PREFERRED CONTEXTS FOR MATHEMATICAL LITERACY OF KOREAN GRADE 8 – 10 LEARNERS

SUN HI KIM

A mini thesis submitted in partial fulfilment of the requirements

for the degree of Master of Education in the Faculty of Education,

University of the Western Cape

Supervisors: Professor C. Julie and Dr M. Mbekwa

June 2006

ABSTRACT

The twenty-first century society demands a high level of mathematical literacy. This drove Korean educators to evaluate their students using international mathematics tests such as TIMSS, PISA and IMO. In these tests, Korean students ranked highly among the participating countries. Korean students, however, had done poorly in the application of mathematics in daily life situations as well as in their interest in mathematics in comparison to those of other countries. Based on these observations, the present study is an investigation on the contexts which Korean grade 8 to 10 students would prefer to deal with mathematics, in order to improve these weak points and thus increase their mathematical power.

The aim of this study was thus to investigate mathematical literacy in connection with the relevance of mathematics and mathematical modelling. The study pays more attention to mathematics education in real life situations. Data was collected using the ROSME questionnaire that deals with contexts preferred by students for mathematics education.

A sample made up of over 1600 learners in grades 8 to 10 were randomly selected from 21 schools. Data collected from these learners was analysed using Kendall's W mean rank method in the SPSS 12.0 program since the data for this study were ordinal.

The most important finding of this study was that, “Mathematics that entertains and surprises us” came up the highest ranked item. This indicates that mathematics education must be directed towards raising learners’ interests. The lowest ranked item was, “Mathematics used to calculate the number of seats for parliament given to political parties after elections,” and this might indicate among other things that political activity does not attract students’ interest in a society where the concept of well-being is dominant. In general, Korean learners appear to favour learning mathematics in technological contexts and show less interest in political and agricultural contexts.

In conclusion, this study suggests that teachers should use contexts that increase learners’ interest in classroom activities. Korea has today become one of the strongest Information Technology countries. Therefore mathematics curricula and textbooks which are appropriate to this context must be provided for more efficient mathematics education. Thus, it becomes imperative that the Korean school system must develop a particular program for nurturing learners’ mathematical power. Furthermore, mathematics education policy makers must reconsider whether the current education system, Pyungjunhwa Kyoyuk system, should be used or not.

DECLARATION

I declare that **THE PREFERRED CONTEXTS FOR MATHEMATICAL LITERACY OF KOREAN GRADE 8-10 LEARNERS** is my own work, that it has not been submitted before for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Sun Hi Kim June 2006

____

Signed

ACKNOWLEDGEMENT

The twenty-first century requires mathematical power, thus making the provision of mathematical literacy indispensable. As a missionary working in South Africa I wish to make a tiny contribution to this field, and this desire led me to conduct this study.

There are many people, who deserve my sincere gratitude for the assistance they provided in the completion of this study, but due to limited space, I can only mention a few.

Professor Cyril Julie has given me useful insight from the conception of this study. He eventually became my supervisor and not only introduced me to the ROSME but also encouraged me to carry it out. Without his assistance and advice, this study would not have been completed. It is for this reason that I sincerely thank Professor Cyril Julie.

Dr Monde Mbekwa also deserves my thanks for his academic critique which I used as a guide for my study.

Professor Meshach Ogunniyi for introducing me to research study.

Mr Joseph Mafofo for polishing English.

My brother-in-law, Mr Dong-Seok Kim, who is a teacher in Korea thoroughly checked my translation of the English version of ROSME into Korean and helped me with the data collection.

So many Korean teachers and students also deserve my special thanks for their involvement in the collection of the questionnaires of ROSME. I really appreciate it.

My family, my husband, and my three children, all supported me to succeed in this study.

Finally I thank God who gave me this idea and led me to finish this study.

Soli Deo Gloria

TABLE OF CONTENTS

TABLES

FIGURES

KEYWORDS

Mathematical Literacy
Contexts in Mathematics
Mathematical Modelling
Relevance of Mathematics
Learner’s interest in Mathematics
ROSME

CHAPTER ONE

INTRODUCTION

1. 1 Background

The twenty-first century is gradually becoming characterized more and more by the diversity of information involving mathematical literacy. Further, there is a consensus that mathematical power is the key to success in our global economy, which is driven by technological development and information. Hence, Korean educators want to compare the achievements of their learners to those of learners from other countries in order to review the relationship between the current education curriculum and the afore-mentioned twenty-first century demands. These observations offer Korean educators insight into their mathematics curriculum from a comparative international perspective.

1. 1. 1 Korean Participation in International Competitions

Korean learners have participated in international competitions of mathematical achievement such as the Trends in International Mathematics and Science Study (TIMSS) and its follow-up study (TIMSS-R), the Organisation for Economic Co-operation and Development (OECD) Program for International Student Assessment (PISA) and the International Mathematics Olympiad (IMO). The purpose of this participation was to evaluate their mathematical performance in comparison to those of learners from other countries, in order to objectively review the Korean educational environment as a whole. In these tests, Korean learners ranked highly as shown in the tables below:

Table 1-1: The Results of the Highest Ranked Countries for Mathematics Performance in TIMSS 1995 (Beaton, *et al*. 1996) and TIMSS-R 1999 (Mullis, *et al*., 2000, Park, 2004a)

TIMSS 1995			TIMSS-R 1999		
Rank	Country	Score	Rank	Country	Score
1	Singapore	643	1	Singapore	604
2	Korea	607	2	Korea	587
3	Japan	605	3	Chinese Taipei	585
4	Hong Kong SAR	588	4	Hong Kong SAR	562

Table 1-2: The Results of the Highest Ranked Countries for Mathematics Performance in TIMSS 2003 (Mullis, *et al*., 2004; Park, 2004b)

Rank	Country	Score	Advanced International Benchmark	High International Benchmark	Intermediate International Benchmark	Low International Benchmark
1	Singapore	605	44	77	93	99
2	Korea	589	35	70	90	98
3	Hong Kong SAR	586	31	73	93	98
4	Chinese Taipei	585	38	66	85	96
International Average		467	7	23	49	74

Table 1-3: The Results of the Highest Ranked Countries for Mathematics Performance in PISA 2000 (OECD, 2001) and PISA 2003 (OECD, 2004)

PISA 2000			PISA 2003		
Rank	Country	Score	Rank	Country	Score
1	Japan	557	1	Netherlands	551
2	Korea	547	2	Korea	548
3	New Zealand	537	3	Finland	543
4	Finland	536	4	Hong Kong SAR	540
Average		488	Average		499

Table 1-4: The Results of Korean Learners' Performance in IMO (Park, 2004)

Year	Rank	Score	Number of participating countries
1999	7	164	81
2000	4	172	81
2001	4	185	83
2002	6	163	84
2003	6	157	82

1. 1. 2 Factors for High Achievement in Mathematics

There are various reasons why Korean learners participating in international comparative studies of mathematics achieve so well. I will explain this according to the five most influential factors:

1. The focus of education in Korea is on subjects required in Jin-Hak[1] examinations (Park, 2004) of which the very competitive national college entrance examination known as the

[1] This is a Korean word referring to the concept of going up for studying. For example, Jin-Hak refers to go from middle school to high school and from high school to university.

College Scholastic Ability Test (CSAT) or Su-Neung test[2] is of most importance. As mathematics is one of the most important subjects in Jin-Hak examinations, this is maybe *the* major factor influencing learners' high achievements in mathematics. Since learners are affected more by their mathematics results than by any other subject, schools tend to place a high importance on mathematics. Thus, for mathematics, Korean learners have private extracurricular lessons called "Goawe." According to Park (2004), in general 72.6% of the learners have private lessons and of these, 83.1% are elementary learners, 75.3% are in middle school and 56.4% are high school learners.

2. Another factor is that learners have very serious attitudes regarding tests (Park, 2004). Korean learners are brought up to take testing very seriously and as a result generally tend to voluntarily review the subject to be tested before a test. This kind of attitude might have contributed positively to their performance in the TIMSS and PISA tests.

3. One of the characteristics of Korean education is repetition. For mathematics education, thus the repetitive learning method is also used. This is similar to the so-called

[2] It is equivalent to Matric in South Africa. However the Su-Neung test must be written every year by every learner who wants to go to university, whilst Matric is not necessarily taken every year by those who want to go to university. The numbers of those who had this exam are 655,384 in 2003, 642,583 in 2004, and 554,345 in 2005.

procedure-oriented teaching and learning rather than a conceptually profound one. Within the classroom, this is manifested in the so-called Topaze Effect (Brousseau, 1997), where teachers may feel a kind of social contract in their role and thus consider it a duty to efficiently deliver the content in a given time period.

"Procedural teaching" does not necessarily imply rote learning or learning without understanding. Since understanding itself is a continuous process, the process of learning often starts with gaining competence in the procedure, before learners gradually gain understanding through repeated practice (Leung, 2001). In Korean education, repeated practice is actually the use of a set of exercises that vary systematically and repeated practice is seen as an important method in enabling learners to understand (Hess and Azuma, 1991).

4. A very high competence level is required to become a mathematics teacher. Recent studies have shown that teachers in East Asian countries including in Korea have a more profound knowledge of fundamental mathematics than teachers in the United States (Ma, 1999; Leung and Park, 2002; Park, 2004). This may be another factor contributing to high achievement.

In Korea, learners who want to become mathematics teachers have one of two options. Either they proceed straight into studying mathematics education at university if they are from the higher-achieving group in the CSAT, or they transfer to the department of mathematics after completing a bachelor's degree in another field. Therefore entry into these courses and subsequently into the teaching profession itself is a highly competitive process.

Furthermore, completing a four-year university education does not in itself qualify the graduates to teach in public schools[3]. The graduation only guarantees them a teacher's certificate, which enables them to teach at private schools. In order to teach in public schools the certificate holders are required to pass a national examination called the Teachers Employment Test (TET).

5. There is a very high competency cycle among mathematics teachers and this passes on to the next generation (Park, 2004). In Korea, there is a high level of competition among schools. Therefore a teacher is held in high esteem as an expert or a learned figure in their subject matter. Those teachers who are not experts in the subjects they teach are not respected. This image of the scholar-teacher may provide incentives for Korean teachers to strive to attain even higher competence levels in both the subject matter and teaching skills. Needless to say, this attitude is passed on to the next generation of teachers.

[3] Korea has two types of schools: private and national public schools.

1. 1. 3 Some Points to Discuss

1. 1. 3. 1 Performance according to Benchmark Tests

The achievements in the international benchmarks of the TIMSS 2003 have been divided into four categories (Mullis, *et al*., 2004:55-88): advanced (625), high (550), intermediate (475) and low benchmark (400)[4]. From table 1-2 above, Korean learners' achievements were distributed among all four benchmarks with 35% qualifying for the advanced international benchmark. Taking the total number of Korean learners who participated, 70% are ranked in the high international benchmark. 90% of Korean learners fall into the intermediate international benchmark. 98% of Korean learners are ranked in the low international benchmark.

According to this table, almost all the Korean learners were placed at least from the low international benchmark, and this should be enough evidence to show their capacity to work with mathematics.

[4] The number in bracket refers to the total score for the benchmark.

According to the same table the top five highest achieving countries are Singapore, Chinese Taipei, Korea, Hong Kong SAR and Japan. Singapore has the highest results with 44% of her learners in the advanced international benchmark, followed by Chinese Taipei in second with 38%. Looking at the overall achievement average, Korea is in second place. However under the present classification that only considers results in the advanced international benchmark, it comes third at 35%. It is noteworthy that the top five countries achieved results far higher than the rest of the participating countries.

Of all the participating learners, 7% fall into the advanced international benchmark category, in comparison with the top 5 countries' percentages which range from 24-44% (Korea: 35%). 23% fall into the high international benchmark category, in comparison with the top 5 countries' percentages which range from 62-77% (Korea: 70%). 49% of all the participating learners are ranked in the intermediate benchmark category, in comparison with the top 5 countries' percentages ranging from 88-93% (Korea: 90%). In the low international benchmark category are 74% of all the participating learners, in comparison with the top 5 countries' percentages ranging from 96-99% (Korea: 98%).

The percentage of Singaporean learners' rankings in the various international benchmark categories: advanced, high, intermediate, low, are as such: 44%, 77%, 93% and 99%.

Compared to Korea's percentages, which are: 35%, 70%, 90% and 98%, one notes a clear 16-mark gap in the mean between Singapore and Korea in the advanced international benchmark.

Korea's overall average is high and the country has an excellent international record, although it still needs work in the advanced level. This upward push might be facilitated by the 'Pyungjunhwa Kyoyuk system[5]', which was initiated 30 years ago by the Korean education department. The results of the TIMSS allowed for the identification of aspects of our education policy that must be reconsidered, especially if the system is to produce more excellent learners that are competitive enough for the international society. In addition to this, the teaching-learning relationship needs to be reconsidered on the basis of its appropriateness to individual learners' contexts, and must also be adjusted to take into account various parameters influencing individual achievement.

It is remarkable to note that the overall percentage of learners who qualify for the advanced international benchmark has declined at a time when Korean percentage is increasing.

[5] This is an education system that was employed by the Department of Education in the beginning of the 1970s. Before the inception of this system, learners had to write entrance exams to enter so-called better or best middle and high schools. Since these schools offered study based on the capability of learners, the quality of these schools naturally differed from others. This had a positive and negative impact in Korean society. Nonetheless, the Education Department abolished this system of entrance exams, and instead, created the Pyungjunhwa Kyoyuk system which allocates learners to schools regardless of academic ability by random selection.

According to the TIMSS 2003 report (Mullis, *et al*., 2004:66-67), 'the advanced international benchmark in 1995, 1999 and 2003 was 11%, 10% and 8% respectively' while those for Korea were 31%, 32% and 35% respectively.

This phenomenon is also applicable to learners of the other top five countries except Japan, whose numbers have decreased. It appears that the big gap between the top five and the rest of the other countries had already been detected in TIMSS 1995. Considering this point, it becomes apparent that the gap in achievement between the top five and the rest of the countries is becoming greater. According to the TIMSS 2003 report (Mullis, *et al*., 2004:66-67), the average of the learners' achievements is decreasing (see Table 1-5).

Table 1-5: The Results of the international Benchmark for Mathematics Performance in TIMSS (Mullis, *et al*., 2004)

Year	Advanced International Benchmark	High International Benchmark	Intermediate International Benchmark	Low International Benchmark
1995	11	37	69	89
1999	10	31	57	80
2003	8	28	56	80

1. 1. 3. 2 Application of Mathematics

The application of mathematics to real-life contexts in the intended mathematics curriculum can be classified into four categories, depending on the amount of emphasis placed: “a lot of emphasis,” “some emphasis,” “very little emphasis,” and “no emphasis.” Under this classification system, Korea was placed in the “some emphasis” category (Mullis, *et al*., 2004:178).

The results of TIMSS 2003 shows that Korean learners’ average for the application of mathematical knowledge in solving problem situations of everyday life is still very low (17%) in comparison with the international average, 44% (Mullis, *et al*., 2004:281). This implies that Korean mathematics education puts more emphasis on computation and algorithmic skills, and that the lack of understanding of real-world situations has led Korean learners to have difficulties adapting their mathematical knowledge to real-world situations.

1. 1. 3. 3 Affective Dimensions

1. 1. 3. 3. 1 Learners' Self-Confidence in Learning Mathematics

The first point in the affective dimension of mathematics education is learners' self-confidence in learning mathematics (SCM) (Mullis, *et al*., 2004:154). Internationally there is an average of 40% of the eighth-grade learners who had a high self-confidence in learning mathematics. The percentages ranged from a high of 59% in Israel to a low of 17% in Japan. Korea showed comparatively lower rates than other countries and has 30% in high SCM, 36% in medium SCM and 34% in low SCM (Mullis, *et al*., 2004:154; Park, 2004b).

It is surprising to note that the four countries, Chinese Taipei, Hong Kong SAR, Japan and Korea with the lowest percentages of learners in the high self-confidence category, also had high average mathematics achievements. It is also interesting to note that all of these are Asian Pacific countries that possibly may share cultural traditions that encourage modest self-confidence. This means that learners who have a high SCM do not necessarily have high achievements. However, in Korea those learners who had a high SCM also had high achievements and in this case it might be necessary for the education system to cultivate methods of teaching and learning which can produce higher SCMs.

1. 1. 3. 3. 2 Learners' Valuing of Mathematics

The second point in the affective dimension of mathematics education is learners' valuing of mathematics (SVM) (Mullis, *et al*., 2004:158). The index of SVM has three categories, which are high, medium and low. On average, learners generally placed a high value on mathematics, with 55% in the high, 35% in the medium and only 10% in the low category. Learners who indicated a high level are from Morocco, Botswana, Ghana, Egypt and Jordan, with 80% or more in this category and learners placing less value on mathematics are from Korea, Japan and the Netherlands, which collectively had less than 20% in this category.

The index for Korean learners is as follows: 18% is high (international average is 55%), 59% is medium (international average is 35%) and 23% is low (international average is 10%). Korean learners have high to average mathematics achievements, but show little enthusiasm for the subject. This phenomenon may be explained by the fact that the learners follow a demanding mathematics curriculum. Their valuing of mathematics is also very low in comparison with other developed countries (Mullis, *et al*., 2004:158; Park, 2004b).

1. 1. 3. 3. 3 Learners' Enjoyment in Mathematics

The TIMSS 2003 investigated the index of enjoyment in mathematics (Mullis, *et al*., 2004:159). This index was divided into three categories namely 'Agree a lot', 'Agree a little' and 'Disagree' and the international averages in each of these were 29%, 36% and 35% respectively. Korean learners scored 9% in the "Agree a lot" category, 34% in "Agree a little," and 57% in "Disagree." This means that 43% of Korean learners like mathematics and 57% do not. By comparison with the international average, Korea shows low averages. According to PISA 2003, the interest of Korean learners in mathematics is ranked 31st out of the 41 countries considered in this survey. According to Park (2004b), this is considered to be very low.

1. 1. 4 Evaluation

Through these international comparative studies, Korean educators have discerned that their learners have many serious weak points, despite their admirable achievements. These areas of weakness are considered in the five points stated below.

First, Korean learners' affective dimension in the confidence and interest categories was amongst the lowest, together with Japan and Lithuania.

Second, it came through that the high achievement of TIMSS is mainly not because of a good public education system but a private extracurricular program called "Goawe" (Lew, 2004).

Third, the whole class activities with teachers' control are reconsidered to reform classes and that lessons inevitably rely more on the teachers' verbal explanations and at the same time ignore learners' activities.

Fourth, it was revealed that Korean mathematics teachers were the lowest ranking among countries participating in TIMSS in employing such technologies as computers and calculators. This phenomenon was unexpected because at the time of the TIMSS test, Korea was one of the top five computer manufacturing countries, and every elementary and secondary school had over 50 computers. Most mathematics teachers today, however, agree that technology is an inevitable tool that every learner has to use in this information society (Lew, 2004).

Fifth, it appeared that many mathematics teachers do not seriously consider mathematical applications in daily life and thus the reasoning ability to support logical conclusions is not one of the competencies they cultivate. In this regard, Korea belonged to low-rating countries.

With this in mind, it becomes logical to summarize that traditionally Korean mathematics teachers focused only on concepts and skills in solving theoretical problems. School education, however, presupposes the application of mathematics in a variety of situations. There are a lot of cases where one uses mathematics in real life situations.

This means that if skills and knowledge of mathematics are inapplicable to everyday life, then mathematics education in schools is obviously not enough. In everyday life, what is more important is the ability to apply mathematical knowledge and skills. Educators realized that learners have an ability to create an environment conducive to the integration of known knowledge, rather than many individual pieces of knowledge.

Secondly, the content of school mathematics was perceived as being unattractive to learners. The content of mathematics textbooks tend to be more abstract. New symbols, letters, generalizations and proofs are introduced. The contents of mathematics become more complex with the increase in grade. More learners lose their interest in the subject and it gets worse in high school. Many learners complain that mathematics is too difficult to understand.

A negative attitude towards mathematics can be changed through incorporating investigative activities, and other interesting and challenging problems, rather than sticking to the conventional direct and easy application of knowledge and skills. This approach has the added benefit of improving learners' critical thinking abilities (Jung, 2004).

In conclusion, Korean learners have achieved high marks in international mathematics tests including TIMSS, PISA and IMO, although they scored very low marks in the affective dimension. Furthermore, Korean learners show a weakness in applying mathematics to daily life situations at a time when the world demands mathematical power.

1. 2 Motivation

The present study comes from two motivations, first of which is the learning contexts of mathematics. The twenty-first century demands a high level of mathematical literacy, which involves mathematics in context. In relation to this, the international mathematics tests such as TIMSS, PISA and IMO have proved that although Korean learners achieved remarkably high marks in comparison to those of other countries, their ability to apply mathematics to real life situations is very low.

Superficially, it appears as if Korean learners possess advanced mathematical knowledge and skills when compared to other learners of the same age in different countries. Most Korean learners however, display an inability to relate their well-developed manipulative skills to realistic contexts found in real-world situations.

Recently the term "saeng-hwal mathematics"[6] which indicates Realistic Mathematics Education (RME), referring to mathematics education in daily context, has appeared on Korean Internet sites[7]. This type of mathematics education helps learners enhance their capacity to learn mathematics. There have been very few studies done in this area and thus no real challenge has occurred in mathematics education. In this regard, I will describe the learning contexts of mathematics from the learner's perspective and further.

The second motivation, which is related to the first one, deals with learners' interest in contextual issues to be used in mathematics. Learners' interest in learning mathematics varies and depends on the teacher's ethos including method, contents of mathematics including extra materials and contextual situations used in mathematics. In this present study I investigate the

[6] Saeng-hwal is a transliteration of Korean into English, referring to life, life situation or daily life.

[7] For instance, it has appeared at http://classroom.kice.re.kr/content07/second04/data03/sub8/. retrieved on 2006-03-21.

degree of learners' interest in contextual situations.

As evidenced in international competitions, the affective dimension in mathematics education that includes interest, self-confidence, the valuing mathematics and pleasure is very low. Positive attitudes to mathematics, however, are related to achievements.

Interest is a person-object relationship that is characterized by value, commitment and positive emotional valences and thus the role of interest is particularly relevant in mathematics because it is perceived as a very difficult subject in which motivational factors are very important for enhancing academic achievement (Köller, *et al*., 2001).

There have been reports on the importance of academic interest and its relationship to academic achievement and other desirable academic outcomes. Individual interest is hypothesized to be a relatively enduring predisposition to attend to certain objects and activities, and is associated with positive effect, persistence and learning (Hidi and Ainley, 2002; Krapp, 2000; Renninger, 2000).

According to Schiefele (1992:151-182), the overall correlation between interest and academic achievement was about 0.30. This mark indicates that interest in mathematics has a strong correlation with achievement. I need to keep in mind that there is a difference between "interest in mathematics" and "interest in contexts used in mathematics."

Bearing this in mind, I want to examine the relationship between the learner's interest and the contexts used in mathematics so as to help learners increase their interest in mathematics education. The need for such a service was evidenced by the weakness displayed by Korean learners in the international mathematics tests.

Further, I also have the ambition to provide a theoretical insight into the relevance of mathematics education, as well as the context of the curriculum. I believe that one of the biggest barriers to good learning, as well as lack of interest in mathematics education, has something to do with its lack of the relevance to real life situations.

1. 3 Purpose and Objective

Broadly, the purpose of this study is to provide a theoretical insight into the relevance of mathematics education from the learner's perspective in order to enhance the mathematical literacy of Korean learners.

The objective of this study is to investigate Korean learners' preferred contexts to be used in school mathematics.

To address this objective, I need to ask the question; "What are the contexts that Korean learners in grades 8 to 10 prefer to deal with in mathematics?"

1. 4 Conclusion

This chapter dealt with the background, motivation, purpose and the research objective. In international tests such as TIMSS, PISA and IMO, though the general performance of the South Korean learners were highly ranked, their performances on the affective dimension and the literacy aspects that deal with mathematics in context is very weak. This mini-thesis will try to provide theoretical suggestions to enhance mathematical literacy from learners' perspective.

1. 5 Structure of the Present Study

The present study has the following structure:

Chapter one describes the background, motivation and aim of the study. Chapter two deals with a brief survey of literature on mathematical literacy and mathematical modelling. Chapter three describes the methodology. The survey is described and the sample is presented. Kendall's W was used for the collection of data and its analysis; details of this process will be discussed. Chapter four deals with the interpretation of the findings and chapter five will give the conclusion and suggestions for further study.

CHAPTER TWO

LITERATURE REVIEW

As mentioned in chapter one, this study focuses on the contexts which Korean learners prefer to deal with in the learning of mathematics. Furthermore, it has been asserted that the applications of mathematics in real-life situations brings to the fore the notion of relevance. All these topics are related to "mathematical literacy." Thus this chapter deals with the issue of relevance and how it relates to mathematical literacy.

The concept of literacy that is mainly based on the applications and modelling of mathematics has gained considerable attention. Even international comparative studies, such as the PISA and TIMSS, are no longer marked by the 'pure' testing of curricular-bound knowledge, but are aimed at the functional application of mathematics in the context of the real world.

2. 1 Relevance of Mathematics

2. 1. 1 Definition

Relevance has been a much discussed concept in the last few years. Questions about the relevance of an institution, an activity, or a subject are often asked and less often answered. According to the "free dictionary" (Farlex, 2005), the definition of relevance is "pertinence to the matter at hand," or "applicability to social issues." If I take this meaning further, relevance must refer, at least implicitly, to a relationship with some body of values or purposes. Thus a subject may be relevant in the first instance by way of its applications to another subject – which in turn may then be tested for its further relevance, ultimately to human welfare or to an overriding conception of good.

The everyday use of arithmetic and the display of information by means of graphs are an everyday practice. These are the elementary aspects of mathematics. Advanced mathematics is widely used, but often in an unseen and unadvertised way. Therefore, mathematics is everywhere[8]. In short, the relevance of mathematics involves both the various applications of

---

[8] *Mathematics is Everywhere* is a part of The Pacific Institute for the Mathematical Sciences' contribution to the World Mathematical Year 2000 sponsored by the United Nations Educational Scientific and Cultural Organization (UNESCO) and the International Mathematical Union (IMU). Retrieved from

mathematics and the position of mathematics in the spectrum of human values.

2. 1. 2 Importance of Mathematics

The importance of mathematics is becoming more recognised in the 21st century society. President Ronald Reagan of the United States of America, for example, proclaimed the week of April 14 through April 20, 1986, as National Mathematics Awareness Week. In his speech he mentions that:

> Despite the increasing importance of mathematics to the progress of our economy and society, enrolment in mathematics programs has been declining at all levels of the American educational system. Yet the application of mathematics is indispensable in such diverse fields as medicine, computer sciences, space exploration, the skilled trades, business, defence and government. To help encourage the study and utilization of mathematics, it is appropriate that all Americans be reminded of the importance of this basic branch of science to our daily lives (Reagan, 1986).

Since then, "Mathematics Awareness Week" has continued at the local, state and regional levels in the United States. The main aim over the years was to draw attention to the field of

---

http://www.pims.math.ca/education/everywhere/ on 15 May 2006.

mathematics and thereby educate a larger audience on its relevance, intrigue and power. In 1999, "Mathematics Awareness Week" became "Mathematics Awareness Month."[9]

Because of the importance of mathematics, many periods of the school timetable are allocated to mathematics, which indicates the importance of mathematics skills in everyday life and work. It is no longer obvious, however, that the skills learned in secondary school mathematics are being used much by most people. This is despite a tremendous increase in the sophistication of society, which has led to an explosion of mathematics use by a few at a high level in science and social science, technology, industry and government.

It has been reported that learners have problems relating their well-developed manipulative skills to realistic context problems in real-world situations, as secondary mathematics lessons put much emphasis on computation and algorithm skills (Boyce, 1994; Hubbard, 1994; Lew, 1999; Kwon, 2002). The question then becomes: how do instructors teach learners mathematics in such a meaningful way as to foster learners' mathematical growth.

Mathematics is a powerful learning tool. When learners identify relationships between mathematical concepts and everyday situations, and make connections between mathematics

9 http://www.mathaware.org/about.mam.html. retrieved on 2006/03/25.

and other subjects, they develop the ability to use mathematics to extend and apply their knowledge in other curriculum areas, including science, music and language. Therefore, through mathematical activities that are practical and relevant to their lives, learners develop mathematical understanding, problem-solving skills, and related technological skills that they can apply in their daily lives and, eventually, in the workplace.

Mathematics is a powerful tool in solving practical problems from everyday life, but to use it effectively requires a wider range of skills than is traditionally taught in schools – the skills of mathematical modelling.

Learning mathematics should result in more than a mastery of basic skills. Mathematics equips learners with a concise and powerful means of communication because mathematics is a special language. Mathematical structures, operations and processes provide learners with a framework and tools for reasoning, justifying conclusions and expressing ideas clearly.

It was noted in the late 1970's that more and more school leavers and adults alike could not connect the mathematics they learnt in school to the real world, this affected efficiency in industry thus prompting policy makers to design curricula linked to everyday life. For this Boaler (1993:2) says:

> Advocates of everyday mathematics generally believe that this focus not only prepares learners for the specific content studied but that real world problems provide learners with a bridge between the abstract role of mathematics and their role as members of society

Thus a branch of school mathematics that dealt with mathematics in context, and not abstract mathematics was developed. It was deemed to reflect the demands of real life problems and to prepare learners for the mathematical requirements they would face in their everyday lives.

According to Boaler (1993:14), there are two reasons for learning in contexts: "one concerning the motivation and interest of learners through an enriched and vivid curriculum, the other concerning the enhanced transfer of learning through a demonstration of the links between school mathematics and real world problems." As a result of these assertions from mathematics educators, many current mathematics schemes present mathematics "in context."

2. 2 Mathematical Literacy

2. 2. 1 Definition

Literacy of any type is often defined in similar terms, ultimately meaning "using printed and written information to function in society" (Kirsh and Jungeblut, 1986). More broadly the term "literacy" refers to the human use of language (Gee, 1998). With this, a simple connotation of mathematical literacy is the human use of mathematical language in daily life.

Since mathematical literacy was introduced in the 1980s it has been defined in a wide variety of ways over the past few years. Everyone more or less has come to agree that mathematical literacy cannot be defined in terms of mathematical knowledge only and that it focuses on individual competencies in using mathematical knowledge in a practical and functional way.

PISA/OECD (2003:24) offers the definition as follows:

> Mathematical literacy is an individual's capacity to identify, to understand and to engage in mathematics and make well founded judgments about the role that mathematics plays, as needed by an individual's current and future private life, occupational life, social life with peers and relatives, and life as a constructive concerned and reflective citizen.

It is apparent in the work done by Julie and Mbekwa (2005) that mathematical literacy deals primarily with contexts.

The department of education of South Africa defines mathematical literacy using this perspective as follows:

> Mathematical literacy is to provide learners with an awareness and understanding of the role that mathematics has in the modern world. Mathematical Literacy is a subject driven by life-related applications of mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and solve problems. (Department of Education, 2005:7)

Jablonka (2003) identifies five functional approaches to mathematical literacy. These are Mathematical literacy for (i) developing human capital, (ii) cultural identity (iii) social change, (iv) environmental awareness and (v) evaluating mathematics. She argues that the fifth approach should be the focus of mathematical literacy since this would allow learners to critically engage with the mathematical installations in society.

2. 2. 2 Purpose of Mathematical Literacy

Modern society has changed rapidly and become an information-driven society with new social goals. Because of these new goals, today's society expects all learners to become mathematically literate, to extend their learning, to have equal opportunities to learn, and to become informed citizens with a better understanding in this technological society. Therefore, the National Council of Teachers of Mathematics (NCTM) (1989:5) established five goals for mathematical literacy: (1) that learners learn to value mathematics; (2) that they become confident in their ability to do mathematics; (3) that they become mathematical problem solvers; (4) that they learn to communicate mathematically; (5) and that they learn to reason mathematically.

The education on mathematical literacy is also seriously expressed in the National Curriculum Statement of South Africa.

> Across the world, there is evidence that many adults are not able to do any but the simplest arithmetical calculations. They struggle to calculate percentages or interpret interest rates and graphs. The implications for such lack of understanding and facility are far reaching. People are exploited by biased reporting and advertising and ill equipped to make responsible financial decisions. The pervasive presence of handheld calculators and computers makes it critical that people understand how to interpret results of calculations and that they are able to decide logically what mathematics to use. In general, the mathematics learnt in school is not transferred to other contexts.

> The teaching and learning of Mathematical Literacy should thus provide opportunities to analyse problems and devise ways to work mathematically in solving them. Opportunities to engage mathematically in this way will also assist learners to become astute consumers of the mathematics reflected in the media. (Department of Education,

2005:8)

According to the National Curriculum Statement of South Africa, the purpose of mathematical literacy is to provide learners with opportunities in which they can engage with real life problems in different contexts, and so consolidate and extend basic mathematical skills; to equip learners with the ability to understand mathematical terminology, and make sense of numerical and spatial information communicated in tables, graphs, diagrams and texts; to develop the use of basic mathematical skills in critically analysing situations and creatively solving everyday problems; and to enable the learner to become a self-managing person, a contributing worker and a participating citizen in a developing democracy (Department of Education, 2005:7). Here a self-managing person refers to one who is capable of managing mathematics in everyday life, a contributing worker is one who deals with work-related finance and statistics, and a participating citizen is one who has the ability to communicate mathematically.

In summary, mathematical literacy aims to develop four important abilities:

1. The ability to use basic mathematics to solve problems encountered in everyday life and in work situations.
2. The ability to understand information represented in mathematical ways.

3. The ability to engage critically with mathematically based arguments encountered in daily life.
4. The ability to communicate mathematically.

(Department of Education, 2005:8)

2. 2. 3 Importance of Mathematical Literacy

Romberg (2001:5) argues that in 1989 when the NCTM used the term "mathematical literacy," it refers to mathematical knowledge and skills that are not defined within the traditional school mathematics curriculum. It is about individual competencies in using mathematical knowledge in a practical and functional way. In this context, therefore, mathematical literacy has become the primary focus of mathematics education.

Thus mathematical literacy implies functional use of mathematical knowledge in a multitude of different situations and contexts in varied, reflective and insight-based ways.

Therefore, mathematical literacy is not merely literacy but it becomes a subject which learners must learn in school. In this regard, South Africa is the first country where Mathematical Literacy has become a subject of the regular curriculum for senior secondary education.

2. 2. 4 Realistic Mathematics Education

Realistic Mathematics Education (RME) was developed in the Netherlands in the early seventies in reaction to the "New Math" movement based on the theory of fundamental mathematical structures. The New Math, thus, stresses the structure, but ignores the application to social problems, the value of education and the individual capacity. Because of these characteristics, the New Math is often labelled as "mechanistic mathematics education" and eventually must have been challenged. By contrast, RME is a method of mathematics education that uses contexts from either the real or abstract world.

2. 2. 4. 1 Founding Principles

The RME was developed by Freudenthal (1973, 1978) who sees mathematics as a human activity. According to him, mathematics is not a subject matter of skill and knowledge, but it has relationship with reality. Mathematics is relevant to society and thus has human value. Consequently, Freudenthal (1973) stresses that mathematics education is an activity called mathematization, which he defines as a process of maximizing the understanding of the concepts of a mathematical model within the learner's mind.

Freudenthal (1991) and Treffers (1987) further develop mathematization into two different types of mathematical activity. On the one hand, horizontal mathematization that involves moving from the context of the practical problem towards the mathematical context of articulating and solving the problem; on the other hand, vertical mathematization that leads to the creation of new associations between the learning tools, and therefore also of new structures. These two forms of mathematization are of equal value. Furthermore one must keep in mind that mathematization can occur on different levels of understanding.

2. 2. 4. 2 Realistic Approach versus Mechanistic Approach

According to Van den Heuvel-Panhuizen (1998), there are two significant differences between the two approaches. They are as follows:

A) For Context Problems in Mathematics Education

In the traditional, mechanistic approach, mathematics education takes skill and techniques into account through which most learners deal with bare, “naked” problems. As a result, the context problems function only as a field of application. By solving context problems the learners can apply what was learned earlier in the bare situation. In the mechanistic approach, learners mostly use context problems to conclude the learning process (van den Heuvel-Panhuizen, 1998).

The RME emphasizes solving problems in realistic contexts. In RME context problems function as a source for the learning process. Context problems and real-life situations are used both to constitute and to apply mathematical concepts. Learners use context problems to develop mathematical tools and understanding in the following way:

First, learners develop strategies closely connected to the context. Later on, certain aspects of the context situation can become more general, which means that the context becomes more of a model and as such can give support for solving other related problems. Eventually, the models give the learners access to more formal mathematical knowledge (Van den Heuvel-Panhuizen, 1998).

B) For the Process of Solving Problems

The traditional mathematics education deals with a procedure-focused way of teaching. The learning content is split up in meaningless small parts and then learners often solve the problems individually according to their training.

In RME, learners are not just receivers of ready-made mathematics, but are active participants in the teaching-learning process, in which they develop mathematical tools and insights. Learners are also offered opportunities to share their experiences with others. In this regard RME has a lot in common with socio-constructivist based mathematics education (Van den Heuvel-Panhuizen, 1998).

2. 2. 5 Mathematics in Context

Mathematics education for mathematical literacy is also related to "Mathematics in Context" (MiC) which is a comprehensive mathematics curriculum. MiC was developed in America in connection with the RME in the Netherlands. As in RME, the basic idea of MiC is that mathematics is a human activity in society. Mathematics does not concern pure rules and principles to learn in isolated pieces. It must be learned through contexts.

According to Villarrubia (2001:3), the key focus of MiC is on connections;

> connections among topics, connections to other disciplines, and connections between mathematics and meaningful problems in the real world. MiC emphasizes the dynamic, active nature of mathematics and the way mathematics enables learners to make sense of their world.

Traditional mathematics education deals more with abstract strategies from memorizing algorithms and rules to specific examples, and then to applications in context. By contrast, MiC is highly contextual. Mathematics is a tool to understand the real world objectively. Mathematics originated from real life and therefore, MiC uses real-life situations as a starting point for learning. This means that learners are immediately able to engage with real life problems. MiC minimizes the abstract learning and maximizes the concrete learning which is applicable to society, namely, increasing mathematical literacy. Thus the real goal of MiC is to make learners to solve non-routine problems in any mathematical situation they encounter in daily lives (Villarrubia, 2001:8).

2. 2. 6 Mathematical Literacy in Korean Mathematics Education

2. 2. 6. 1 Mathematical Literacy in Korean Mathematics Curriculum

Although it has had seven revisions, the curriculum of Korean mathematics education does not use the term mathematical literacy. According to Lew (2004:1), however, the 6th curriculum was revised for mathematical literacy:

> the 6th curriculum, issued in 1993 was designed for mathematical literacy education for all people to cope with very rapid social change of the 21st century by emphasizing mathematical problem solving ability and application of mathematics. Computer and calculator as an instructional tool, and various teaching and evaluation methods were supported. But, there was few educational effort to support successful realization of the slogan. Different with general remark, the approach of textbook and contents were not different with the past and in classes verbal method without any technological support continued and evaluation measured to measure how many pieces of knowledge. As a result, learners could not attain goals the curriculum pursued in mathematics.

Thus mathematics spread throughout our society and there is no field, from daily life to the rocket manufacturing industry, that does not use mathematics. Therefore the Korean society requires mathematical literacy to be upgraded for its people.

In 1998 the 7th curriculum was produced in reflection of the movement of mathematics education throughout the world, particularly in the USA. This new curriculum is very different from its predecessor mostly because it makes use of terms such as “mathematical power,” instead of “mathematical literacy.” Thus the foundational principle of the 7th curriculum is to enhance mathematical power, which is required in the 21st century.

> Mathematical power includes the ability to explore, conjecture and reason logically; to solve non-routine problems; to communicate about and through mathematics; and to connect ideas within mathematics and between mathematics and other intellectual activity. Mathematical power also involves the development of personal self-confidence and a disposition to seek, evaluate and use quantitative and spatial information in solving problems and in making decisions. Learners’ flexibility, perseverance, interest, curiosity and inventiveness also affect the realization of mathematical power (National Council of Teachers of Mathematics, 1991:1).

2. 2. 6. 2 Mathematical Literacy in Korean Text Books

Korea has two educational periods: a compulsory period of 10 years from grade 1 to grade 10 and an elective period for 2 years from grade 11 to grade 12. Mathematics curricula are developed corresponding to these divisions. The compulsory period has only one subject called “Mathematics,” while the elective period has five subjects such as Practical

Mathematics, Mathematics I, Mathematics II, Calculus, Probability and Statistics and Discrete Mathematics.

In the textbook designed by the 7th Korean mathematics curriculum for the compulsory period, there is no special room for mathematical literacy as mentioned above. A direct relationship to mathematical literacy is seen in the ‘Practical Mathematics’ in the elective period and thus ‘Practical Mathematics,’ as an optional course, is mathematics designed for daily life.

This subject enables learners to apply mathematical knowledge and skills to various types of problem solving in real life situations. The contents focus on the application of mathematics in four domains as seen in table 2-1 on the next page: the calculator and the computer, economic life, everyday statistics and problem solving. The contents use easy and interesting material from real life, which is based on mathematics which is at a stage lower than the 10^{th} grade level.

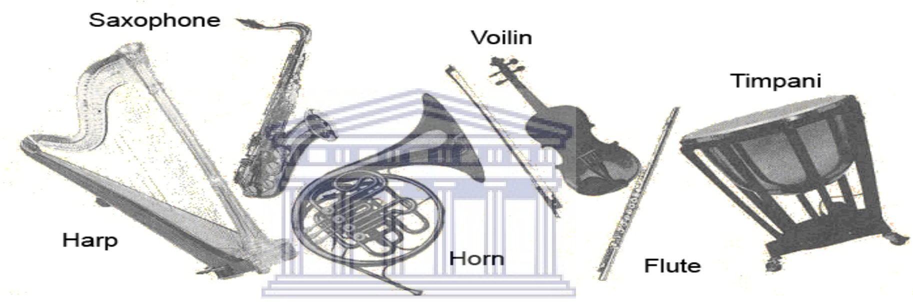
Table 2-1: Contents of Practical Mathematics (Paik, 2004)

Domain	**Contents**	
calculator and computer	Calculator	functions of the calculator / use of the calculator
	Computer	functions of the computer / simple programming / use of computer software
economic living	Banking	Interests / saving instalment and loan instalment
	Insurance	Medical insurance / car insurance
everyday statistics	arrangement and summary of a set of data	various graphs and tables / mean and variance
	application of probability and statistics	concepts and application of probability / expected value / application of binomial distribution / poll
Problem solving	Optimization	linear programming / optimization
	problem solving	problem solving in daily life / problem solving through the computer

One of the characteristics of the Korean Secondary Mathematics Texts (KSTM) is the presence of contextual tasks. The text provides a variety of contexts to develop the understanding of mathematical concepts and basic skills. Real life situations from other areas have been integrated into tasks to foster the learning of fundamental mathematical concepts and skills.

Figure 2-1 on the next page is an example of an activity taken from one text that illustrates the teaching of the concept of the set.

The definition of ‘set’ is hard to understand as it is an abstract concept. Yet it is the first concept learners learn when they enter middle school from grade 7 to 9. As a result, it plays an important role in the onset of secondary school mathematics. The activity in Figure 2-1 on the next page attempts to teach this concept by use of the fact that most learners are familiar with an array of musical instruments and the manner of classifying them.



Many musical instruments produce beautiful sounds

1. Find all the string instruments.
2. Find all the wind instruments.
3. Find all the instruments producing big sound.
4. Compare the answers, if there is something that seems different, think about the reason why.

Figure 2-1: A ‘definition of set’ contextual task

For example, most learners can separate the string instruments from other musical instruments and consequently, they can recognize the differences between 'string instruments' and 'instruments producing big sound' as a standard for classifying musical instruments. The former enables one to explicitly classify musical instruments while the latter cannot. All KSMTs writers design an assortment of contexts that deal with explicitness in classification, only after a formal definition of set has been presented (Lee, 2004).

Figure 2-2 on the next page reflects a real-life phenomenon; that is, the monthly charge method for cellular phones. Learners are required to fill in the given table, develop equations for finding call charges, make a graph of all the equations in the same coordinate plane, and finally find intervals which make each method of charge the most economical (Lee, 2004).

There are several ways to calculate monthly charges for a cellular phone. The company named Startelecom presented the following charge options available to customers.

Opinions	Basic fee (Won)	Fee per 10 sec (Won)
Economy	9000	15
Super	12000	10
Royal	16800	5

(1) Fill in the below table and select the most economical way for each time.

Options	40min	80min	120min	160min	200min
Economy					
Super					
Royal					
The most economic					

(2) Let x represent time in minutes, and y represent the call charge in 100 won[10]. Develop equations for finding the computation of call charges. (Let represent call charge options, respectively)

(3) Make graphs of all equations on the same coordinate plane. Based on the graph, find the most economical range of time for each charge option.

Figure 2-2: Contextual task related to real-life phenomena

In conclusion, as indicated before the 7th curriculum of Korean mathematics education employs the concept of mathematical power instead of the concept of mathematical literacy.

[10] Won (₩) is Koran currency. About 180 won at the present time is equal to about 1.00 rand.

There is actually no big difference between these two concepts. In reality, KSMT contains a lot of mathematics in context.

In TIMSS 2003, teachers said that although 50% of classroom activity is related to daily life situations, learners answered only 17% (Mullis, *et al*., 2004:281-2). It seems true that learners would have difficulties in using real-life problem situation contexts since data in real life are not simple. It would not have been a problem if calculators or computers were being used adequately, but most Korean secondary schools are still not satisfied with these standards (Lee, 2004).

The high achievement of Korean learners in the International competitions like TIMSS encourages Korean educators to develop a higher level of mathematics curricula and textbooks, and to provide more efficient mathematics teaching methods. The Korean mathematics education community recognizes that mathematics is the most important and the most basic intellectual resource that its people can use to build up the new society.

2. 3 Mathematical Modelling

The aims of mathematics education should be linked to the social, political or pedagogical issues that affect people's lives. For this, mathematics education must employ mathematical modelling because knowledge of mathematical modelling has a potential to increase learner's ability to apply mathematics to the real world, which means the world outside mathematics. In other words, involvement of mathematical modelling enhances learner's competences in their daily lives.

Mathematical modelling is a part of mathematical literacy programming since it is a powerful instrument of communication between the real world and the mathematical world and is also one of several ways of solving real problems.

2. 3. 1 Definition

The term "model" implies a "change of scale in its representations" and only later in its history did it acquire the meaning of "a type of design." However, the word model (without its adjective "mathematical") has been and is still being used in a number of different senses by many philosophers as well as scientists. A model is a description of a system, theory, or phenomenon that accounts for its known or inferred properties and may be used for further study of its characteristics. By extension, a mathematical model is a mathematical structure that can be used to describe and study a real situation.

According to Aris (1979:1), a mathematical model is any complete and consistent set of mathematical equations which is thought to correspond with some other entity: its prototype. In this definition, the term "prototype" represents any physical or conceptual entity. It may also represent another mathematical model.

Mathematical modelling is the process of using various mathematical structures - graphs, equations, diagrams, scatterplots, tree diagrams and so forth - to represent real world situations. The model provides an abstraction that reduces a problem to its essential characteristics.

2. 3. 2 Kinds of Models

According to Davis and Hersh (1986), there are three types of models and these types are classified on the basis of the purposes that they serve.

- Descriptive models are constructed to describe an existing reality as accurately as possible.

- Predictive models also describe a section of reality, but in this case it is a state that does not yet exist.

- Prescriptive models intend to give guidelines for the construction of a section of reality. The distinction between the models is which perspective it takes. Some models might even contain all three perspectives.

2. 3. 3 Modelling Process

Mathematical modelling deals with reality-based contextual examples and therefore is increasingly regarded as being important. According to Kaiser (2005), a modelling process is done on the basis of the following ideal-typical procedure in Figure 2-3 on the next page.

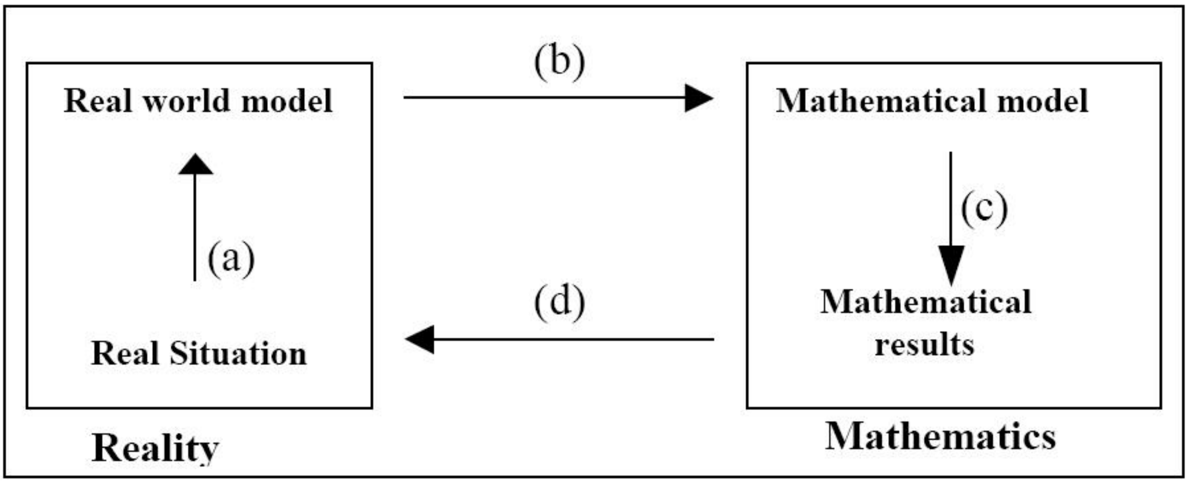


Figure 2-3: A modelling process (Kaiser, 2005)

The first step: a real world situation is the process' starting point. Then the situation is idealized (named (a) in figure 2-3), i.e. simplified or structured in order to get a real world model.

The second step: this real world model is mathematized in (b), i.e. translated into mathematics so that it leads to a mathematical model of the original situation.

The third step: mathematical considerations during the mathematical model produce mathematical results at point (c) which must then be reinterpreted into the real situation at point (d).

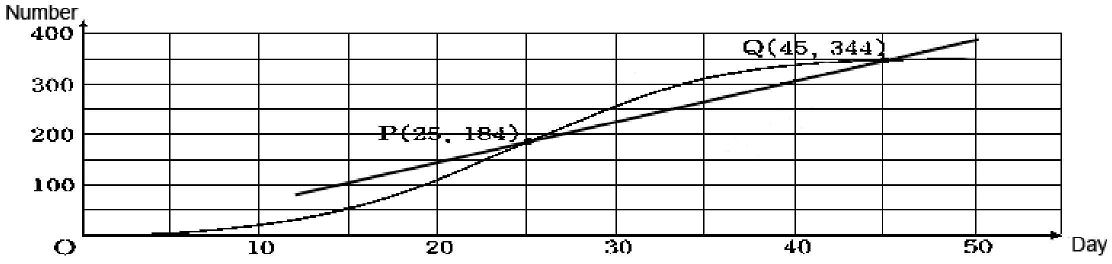
The fourth step: The results' adequacy must be checked, i.e. validated. In case of an unsatisfactory problem solution, which happens quite frequently in practice, this process must be repeated.

2. 3. 4 Modelling in Korean Mathematics Education

One of the aims of the 7th curriculum of the Korean Mathematics Education is to foster mathematical modelling abilities through solving various problems posed within and outside mathematics. Mathematical modelling consists of mathematically analyzing, representing, solving and reinterpreting problem situations.

Therefore mathematical modelling is offered in most KSMTs. It is based on interconnections among mathematical topics and the connection that exists between mathematics and other subjects. For example, in Figure 2-4 on the next page, learners may be required to study environmental problems by observing the number of drosophilae for 50 days, using a table and graph to represent the observed changes, and re-analyzing the problem situation (Lee, *et al*. 2002).

The ratio that the individual number of creatures increases in a given environment is important in environment research. The following table and graph display changes in the number of drosophilae observed over a 50 days period



1. How many drosophilae are increased per day from the 25th to the 45th day?
2. What does the slope mean that joins point P and Q on the curve?

Figure 2-4: A problem for mathematical Modelling

2. 4 Summary and Conclusion

In this section, I described and discussed relevance, mathematical modelling and mathematical literacy. In doing so I alluded to how far mathematical literacy can be supported, and in connection with it, how competencies needed for modelling and solving real world problems can be developed by innovative projects aiming at the integration of modelling and real world examples in everyday teaching.

In today's society people understand the relevance of mathematics in everyday life. Both elementary and advanced mathematics are often widely used often in an unseen and unadvertised way. Furthermore, the relevance of mathematics involves both the various applications of mathematics and the position of mathematics in the spectrum of human values. However, it is generally accepted that mathematics education focuses on teaching and learning mathematical knowledge and skills which are isolated from context. Thus today's society is characterised by the absence of 'mathematical literacy'.

As methods to enhance mathematical literacy, 'Realistic Mathematical Education' and 'Mathematics in Context' have been developed. The common factor of these two methods is dealing with mathematics in context. 'Realistic Mathematical Education' is characterised by mathematizing which refers to the procedure of understanding in two ways - horizontal and vertical in learners' mind. 'Mathematics in Context' is highly contextual. MiC employs real-life contexts for learning mathematics. Thus the real goal of MiC is to make learners solve non-routine problems in any mathematical situation they encounter in daily lives, namely, increasing mathematical literacy.

A mathematical model is a representation or transformation of a real situation into mathematical terms, in order to understand more precisely, analyze and possibly predict what is going to happen. Mathematical modelling is recognised to be in use of mathematics education and is required to enhance mathematical literacy in the use of mathematical models.

Thus mathematical modelling is an art or exercise of building and working with mathematical models. Mathematical modelling is the process of using various mathematical structures - graphs, equations, diagrams, scatterplots, tree diagrams and so forth - to represent real world situations. The model provides an abstraction that reduces a problem to its essential characteristics. Mathematical modelling is a powerful instrument of communication between the real world and the mathematical world.

In Korea the 6th curriculum, issued in 1993, was designed for mathematical literacy education for all people to cope with the very rapid social changes of the 21st century by emphasizing mathematical problem solving abilities and application of mathematics. Learners, however, could not attain the curriculum's goals. In 1998 the 7th curriculum was produced in order to enhance mathematical power, which is required in the 21st century.

Since mathematics has spread throughout the Korean society and there are no fields, from daily life to the rocket manufacturing industry, that do not use mathematics, Korean society requires mathematical literacy to be upgraded for its people.

One of the aims of the 7th curriculum of the Korean Mathematics Education is to foster mathematical modelling abilities through solving various problems posed within and outside mathematics. Mathematical modelling consists of mathematically analyzing, representing, solving and reinterpreting problem situations. Therefore mathematical modelling is offered in most KSMTs.

Today's society needs people who are equipped with mathematical literacy. The Korean mathematics education community recognizes that mathematics is the most important and the most basic intellectual resource for its people to open up an upcoming new kind of society.

In order to enhance the mathematical literacy of Korean learners, this study aims at ascertaining the contexts preferred by learners in learning mathematics. These contexts are also related to their interest in studying mathematics. The methodology for achieving this will be discussed in the next chapter.

CHAPTER THREE

METHODOLOGY

This chapter deals with the methodology employed in this study. I will describe and motivate the use of nonparametric statistics. Instrumentation, sample selection, data collection and the techniques of analysis and their descriptions will also be described.

3. 1 Motivation for the Use of Nonparametric Techniques

This study deals with the issues, situations and contexts that Korean learners in grades 8-10 would prefer to deal with in Mathematics. The choice was made to survey the preferences of a fairly large number of learners using a questionnaire, as will be described later. This necessitated the use of appropriate statistical techniques and procedures. Given that respondents had to indicate their preference on a scale for ordinal variables and that no assumptions were made about the equality of the distances between the four response categories, non-parametric techniques were used.

Before discussing nonparametric techniques, it is necessary at this point that I should introduce parametric statistics. A parametric test is one that requires data from one of the large catalogues of distributions that statisticians have described. Normally parametric tests are based on the normal distribution (Field, 2005:740; Conover, 1999:114-119) and require four basic assumptions that must be met for the test to be accurate: normally distributed data, homogeneity of variance, interval or ratio data and independence (Field, 2005:740). Parametric tests involve estimating or testing the value(s) of parameter(s) which are usually population means or proportions.

The precise definition of nonparametric varies slightly from one author to the next. Fisher and Van Belle (1993:306) define nonparametric statistics as a family of probability distributions if the distributions of the family cannot be conveniently characterized by a few parameters. Statistical procedures that hold or are valid for a nonparametric family of distributions are called nonparametric statistical procedures.

According to Bradley (1968:15), the terms nonparametric and distribution-free are not synonymous. Roughly speaking, a nonparametric test is one which makes no hypothesis about the value of a parameter in a statistical density function, whereas a distribution-free test is one which makes no assumptions about the precise form of the sampled population. Lehmann

(1975:58) states that distribution-free or nonparametric tests are characterized by freedom from the assumption that the underlying distribution of the data belongs to some parametric family of distributions.

3. 1. 1 Ties

Many nonparametric procedures are based on ranked data (Field, 2005:521). Data is ranked by ordering from lowest to highest and then being assigned integer values in that order from 1 to the sample size. Occasionally, the values of scores are tied. In order to explain ties, I will employ an example from McCall (1986:326-327).

In a set of scores {13, 15, 15, 18}, the score of 13 receives rank 1. The two scores of 15 are given the average of the next two ranks which are 2 and 3 and thus the said rank becomes 2.5. Consequently, each of the two scores of 15 receives a rank of 2.5. The score of 18 is then assigned a rank of 4. If three or more scores are tied, each score receives the average of the total of their respective ranks. The next score(s) however, is assigned the next unused rank after the last of the tied scores. An example of ranking with several ties in table 3-1 on the next page.

Table 3-1: Example of ranking with several ties (McCall, 1986:326-327)

Scores	13	13	16	19	19	22	22	22	28	28	30
Rank	1.5	1.5	3	4.5	4.5	7	7	7	9.5	9.5	11

3. 1. 2 Advantages of Nonparametric Procedures

Nonparametric methods have a number of clear advantages in comparison to parametric methods (Levin, 1978:377-378; Stell and Torrie, 1980:533-534) and these are discussed below.

1) They do not require us to make the assumption that a population is distributed in the shape of a normal curve or another specific shape.

2) Nonparametric procedures are easier to do and to understand and sometimes they can be used to get a quick answer with little calculation. Most nonparametric tests do not demand the kind of laborious computations often required, to calculate for example, the standard deviation. A nonparametric test may request for the replacement of numerical values with the order in which those values occur in a list, as has been done in table 3-2 on the next page.

Obviously, dealing computationally with 1, 2, 3, 4 and 5 takes less effort than working with 13.33, 76.50, 101.79 and 189.42.

Table 3-2: Converting parametric values to nonparametric ranks (Levin, 1978:378)

Parametric value	113.45	189.42	76.50	13.33	101.79
Nonparametric rank	4	5	2	1	3

3) Sometimes even formal ordering or ranking is not required. Often, all that can be done is to describe one outcome as "better" than another. When this is the case, or when measurements are not as accurate as is necessary for parametric tests, it becomes imperative that nonparametric methods are used.

3. 1. 3 Disadvantages of Nonparametric Procedures

There are also disadvantages to the use of nonparametric statistics (Levin, 1978:378)

1) In nonparametric techniques, there are no parameters to describe and it becomes more difficult to make quantitative statements about the actual difference between populations.

2) Nonparametric procedures throw away information. The sign test, for example, uses only the signs of the observations. Ranks preserve information about the order of the data but discard the actual values and because information is discarded this way, nonparametric procedures can never be as powerful as their parametric counterparts in cases where parametric tests can be used.

3. 2 Survey

A survey gathers data about variables as they are found in the world, and it can also be used to collect data on what people say. The important distinction between a survey and an experiment is that the former takes the world as it comes without trying to alter it, whereas the later systematically alters some aspects of the world in order to see what changes follow.

3. 2. 1 Definition of Survey

"Survey" is defined in various ways. For this study, I employed Marsh's definition. According to him (Marsh, 1982:9), a survey is defined as "an inquiry which involves the collection of systematic data across a sample of cases, followed by statistical analysis of the results." Thus using this definition, survey refers to a method of social research that employs particular techniques both for collecting and analysing information on a particular substance.

3. 2. 2 Origin of Survey

Surveys originated in the ancient civilization. The Greek historian, Herodotus (about 447-425 BC) recorded a "survey of the population and wealth" of the Egyptian kings prior to the building of the pyramids at around 3.000 BC (Young, 1956:4). Since then, these types of studies were made through the ages. The *Book of Domesday* of William the Conqueror in 1085 is notable for its reflection of the survey-type studies of social investigation (Young, 1956:4).

One of the earliest known attempts in the modern age is the work by Howard (1775) in which he made a comparative study of prison conditions (Young, 1956:4). Through this study the value of field observation and detailed recordings were recognized, and thus his practices and methods have been improved to become the standard practice for this type of study. In the course of time, many studies using this method have been produced, and the term survey movement appeared as a result in the social research area (Young, 1956:3).

3. 2. 3 Types of Survey Research

3. 2. 3. 1 Causal Relationship

The survey research is applied to two very different sorts of investigations (Simon, 1969:191-193). The causal-analysis aims to learn about the relationship between variables, and is quite analogous to experimentation.

One of the characteristics of experiments is the control of the independent variable(s). The researcher intentionally manipulates one or more of the independent variable(s), thus exposing various groups of subjects to the different variables, and then observes the changes in the dependent variables. By contrast, in surveys, the independent variable(s) is not controlled and manipulated by the researcher. Instead the researcher seeks out groups of people that have already been exposed to different levels of the independent variable.

There are three types of evidences that are relevant to the causal relationship survey (Mosar and Kalton, 1971:211). The first type concerns the cause-effect relationship. If *X* is a cause of the effect *Y*, then the relationship that exists here is referred to as a ‘causal relationship’ between these two. The second type is related to the time sequence of variables. If Y precedes

X, then X cannot be a cause of Y. The third type is that the other variables can be ruled out in the explanation of association. If a third variable, Z, is the cause of two effects, X and Y, these two effects are associated with regard to Z.

3. 2. 3. 2 Descriptive Surveys

Descriptive surveys aim to provide true quantitative descriptions of aspects of a universe of people or things (Simon, 1969:193). Because the purpose of the descriptive survey is to obtain an accurate picture of the universe, random sampling is particularly important. If the sample is biased in some way, so that it does not cover an important segment of the universe, and if each segment is not sampled in proportion to the relative size of the segment, then the picture of the universe will be distorted and misleading.

This study falls into this category of surveys. Questionnaires, which have become a common technique for gathering data for descriptive surveys, were employed in this study. Data was collected from a sample of about 1600 learners since the larger the sample size, the more representative of the target population it is.

3. 2. 3. 3 Advantages of Survey Method for Relationship Research

Simon (1969:191) summarizes a number of the advantages of surveys as follows;

1) With a survey, a researcher can get closer to the "real" hypothetical variables than with a laboratory experiment. One can actually inspect the variables in their real-world setting.

This is the pre-eminent advantage of a survey over an experiment in cases where one needs to investigate relationships, which are impossible in real- world experiments.

2) A survey is often quite cheap, especially if one can use already existing records and data.

3) Huge masses of data are often already available or can be culled from existing records. This is a major statistical advantage, because the large samples provide high internal reliability. Such huge samples are seldom available in experimentation.

4) Surveys can yield a very rich understanding of people both in breadth by collecting a wealth of information, and in depth by probing people's motives.

3. 2. 3. 4 Disadvantages of Survey Method for Relationship Research

Below is a list of the major disadvantages of surveys, which apply only to causal and non-causal relationship research (Simon, 1969:192).

1) The crucial disadvantage of the survey method in causal analysis is the lack of manipulation of the independent variable.

2) One cannot progressively investigate one aspect after another of the independent variable to get close to the "real" cause.

3) Statistical devices are not always able to separate the effects of several independent variables when there is multivariable causation, especially when two independent variables are themselves highly associated.

3. 3 Sampling

According to Korean law, education is one of the four kinds of duties of the Koreans who live in Korea, along with tax, army and labour. Thus children at the age of seven must enrol at primary school where they will receive free school education. Following this, Grade 8, 9 and 10 learners are 14, 15 and 16 years respectively. According to our survey, only a few learners in rural and island areas break this norm by being older than the expected age. However, since this was a negligible difference in number it was therefore ignored.

According to the Korean school system, Grade 7 to 9 is middle school and Grade 10 to 12 is high school. In this system Grade 10 is in a different stage to grades 8 - 9. According to the 7th revision of the curriculum, however, mathematics education has 10 steps from grade 1 to grade 10. Learners in this stage must be taught 10 basic common subjects including mathematics. In these stages there is no repetition or logical jumps in this course in subject study. According to the 7th curriculum, the mathematics curriculum has 6 fields that include 1) numbers and operations, 2) algebraic language skill and formulas, 3) functions, (4) probability and statistics, 5) geometry, and 6) measurement.

For this study I used both the simple random and the cluster sampling methods. *Simple random sampling* selects samples by methods that allow each possible sample to have an equal probability of being picked and each item in the entire population to have an equal chance of being included in the sample. *Cluster sampling* selects a random sample of these clusters or groups of the population (Levin, 1978:182).

Data was collected from 21 schools in the regions ranging from the urban capital city, Seoul, to poverty-stricken rural and island areas. These regions were classified into three clusters. For the selection of schools in each region, simple random sampling was employed. In addition to this, the present data was collected from boys and girls in three grades (grade 8 to grade 10). The total numbers of learners are in table 3-3 below.

Table 3-3: Total number of boy and girl learner of each grade

Grade	Girls	Boys	Total
G8	234	248	482
G9	309	75	384
G10	228	551	779
Total	771	874	1645

3. 3. 1 Metropolitan Group

The first category is the metropolitan city group. In this study, the first group consists of only three metropolitan cities: Seoul, Pusan and Daegu. The population of each of these metropolitan cities is over 2.6 million. Their combined population is over 17 million, which is approximately 35% of the total population of Korea, which is currently estimated at 48 million. The total number of learners who participated in this study is 523 (from eight different schools), which is approximately 32% of the total number of participants in this study.

The education system of this group is the best among the three groups. Well-known universities are situated in these three metropolitan cities. The high competency levels evidenced in these schools enables most of their final year learners to enter the best universities. Along with this, the level of the parents' education is very high and their enthusiasm for their children's education is the highest of these three groups.

Learners are more likely to study with private tutors or at private institutes, which offer entrance-exam oriented study, as a result of this. Almost all the families in this group have access to highly developed IT systems with internet access enabled by high speed optical cables. The financial situation of most families is better than the other two groups. Most of the parents prefer an urban life style to a rural one.

3. 3. 2 City Group

The second category is the city group. For this study, this group consists of the other 11 cities excluded from the first group. The population of each city varies from 170,000 to 1.5 million. This survey used 628 learners from 7 schools, which constitutes 38% of the total number of participants. As in the first group, most families in this group have Internet access connected through high-speed cables. The financial situation of these families is the average between the other two groups. Most learners' parents in this group prefer that their children live in an urban rather than rural area, and most of them want to send their children to university for further study.

3. 3. 3 Country Group

The last category is the country group that includes rural areas and islands. For this study the number of participating learners was 494 making up approximately 30% of the total number of participants. Their financial background is the lowest amongst the three groups, and most of them do not go to private tutors for extra lessons. Rather learners in this group are frequently involved in helping with their parents' work. For instance learners in agricultural areas are familiar with working in the fields whilst those on islands are usually involved with catching fish or engaging in seaweed farming etc. They also have high speed cable internet access.

The following table reflects the number of participants from the above-mentioned groups. The total number of boy and girl learners in each region is summarised in table 3-4 below and the total number of learners per grade and per region is summarised in table 3-5 on the next page.

Table 3-4: Total number of boy and girl learners in each region

	Metropolitan	City	County	Total
Total Number of Schools (%)	8 (38)	7 (33)	6 (29)	21 (100)
Total Number of Girl Learners (%)	289 (18)	177 (10)	189 (12)	655 (100)
Total Number of Boy Learners (%)	234 (14)	451 (28)	305 (18)	990 (100)
Total Number of Learners (%)	523 (32)	628 (38)	494 (30)	1645 (100)

Table 3-5: Total number of learners per grade and per each region

	Metropolitan	City	County	Total
G8	195	124	163	482
G9	147	111	126	384
G10	181	393	205	779
Total	523	628	494	1645

3. 4 Instrument

There are many ways to collect data and these include documentary sources, observation, interviews, and questionnaires. The choice of method one makes depends on the subject matter, the unit of enquiry, and the scale of the survey. The 'unit of enquiry' refers to the 'unit' such as the individual or household, for which information is required. The scale is the measurement that involves judgment or subjective ratings. The present study employed the method of questionnaires.

3. 4. 1 Questionnaires

The questionnaire was designed to collect data from large, diverse and widely scattered groups of people. It is used in gathering objective, quantitative data as well as in securing the development of information of a qualitative nature.

3. 4. 1. 1 Types of Questionnaires

The vast variety of questionnaires used in research and survey work can be classified in a number of different ways. Young (1956:177) classifies questionnaires into two kinds: *structured* and *nonstructured*.

Structured questionnaires are those in which there are definite, concrete, and pre-ordained questions with additional questions limited to those necessary to clarify inadequate answers or to elicit a more detailed responses. The form of the questions may be either *closed* or *open.* A closed or forced-choice question is one in which a number of alternative answers are provided from which respondents are to select one or more. An open-ended question is one for which respondents formulate their own answers. The important point is that they are stated in advance, not constructed during the interview.

These questionnaires are used in a wide range of projects, both to initiate a formal inquiry and also to supplement and check data previously accumulated. The purpose of the inquiries may be to obtain social or economic information, measure opinion on public issues or events, study administrative policies and changes etc. Extensive use of the structured questionnaire is made, for example in studies of the cost of living, consumer expenditures, child welfare, public health, and investment practices.

Nonstructured questionnaires are also called interview guides. These are used for interviews designated by various names, such as the "focused," "depth," and "non-directive" interview. The nonstructured questionnaire contains definite subject-matter areas, the coverage of which is required during the interview, but the interviewer is largely free to arrange the form and the timing of the inquiries. Occasionally this type of form will also include a few suggested direct questions about a given portion of the subject

The "depth" interview, as suggested by its title, is intensive and searching in character. It is used principally for studies requiring full and detailed expression of social attitudes, convictions or emotions.

3. 4. 1. 2 Types of forced-choice response formats

According to de Vaus (1994:88-89), there are five kinds of forced-choice questions:

1) Likert-style formats for rating scales: this general approach involves providing people with statements and asking them to indicate how strongly they agree or disagree. In the present study, there are four categories: 1) not at all interested, 2) a bit interested, 3) quite interested and 4) very interested.

2) Semantic differential formats: this format consists of choosing adjectives to represent the two extremes of a continuum and asking respondents to put a mark between the two extremes. An example is

How would you describe your mother?

Warm	1 2 3 4 5 6 7	Cold
Lonely	1 2 3 4 5 6 7	Not at all lonely
Dominant	1 2 3 4 5 6 7	Submissive

3) Checklists: These consist of a list of items and respondents are asked to circle each relevant item. An example is:

What things do you talk to your mother about?

Sport	food	relatives
Religion	jobs	TV
Neighbours	feelings	health
Marital problems	garden	books or films
Children	hobbies	
Weather	politics	

4) Ranking formats: respondents can be given a list of alternative answers, but rather than selecting between them they are asked to rank their importance.

5) Attitude choices rather than agree-disagree statements: although the agree-disagree question format is one of the most widely used, it can suffer from the 'acquiescent response set' problem where some people agree with the statements regardless of their content. One way of avoiding this is to provide a number of alternative views and ask respondents to select

the view that is closest to their own.

3. 4. 2 Questionnaire of ROSME

The ‘Relevance of School Mathematics Education’ project, or in brief, the ROSME project is an international comparative project inspired by the Science and Scientists project and its extension, the Relevance of Science Education (Julie and Mbekwa, 2005:32).

The questionnaire was developed from 2003 to 2005. According to Julie and Mbekwa (2005), in designing this questionnaire firstly topics or clusters were identified by mathematics educators from Zimbabwe, Uganda, Eritrea, Norway and a group of mathematics teachers from South Africa. Thirteen clusters including two intra-mathematical ones evolved through the identification process. The identification of the eleventh extra-mathematical cluster was affected mainly by modules and learning materials developed by the Consortium for Mathematics and its Applications to ensure compliance with the possible mathematical treatment of the cluster items which were developed as indicators of the identified clusters.

Numerous gatherings were held in South Africa to adapt, change or add in order to have a quality instrument at hand. A pilot study to assess the learners’ questionnaire was done by

Julie and Mbekwa (2005). The final one was compiled in January 2005 and contained 65 items including sixty one closed and four open questions.

Learners responded to sixty one items by selecting a response from one of four response-categories. The response categories on the four-point Likert-type scale were: “not at all interested,” “a little bit interested,” “interested,” and “very interested” for the first sixty one items. The last four items required an open response. Qualitative data (the learners’ reasons and drawings) were also collected but this study does not deal with that data.

Another motivational factor for the use of this survey instrument was the need to include a relatively large number of items in order to cover as vast a range of different contexts as possible. The large number was to ensure that as many contexts as possible were covered to address the issue of validity.

3. 4. 2. 1 Korean Translation of Questionnaires

The original ROSME questionnaire was developed in English in South Africa (see APPENDIX 1). The Korean version of the questionnaire was based on this version (see APPENDIX 2). I translated the English version into Korean in October 2004 and this first version was corrected by a mathematics teacher. The second Korean version has been modified by another mathematics teacher and finally crosschecked with the English version in January 2005.

Notable things in the translations were that two items in the English version were translated according to the Korean context (C with numbers such as C31 and C27 refers to the number in the questionnaires). C30, ‘mathematics linked to South African pop music’ was changed to ‘mathematics linked to pop music.’ C43 ‘mathematics linked to decoration such as the house made by Ndebele women’ has been translated into ‘mathematics linked to Korean traditional games such as “yut.”[11]

3. 4. 2. 2 Pilot Study

A pilot study was done in mid February 2005 with 30 learners, 15 boys and 15 girls in grade 8 in the city region. The class teacher instructed learners to mark all items and then observed their behaviour while they were answering the questionnaire. Subsequently a few questions were given to the class teacher and the teacher brought back those questions to the researcher.

[11] yut is a Korean traditional game played on New Year’s Day using four sticks. Markers and a board are needed to play “Yut,” Players, divided into two teams, toss the sticks in turn and move the markers around the board according to the position in which the sticks land on the ground. The objective is to get all the team’s markers around the board and home before the opposition.

One of the questions, for instance, was based on the agricultural cluster. Korean learners cannot even imagine the agricultural situation appearing in the questionnaire since agricultural land possessed by a farmer in Korea is very small in size. This type of question was therefore somewhat awkward to them; however, the questionnaire has not been modified because the present researcher thought that the questionnaire is common to international study.

3. 5 Data Collection

The data for the present study was collected from February to April of 2005. I obtained permission from the subject- and class teachers through conversation face-to-face and via telephone. The researcher explained to the teachers that learners must be encouraged to answer all the questions. Because Korean teachers are regarded as trustworthy people in general by Korean society, this encouragement by the teacher would probably result in the proper completion of the questionnaires. The questionnaire was sent to either the mathematics teacher or class teacher by post or hand and then was returned to the researcher by April 2005.

3. 6 Data Analysis

The present study utilizes only sixty one closed questions out of a total of sixty five questions that include four open questions in the ROSME questionnaire. The four questions were not taken into account. The sixty one questions however, are a type of nonparametric statistics that make use of the Likert rating scales. In this scale each item of the questions must be ranked. For this Kendall's W was chosen to obtain a mean ranking of the items.

The data obtained for this research was analyzed by SPSS 12.0 (Statistical Package for the Social Science) computer program.

3. 7 Summary and Conclusion

The present study, by nature, is in the area of nonparametric statistics. I first translated the English version of the questionnaires of the ROSME into Korean and then conducted a pilot study by employing the Korean version of the questionnaires. Then by using self-administered measurement to classes, I collected data from a sample of 1645 learners from grade 8 to grade 10 of 21 schools in three different regional groups: metropolitan, city and country. The data were analyzed by Kendall's W to obtain the mean rank through the SPSS 12.0 computer program.

CHAPTER FOUR

FINDINGS

This chapter deals with the analysis of data which is relevant to the research question. In order to investigate learners' perspective on the contexts to be used in mathematics, data were collected using the ROSME questionnaires as mentioned in the previous chapter. This chapter presents the findings obtained by the use of the SPSS 12.0 computer program.

4. 1 General View on the Findings

The ROSME questionnaires consist of 61 items. They include items for mathematics, mathematicians' practices, health, physical science, technology, transport and delivery, life science, crime, sport, youth culture, politics, agriculture and other general items. The ranking of the variables are given in figure 4-1 on the next page.

The height in figure 4-1 indicates the mean rank obtained by Kendall's W and the horizontal line refers to the variables which indicate the number of items in ROSME questionnaires. For instance, variable 1 in figure 4-1 is connected to C31 in table 4-1 and variable 2 in figure 4-1 is connected with C27 in table 4-1 on the next page.

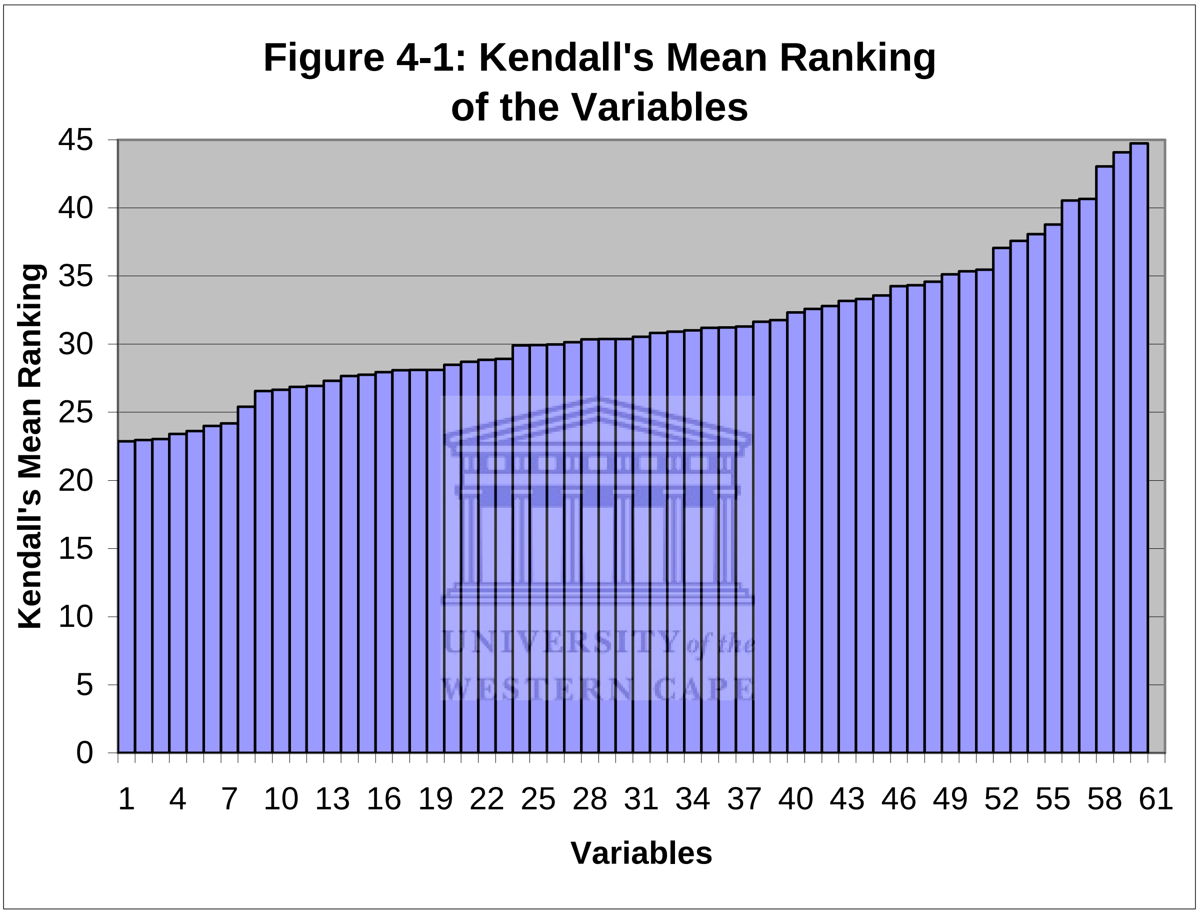


Table 4-1: The Relationship between Variables of Figure 4-1 and the Numbers of the Items in Questionnaires of the ROSME

Nos. of variables in figure 1	Nos. of Items in Questionnaires	Mean Rank
1	C31	21.47
2	C27	22.87
3	C36	22.98
4	C34	23.03
5	C14	23.42
6	C17	23.62
7	C08	24.00
8	C32	24.19
9	C59	25.42
10	C10	26.57
11	C04	26.65
12	C26	26.85
13	C60	26.93
14	C18	27.30
15	C39	27.66
16	C13	27.76
27	C61	27.94
18	C49	28.08
19	C47	28.11
20	C06	28.12
21	C37	28.49
22	C25	28.71
23	C38	28.87
24	C05	28.93
25	C11	29.91
26	C44	29.94
27	C56	29.99
28	C21	30.15
29	C53	30.37
30	C54	30.38
31	C52	30.39
32	C23	30.55
33	C33	30.83
34	C07	30.92
35	C01	31.02
36	C29	31.20
37	C12	31.22
38	C28	31.29
39	C43	31.65
40	C09	31.77
41	C16	32.33
42	C22	32.58
43	C19	32.80
44	C50	33.18
45	C30	33.32
46	C02	33.56
47	C41	34.26
48	C40	34.33
49	C45	34.58
50	C24	35.12
51	C51	35.35
52	C58	35.47
53	C42	37.06
54	C03	37.59
55	C48	38.08
56	C57	38.79
57	C15	40.54
58	C35	40.66
50	C46	43.05
60	C20	44.07
61	C55	44.74

4. 1. 1 Ten Most Preferred Items

The ten most preferred items by Grade 8 – 10 Korean learners are shown in table 4-2 below.

Table 4-2: The Ten Most Preferred Items by Grade 8-10 of Korean Learners.

Items	Mean Rank
C55: Mathematics that entertains and surprises us	44.74
C20: Mathematics involved in determining the state of health of a person	44.07
C46: Mathematics involved in the sending of messages by SMS, cellphones and emails	43.05
C35: Mathematics about the age of the universe	40.66
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	40.54
C57: How mathematics can be used in planning a journey	38.79
C48: Mathematics involved in my favourite sport	38.08
C3:Mathematics involved in making computer games such as playstations and TV games	37.59
C42: Mathematics of the storage of music on CD's	37.06
C58: How mathematics can be used in sport competitions like ski jumping, athletics, aerobics, swimming, gymnastics and soccer	35.47

The highest ranked item, 'Mathematics that entertains and surprises us,' reflects the mindset of Korean learners. According to the PISA test in 2003, interest in mathematics is very low. In general, interest in academic study is related to achievements, so accordingly the achievement of Korean learners in mathematics education should be low. However, contrary to this accepted belief their achievement is of a very high standard.

Mathematics in Korean schools is regarded as one of the most important subjects specifically for the Jin-Hak entrance exam to tertiary education. Therefore learners must study mathematics regardless of whether or not they have an interest in it. In other words, Korean mathematics education in schools is national-college entrance-examination orientated study (known as the College Scholastic Ability Test/ CSAT/ Su-Neung test).

Furthermore, South Korea could be classified as a strong scientific and technological country and thus most Koreans understand the importance of mathematics. All learners also know the importance of mathematics. Therefore, they must spend time memorizing formulas and summaries of what the teachers would have explained to them. Whether or not they understood the content of the previous study, they are led to the next stage. In reality learners are able to discover sets of mathematical formulations, introduction of proofs, and solutions for a given problem, regardless of their interest and creativity.

Given this scenario, learners feel that if they have to study mathematics it should at least be out of interest. Thus C55, “mathematics which entertains,” might be the most serious desire for learners. This, assumedly, does not refer to “card games, juggling, and games of chance” but rather involves perfect and random shuffles, and figuring the odds” in the “Mathematics of Entertainment, the Entertainment of Mathematics" as Brown said in 2002[12], C55 indicates the whole activity in teaching mathematics as provoking interest and pleasure to learners.

The second highest preference, C20, is related to health: Mathematics involved in determining the state of health of a person. Since the country's liberation from Japanese colonization in 1945, the Korean society mainly focused on poverty eradication and development of science and technology. Although through these periods, developments of welfare and health status were also emphasized, though in reality they were largely ignored in a sense due to the other two big tasks that took the bulk of national government's time. Very recently, however, the Korean society began to use the term well-being, thus highlighting the international trend of interest in health and well-being.

Generally it is everybody's dream to live long. The life expectancy in Korea has recently been reported to increase to 78.2 years. Although all Korean people have medical insurance offered by government, the schemes they offer are not enough and medical expenditure is very expensive. In addition to this, Koreans are very aware of the so-called modern diseases such as diabetes, high blood pressure, Alzheimer's, arthritis, asthma, eczema, fibromyalgia, gout, migraine, osteoporosis, etc. Thus individual health status has become one of the main

[12] http://www.alumni.vt.edu/chapters/Speakers/brown.html.

concerns. There is now a need for people to know objectively their health status, for instance in terms of numbers.

In relation to health, mathematics can be applied to healthy living such as budgeting for healthy meals through calculating ‘best buy’ produce in the market and measuring pollution in every day life.

The third highest preference is “Mathematics involved in the sending of messages via cellphone, SMS and emails” which is related to so-called Information and Communication(s) technology (ICT) or delivery. ICT is an umbrella term that includes any communication device or application, and encompasses: radio, television, cellular phones, computer networks’ hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as video conferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries.

Communication is a central aspect of all our lives. Today, our modes of communication are highly dependent on technologies such as the internet, wireless networks, phones and computers. These forms of communication are part of our lives and highlight some new directions in the communications technology.

South Korea has become a strong ICT country, if not the strongest. Most families in Korea have access to an ASDL for high speed internet use. Furthermore, recently DMB (Digital Multimedia Broadcasting) has been developed in Korea and is in use at the present time. This is the latest development in the multimedia field. In this regard, there is a new saying: "information is power." In other words, in order to get power one must have information.

Information technology (IT) is a broad subject concerned with technology and other aspects of managing and processing information, especially in large organizations. In particular, IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information. For that reason, computer professionals are often called IT specialists, and the division of a company or university that deals with software technology is likewise called the IT department. Other names for the latter are information services (IS), management information services (MIS), or managed service providers (MSP).

IT is transforming all aspects of our lives including commerce, employment, manufacturing, education, health care, government, national security, communications, entertainment, science, engineering, etc.

The topic of "Mathematics about the age of the universe (C35)" was ranked fourth. The study concerning the age of the universe is a big question. Korea launched a project to study space with the aim of calculating the age of the universe with NASA and shot Galaxy Evolution Explorer (GALEX) on 28 April 2003.

The Galaxy Evolution Explorer (GALEX) is an orbiting space telescope that will observe galaxies in ultraviolet light across 10 billion years of cosmic history. Such observations will tell scientists how galaxies, the basic structures of our Universe, evolve and change. Additionally, GALEX will probe the causes of star formation during a period when most of the stars and elements I see today had their origins. Scientists would like to understand when the stars that I see today and the chemical elements that make up our Milky Way galaxy were formed. With its ultraviolet observations, GALEX will fill in one of the key pieces of this puzzle[13]. The Korean government also contributed to a special observatory in Sutherland, South Africa in 2002. Transmission of photos from space was calculated by mathematical principles.

The space industry is the latest industrial field, which the Korean government is pursuing. The Korean government has established the Korean Aerospace Research Institute through which several satellites have been shot into space. In order to increase interest in aerospace study,

13 http://www.galex.caltech.edu/index.html

this company operates school tours twice a day to view the display centre that was installed in the company's buildings. This situation might inspire children to have interest.

C15, Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM, is classified as technology. As mentioned above, South Korea is equipped with information technology. Along with the development of IT, hacking skills have also developed. In this context, the protection technology in internet, for instance, is predicted. Recently the government of South Korea announced that all municipal public documents would be spread on the internet so that people can have access to this system. The practice was utilized temporarily, however, because of the leaking of personal information.

C57, C48, C42 and C58 are related to the leisure industry. Since being a member of OECD 1996, South Korean society is moving towards the development of well-being which is related with the leisure industry such as travel and sport.

C3 that deals with mathematics involved in making computer games such as playstations and TV games, occupies the eighth place, which is classified as technology since making computer games involves a highly advanced technology with creative logic. This means that making computer games relates to the synergy of hard- and soft-ware.

4. 1. 2 Ten Least Preferred Items

The ten least preferred items by Korean learners in grades 8 -10 are summarised in table 4-3 on the next page. The first and tenth lowest preferred items (C31 and C10) are related to the cluster of politics. Korea has a democratic election system, which is different from that of other countries such as USA, Britain, or RSA.

In South Korea, the numbers of seats in parliament are not calculated by the number of votes a political party gets. Rather the central election management committee decides the number of electoral districts and the top winner of each constituency occupies the seat. Therefore, the topic of “Mathematics used to calculate the number of seats for parliament given to political parties after elections (C31)” might not be of interest.

The topic of “Mathematics political parties use for election purposes (C10)” may refer to mathematics in various fields. Therefore, during election time politicians may use various mathematical statistics to win votes. But politics is usually beyond the concern of learners in South Korea.

Table 4-3: The Ten Least Preferred Items by Grade 8-10 of Korean Learners.

Items	Mean Rank
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	21.47
C27: Geometry	22.87
C36: Mathematics involved in working out the best arrangement for planting seeds	22.98
C34: Algebra	23.03
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	23.42
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	23.62
C8: How to estimate and predict crop production	24.00
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	24.19
C59: Mathematics use to describe movement of big groups on people in situations such as emigration and refugees fleeing from their countries	25.42
C10: Mathematics political parties use for election purposes	26.57

Another notable fact is related to the agricultural cluster (C36, C14, C17 and C8). In the sixties and seventies, the agricultural industry was regarded as the backbone of South Korean society, but this concept has since changed. Since the Uruguay round of talks of 1993 through which South Korea was forced to import agricultural products of OECD countries, the agricultural industry in the country has lost its popularity in the society. There has been a huge migration from rural areas, agricultural areas specifically, to the cities. Further, South Korea has a small area of arable land with a high population density and as such only big companies have the financial muscle to possess big farms. This might be the major reason why mathematical application to the agriculture industry has not paid any attention to learners.

C27 and C34 can be classified as pure mathematics, which according to the findings this study does not attract the interest of learners. In the case of Geometry, learners have lost interest since they are rarely exposed it during classroom study. As stated earlier, however, Korean learners have no choice over what area of mathematics they study during the grades under consideration here that means regardless of their interest they study whatever is specified by the curriculum. It is clear through the findings of this study, that learners have highest preference for mathematics that entertain and surprise them. It is for this reason that a strange phenomenon has arisen in which some universities have converted their department of mathematics to the department of mathematics education.

Korean learners are not familiar with C32 (organizing a task group or commission) and C59 (movement of big groups of people in emigration and refugees fleeing their countries). In the case of C32, “organizing a task group or commission” is not familiar to learners. In the case of C59, Korea is not exposed to the concepts of both emigration and refugees. As mentioned earlier, Korea has a high population density and is not interested in emigration and also does not have refugees.

4. 2 Contexts Preferred by Girls

This section deals with both the ten most and least preferred items by Korean girl learners.

4. 2. 1 Ten Most Preferred Items by Girls

The ten most preferred items by grade 8-10 Korean girl learners are summarised in table 4-4 on the next page. According to TIMSS 2003, Korean girls have, on average, lower marks than boys. The highest preference for them is the topic of “Mathematics that entertains and surprises us.” Most of the items have been discussed in previous sections. It is very interesting to note that the topic of “How to predict the sex of a baby (C51)” has appeared as the seventh placed preference for female learners.

Table 4-4: The Ten Most Preferred Items by Grade 8-10 of Korean Girl learners

Items	Mean Rank
C55: Mathematics that entertains and surprises us	46.51
C20: Mathematics involved in determining the state of health of a person	45.76
C46: Mathematics involved in sending of messages by SMS, cellphones and emails	45.14
C35: Mathematics about the age of the universe	40.99
C57: How mathematics can be used in planning a journey	40.03
C42: Mathematics of the storage of music on CD's	39.74
C51: How to predict the sex of a baby	39.69
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	39.43
C40: Mathematics linked to rave and disco dance patterns	38.62
C30: Mathematics linked to pop music	37.24

Traditionally, the Korean society was androcentric, based on Confucianism and thus boys were preferred to girls in a family. The irony is that having a boy was considered the mother's responsibility. The present study shows that this thinking is still apparent in some areas of society. There is a report that mothers, rather than father, want to have a baby boy[14]. In this context, one would expect that girls would want to know how to work out the sex of an unborn baby.

[14] http://www.momilk.co.kr/news_view.htm?no=392

Girls also selected three items from the youth cluster: “Mathematics of the storage of music on CD’s,” “Mathematics linked to rave and disco dance patterns,” and “Mathematics linked to pop music”. The reason for these choices might be due to the emotional character of girls.

4. 2. 2 Ten Least Preferred Items by Girls

The ten least preferred items by grade 8-10 Korean girl learners are in table 4-5 below.

Table 4-5: The Ten Least Preferred Items by Grade 8-10 of Korean Girl Learners

Items	Mean Rank
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	21.36
C34: Algebra	21.98
C27: Geometry	22.43
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	22.86
C61: Mathematics involved in military matters	22.90
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	23.22
C36: Mathematics involved in working out the best arrangement for planting seeds	23.30
C8: How to estimate and predict crop production	23.65
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	23.73
C39: Mathematics that air controllers use for sending off and landing planes	24.27

Most items in table 4-5 come from the fields in which males are still dominant in the Korean society. These fields include the political (C31), agricultural (C14, C17, C36 and C8), military (C61) and transport or delivery (C39) clusters. Girls had high marks in algebra and geometry although they included these in the ten least preferred items. This indicates that a method must be sought out to increase girls' interest in these subjects.

4. 3 Contexts Preferred by Boys

This section deals with both the ten most and least preferred items by Korean boy learners.

4. 3. 1 Ten Most Preferred Items by Boys

As seen in table 4-6 on the next page, the highest preference for boys was the topic of "Mathematics involved in making computer games such as playstations and TV games." This might be due to the fact that boys are viewed as more logical than girls. Programming games require both a superior logical capacity and mechanical analysis (mathematical power) since game programmers have to be investigative and realistic[15]. A game programmer must also be

[15] http://job.inews24.com/info/profile/profile_view.asp?id_num=30

equipped with knowledge in such areas as mathematics, computers and electronic engineering, physics and communications technology.

Table 4-6: The Ten Most Preferred Items by Grade 8-10 of Korean Boy Learners

Items	Mean Rank
C3: Mathematics involved in making computer games such as playstations and TV games	43.24
C55: Mathematics that entertains and surprises us	43.08
C20: Mathematics involved in determining the state of health of a person	42.51
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	41.58
C46: Mathematics involved in sending of messages by SMS, cellphones and emails	41.09
C48: Mathematics involved in my favourite sport	40.70
C35: Mathematics about the age of the universe	40.35
C57: How mathematics can be used in planning a journey	37.62
C58: How mathematics can be used in sport competitions like ski jumping, athletics, aerobics, swimming, gymnastics and soccer	37.50
C7: Mathematics used in making airplanes and rockets	36.06

Knowing the sex of babies is not amongst the ten most preferred items for boys, as is the case for girls. Unlike girls, however, boys did not include any items from the youth cluster in their ten most preferred items they rather chose items about sport and journey. Note that there is nothing from the sport cluster in the girls' list of choices. While girls selected two items from the technology cluster, boys selected four items from the same cluster.

4. 3. 2 Ten Least Preferred Items by Boys

This section deals with the ten least preferred items by Korean boy learners. As seen in table 4-7 on the next page, C38, 'Mathematics linked to music from the United States, Britain and other such countries', is the last of the ten items least preferred by boys. C42, Mathematics of the storage of music on CDs, has been recorded as the ninth most preferred item in table 4-2. This subject is related to the so-called digital storage system, which requires highly advanced technological skills. For C38: Mathematics linked to music from the United States, Britain and other such countries, Korean learners in general know that there is a relationship between music and mathematics. In the Korean situation of high technology, however, this subject is not popular and thus it has a low interest rating.

Table 4-7: The Ten Least Preferred Items by Grade 8-10 of Korean Boy Learners

Items	Mean Rank
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	21.58
C36: Mathematics involved in working out the best arrangement for planting seeds	22.67
C27: Geometry	23.28
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	23.94
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	23.99
C34: Algebra	24.01
C8: How to estimate and predict crop production	24.32
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	24.61
C59: Mathematics use to describe movement of big groups on people in situations such as emigration and refugees fleeing from their countries	24.97
C38: Mathematics linked to music from the United States, Britain and other such countries	25.40

4. 4 Contexts Preferred by Grade 8 Learners

This section deals with both the ten most and ten least preferred items by the Korean grade 8 learners.

4. 4. 1 Ten Most Preferred Items by Grade 8 Learners

This section deals with the ten most preferred items by grade 8 Korean learners as summarised in table 4-8 below.

Table 4-8: The Ten Most Preferred Items by Korean Grade 8 Learners.

Items	**Mean Rank**
C55: Mathematics that entertains and surprises us	47.22
C20: Mathematics involved in determining the state of health of a person	43.39
C46: Mathematics involved in sending of messages by SMS, cellphones and emails	42.80
C35: Mathematics about the age of the universe	42.21
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	39.15
C48: Mathematics involved in my favourite sport	38.75
C57: How mathematics can be used in planning a journey	38.08
C3:Mathematics involved in making computer games such as playstations and TV games	37.56
C42: Mathematics of the storage of music on CD's	37.12
C58: How mathematics can be used in sport competitions like ski jumping, athletics, aerobics, swimming, gymnastics and soccer	35.93

The learning contexts in this table have been discussed in the previous section. The ten most preferred contexts of grade 8 Korean learners are similar to the ten most preferred contexts of

Korean learners in the table 4.1. A difference between these two is that grade 8 learners prefer C48 and C57 in that order, whereas Korean learners in general prefer C57 and C 48.

4. 4. 2 Ten Least Preferred Items by Grade 8 Learners

Table 4-9: The Ten Least Preferred Items by Grade 8 of Korean Learners

Items	Mean Rank
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	20.92
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	23.24
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	23.29
C8: How to estimate and predict crop production	23.47
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	23.50
C36: Mathematics involved in working out the best arrangement for planting seeds	23.91
C34: Algebra	24.28
C27: Geometry	24.93
C59: Mathematics use to describe movement of big groups on people in situations such as emigration and refugees fleeing from their countries	25.53
C47: Mathematics involved in working out financial plans for profit-making	25.96

This section deals with the ten least preferred items by Korean grade 8 learners as summarised in table 4-9 on the previous page. The political cluster indicating "Mathematics used to calculate the number of seats for parliament given to political parties after elections" and the agricultural cluster both occupy the lowest ranks for these learners.

4. 5 Contexts Preferred by Grade 9 Learners

This section deals with both the ten most and ten least preferred items by Korean grade 9 learners.

4. 5. 1 Ten Most Preferred Items by Grade 9 Learners

This section deals with the ten most preferred items by Korean grade 9 learners as summarised in table 4-10 on the next page. The most preferred learning contexts as evident in the table from the perspective of the grade 9 learners also have similarities with the ten most preferred contexts of Korean learners shown in table 4.1 on the next page. This table shows some peculiar points. The general and final cluster, "Mathematics involved in making pension and retirement schemes" and "mathematics for predicting the sex of a baby" which is related to the life science cluster are also included.

Table 4-10: The Ten Most Preferred Items by Grade 9 of Korean Learners

Items	Mean Rank
C55: Mathematics that entertain and surprise us	47.50
C20: Mathematics involved in determining the state of health of a person	46.31
C46: Mathematics involved in sending of messages by SMS, cellphones and emails	43.43
C35: Mathematics about the age of the universe	42.05
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	40.69
C57: How mathematics can be used in planning a journey	40.46
C42: Mathematics of the storage of music on CD's	39.33
C51: How to predict the sex of a baby	38.88
C41: Mathematics involved in making pension and retirement schemes	37.12
C40: Mathematics linked to rave and disco dance patterns	36.75

4. 5. 2 Ten Least Preferred Items by Grade 9 Learners

This section deals with the ten least preferred items by Korean grade 9 learners as shown in table 4-11 on the next page. Learning contexts in this table have been discussed and they are more or less the same as the others.

Table 4-11: The Ten Least Preferred Items by Grade 9 of Korean Learners

Items	Mean Rank
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	19.69
C36: Mathematics involved in working out the best arrangement for planting seeds	21.93
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	21.97
C27: Geometry	22.42
C8: How to estimate and predict crop production	22.46
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	22.70
C34: Algebra	22.91
C61: Mathematics involved in military matters	24.50
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	24.92
C39: Mathematics that air controllers use for sending off and landing planes	25.04

4. 6 Contexts Preferred by Grade 10 Learners

This section deals with both the ten most and the ten least preferred items by Korean grade 10 learners.

4. 6. 1 Ten Most Preferred Items by Grade 10 Learners

As shown in table 4-12 below, this section deals with the ten least preferred items by Korean grade 9 learners.

Table 4-12: The Ten Most Preferred Items by Grade 10 of Korean Learners.

Items	Mean Rank
C20: Mathematics involved in determining the state of health of a person	43.35
C46: Mathematics involved in sending of messages by SMS, cellphones and emails	43.01
C55: Mathematics that entertain and surprise us	41.74
C15: Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	41.35
C3: Mathematics involved in making computer games such as playstations and TV games	39.78
C48: Mathematics involved in my favourite sport	38.98
C35: Mathematics about the age of the universe	38.95
C57: How mathematics can be used in planning a journey	38.37
C58: How mathematics can be used in sport competitions like ski jumping, athletics, aerobics, swimming, gymnastics and soccer	36.38
C42: Mathematics of the storage of music on CD's	35.85

The highest preference is given to "Mathematics involved in determining the state of health of a person." Grade 10 learners place health matters first and this is different from the perspectives of both grade 8 and 9 learners who have their first preferred context as "Mathematics that entertain and surprise us" as the first preferred context.

4. 6. 2 Ten Least Preferred Items by Grade 10 Learners

Table 4-13: The Ten Least Preferred Items by Grade 10 of Korean Learners

Items	Mean Rank
C27: Geometry	21.79
C34: Algebra	22.30
C31: Mathematics used to calculate the number of seats for parliament given to political parties after elections	22.75
C36: Mathematics involved in working out the best arrangement for planting seeds	22.93
C14: Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	23.73
C32: Mathematics involved in assigning people to tasks when a set of different tasks must be completed	24.38
C17: Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	24.71
C8: How to estimate and predict crop production	25.13
C59: Mathematics use to describe movement of big groups on people in situations such as emigration and refugees fleeing from their countries	25.47
C26: The kind of work mathematicians do	26.00

This section deals with both the ten least and ten most preferred items by Korean grade 10 learners as shown in table 4-13 on the previous page. The mathematics cluster which has both "geometry" and "algebra" is the least preferred context whereas both grades 8 and 9 selected "Mathematics used to calculate the number of seats for parliament given to political parties after elections" as the least preferred context of mathematical learning. Although Korean learners have high achievements in these two fields, their interest is lowest in these areas. This means that a method to increase learners' interest in these subjects is required.

4. 7 Summary and Conclusion

"Mathematics that entertains and surprises us" has been selected as the context of highest preference. This choice might be caused by the fact that learners are forced to study contexts they might not have interest in since mathematics is regarded as one of the very important subjects in school. Although these learners have achieved the highest marks in international mathematics competitions, they show, however, that their interest in mathematics education is very low. Mathematics study is an inescapable burden for Korean learners. Thus learners eagerly want to learn mathematics with interest.

The tenth lowest preferred item is “Mathematics used to calculate the number of seats in parliament given to political parties after elections” which is related to the cluster of politics. In Korea, the central election management committee decides the number of electoral districts and the top winner of each constituency occupies the seat. Thus the method for obtaining the number of seats at parliament does not attract attention from the Korean people. This choice may be due to the fact that Korean learners may not see the relationship between mathematics and this topic.

“Mathematics that entertains and surprises us” is selected as the most wanted learning context of mathematics by Korean girl learners in grade 8-10 and “Mathematics used to calculate the number of seats for parliament given to political parties after elections” is selected as the least desirable learning context of mathematics by the same group of learners.

“Mathematics involved in making computer games such as playstations and TV games” was selected as the most preferred learning context for Korean boy learners of grade 8-10 and “Mathematics used to calculate the number of seats for parliament given to political parties after elections” was selected as the least desirable learning context by the same group of learners.

“Mathematics that entertains and surprises us” was the most preferred item for grades 8 and 9 learners and coincidentally “Mathematics used to calculate the number of seats for parliament given to political parties after elections” was the least preferred item for both.

“Mathematics involved in determining the state of health of a person” is the most preferred item of grade 10 learners. “Geometry” and “algebra” is the least preferred item of grade 10 learners. These are peculiar to the items of both grade 8 and 9.

Of the 13 clusters in the ROSME, health, transport and delivery, physical science, technology and youth culture were frequently selected as the clusters most preferred, whereas political and agricultural clusters were frequently selected as the least preferred learning contexts.

In conclusion, Korean learners want to learn mathematics in which they have a high interest in and therefore a method to increase interest must be sought out with urgency. They prefer mathematics related to technology such as computer networks and communications since Korea is a strong IT country.

CHAPTER FIVE

CONCLUSION AND SUGGESTIONS

5. 1 Conclusion

This study investigated the contexts Korean grade 8 to 10 learners would prefer to deal with in mathematics education. It is assumed that such contexts would contribute towards the enhancement of learners' mathematical power in the 21st century society, in which the importance of mathematics is recognised more and more.

Since Korean educators think that national power in the competitive global society can be measured by the country's mathematical power, they want to know the achievements of their learners in comparison with learners from other countries. These comparisons are assessed through participation in international tests such as the TIMSS, PISA and IMO and the result obtained assist in evaluating the current education curriculum. These tests are carried out to measure mathematical knowledge as well as functional application of mathematics in real world contexts. Korean learners have obtained high ranking achievements in the recent past and at the same time revealed their weak points.

In benchmark tests, Korean learners in general have an excellent international record, but in the advanced international benchmark they retain the third position with 35%. This is not high enough in the competitive society of the 21st century. This phenomenon might be caused by the 'Pyungjunhwa Kyoyuk system.' In this context, I identified that the Korean education policy must be reconsidered, specifically in ways of producing more excellent learners, in order to enhance the national power.

In the applications of mathematics in daily life, only 17 % of Korean learners could relate mathematics to real life situations. This percentage is very low in comparison with the international average of 44%. This implies that Korean mathematics education puts more emphasis on computation and algorithm skills, and that the lack of understanding of real-world situations has led learners to have difficulties in adapting their mathematical knowledge to real-world situations.

Learners' interests in learning mathematics vary and depend on the teacher's ethos, which includes method, content of mathematics including extra materials and the learning context. In this study, I investigated the degree of learners' interest in contexts preferred by learners.

This study employs the questionnaires of the ROSME project and discovers that the most favourite context for learning mathematics is the topic “Mathematics that entertains and surprises us.” This does not refer to “Mathematics of Entertainment, or the Entertainment of Mathematics” including card games, juggling and games of chance, perfect shuffles, random shuffles and figuring the odds. For the Korean learners, however, “Mathematics that entertains and surprises us” must be understood in a wider sense than “Mathematics of Entertainment, or the Entertainment of Mathematics” since the degree of entertainment depends on individuals.

The least preferred context is the political context: “Mathematics used to calculate the number of seats for parliament given to political parties after elections.” In the Korean political context, this concept is not applicable because of a different electoral system in which each electoral constituent elects in general its own representative for parliament. Furthermore, it is generally perceived that mathematics is related to natural science and engineering and therefore mathematics in politics or agriculture does not appeal to learners. Today, mathematics has become more and more important to every subject including social science and economics.

5. 2 Suggestions

Mathematics is the most important and the most basic intellectual resource for people to open up an upcoming new kind of society. Therefore, based on this study I suggest the following to enhance learners' mathematical power.

The suggestion concerns the questionnaires of the ROSME. They were originally produced for the South African context, thus making some of the items inappropriate for the Korean situation. Therefore the ROSME questionnaires should be adapted for the Korean context.

This study indicates other contexts or preferences learners have. According to my study the most favourite context was "Mathematics that entertains and surprises us." Based on this, I strongly suggest that teachers should offer opportunities to increase learners' interest in classroom activities.

Korea has today become one of the strongest IT (information technology) countries. Therefore a mathematics curricula and textbooks which are appropriate to this context must be provided for more efficient mathematics education. Thus, the Korean school system has an urgent need to develop a particular program for nurturing learners' mathematical power.

REFERENCES

Aris, R 1978. *Mathematical modelling techniques*. San Fransisco: Pitman Publishing Limited.

Beaton, A E, *et al*. 1996. Mathematics achievement in the middle school years: IEA's third international mathematics and science study (TIMSS). Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

Boaler, J 1993. The Role of Contexts in the Mathematics Classroom: do they make mathematics more real? *For the learning of Mathematics*, 13 (2) 12 - 17.

Boyce, W E 1994. New directions in elementary differential equations. *The College Mathematics Journal* 25 (5), 364-371.

Bradley, J V 1968. *Distribution Free Statistical Tests*. Englewood Cliffs, NJ: Prentice Hall.

Brousseau, G 1997. *Theory of Didactical Situations in Mathematics*. Norwell, MA: Kluwer Academic Publishers.

Conover, W J 1999. *Practical nonparametric statistics*. 3ed. NY: John Wiley & Sons, Inc.

Davis, P and Hersh, R 1986. *Decartes' dream: The word according to mathematics*. London: Penguin Books.

De Vaus, D A 1991. *Survey in social research*. 3ed. London: ULC Press Limited.

Department of Education, 2003. National curriculum statement Grades 10-12 (general): Mathematical literacy. Republic of South Africa.

Department of Education, 2005. National curriculum statement grades 10-12 (general): learning programme guidelines mathematical literacy. Republic of South Africa.

Farlex, 2005. Farlex Free Dictionary. Huntingdon Valley, PA: Farlex, Inc. retrieved from http://www.thefreedictionary.com/relevance on Saturday, May 06, 2006

Field, A 2005. *Discovering statistics using SPSS*. 2ed. London: SAGE Publication.

Fisher, L D and van Belle, G 1993. *Biostatistics: A Methodology for the Health Sciences*. New York: John Wiley & Sons, Inc.

Freudenthal, H 1973. *Mathematics as an education task*. Dordrecht, Netherlands: D. Reidel Publishing Company.

Freudenthal, H 1978. *Weeding and sowing: Preface to a science of mathematical education.* Dordrecht: Reidel.

Freudenthal, H 1991. *Revisiting mathematical education*. Dordrecht: Reidel.

Gee, J 1998. *Preamble to a literacy program*. Madison, Wisc: Department of Curriculum and Instruction.

Hess, R D and Azuma, M 1991. Cultural Support for Schooling: Contrasts between Japan and the United States. *Education Researcher*, 20 (9), 2-8.

Hidi, S and Ainley, M 2002. Interest and adolescence. In F. Pajares and T. Urdan (Eds.), *Academic motivation of adolescents*, pp. 247-275. Greenwich Conn: Information Age.

Hubbard, J H 1994. What it means to understand a differential equation. *The College Mathematics Journal*, 25 (5), 372-384.

Jablonka, E 2003. Mathematical Literacy, in Bishop, A J, Clements, M A, Keitel, C, Kilpatrick, K and Leung, F K S (Eds.), *Second international handbook of mathematics education,* pp. 77 - 104. Dordrecht: Kluwer Academic Publishers

Julie, C and Mbekwa, M 2005. What would grade 8 to 10 learners prefer as context for mathematical literacy? The case of Masilakele Secondary School. *Perspective in Education*, 23 (3), 31-43.

Kaiser, G 2005. Mathematical modelling in school: examples and experiences. presented at The fourth Congress of the European society for Research in Mathematics Education (CERME 4), 17 - 21 February 2005 in Sant Feliu de Guíxols, Spain, YERME day: 16-17 February.

Kirsh, I S and Jungeblut, A 1986. *Literacy profiles of America's young adults*. Princeton, New Jersey: Educational Testing Service.

Köller, O, Baumert, J and Schnabel, K 2001. Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*, 32, 448-470.

Krapp, A 2000. Interest and human development during adolescence: An educational-psychological approach. In J Heckhausen (ed), *Motivational psychology of human development,* pp. 109-128. London: Elsevier.

Kwon, O N 2002. The effects of calculator-based ranger activities on students' graphing ability. *School Science & Mathematics,* 102 (2), 5-15.

Lee, G-S, *et al*. 2002. *Differentiation and integration*. Seoul, Korea: Jihak Textbooks.

Lee, K-H 2004. Development and Characteristics of Korean Secondary Mathematics Textbooks. presented at the International Congress on Mathematical Education (ICME)-10, July 4-11, 2004, Copenhagen, Denmark.

Lehmann, E L 1975. *Nonparametrics: Statistical Methods Based on Ranks*. San Francisco: Holden-Day, Inc.

Leung, F K S 2001. In search of an East Asian Identity in Mathematics Education. *Educational Studies in Mathematics,* 47. 35-51.

Leung, F K S and Park, K M 2002. Competent Students, Competent Teachers? *International Journal of Educational Research,* 37 (2), 113-129.

Levin, R I 1978. *Statistics for management*. Englewood Cliffs, NJ: Prentice Hall.

Lew, H C 1999. New goals and direction for mathematics education in Korea. In C. Hoyles, C. Morgan, and G. Woodhouse (Eds.), *Rethinking the Mathematics Curriculum.* pp. 240-247. London: Falmer Press.

Lew, H-C 2004. Mathematics Education in Korea after TIMSS. presented at the International Congress on Mathematical Education (ICME)-10, July 4-11, 2004, Copenhagen,

Denmark.
Ma, L 1999. *Knowing and Teaching Elementary Mathematics*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
Marsh, C 1982. The survey method: the contribution of surveys to sociological explanation. London: George Allen & Unwin.
McCall, R B 1986. *Fundamental statistics for behavioural sciences*. 4th. NY: Harcourt Brace Jovanovich publisher.
Mosar, C and Kalton, G 1971. *Survey methods in social investigation*. 2ed. London: Heinemann Educational Books.
Mullis, I V S, *et al*. 2000. *TIMSS 1999: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade*. Chestnut Hill, MA: The International Study Center, Lynch School of Education, Boston College.
Mullis, I V S, *et al*. 2004. TIMSS 2003 International Mathematics Report: Findings From IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.
National Council of Teachers of Mathematics, 1989. *Curriculum and evaluation standards for school mathematics*. National Council of Teachers of Mathematics, Reston, Virginia.
National Council of Teachers of Mathematics, 1991. *Professional standards for teaching mathematics.* National Council of Teachers of Mathematics, Reston, Virginia.
OECD, 2001. Knowledge and skills for life: First result from OECD programme for international students assessment (PISA) 2000.
OECD, 2003. PISA 2003 Assessment Framework: Mathematics, Reading, Science and Problem Solving Knowledge and Skills - Publications 2003.
OECD, 2004. Learning for tomorrow's world: first results from PISA 2003.
Paik, S-Y 2004. Mathematics Curriculum in Korea. presented at the International Congress on Mathematical Education (ICME)-10, July 4-11, 2004, Copenhagen, Denmark.
Park, J 2004a. Teacher, class teaching and achievement. Seoul: Korean Institute of Curriculum and Evaluation (박정 2004. 교사 수업 그리고 학생 성취: TIMSS 1999 결과 보고서. 서울: 한국교육과정평가원).
Park, J 2004b. The international study on the trends changed in achievement of mathematics and science. Seoul: Korean Institute of Curriculum and Evaluation (박정 2004. 수학 과학 성취도 추이변화 국제연구: TIMSS 2003 결과 보고서. 서울: 한국교육과정평가원).
Park, K-M 2004. Factors Contributing to Korean Students' High Achievement in Mathematics, presented at the International Congress on Mathematical Education (ICME)-10, July 4-11, 2004, Copenhagen, Denmark.
Reagan, R 1986. Proclamation 5461 -- National Mathematics Awareness Week, 1986.

Renninger, K A 2000. How might the development of individual interest contribute to the conceptualization of intrinsic motivation? In C. Sansome and J. M. Harackiewicz (eds), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance*. New York: Academic Press.

Romberg, T A 2001. Mathematical literacy: What does it mean for school mathematics? *Wisconsin School News*, October, 5-31.

Schiefele, U 1992. Topic interest and levels of text comprehension, in K A Renninger, S Hidi, and A Krapp (eds), *The role of interest in learning and development*. Hillsdale, NJ: Erlbaum.

Simon, J L 1969. *Basic research methods in social science*. 2ed. NY: Random House.

Stell, R G D and Torrie, H H 1980. *Principles and procedures of statistics: A biometrical approach*. 2ed. Tokyo: McGraw-Hill Inc.

Treffers, A 1987. *Three dimensions. A model of goal and theory description in mathematics education*. Dordrecht, the Netherlands: Reidel.

Van den Heuvel-Panhuizen, M 1998. Realistic Mathematics Education: work in progress. presented at NORMA 98, The 2nd Nordic Conference on Mathematics Education, June 5-9, 1998, Kristiansand, Norway. summary retrieved from http://www.fi.uu.nl/en/rme/

Villarrubia, B 2001. Mathematics in context (MiC). Encyclopaedia Britannica.

Young, P V 1956. *Scientific social surveys and research: an introduction to the background, content, methods, principles, and analysis of social studies*. 3ed. Englewood Cliffs, NJ: Prentice Hall.

APPENDIX 1

CODE:…………………

RELEVANCE OF SCHOOL MATHEMATICS EDUCATION (ROSME)

October 2004

Things I'd like to learn about in Mathematics

I am: a female …… a male …..

I am ……. years old

I am in Grade …………….

What would you like to learn about in mathematics? Some possible things are in the list below. Beside each item in the list, circle only one of the numbers in the boxes to say how much you are interested. Please respond to all the items.

1 = Not at all interested
2 = A bit interested
3 = Quite interested
4 = Very interested

There are no correct answers: I want you to tell us what you like. The items are not in any specific order of importance.

For office use	Things I'd like to learn about in Mathematics	Not at all interest-ed	A bit interest-ed	Quite interest-ed	Very interest-ed
C1	Mathematics linked to designer clothes and shoes	1	2	3	4
C2	Mathematics of a lottery and gambling	1	2	3	4

C3	Mathematics involved in making computer games such as play stations and TV games	1	2	3	4
C4	Why mathematicians sometimes disagree	1	2	3	4
C5	Mathematics used to predict the growth and decline of epidemics such as AIDS; tuberculosis and cholera	1	2	3	4
C6	The personal life stories of famous mathematicians	1	2	3	4
C7	Mathematics used in making aeroplanes and rockets.	1	2	3	4
C8	How to estimate and predict crop production	1	2	3	4
C9	Mathematics to predict whether certain species of animals are on the brink of extinction	1	2	3	4
C10	Mathematics political parties use for election purposes	1	2	3	4
C11	Mathematics that is relevant to professionals such as engineers, lawyers and accountants	1	2	3	4
C12	How mathematics is used to predict the spread of diseases caused by weapons of mass destruction such as chemical, biological and nuclear weapons	1	2	3	4
C13	Mathematics involved in designing delivery routes of goods such as delivering bread from a bakery to the shops.	1	2	3	4
C14	Mathematics needed to work out the amount of fertilizer needed to grow a certain crop	1	2	3	4
C15	Mathematics involved in secret codes such as pin numbers used for withdrawing money from an ATM	1	2	3	4

C16	Mathematics used to calculate the taxes people and companies must pay to the government	1	2	3	4
C17	Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size	1	2	3	4
C18	Mathematics of inflation	1	2	3	4
C19	Mathematics about renewable energy sources such as wind and solar power	1	2	3	4
C20	Mathematics involved in determining the state of health of a person	1	2	3	4
C21	Mathematics to assist in the determination of the level of development regarding employment, education and poverty of my community	1	2	3	4
C22	Mathematics to prescribe the amount of medicine a sick person must take	1	2	3	4
C23	Mathematics that will help me to do mathematics at universities and technikons	1	2	3	4
C24	Mathematics involved in the placement of emergency services such as police stations, fire brigades and ambulance stations so that they can reach emergency spots in the shortest possible time	1	2	3	4
C25	Mathematics involved in making complex structures such as bridges	1	2	3	4
C26	The kind of work mathematicians do	1	2	3	4
C27	Geometry	1	2	3	4

C28	Mathematics involved in packing goods to use space efficiently	1	2	3	4
C29	How mathematicians make their discoveries	1	2	3	4
C30	Mathematics linked to South African pop music	1	2	3	4
C31	Mathematics used to calculate the number of seats for parliament given to political parties after elections	1	2	3	4
C32	Mathematics involved in assigning people to tasks when a set of different tasks must be completed	1	2	3	4
C33	Blunders and mistakes some mathematicians have made	1	2	3	4
C34	Algebra	1	2	3	4
C35	Mathematics about the age of the universe	1	2	3	4
C36	Mathematics involved in working out the best arrangement for planting seeds	1	2	3	4
C37	Mathematics to determine the number of fish in a lake, river or a certain section of the sea	1	2	3	4
C38	Mathematics linked to music from the United States, Britain and other such countries	1	2	3	4
C39	Mathematics that air traffic controllers use for sending off and landing planes	1	2	3	4
C40	Mathematics linked to rave and disco dance patterns	1	2	3	4
C41	Mathematics involved in making pension and retirement schemes	1	2	3	4
C42	Mathematics of the storage of music on CD’s	1	2	3	4

C43	Mathematics linked to decorations such as the house decorations made by Ndebele women	1	2	3	4
C44	Mathematical ideas that have had a major influence in world affairs	1	2	3	4
C45	Numbers	1	2	3	4
C46	Mathematics involved in sending of messages by SMS, cellphones and e-mails	1	2	3	4
C47	Mathematics involved in working out financial plans for profit-making	1	2	3	4
C48	Mathematics involved in my favourite sport	1	2	3	4
C49	Mathematics involved in dispatching a helicopter for rescuing people	1	2	3	4
C50	Mathematics used to work out the repayments (instalment) for things bought on credit are worked out	1	2	3	4
C51	How to predict the sex of a baby	1	2	3	4
C52	How mathematics can be used by setting up a physical training program, and measure fitness	1	2	3	4
C53	Strange results and paradoxes in Mathematics	1	2	3	4
C54	Mathematics to monitor the growth of a baby the first period of life	1	2	3	4
C55	Mathematics that entertain and surprise us	1	2	3	4
C56	Mathematics to describe facts about diminishing rain forest and growing deserts	1	2	3	4
C57	How mathematics can be used in planning a journey	1	2	3	4

C58	How mathematics can be used in sport competitions like ski jumping, athletics, aerobic, swimming, gymnastics and soccer	1	2	3	4
C59	Mathematics to describe movement of big groups of people in situations such as emigration and refugees fleeing from their countries	1	2	3	4
C60	Mathematics involved in determining levels of pollution	1	2	3	4
C61	Mathematics involved in military matters.	1	2	3	4

C62 Please write down 3 issues that you are very interested in learning about the use of mathematics in these issues.

(a) ....

(b) ....

(c) ....

Why are you interested in these issues?

....

....

C63 Are you interested in learning something on mathematics that arises while you are learning other school subjects?

YES ....

Why? ....

.................………………...................………………...................………………..................................

………………...................………………...................………………...................………………………..

NO ....……………..

Why not? ………………………………....................................…………………………

....................................………………………………….......................................……………

....................................………………………………….......................................……………

C64 Are you interested in learning something on mathematics related to issues that have been in the newspapers or radio or TV recently?

YES ....……………..

Why? ....………………...................………………...................………………...................

.................………………...................………………...................………………..................................

………………...................………………...................………………...................………………………..

NO ....……………..

Why not? ………………………………....................................…………………………

....................................………………………………….......................................……………

....................................………………………………….......................................……………

C65 Make a sketch or drawing of a mathematician working.

APPENDIX 2

THE KOREAN TRANSLATION OF ROSME

CODE:…………………

학교 수학 교육 관련성 학생 질문지

2004년 10월

<u>수학 응용 분야</u>

성별: 여　　남　　　　　　　　　　　　　　　나이:

학년: 중 2, 중 3, 고1

이 문항지는 배우고 싶은 수학 응용 분야에 관한 질문지입니다. 각 항목마다 당신의 의견대로 네모 안에 있는 하나의 숫자에만 O 표를 하십시오 그리고 모든 항목에 다 답해 주십시오.

문항들에서 다음을 선택하여 주십시오

1 = 전혀 관심이 없음
2 = 약간 관심이 있음
3 = 관심이 많음
4 = 아주 관심이 많음

정답은 없습니다. 각 항목마다 솔직하게 당신이 좋아하는 것을 대답해 주십시오. 표에 영어 알파벳 C1등으로 표시된 순서는 중요도와는 상관없습니다.

공란	수학 응용 분야	전혀 관심이 없음	약간 관심이 있음	관심이 많음	아주 관심이 많음
C1	디자이너의 옷과 신발과 관련된 수학	1	2	3	4

C2	복권과 도박에 관련한 수학	1	2	3	4
C3	플레이스테이션이나 TV 게임 등과 같은 컴퓨터 게임을 만드는 것과 관련된 수학	1	2	3	4
C4	수학자들은 의견이 왜 때때로 다른지에 관한 수학	1	2	3	4
C5	에이즈, 결핵과 콜레라 등의 전염병의 확산과 감소를 예상하는데 쓰이는 수학	1	2	3	4
C6	유명한 수학자의 개인적인 삶	1	2	3	4
C7	비행기와 로켓을 만드는데 쓰이는 수학	1	2	3	4
C8	작물 생산을 어림잡고 예측하는 수학	1	2	3	4
C9	특정 종류의 동물이 멸종 위기에 있는지를 예측하는 수학	1	2	3	4
C10	선거를 위해 정당이 사용할 수 있는 수학	1	2	3	4
C11	공학자, 변호사와 회계사 등과 같은 전문인과 관련 있는 수학	1	2	3	4
C12	생화학이나 핵무기 등의 대량살상무기에 의해 생기는 병의 확산을 예측하는데 쓰이는 수학	1	2	3	4
C13	빵을 가게에 배달하는 것과 물품의 공급 경로를 계획하는 것에 관련된 수학	1	2	3	4
C14	특정 곡물을 성장시키기 위해 필요한 비료의 양을 산정하는데 쓰이는 수학	1	2	3	4
C15	현금자동인출기에서 돈을 인출하기 위해 쓰이는 비밀번호와 같은 비밀 코드와 관련된 수학	1	2	3	4
C16	시민과 기업이 정부에 내야 할 세금을 계산하는데 쓰이는 수학	1	2	3	4

C17	목장의 면적과 이 면적으로 사육 가능한 소, 양 또는 사슴의 수를 결정하는 수학	1	2	3	4
C18	경제 인플레이션의 수학	1	2	3	4
C19	바람과 태양 에너지와 같은 재생 가능한 에너지 자원에 관한 수학	1	2	3	4
C20	개인의 건강 상태를 측정하는데 관련된 수학	1	2	3	4
C21	우리 지역사회의 고용, 교육과 빈곤 수준을 측정하는데 도움이 되는 수학	1	2	3	4
C22	환자가 복용해야 할 약의 양을 처방하는 수학	1	2	3	4
C23	대학교와 기술 전문대학에서 필요한 수학	1	2	3	4
C24	경찰서, 소방대와 구급차 사무실 등 긴급 서비스의 위치를 잘 선정하여 긴급 상황이 발생한 곳에 최대한 빨리 도착할 수 있도록 위치 계산에 도움을 주는 수학	1	2	3	4
C25	다리와 같은 복잡한 구조물을 만드는데 관련된 수학	1	2	3	4
C26	수학자들이 하는 일	1	2	3	4
C27	기하학	1	2	3	4
C28	공간을 효율적으로 쓰기 위해 물품을 포장하는 것과 관련된 수학	1	2	3	4
C29	수학자는 어떻게 발견을 하는가	1	2	3	4
C30	대중 음악과 관련된 수학	1	2	3	4

C31	선거 후 의회에서 각 정당 별 국회의원 의석 배정수에 관련 있는 수학	1	2	3	4
C32	다양한 업무가 마무리 되는 것과 관련해 사람들에게 업무를 분배하는 과정에 관련된 수학	1	2	3	4
C33	수학자들의 실수와 실책	1	2	3	4
C34	대수학	1	2	3	4
C35	우주의 나이에 관한 수학	1	2	3	4
C36	씨 뿌리기와 관련된 수학	1	2	3	4
C37	호수, 강 또는 바다의 어떤 부분의 물고기 수를 헤아리는 수학	1	2	3	4
C38	미국, 영국과 다른 나라의 음악과 관련된 수학	1	2	3	4
C39	비행기를 이착륙 시키는 공항 관제탑에 사용되는 수학	1	2	3	4
C40	청소년 축제인 라이브 콘서트와 디스코형식에 관련된 수학	1	2	3	4
C41	연금과 퇴직 이후의 계획에 필요한 수학	1	2	3	4
C42	CD 에 음악을 저장하는 데 쓰이는 수학	1	2	3	4
C43	윷과 같은 한국의 전통놀이와 관련된 수학	1	2	3	4
C44	국제 정세에 큰 영향을 끼쳤던 수학 사고	1	2	3	4
C45	숫자	1	2	3	4
C46	문자메시지, 휴대폰과 이메일 등 메시지를 보내는데 관련된 수학	1	2	3	4

C47	이윤 창출을 위한 재정 계획의 수학	1	2	3	4
C48	내가 좋아하는 운동과 관련된 수학	1	2	3	4
C49	사람을 구조하는데 필요한 헬리콥터를 배치하는데 쓰이는 수학	1	2	3	4
C50	신용카드로 구입한 물건의 할부금을 계산하는 수학	1	2	3	4
C51	태아의 성별을 예측하는 수학	1	2	3	4
C52	운동 프로그램을 짜는데 관련된 수학	1	2	3	4
C53	수학의 이상한 결과나 역설	1	2	3	4
C54	아기의 성장 초보단계를 체크하는 수학	1	2	3	4
C55	우리를 즐겁게 하고 놀라게 하는 수학	1	2	3	4
C56	우림이 (아프리카 등지의 오래된 삼림) 줄어들고 사막이 증가하는 사실을 설명하는 수학	1	2	3	4
C57	여행을 계획하는 데 관련한 수학	1	2	3	4
C58	스키, 점핑, 육상 경기, 에어로빅, 수영, 체조와 축구 등 운동에서 사용하는 수학	1	2	3	4
C59	이민과 난민 등의 상황에 처한 사람들의 이동을 설명하는 수학	1	2	3	4
C60	공해 정도를 측정하는데 관련된 수학	1	2	3	4
C61	군사적 문제에 관련된 수학	1	2	3	4

C62 위에서 가장 흥미 있는 3가지만 쓰세요

(a) ……………………………………………………………………………………….

(b) ……………………………………………………………………………………….

(c) ……………………………………………………………………………………….

이런 문제에 왜 관심이 있습니까?

……

……

……

……

C63 다른 과목을 배울 동안 생기는 수학에 관한 무언가에 관심이 있습니까?

예……………………………… 아니오………………………………

예에 대해서 이유를 설명하시오?

………

………

……

아니오에 대한 이유를 설명하시오

………

………

……

C64　최근 신문, 라디오 또는 TV에 나왔던 사건과 관련해 수학에 대해 관심 있습니까?

예……………………………………　　　아니오……………………………………

예에 대해서 이유를 설명하시오?

………

………

……

아니오에 대한 이유를 설명하시오

………………………………………………………………………………………………………

………………………………………………………………………………………………………

…………………………………………………………………………………………………

C65 수학자의 작업을 스케치하거나 그려 보세요.