing by students while the teacher provides guidance to the students. The combination of direct instruction, practice and guidance might help to ensure an excellent performance in mathematics.

5.5 Recommendations

The following recommendations are suggested:

(i) The mathematics classroom from South Korea should be observed and compared to other mathematics classrooms in other countries. How do these practices differ?

(ii) By using statistics, the hours spent studying mathematics and the performances achieved, could be analysed and correlated to find out whether a relationship exists.

(iii) A case study with two groups of South Korean students who are instructed using different teaching strategies would help to determine if their performance was related to the teaching strategies used.

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APPENDIX A: Students' questionnaire

Dear Student

The purpose of this questionnaire is to collect information to investigate the teaching strategies used in the grade eight classrooms in the learning of mathematics. Your participation in completing the questionnaire is extremely useful. Each part of the questionnaire has its own instruction. Please strictly follow up the instructions of each part before responding to the questions. Please choose the answer that best reflects your views from the given alternatives.

Section 1:

In your mathematics classroom, indicate how often the following occurs.
Please indicate your answer by checking (√) the column of your best choice.

	Whole class activities	**Very often**	**Often**	**Sometimes**	**Hardly ever**	**Never**
1	Teacher talks most of the class					
2	Teacher gives a question and class answers					
3	Watching a video					
4	White / blackboard instruction					
5	Teacher led whole class discussion					
6	Free flowing whole class discussion					

	Individual activities	**Very often**	**Often**	**Sometimes**	**Hardly ever**	**Never**
7	Exam paper questions					
8	Worksheets					
9	Homework / private study					
10	Regular tests					
11	Library research / information					
12	Case studies					
13	Demonstrations by students					
14	Practical experience					
15	Interviewing / surveys					
16	Self-evaluation					
17	One-to-one teaching					
18	Computer aided learning					
19	Use of the internet					
20	Writing an essay about mathematics					

	Small group activities	**Very often**	**Often**	**Sometimes**	**Hardly ever**	**Never**
21	Small group discussions					
22	Student presentation in groups					

23	Small group assignments					
24	Games					

Section 2:

Please indicate your answer by checking (√) the column of your best choice.

A: Strongly Agree B. Agree C. Undecided D. Disagree E. Strongly disagree

	What you prefer:	**A**	**B**	**C**	**D**	**E**
25	You prefer to see the math visually, on the screen / projector					
26	You prefer to listen to your teacher while he/she explains the work					
27	You prefer to discover the solutions to a problem for yourself					
28	You prefer to memorize the new work first so you can remember it					
29	You prefer to learn a strategy to solve the problem and then try it yourself					
30	You want your teacher to teach you individually so that you can understand					
31	You prefer to learn with your friends in a small group					
32	Learning mathematics on your own through your own experience is better					
33	Discussing a problem with your friend will give you better solutions					
34	You need more information about how mathematics is applied in real life					
35	Listening to a mathematics discussion or lecture helps you to learn better					

Section 3:

Please indicate your answer by checking (√) the column of your best choice.

A: Strongly agree B. Agree C. Undecided D. Disagree E. Strongly disagree

	What you prefer:	**A**	**B**	**C**	**D**	**E**
36	You want clear outcomes to know what you are going to do in the class					
37	You set your own learning goals (determine what you need to learn)					
38	You are motivated to learn mathematics					
39	You get feedback about your progress from your teacher					
40	You evaluate your own work					
41	You know how the teacher will evaluate you					
42	You can identify areas of mathematics that you need to improve					
43	You feel the need to use a computer in the mathematics class					

Section 4

Please choose between “yes” and “no” and indicate your answer by checking (√) the correct option.

Questions 44 and 46 require you to write a number.

44	How many students are in your classroom?		
45	Do you go to a mathematics academy after school?	Y	N
46	How many hours a week do you study mathematics (Monday - Sunday)		
47	Are you interested in mathematics?	Y	N
48	Do you consider yourself good at mathematics?	Y	N
49	Do you think Korean education regarding mathematics is well developed?	Y	N
50	Do you think that your mathematics classroom is efficient to learn mathematics?	Y	N

APPENDIX B

Interview guide

General Instruction

Dear Teacher

The purpose of this interview is to collect information to investigate the teaching strategies used in the classroom in the learning of mathematics. Your participation in answering the questions is extremely useful. Please try to understand the questions before giving your responses. Thus, for the closed ended questions given, please choose the answer that best reflects your view. For the open-ended questions, give your answer in detail to explain your answer.

Note that you are not required to give your name. Your responses will be kept confidential and anonymous. Thank you for your cooperation.

Please take your time and listen to the following questions, if you don't understand you can ask me to repeat the question.

1. Do you prefer to lead the class or do you prefer to facilitate the students? Please explain your answer.

2. There are different teaching styles, for example:

    a. Direct instruction – you make most of the decisions.
    b. Practice – Students practice tasks you give them.
    c. Reciprocal – students work in pairs and give feedback to each other.
    d. Self-check – Students assess their own performance.
    e. Guided discovery – Students solve problems with your assistance.
    f. Individual study – students study alone.
    g. Student initiated – Students plan their own program.
    h. Self-teaching – Students take full responsibility.

    What is your preferred teaching style? Why do you prefer this style of teaching?

3. When we talk about a teaching strategy it refers to the strategy that you use in the classroom to guide the students to the outcomes that they should achieve. It is the plan that your follow for your lessons and can be considered as a combination of teaching styles and methods to achieve your goals. What is your opinion about different teaching strategies?

4. Do you have a preferred teaching strategy? If so, explain why you prefer it?

5. What do you think is the best strategy to learn mathematics in the classroom?

6. To manage a big class can be difficult. What do you find is the best way to manage a big class?

7. The curriculum is quite full and you have a lot of work to do in one year with the students. Do you feel the need to rush through the work or do you have enough time to explain the work and to make sure the students understand everything?

8. Do you think the curriculum is well suited for the student to prepare them for further studies in mathematics?

9. South Korea is known for their high achievement in mathematics. What do you think is the reason why South Korean students are good in mathematics?

10. What do you think needs to change in the mathematics classroom so that the students can learn better and more efficiently?

Thank you for your cooperation.

APPENDIX C: Ethical clearance certificate

UNISA college of education

Research Ethics Clearance Certificate

This is to certify that the application for ethical clearance submitted by

Van Der Wal, LG [4436-299-4]

for a M Ed study entitled

Exploring teaching strategies to attain high performance in grade eight Mathematics: a case study of Chungcheongbuk Province, South Korea

has met the ethical requirements as specified by the University of South Africa College of Education Research Ethics Committee. This certificate is valid for two years from the date of issue.

Prof CS le Roux
CEDU REC (Chairperson)
lrouxcs@unisa.ac.za
Reference number: 2013 Aug/4436-299-4/CSLR

15 August 2013

APPENDIX D: Permission letter: Teachers

연구 참가 동의서: 선생님

본 연구에 참가할지 결정하시기 전에 이 동의서를 주의 깊게 읽고 궁금한 점이 있으면 얼마든지 질문해 주시기 바랍니다. 인터뷰를 하는 동안이나 혹은 전후에도 언제든지 질문하셔도 좋습니다.

프로젝트 안내	
제 목	중학교 2학년 학생들이 수학 교과에서 높은 성과를 얻기 위한 교수 전략 탐구: 대한민국 충청북도 지역을 대상으로 한 사례 연구
이 동의서는 UNISA 연구 윤리 방침(UNISA Research Ethics Policy)을 준수합니다.	

연구에 대한 정보

본 연구와 관련하여 귀중한 시간을 할애해 주시고 협조해 주신 데 감사를 드립니다. 이 연구는 한국의 수학 교과에서의 교수 전략에 초점을 두고 있습니다. 한국은 수학 교과에서 세계에서도 선두를 달리고 있으며 선생님의 도움을 통해 효과적인 교수 전략이 미치는 긍정적 효과에 대해 배우고자 합니다. 이 연구는 중학교 2학년 학생을 대상으로 실시됩니다. 학생들은 설문 조사에 참여하며 수학 교과 선생님들께서는 인터뷰를 하시게 됩니다. 본 연구에 대한 참여는 전적으로 자발적으로 이루어지며 참가자가 원하지 않는 경우 언제든 그만두어도 좋습니다. 참가하지 않는 데 대한 불이익이나 피해를 받지 않을 것입니다. 설문 조사 및 인터뷰 내용은 비밀이 보장되며 참가자들의 신원은 밝혀지지 않을 것입니다. 연구 결과는 연구가 종료된 시점에 알 수 있으며, 결과의 열람을 원하시면 담당 조사원에게 문의하시면 됩니다. 연락처는 아래 기재되어 있습니다. 참가자가 연구와 관련해 질문이 있을 때는 근무 시간 동안 아래의 번호로 담당 조사원에게 연락할 수 있습니다. 설문 조사 및 인터뷰 당일에도 질의 응답을 위한 시간이 마련될 것입니다. 본 연구에 대해서라면 뭐든 주저하지 마시고 문의해 주시기 바랍니다. 본 연구는 남아프리카 대학교의 재학생인 Gerhard van der Wal 에 의해 실시됩니다.

연구 감독: Gerhard van der Wal

연 락 처: 이메일: gerhardwal@gmail.com / 전화번호: 010-4508-3537

위의 내용을 확인하였습니다.

2013 년 9 월 11 일

서명 변라영

1. 연 구 목 적

이 연구의 목적은 수학 수업에서 사용하는 효과적인 교수 방법을 찾아내는 것입니다.

2. 절 차

가. 선생님은 인터뷰에 참가하게 됩니다.

나. 인터뷰에는 약 20분 가량이 소요됩니다.

3. 참 가 자

가. 충청북도에 소재해 있는 열 개의 학교(한 학교 당 한 학급)가 무작위로 참가하게 됩니다.

나. 학생들은 설문 조사에 참가합니다.

다. 각 학급의 수학 교과 선생님들은 인터뷰에 참가하게 됩니다.

4. 혜 택

가. 선생님의 도움은 다른 나라 학생들이 수학을 더 효과적으로 배우는 데 도움을 주게 될 것입니다.

나. 수학에 대한 개인적인 의견을 표현해 주셔도 됩니다.

5. 위험 및 불편

가. 만약 인터뷰를 하는 것이 불편하시면 하시지 않아도 좋습니다.

나. 참여를 결정하는 것은 선생님의 자유입니다. 참여하지 않는다고 해서 어떠한 불이익이나 피해도 받지 않을 것입니다.

6. 비 밀 보 장

가. 선생님의 신원은 비밀이 보장됩니다. 연구 결과는 과학적 목적을 위해 출판될 수 있으나 선생님의 이름은 밝혀지지 않을 것이며 선생님임을 알 수 있는 어떠한 언급도 포함되지 않을 것입니다.

7. 연 구 결 과

가. 연구 결과는 연구가 종료된 시점에 알 수 있습니다.

나. 연구가 종료된 이후 담당 연구원을 통해 연구 결과를 열람하실 수 있습니다.

8. 허 가

이 동의서를 읽고 이해했으며, 설문 조사에 자발적으로 참여합니다. 이 동의서의 사본을 받게 된다는 사실을 알고 있으며, 참가에 동의한다고 해서 이 연구와 관련해 법적인 문제가 발생할 경우 어떠한 법적인 권리도 양도하는 것이 아님을 이해합니다.

2013 년 9 월 17 일

참 가 자 _____

서 명 _____

연구원 Gerhard 서명 _____

APPENDIX E: Permission letter: Parents

연구 참가 동의서: 부모님 또는 법정 보호인

본 연구에 귀하의 자녀가 참가할 것인지를 결정하시기 전에 이 동의서를 주의 깊게 읽고 궁금한 점이 있으시면 얼마든지 질문해 주시기 바랍니다. 연구에 참가할 지를 결정하는 선택권은 자녀분께 있습니다.

프로젝트 안내	
제 목	중학교 2 학년 학생들이 수학 교과에서 높은 성과를 얻기 위한 교수 전략 탐구: 대한민국 충청북도 지역을 대상으로 한 사례 연구
이 동의서는 UNISA 연구 윤리 방침(UNISA Research Ethics Policy)을 준수합니다.	

연구에 대한 정보

본 연구와 관련하여 귀중한 시간을 할애해 주시고 협조해 주신 데 감사를 드립니다. 이 연구는 한국의 수학 교과에서의 교수 전략에 초점을 두고 있습니다. 한국은 수학 교과에서 세계에서도 선두를 달리고 있으며 자녀분의 도움을 통해 효과적인 교수 전략이 미치는 긍정적 효과에 대해 배우고자 합니다. 이 연구는 중학교 2 학년 학생을 대상으로 실시됩니다. 학생들은 설문 조사에 참여하며 수학 교과 선생님들께서는 인터뷰를 하시게 됩니다. 본 연구에 대한 참여는 전적으로 자발적으로 이루어지며 참가자가 원하지 않는 경우 언제든 그만두어도 좋습니다. 참가하지 않는 데 대한 불이익이나 피해를 받지 않을 것입니다. 설문 조사 및 인터뷰 내용은 비밀이 보장되며 참가자들의 신원은 밝혀지지 않을 것입니다. 연구 결과는 연구가 종료된 시점에 알 수 있으며, 결과의 열람을 원하시면 담당 조사원에게 문의하시면 됩니다. 연락처는 아래 기재되어 있습니다. 참가자가 연구와 관련해 질문이 있을 때는 근무 시간 동안 아래의 번호로 담당 조사원에게 연락할 수 있습니다. 설문 조사 및 인터뷰 당일에도 질의 응답을 위한 시간이 마련될 것입니다. 본 연구에 대해서라면 뭐든 주저하지 마시고 문의해 주시기 바랍니다. 본 연구는 남아프리카 대학교의 재학생인 Gerhard van der Wal 에 의해 실시됩니다.

연구 감독: Gerhard van der Wal
연 락 처: 이메일: gerhardwal@gmail.com / 전화번호: 010-4508-3537

위의 내용을 확인하였습니다.

2013 년 9 월 7 일

서명 _____

1. 절　　차

가. 자녀분은 설문 조사에 참여하게 됩니다.

나. 설문 조사를 마치는 데는 약 20분 가량이 주어집니다.

다. 질문을 이해하지 못하는 경우 도움을 요청할 수 있습니다.

2. 참　　가

가. 충청북도에 소재해 있는 열 개의 학교(학교 당 한 학급)가 무작위로 참가하게 됩니다.

나. 해당 학교의 수학 선생님들도 참가하게 됩니다.

3. 혜　　택

가. 자녀분의 협조는 다른 나라 학생들이 수학을 더 효과적으로 배우는 데 도움을 주게 될 것입니다.

4. 위험 및 불편

가. 만약 자녀분이 연구에 참여하기를 원하지 않는다면 하지 않아도 좋습니다.

나. 참여를 결정하는 것은 자녀분의 자유입니다. 참여하지 않는다고 해서 어떠한 불이익이나 피해도 받지 않을 것입니다. 연구가 진행되는 동안에도 참여를 계속할지에 대해 영향을 미칠 수 있는 새로운 상황이 발생할 경우 알려드리겠습니다.

5. 비 밀 보 장

가. 자녀분의 신원은 비밀이 보장됩니다. 연구 결과는 과학적 목적을 위해 출판될 수 있으나 자녀분의 이름은 밝혀지지 않을 것이며 자녀분임을 알 수 있는 어떠한 언급도 포함되지 않을 것입니다.

6. 연 구 결 과

가. 연구 결과는 연구가 종료된 시점에 알 수 있습니다.

나. 자녀분은 연구가 종료된 이후 담당 연구원을 통해 연구 결과를 열람할 수 있습니다.

7. 허　　가

이 동의서를 읽고 이해하였으며, 우리 아이가 이 연구에 참가하는 것에 동의합니다. 이 동의서의 사본을 받게 됨을 알고 있습니다. 아이가 자발적으로 참가 여부를 결정할 수 있음을 알고 있으며, 이에 동의한다고 해서 이 연구와 관련해 법적인 문제가 발생할 경우 어떠한 법적인 권리도 양도하는 것은 아님을 이해합니다.

2017 년　9 월　7 일

참가 학생 학부모 / 법정 보호인 [illegible]

서　　명 [illegible]

APPENDIX F: Permission letter: Schools

연구 참가 동의서

가경중학교 교장 선생님께

귀교의 참가 여부를 결정하시기 전에 이 동의서를 주의 깊게 읽어보시고 궁금한 점이 있으면 얼마든지 질문해 주시기 바랍니다.

프로젝트 안내	
제 목	중학교 2 학년 학생들이 수학 교과에서 높은 성과를 얻기 위한 교수 전략 탐구: 대한민국 충청북도 지역을 대상으로 한 사례 연구

연구에 대한 정보

본 연구와 관련하여 귀중한 시간을 할애해 주시고 협조해 주신 데 감사를 드립니다. 이 연구는 한국의 수학 교과에서의 교수 전략에 초점을 두고 있습니다. 한국은 수학 교과에서 세계에서도 선두를 달리고 있으며 귀교의 도움을 통해 효과적인 교수 전략이 미치는 긍정적 효과에 대해 배우고자 합니다. 이 연구는 중학교 2 학년 학생을 대상으로 실시됩니다. 학생들은 설문 조사에 참여하며 수학 교과 선생님들께서는 인터뷰를 하시게 됩니다. 본 연구에 대한 참여는 전적으로 자발적으로 이루어지며 참가자가 원하지 않는 경우 언제든 그만두어도 좋습니다. 참가하지 않는 데 대한 불이익이나 피해를 받지 않을 것입니다. 설문 조사 및 인터뷰 내용은 비밀이 보장되며 참가자들의 신원은 밝혀지지 않을 것입니다. 연구 결과는 연구가 종료된 시점에 알 수 있으며, 결과의 열람을 원하시면 담당 조사원에게 문의하시면 됩니다. 연락처는 아래 기재되어 있습니다. 참가자가 연구와 관련해 질문이 있을 때는 근무 시간 동안 아래의 번호로 담당 조사원에게 연락할 수 있습니다. 설문 조사 및 인터뷰 당일에도 질의 응답을 위한 시간이 마련될 것입니다. 본 연구에 대해서라면 뭐든 주저하지 마시고 문의해 주시기 바랍니다. 본 연구는 남아프리카 대학교의 재학생인 Gerhard van der Wal 에 의해 실시됩니다.

연구 감독: Gerhard van der Wal

연 락 처: 이메일: gerhardwal@gmail.com / 전화번호: 010-4508-3537

위의 내용을 확인하였습니다.

2013 년 9 월 07 일

서명 최현진

1. 연구 목적

귀교에서 수학 교과의 효과적인 교수 전략을 파악하기 위한 설문 조사 및 인터뷰를 실시하고자 하며 이를 허락해 주시기를 부탁 드립니다.

2. 절 차

가. 설문 조사 및 인터뷰를 실시하기 전 연구 감독이 귀교를 방문하여 연구 내용과 절차에 대해 간단히 설명합니다. 참가자들은 동의서에 서명하기 전 필요한 정보를 듣게 되며 질의 응답 시간이 주어집니다.

나. 중학교 2학년 학생들(한 학급)이 설문 조사를 완료합니다.

다. 수학 교과 선생님들이 인터뷰에 참여하게 되며 약 20분 가량이 소요됩니다.

3. 혜 택

가. 귀교의 도움은 다른 나라 학생들이 수학을 더 효과적으로 배우는 데 도움을 주게 될 것입니다.

4. 비밀 보장

가. 귀교의 이름은 비밀로 보장됩니다. 연구 결과는 과학적 목적을 위해 출판될 수 있으나 학교 이름은 밝혀지지 않을 것이며, 귀교임을 알 수 있는 어떠한 언급도 포함되지 않을 것입니다.

5. 허 가

연구 동의서를 읽고 이해하였으며, 우리 학교가 이 연구에 참가하는 것을 허락합니다.

2013 년 9 월 04 일

교 장 [redacted]

서 명 최연진

APPENDIX G: Permission letter: Students

연구 참가 동의서: 학 생

이 연구에 참가할지 결정하기 전에 동의서를 잘 읽고 궁금한 점이 있으면 얼마든지 질문해 주시기 바랍니다. 설문 조사를 하는 동안이나 전후에도 언제든 질문해도 좋습니다. 설문 조사에 참여하는 것은 다른 사람이 아닌 바로 여러분이 결정할 일입니다.

프로젝트 안내	
제 목	중학교 2 학년 학생들이 수학 교과에서 높은 성과를 얻기 위한 교수 전략 탐구: 대한민국 충청북도 지역을 대상으로 한 사례 연구
이 동의서는 UNISA 연구 윤리 방침(UNISA Research Ethics Policy)을 준수합니다.	

연구에 대한 정보

본 연구와 관련하여 귀중한 시간을 할애해 주시고 협조해 주신 데 감사를 드립니다. 이 연구는 한국의 수학 교과에서의 교수 전략에 초점을 두고 있습니다. 한국은 수학 교과에서 세계에서도 선두를 달리고 있으며 여러분의 도움을 통해 효과적인 교수 전략이 미치는 긍정적 효과에 대해 배우고자 합니다. 이 연구는 중학교 2 학년 학생을 대상으로 실시됩니다. 학생들은 설문 조사에 참여하며 수학 교과 선생님들께서는 인터뷰를 하시게 됩니다. 본 연구에 대한 참여는 전적으로 자발적으로 이루어지며 참가자가 원하지 않는 경우 언제든 그만두어도 좋습니다. 참가하지 않는 데 대한 불이익이나 피해를 받지 않을 것입니다. 설문 조사 및 인터뷰 내용은 비밀이 보장되며 참가자들의 신원은 밝혀지지 않을 것입니다. 연구 결과는 연구가 종료된 시점에 알 수 있으며, 결과의 열람을 원하시면 담당 조사원에게 문의하시면 됩니다. 연락처는 아래 기재되어 있습니다. 참가자가 연구와 관련해 질문이 있을 때는 근무 시간 동안 아래의 번호로 담당 조사원에게 연락할 수 있습니다. 설문 조사 및 인터뷰 당일에도 질의 응답을 위한 시간이 마련될 것입니다. 본 연구에 대해서라면 뭐든 주저하지 마시고 문의해 주시기 바랍니다. 본 연구는 남아프리카 대학교의 재학생인 Gerhard van der Wal 에 의해 실시됩니다.

연구 감독: Gerhard van der Wal

연 락 처: 이메일: gerhardwal@gmail.com / 전화번호: 010-4508-3537

위의 내용을 확인하였습니다.

2013 년 9 월 16 일

서명 _____

1. 연 구 목 적

이 연구 및 설문 조사의 목적은 수학 수업에서 사용하는 효과적인 교수 방법을 찾아내는 것입니다.

2. 절 차

가. 설문 조사 종이를 받게 됩니다.

나. 설문 조사를 마치는 데 약 20분 가량이 걸립니다.

다. 문제가 이해되지 않을 때는 도움을 요청하세요.

3. 참 가 자

가. 충청북도에 소재해 있는 열 개의 학교(한 학교 당 한 학급)가 무작위로 참가하게 됩니다.

4. 혜 택

가. 여러분의 도움은 다른 나라 학생들이 수학을 더 효과적으로 배우는 데 도움을 주게 될 것입니다.

5. 위험 및 불편

가. 만약 여러분이 설문 조사에 참여하는 것이 불편하다면 하지 않아도 좋습니다.

나. 참여를 결정하는 것은 여러분의 자유입니다. 참여하지 않는다고 해서 어떠한 불이익이나 피해도 받지 않을 것입니다.

6. 비 밀 보 장

가. 여러분의 신원은 비밀이 보장됩니다. 연구 결과는 과학적 목적을 위해 출판될 수 있으나 여러분의 이름은 밝혀지지 않을 것이며, 여러분임을 알 수 있는 어떠한 언급도 포함되지 않을 것입니다.

7. 부모님 / 법정 보호인의 허락

가. 이 동의서에 서명하기 전에 부모님과 충분히 이야기를 나누세요.

나. 여러분의 부모님/법정 보호인이 질문이 있는 경우 담당 연구원에게 연락할 수 있습니다.

다. 연구 동의서에 서명한 후에는 부모님께 드릴 수 있도록 사본을 받게 됩니다.

라. 부모님께서 허락하셨다 하더라도 설문 조사에 참가할지를 결정하는 것은 여러분의 몫입니다.

8. 허 가

이 동의서를 읽고 이해했으며, 설문 조사에 자발적으로 참여하기로 결정했습니다. 동의서의 사본을 받게 됨을 알고 있습니다.

2013 년 9 월 16 일

참 가 자 이진희

서 명 _____

연구원 Gerhard 서명 _____

APPENDIX H: Certificate of language editing

TO WHOM IT MAY CONCERN

I am a retired academic and freelance language editor. I have performed a language edit on Mr van der Wal's thesis, mainly to correct errors of expression. I edited using Track Changes, which leaves final control over and responsibility for the Document with the client. This means that I have not seen the final edited document.

Kind regards

Rob Gaylard

2/11/2014