

REAL WORLD CONNECTIONS IN HIGH SCHOOL
MATHEMATICS CURRICULUM AND TEACHING

A MASTER'S THESIS

BY

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To my beloved mother

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ABSTRACT

REAL WORLD CONNECTIONS IN HIGH SCHOOL MATHEMATICS CURRICULUM AND TEACHING

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The effectiveness of real world connections (RWC) in teaching is well accepted in the mathematics education community, however, little research has attended how and why to use RWC in mathematics. Additionally, there is a perception that the use of these connections is utilized less than its potential in the Turkish high school mathematics curriculum. Many would argue that development of students' basic mathematical skills and the use of these skills in solving real life problems appear to be among the primary purposes of mathematics education. It can be inferred that teaching mathematics in a real world context may have a valuable place for achieving these purposes of education.

This study described the feasibility of the use of RWCs in mathematics lessons as perceived by the teachers and academics (experts, n=24). In other words, experts' opinions about advantages, disadvantages and examples of RWCs suggested by the experts were reported, using the Delphi method in two rounds. In the first round, an open-ended questionnaire to explore the subject was sent to the participants and their answers were used to create a second round Likert scale to reach a consensus.

Experts suggested that the use of RWCs in mathematics lessons improves students' motivation and interest in mathematics, helps students gain a positive attitude to

mathematics, raises awareness of occupational fields where mathematics is used, helps development of conceptual learning, and mathematical process skills. The results of this study can be of interest to curriculum developers, teachers and teacher educators.

Key words: Mathematics curriculum, real world connections, teaching mathematics in high schools.

ÖZET

GERÇEK HAYAT BAĞLANTILARININ LİSE MATEMATİK MÜFREDATI VE ÖĞRETİMİNDEKİ YERİ

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Gerçek hayat bağlantılarının öğrenmede etkinliği matematik eğitimcileri tarafından kabul görmüş bir konudur, fakat matematiğin özellikle gerçek hayat bağlamında neden ve nasıl öğretilmesi gerektiği konusuna odaklanan az sayıda çalışma vardır. Türkiye’de bu bağlantıların kullanılabileceğinden daha az bir kullanımı olduğu bilinmektedir. Matematik eğitimin temel amaçları arasında öğrencilerin temel matematiksel becerilerinin geliştirilmesi ve bu becerilere dayalı yeteneklerinin gerçek hayat problemlerine uygulanması da yer almaktadır. Bu nedenle matematiğin gerçek hayat bağlamında öğretiminin, müfredatların bu amaçlarına ulaşması açısından faydalı olacağı açıktır.

Bu çalışma gerçek hayat bağlantılarının lise matematik derslerinde kullanımının uygulanabilirliğini uzman görüşlerinden yararlanarak araştırmıştır. Bu çalışmada bağlantıların neden ve nasıl kullanılması gerektiği sorularının cevaplanması için matematik öğretmenleri ve öğretmen eğitimcilerinin (uzmanların, n=24) fikirlerine başvurularak, bu konunun avantajları, dezavantajları ve kullanım örnekleri araştırılmıştır. Delphi metodunun kullanıldığı bu çalışmada uzmanların ilk etapta konu ile ilgili açık uçlu sorulara verdiği cevaplar ikinci etap Likert anketinin

hazırlanmasında kullanılmıştır. Likert anketinin bütün katılımcılar tarafından oylanmasıyla görüş birliğine varılmıştır.

Sonuç olarak uzman görüşlerine göre gerçek hayat bağlantılarını kullanmanın öğrencilerde matematiğe ilgi ve motivasyonu arttırdığı, olumlu tutum ve matematiksel süreç becerilerini geliştirdiği, matematiğin hangi meslek dallarında kullanıldığını görmelerini sağladığı ve kavramsal öğrenmeyi kolaylaştırdığı ortaya çıkmıştır. Bu çalışmanın sonuçlarından müfredat geliştiricilerin ve öğretmenlerin yararlanması umulmaktadır.

Anahtar Kelimeler: Gerçek hayat bağlantıları, liselerde matematik öğretimi matematik müfredatı.

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CHAPTER 1: INTRODUCTION

Introduction

This study focused on the mathematics curriculum in Turkish high schools and the use of real world connections in teaching mathematics. The ideas of academics of mathematics education and mathematics teachers were used to bring an insight to issues related to teaching mathematics in the real world context from the perspectives of advantages of the use of real world connections, limitations and disadvantages. In addition, this study included real world connection (RWC) examples for the topics of Turkish high school mathematics curriculum, suggestions for their effective use in classroom and solution offers for limitations of the use of connections in Turkish context.

Background

The Development of students' basic mathematical skills and the use of these skills in solving real life problems are among the purposes of Turkish mathematics education (MEB, 2005). Many would argue that the purposes of teaching mathematics are not isolated from the world we are living in, therefore teaching mathematics in a real world context may have a worthwhile benefit for achieving these purposes of education.

According to Gainsburg, (2008) there is general agreement among educators on the importance of teaching mathematics in real world contexts, and she describes some simple ways of using connections such as using simple analogies, word problems, and real data from real life to analyze. In addition, mathematical modeling of real

phenomena, using and interpreting statistical data from the real world and its discussion in the classroom environment are also ways of making connections with real life. Some of the benefits of using these connections are motivating students, helping them to understand mathematics better, and applying mathematics to real world situations.

Research reported the importance of “application of mathematical concepts integrated with a detailed understanding of the particular workplace context” (Hoyles, Wolf, Hodgson, & Kent, 2002, p.3). Real world connections help students to understand how professionals use mathematics outside the school.

Realistic mathematics education (RME) is an approach developed by the Dutch mathematician Hans Freudenthal and “developing instruction based in experientially real contexts” is one of the principles of RME (Hirsh, 2007, p. 81-82). The ideas of Freudenthal’s institute gained a reputation in mathematics education not only in Netherlands but also in the United States and they developed the Mathematics in Context curriculum in which students’ investigation of mathematical knowledge in a realistic context is valued (Clarke, Clarke, & Sulvian, 1996).

According to Hans Freudenthal, realistic mathematics education is the correct way of teaching, and teaching mathematics should always start with reality and stay within reality (Gravemejier & Terwel, 2000). Research suggests that the use of RWCs improves students’ motivation and helps their better understanding of mathematics. When they learn mathematics in a real world context, it develops their ability to use mathematical skills in solving problems of adult life (Gainsburg, 2008; Özdemir & Üzel, 2011; Sorensen, 2006).

Moreover, the use of these connections help teachers to give an answer to students' well-known question *when are we ever going to use this?* (Fink & Stock, 2008).

Even though there is not much evidence about disadvantages and limitations of the use of RWCs in mathematics, research suggests that if the real world connections are not related to students' background and experiences, it is likely to lose the potential benefits of the use of these connections (Fink & Stock, 2008; Muijs & Reynolds, 2011).

There have been changes in the education system after educational reform efforts in the last decade in Turkey; however, in practice, desired outcomes were not realized (Akşit, 2007). After the reform in the education system in 2005, it is more likely to see the effects of changes in primary schools; however, the high school curriculum is continuously being reformed. To some extent, in primary schools teachers are using new teaching and learning techniques like real world connections, materials, activities. However, teaching mathematics in an abstract way, devoid of RWCs and the use of traditional methods are still often the case in high school math lessons.

Problem

Although the importance of using real world connections is recognized by a wide community in the world, research shows that real world connections are underutilized and infrequent in math lessons. In addition to that there are a limited number of studies about the issue, and there is a need for clarifying why and how to use these connections to give teachers the advantage of using them in their lessons (Gainsburg, 2008).

All told, the use of real world connections is utilized less than its potential and there is a need for mathematics teacher educators to assure and prepare teachers to use

these connections effectively and benefit from them (Gainsburg, 2008). However, the picture is limited by the small number of studies, and there is a need to shed light on the feasibility of the use of these connections in practice.

Additionally, research mostly gives evidence about the advantages of the use of these connections. However the use of these connections might have disadvantages and limitations in terms of teaching and learning, in particular, to mathematics education in the Turkish context.

As mentioned above, the outcomes of the educational reform in 2005 in Turkey were not as intended (Akşit, 2007). Furthermore, there is a lack of studies about the use of connections in math lessons and how they occur in a real classroom environment in the context of Turkish high schools. To sum up, the need is for constructing a framework by clarifying its advantages, disadvantages, and limitations of the use of RWCs in mathematics in terms of curricular and practical aspects.

Purpose

The focus of this study is to describe the issue of real world connections in Turkish high schools. In addition to this study's qualitative nature, there will be quantitative analysis of the second round Likert scale, typical of the Delphi technique that was used in this study. Thus this 'study' is mixed methods in nature.

One goal of this study is to portray the advantages and disadvantages of real world connections, their possible places, and relative weights in the curriculum. A second goal is to investigate the factors that influence teachers' use of connections in math classrooms of Turkey: classroom environment, resources, time, and lack of recognition about RWCs. Another goal of this study was to offer some suggestions

based on the data collected from teachers and academics for addressing these kinds of limitations.

To understand these issues better, ideas about some practical examples for each high school mathematics topic were collected and described in this research. In addition, how to use these connections effectively in Turkish high school math lessons was another issue addressed in this research.

Research questions

The main question I will be asking is: *What do experts in math education think about the feasibility of real world connections and ways of using them in high school classrooms in Turkey?* The sub-questions are:

What are the advantages, disadvantages and limitations of using real world connections in high school mathematics teaching? What might be solutions for the limitations and disadvantages of the use of real world connections in math lessons?

What are some examples of real world connections in the high school mathematics curriculum?

How can real world connections be used effectively for learning and teaching mathematics?

Significance

There is literature about the importance of the use of real world connections in mathematics lessons in the world. But as acknowledged in these studies, there is little or no systematic research consideration of this problem from a practical point of view in math classrooms as well as curricular points of views from teachers and

academics perspective. This research will include ideas from academics and teachers, thus the issue will be clarified both in practical and theoretical ways in the Turkish context.

Results of this study included advantages and disadvantages of using real world connections in math lessons, examples for high school math topics and how to use them in classrooms effectively. In addition to these, there are suggestions from academics and teachers for possible limitations of the use of RWCs and suggestions to overcome limiting factors. Thus, it will be a source for teachers to generate theoretical and practical ideas about the issue.

Since math education is not only the work of teachers, the outcomes of this research could also be of benefit to curriculum developers, and teacher educators for mathematics teaching and learning. They may find this information useful in achieving their educational purposes and in supporting possible changes in curriculum both in practice and theory.

Definitions of key terms

In this study *real world connections or RWCs* is used as a general name for possible connections that can be made to the real world in math lessons. Connecting classroom mathematics to real world can also be used to describe teaching mathematics in real world context. Simple analogies, word problems, and real data from real life can be given as example for these connections. In addition to these mathematical modeling of the real phenomena, using and interpreting statistical data from the real world and its discussion in the classroom environment are also more complex forms of these connections.

Differentiating between curriculum types could be useful to understand the place of real world connections in curriculum. There are three different types of curriculum: *intended, taught and learned*. The first one refers to subject matter, skills and values that are *expected* to be taught and learned by students as planned by the government or other responsible agencies. Taught curriculum is sometimes called “delivered” or “operational” in literature. It can be defined as how teachers use intended curricula and deliver it to the students. Attained curriculum which is also called learned curriculum consists of things that students take out of the classroom (Cuban, 1976).

The effects of using real world connections are a part of this study. *Intrinsic and extrinsic* are two types of motivation which give a new insight to the definition of *motivation*. While intrinsic motivation is mostly related to students’ personal interests which lie within individuals, extrinsic motivation is related to external factors around students such as grades, and validation of students’ works. For example if a student has an interest in a subject like art, it makes a student curious about it and they enjoy studying it, hence it can motivate a student intrinsically (Ormrod, 1999).

Mathematics in Context (MiC) is a curriculum which is developed in the United States with the collaboration of scholars from the Netherlands. The approach to this curriculum is called “Realistic Mathematics.” It has a view that mathematical concepts and structures need to be understood by intuition in contexts relevant to a students’ life (Clarke et al., 1966).

Expert in this study is used for academics who have a doctorate in mathematics education area in universities and teachers who are teaching mathematics in high schools.

Students in this context will only be those learning mathematics in high schools in Turkey.

By *limitations* is meant restricting factors that affect the use of RWCs in a negative way.

By *disadvantages* is meant unfavorable conditions that affect teaching and learning of mathematics in negative ways.

CHAPTER 2: REVIEW OF THE RELATED LITERATURE

Introduction

This research aims to describe the feasibility of using the real world connections (RWCs) in math lessons, and its advantages and disadvantages in terms of the Turkish high school mathematics education system as perceived by teachers and academics in mathematics education. There is currently much emphasis on abstract concepts in school mathematics curricula and in teaching. There is a perception that teaching mathematics in a real world context is utilized less than its potential. The ideas of experts in Turkey will bring an insight into the reasons behind this underutilization. This study will attempt to report experts' opinion not only about advantages but also disadvantages and limitations for using these connections in school mathematics.

There are four main sections in this chapter: (1) theory of math curriculum and RWCs in mathematics, (2) preparing students for real life, (3) affective goals of mathematics, and (4) possible problems with using real world connections. In the first section on the theory of math curriculum and real world connections in mathematics, goals of mathematics education, real world connections in the design of high school mathematics curriculum, components of the curricula, and relations between international assessments (e.g. TIMMS, PISA) and teaching mathematics in the real world context will be addressed, based on related literature. In this section, there will be mention of the goals of mathematics education: goals and functions of schooling in the United States, goals of mathematics education in Turkey according to the national ministry of education documents, and the Cockcroft report from the

UK. These documents will be used to answer the question “why teach mathematics?”

The second section under this title will include different ideas from different countries about the real world connections in the design of high school mathematics curriculum. National Council of Mathematics Education (NCTM) connection standards, ideas on ways of using real world connections in math lessons, the idea of a Dutch mathematician, Hans Freudenthal’s *Realistic Mathematics education (RME)* and different research ideas on RME from different sources will be summarized. Moreover, the case of *Mathematics in Context (MiC)*, a middle school mathematics program jointly developed by the United States and Netherlands will bring an insight into real world connections in the design of high school mathematics curriculum from the perspective of where to place these connections in math lessons. In the third section, taught, intended and attained curricula and the place of RWCs in math curriculum will be addressed within these types of curricula. Finally, the fourth section will address the relation between teaching mathematics in a real world context and international assessments (e.g. TIMMS, PISA).

Under the second main title, one of the common goals of mathematics education in different countries is preparing students for life and how using real world connections is related to this issue will be discussed.

Under the third main title, affective goals of mathematics and the effects of using real world connections on students’ motivation, attitudes and beliefs towards mathematics will be addressed. This will help to understand the values affecting the teaching and learning of mathematics.

Fourth, the possible problems with using real world connections will be addressed. Since using these connections in mathematics lessons is demanding and requires time, patience, and skills on the part of teachers, how to prepare teachers for using these connections will also be addressed. How much real world problems are ‘real’ for students, and how much these problems make sense to students who have different backgrounds will be the final issues addressed in this chapter.

The theory of math curriculum and real world connections in mathematics

Goals of mathematics education

The basic purposes of teaching mathematics to students are similar in different countries. To illustrate from the United States, Cuban (1976) defines goals and functions of schooling in these terms. The public expects students to:

- Master basic skills,
- Think rationally and independently,
- Accumulate general knowledge in various subjects,
- Possess sufficient skills to get a job,
- Participate in the civic culture of the community,
- Know what values are prized in the community and be able to live them.

It can be said that these aims reflect different ideologies of curriculum such as social efficiency, learner centeredness and scholarly academic. Giving importance to students’ independent thinking might be seen as a part of learner-centered ideology. Accumulating general knowledge in various subjects might be seen as a reflection of scholarly academic ideology and finally giving importance to life in community and possessing sufficient skills to get a job is an idea of social efficiency (Schiro, 2008).

According to the Turkish national education basic law, the general objectives are another source to answer the question “why teach mathematics?” As stated in this document (MEB, 2005, p.4-5), we teach mathematics to develop students’:

- mathematical process skills (reasoning, communication, problem-solving, analytical thinking, affective and psychomotor development, etc.),
- use of these skills in solving real life problems,
- understanding of basic principles of mathematics,
- ability to assess our position in the world,
- understanding of the place of mathematics in the arts,
- understanding of mathematics in science and language of computers.

Preparing youngsters for the future and helping them develop their mathematical skills are other purposes of teaching mathematics. Teaching students how to improve their mental skills to be able to follow technological developments appears to be among the purposes of Turkish high school mathematics curriculum. It is safe to say that the purposes of teaching mathematics are not isolated in the world we are living in. As understood from the purposes of mathematics education in the Turkish education system it gives importance to the needs of society and teaching mathematics to solve problems of real life. Moreover, the Turkish education system also wants students to understand not only their environment but also the world and their position in this community.

In 1982 a committee of inquiry under the leadership of Sir Wilfred Cockcroft produced *the Cockcroft report* on teaching of mathematics in primary and secondary schools in England. This report attempts to answer the question “why teach mathematics?” In the view of the committee, the mathematics teacher has the tasks

- of enabling each pupil to develop, within his capabilities, the mathematical skills and understanding required for adult life, for employment and for further study and training, while remaining aware of the difficulties which some pupils will experience in trying to gain such an appropriate understanding;
- of providing each pupil with such mathematics as may be needed for his study of other subjects;
- of helping each pupil to develop so far as is possible his appreciation and enjoyment of mathematics itself and his realization of the role which it has played and will continue to play both in the development of science and technology and of our civilization;
- above all, of making each pupil aware that mathematics provides him with a powerful means of communication (Cockcroft, 1982; p. 1-4)

If the aims of teaching mathematics in these three countries are compared, there are similarities among the aims of mathematics education. Development of mathematical skills of students to meet the needs of society, employment, and adult life are the common points among these aims. Clearly, the place of mathematics in real life is coming up among the common purposes of mathematics education in these three countries.

Real world connections in the design of high school mathematics curriculum

In many studies, real world connections in math are explained from different perspectives in different countries. Recognition and application of mathematics in context outside of mathematics is one of the ten standards of the National Council of Teachers of Mathematics' (NCTM) for high school mathematics in the United States. Connections are one of the ten curriculum standards of school mathematics according to NCTM. Teaching mathematics in real world context is one of the ways of making these connections (NCTM, 2000).

Real world connections in math lessons mean teaching mathematics in a real world context or integrating real world situations into math lessons. Below is a list of the ways of using real world connections in a mathematics lesson.

- Simple analogies (e.g., relating negative numbers to subzero temperatures)
- Classic “word problems” (e.g., “Two trains leave the same station...”)
- The analysis of real data (e.g., finding the mean and median heights of classmates)
- Discussions of mathematics in society (e.g., media misuses of statistics to sway public opinion)
- Hands-on representations of mathematics concepts (e.g., models of regular solids, dice)
- Mathematically modeling real phenomena (e.g., writing a formula to express temperature as an approximate function of the day of the year) (Gainsburg, 2008, p.200).

The originator of realistic mathematics education, Hans Freudenthal, an influential math educator, lived in the twentieth century in the Netherlands. He was also a mathematician on didactics and curriculum theory. He used the term didactics to mean “correct teaching and learning processes, starting with, and staying within, reality” (Gravemeijer, & Terwel, 2000). Mathematization of reality is the term used in literature while talking about Realistic Mathematics Education (RME). This approach of teaching mathematics was developed by the Freudenthal Institute. Here it can be beneficial to understand the use of real world connections in math lessons by looking into philosophical principles of RME, as Hirsch (2007) stated below:

(1) Developing instruction based in experientially real contexts... (3) Designing opportunities to build connections between content strands, through solving problems that reflect these interconnections.... (5) Designing activities to promote pedagogical strategies that support students’ collective investigation of reality (81- 82).

The idea here is that real world connections should be used at the beginning of any instructional sequence to make students immediately engage in activities, which they find meaningful.

Education reform in the Netherlands in the 1960s and 1970s brought a significant change to the mathematical instruction taught in schools. After this reform the idea of starting with a formal system (giving the rules and theorems followed by examples) was replaced by the idea of making students investigate the key ideas in mathematics by themselves (Clarke et al., 1996).

On the other hand, Mathematics in Context (MiC) is a curriculum developed jointly by the United States and the Netherlands. RME’s set of philosophic tenets given above transfers into a design approach for MiC. The approach of this curriculum is also called “Realistic Mathematics.” It has a view that mathematical concepts and structures need to be understood by intuition. One of the key ideas in this curriculum

is that mathematics instruction should not begin with formal systems (as in rules and procedures); letting students investigate knowledge of mathematics is preferred.

Concepts which appear in reality should also be a key element of math lessons in this type of curricula (Clarke et al., 1996). As understood from the literature, realistic mathematics education theory suggests that teaching mathematics should always start with a problem in the real world context.

A special case of using RWCs in curriculum: International baccalaureate diploma program-standard level mathematics

Focus of the international baccalaureate diploma program-standard level (IBDP-SL) mathematics course was defined as “introducing important mathematical concepts to students through the development of mathematical techniques; rather than insisting on mathematical rigor they intend to teach mathematics in a comprehensive and coherent way.” (IBDP, 2006, p.4) Application of mathematical knowledge into realistic problems in an appropriate context is another component of their intention (IBDP, 2006).

Real world problems are also used in assessment tools of the course. Mathematical modeling, a particular way of using RWCs, is the focus of internal assessment of the course. The mathematical modeling paper aims to assess students’ skills of “translating real-world problems into mathematics, construction of a model for a given problem, interpretation of their solution in a real-world situation, realizing the fact that there might be different models to solve a given problem, comparison and evaluating the validity of different models, and manipulation of the data they have” (IBDP, 2006, p.41).

The IBDP mathematics standard level program guide helps to understand that RWCs have a valuable place in both objectives and assessment of the IBDP-SL mathematics. When the textbook of the course is reviewed, it is possible to see many examples of the connections (Maenpaa, Owen, Haese, Haese, & Haese, 2009). One can conclude that the use of RWCs was valued and had a place in the mathematics curriculum. It might be useful to compare the RWCs examples of the participants with the ones available in the IBDP textbook, since it is reputed to be rich in using RWCs in mathematics.

Concepts of curriculum

Differentiating between the types of curriculum could be useful to understand the place of real world connections in curriculum. There are three different types of curriculum *intended, taught and attained curriculum*. Intended curriculum is about what the teachers are expected to teach using the curricula prepared by the responsible agencies (ministers, school districts) of the countries. It includes the subject matter, skills and values that are expected to be taught (Cuban, 1976).

Intended curriculum includes theories of teaching and learning and also beliefs and intentions about schooling, teaching, learning and knowledge.

Besides those intentions there are also some barriers such as inadequately trained teachers, heavy teaching programs, insufficient facilities, and lack of educational perspectives which prevent the teachers from teaching the contents of the intended curriculum effectively. Taught curriculum is sometimes called “delivered” or “operational” curriculum in literature. It can be defined as how a teacher uses the intended curricula and delivers it to the students.

The role of teachers is obvious here for the taught curriculum, since it is shaped by the teacher's decisions in the classroom. For example, how a teacher lectures, asks questions, organizes the class, selects materials, texts, or worksheets and plans activities are common factors affecting taught curriculum. Finally, the last addressee of the curricula is a student. They do not always learn what teachers intend to teach (Cuban, 1976).

After the changes in the Turkish curriculum in 2005, real world connections in math lessons have a place in the intended curriculum of Turkey, especially in primary schools. However, it seems more improvements are needed in the high school curricula in terms of incorporating and using these connections. Obviously it is not enough to include them in the intended curriculum; there should be a connection between intended and taught curriculum. Altun (2006) suggests there should be a way of reaching formal mathematical knowledge by using informal information with the help of modelling problems related to real life which help in the investigation of concepts. Research consistently suggests the use of these connections in the taught curriculum. Possible reasons for the gap between intended and taught curricula are inadequately trained teachers, heavy teaching programs, insufficient facilities, and lack of educational perspectives.

Real world connections and international assessments

Assessment practices in mathematics education are not in line with the educational reform movements in many countries (Vos & Kupier, 2005). One possible reason for the under-achievement in international assessment tests is the mismatch of items used in mathematics assessment in schools and items used in international tests. The gap between the intended and the attained curriculum may be because of the

students' lack of experience in practical mathematics tests like the ones used in TIMSS's performance assessment items.

On the other hand, the Smith Report (2004) states there was a lot of interest in the application of mathematics and making students become mathematically knowledgeable. This report also included the GCSE assessment in mathematics which gave much importance to the use of problems in real life contexts. The main concern of mathematics educators was how to support students in the development of the skills of mathematical applications as well as learning the content of mathematics. They thought it was possible to allocate more time to mathematics teaching. Dickinson, Eade, Gough, and Hough (2010) believed that improvement both in content knowledge of mathematics and problem-solving skills could be achieved by using an approach similar to that of Realistic Mathematics Education (RME) which has a strong characteristic of development in both conceptual and procedural knowledge of mathematics together.

Obviously it is not easy to make real world connections for each topic of mathematics and include these contexts in assessment tasks. Students often ask the question, "When will we ever use this in real life?" (Fink, & Stock, 2008). It might not be easy to answer this question for teachers each time it is asked. Fink and Stock (2008) created a list of websites with brief explanations where teachers can find several real life connected activities and problems. Searching in these websites shows that functions, probability, and geometry topics are the ones in which relatively more real world connected problems and activities can be found compared to other topics of high school mathematics curriculum.

The relation of mathematics to the real world is obvious to many; we always use it in our real life as Saunders MacLane states:

...The nature of mathematics might be formulated thus: mathematics deals with the construction of a variety of formal models of aspects of the world and of human experience. On the one hand this means that mathematics is not a direct theory of some underlying platonic reality, but rather an indirect theory of formal aspects of the world (of reality, if there is such)...(MacLane,1981, p. 102)

Surely, the real part of mathematics and its abstract nature should not be taken separately. Since they are closely related to each other, there should be a place for both of them in math education. While teaching mathematics in a real world context the need for abstract generalization of mathematical ideas cannot be ignored. In other words, even when deliberate connections with real life are made while teaching math, the quantitative relationships still have to be generalized in some abstract form, so that mathematical knowledge can be generalized to different situations beyond the contexts of the problems in which they are introduced.

It might not always be possible to include real world context problems while assessing the performance of students. However, it is obvious in international assessments that these problems are used for assessing students' performance and there is a need for making students familiar with leaning and assessing in real world context.

Preparing for real life

Patton (1997) brings a different perspective to teaching mathematics in the real world context. Math taught to students with learning disabilities should be realistic, and functional which means it should be related to students' current and future needs by emphasizing real life problem-solving. This gives students a chance to be competent

when they are struggling with real life situations. By this way when they become adult, they are ready to face the challenges of adulthood.

In England's state schools, the special educational needs of students are taken into account. There are several strategies to meet different needs of students. British teachers are teaching functional math which means teaching mathematics in real world context and assessing students' functional skills in GCSE level. It might be a strategy to meet the needs of students with learning disabilities as Patton suggested above.

Even though the current situation shows that real world connections have a place in both mathematics teaching and assessment in England, the Smith Report (2004) indicates that there is a need for "...greater challenges...harder problem-solving in non-standard situations..." (p.87). Results of the report shows that students in England at the age of 16 are not concerned with "the growing mathematical needs of the workplace... mathematical modelling or... problems set in the real world contexts" (p.86). A possible reason behind this could be that there is a change in terms of using real world connections in teaching and assessment of mathematics after the Smith report in England. Dickinson, Eade, Gough, and Hough (2010) considered the above evidence from the Smith Report, as there was a need for research to develop an idea of mathematics teaching and learning that encourages students' conceptual understanding and problem-solving skills and the use of these in real world situations.

Development of students' mathematical skills to make them use these skills for solving real life problems is among the aims of teaching mathematics in Turkish high schools. Moreover, preparing young individuals for the future and ensuring their

mathematical skills go forward are other reasons for teaching mathematics. To achieve this goal, looking into appropriate mathematics for solving a real world connected problems might help students to find appropriate ways for dealing with real world situations in their life (Özdemir & Üzel, 2011).

Affective goals of mathematics

Motivating students has long been a topic of interest in education literature. The more students are motivated, the more they should be able to perform at high levels in mathematics; however, it is not always easy to motivate students in class. There are many suggestions for motivating students to contribute to their learning. Bringing flexibility to lessons, and using context that arouses students interests are two of the suggestions for this. Integrating real life situations into math is another. It is not easy to say using real world connections always motivates students but its role in motivation is worth considering (Sorensen, 2006). Real world connections in math have many potential benefits such as providing better understanding of mathematical concepts, motivating students, affecting students' attitudes towards mathematics (Gainsburg, 2008).

In their research in Turkey, Özdemir and Üzel (2011) investigated the effects of RME based instruction on academic achievement and students' opinions towards instruction. The results of this research indicated that students think that teaching mathematics in real world context is more interesting and makes the classroom environment better for learning. This approach in their lessons changed their attitudes towards mathematics positively when compared to problem-solving using just formulas. A possible reason is that when students are engaged purely with the abstract nature of mathematics it may not always make sense to them.

Abstract nature of mathematics is one of the reasons for students to say that mathematics is difficult, which may be why they find it hard to link mathematics to real life situations. Using real world connections in mathematics lesson is a way to overcome these problems, as Muijs and Reynolds (2011) states:

A model that has been proposed is one in which the teacher starts off with a realistic example or situation, turns into a mathematical model, leading to mathematical solutions which are then reinterpreted as a realistic solution. This strategy would certainly be useful in linking mathematical and real world knowledge and applications (p. 261).

Even though research suggests starting with real world connections and eliciting abstract information from the given real world context problem and interpreting solutions realistically, it might not always be as easy as it is described in research. Like other teaching strategies for teaching and learning mathematics, there might be difficulties and disadvantages of using these connections in different situations.

Possible problems with RWCs

In her research, Lubienski (1998) investigated the problem of mathematics taught in a real world context. Her research results showed that while students who had high level socio-economic backgrounds were more comfortable with solving problems in real world context, and were able to make generalizations and analyze the intended mathematical ideas involved, students with lower socio-economic backgrounds were focusing on real world constraints in the problems given and missed some mathematical ideas involved. It was concluded that, although problems in real world contexts were powerful motivators, students who had lower socio-economic backgrounds could have difficulty in learning math in context. Studies show that, in addition to positive aspects of using real world connections, there are also limitations of using it.

Moreover, Boaler, (2002) shared her concern about changes in reform-oriented curricula that are used in different countries, and their willingness to bring some realism to their mathematics education by including real world contexts in curriculum. Her concern about real world contexts was about students' familiarity with situations described in these examples. If students were unfamiliar with the context, the development of higher-level thinking skills for students were not easy. Students' familiarity with these contexts and their interest areas should be considered while using these connections. To prevent possible misconceptions because of the unreality of given examples, teachers should choose examples as close as possible to the real world available to students. Reality of examples from real world situations is one of the crucial parts of this concept to make sure that it is helpful for pupils' application of math, or the use of math outside of the classroom. Effective use of real world connections requires using examples which are connected to pupils' actual experience (Muijs & Reynolds, 2011).

To understand clearly what is meant by realistic mathematics, the definition of Van Den Heuvel-Panhuizen (2003) might be useful. He says that realistic mathematics does not only refer to making students imagine what is taught by making connection to the real world, but also the authenticity of the problems, that is how real the given problems are in students' minds. Made-up stories or formal mathematical contexts can be good examples of real world connections if they are appropriate to students' experiences and backgrounds.

De Bock, Verschaffel, Janssens, Van Dooren, and Claes, (2003) claim that using real world contexts do not always have a positive effect on students' performance. In their case teaching in an authentic, real world context had a negative effect on students' performance. Results of their study contradict other studies including those

cited above, showing that there might be negative ways of using these connections as well as positive.

Another possible problem with using these connections is how the teachers are prepared, since most of them are used to teaching mathematics in traditional ways. Wubbels, Korthagen, and Broekman, (1997) stated that according to mathematics educators mathematics should be taught in real life contexts to make students handle the problems in everyday situations. This would give students a chance to analyze structure and test alternative solutions for problems. On the other hand, results of their study showed that it was not easy for current teachers to be prepared since most of them were still using the traditional way of teaching. Most of the class time was spent explaining and talking while students copied from the board. When teachers were not talking, students were engaged in problem-solving by themselves. Their study also indicated that it is possible to educate student teachers to change their perception to use an inquiry-based approach in teaching.

As mentioned before using innovative strategies for teaching mathematics demands time, patience and skills of the teacher. It is possible, however, to educate teachers to use useful strategies to meet the needs of students and achieve the goals of intended curricula.

Summary

In this chapter, under the theory of math curriculum: goals of mathematics education, real world connection in the design of high school mathematics curriculum, components of curricula, possible places of RWCs in these components, relationship between international assessment tests, and place of RWCs in these performance assessment tasks were reported in the light of relevant literature. Moreover, the

relation between preparing students for real life and RWCs, affective goals of mathematics education and possible problems with the use of real world connections were also addressed.

The goals of mathematics curriculum have some similarities in different countries, especially concerning the preparation of students for real life and providing them with mathematical skills to use in their adulthood and employment. Freudenthal's RME theory, and examples of curricula based on this theory, brought insight on the use of these connections in designing high school mathematics curriculum.

Although there are commonalities among the aims of mathematics in different countries and Turkey, it is obvious that there are possibly different factors affecting education in Turkey. In the light of the ideas of experts this research will explore the place of real world connections in the design of high school mathematics curriculum in Turkey. This study will explore what experts in Turkey think about possible places of these connections in math lessons and their relative weights.

In Turkey, although use of these connections and examples are included in the high school intended curriculum, there is much emphasis on the abstract aspect in the taught curriculum. Due to this, teaching mathematics in a real world context is utilized less than its potential. Research in Turkey also suggests the use of these connections have benefits for students' performance; however, there is not a systematic study about this issue. This study will explain what teachers and teacher educators think about the advantages, disadvantages and limitations of the use of these connections. Furthermore, the suggestions of experts will give an idea for filling the gap between the intended and taught curriculum of math in terms of use of real world connections.

The relationship between the use of RWCs and international tests, based on performance assessments including real world contexts was discussed above. This study aims to describe the appropriateness of the real world context-based problems to the university entrance exams in Turkey and suggestions from the experts on this issue.

Research suggests that teaching mathematics in a real world context has a positive effect on students' motivation and attitudes towards mathematics. However, there is not much evidence about the disadvantages of the used of these connections which is another question addressed by this research and will be described from the perspective of the experts. There is evidence from the literature that authenticity of real world problems and their appropriateness to students' experiences and backgrounds is one of the crucial issues related to the use of RWCs. Moreover, another problem related to the use of RWCs from the literature is that the use of these connections is demanding and requires time, patience and skills from the teachers. This study will explain what experts suggest on this issue to help prepare teachers for their effective use of such connections.

There are many examples of real world problems in different sources and ideas about the most appropriate topics for the use of real world connections. This study aims to explore what themes and examples for real world connections for each topic in the high school mathematics curriculum are available according to experts. Those examples will hopefully provide a more concrete and definitive understanding of the issue.

CHAPTER 3: METHOD

Introduction

In this chapter, the design and methodology used in the study to elicit the ideas of experts about the feasibility, advantages and disadvantages of using real world connections while teaching mathematics in Turkish high schools are described. The study sought to answer the following questions:

1. What do experts in mathematics education think about the feasibility of real world connections and the ways of using them in the high school mathematics curriculum in Turkey?
2. What are the advantages, disadvantages and limitations of using real world connections in high school mathematics according to experts? What might be solutions for the limitations and disadvantages of the use of real world connections in math lessons?
3. What are some examples of the use of real world connections in the mathematics curriculum?
4. How can real world connections be used effectively for learning and teaching mathematics?

The design and the context of the study, the way of sampling and the role of panel members in the data gathering processes, the Delphi instruments, data gathering, analysis procedures and treatment of data are explained in the rest of this chapter.

Research design

A modified version of the Delphi method was used in the data collection of this study. Delphi is “a method for systematic solicitation and collection of judgments on a particular topic through a set of carefully designed questionnaires interspersed with summarized information and feedback of opinions based on earlier responses” (Wiersma & Jurs, 2009, p.281).

Cohen, Manion, and Morrison (2000) describe the structure of the Delphi method as follows: in a Delphi study the experts answer questionnaires in two or more rounds. A facilitator provides an anonymous summary of the experts’ forecasts from the previous round and experts are encouraged to revise their earlier answers in the light of the replies of other members of their panel. The mean or median scores of the final round determine the results. In other words, in the Delphi study individual questionnaires are designed to obtain discussion among experts about intended issues without face-to-face meetings with everyone. The next rounds’ questionnaires are designed according to the collected ideas from previous rounds. Finally, the majority opinion is gathered without judgments of participants on each other (Joiner & Landreth, 2005).

This study aims to describe teaching mathematics in a real world context, with its advantages, disadvantages, and limitations of using RWCs in high school mathematics curriculum. At this point, judgments and insights of experts in this field are thought to be valuable for addressing the purpose of this research. By using the Delphi method, this study aims to describe what academics and mathematics teachers think about the feasibility of using RWCs in high school mathematics.

The Delphi is a group communication process with controlled feedback. It does not require face-to-face interaction among group members. In general, the method is considered a qualitative one; on the other hand, some steps like synthesizing data from each round could include quantitative analysis (Wiersma & Jurs, 2009).

Wiersma and Jurs (2009) described the Delphi procedures: a Delphi panel of experts in the field was created. Based on the research questions and related to the literature review, a first round of open-ended questions was used for subject consideration and exploration to identify items for the next round. A second round Likert scale, including items identified from answers to the first round, was used for conclusion reaching. A second round analysis was done for conclusion drawing before the final report preparation. This research was conducted using a modified type of the Delphi method which is described in detail in the rest of this chapter.

Context

The study was conducted in Ankara, Turkey, with the participation of mathematics education experts (academics and teachers). Academics who have their doctoral degrees in mathematics education were from two leading state universities in Ankara. Teacher participants of this research were from two different private high schools in Ankara. These schools both use the Turkish national curriculum and International Baccalaureate Diploma Program (IBDP) in their schools. Turkish national curriculum is the most common one applied in Turkish high schools all around the country and the IBDP is used in only 26 Turkish high schools.

Participants

Using the Delphi method requires a panel creation after defining the research questions. Choosing members of the panel included consideration of their expertise

in the area and their commitment to join this discussion until a conclusion was reached.

The Delphi method was carried out with the participation of two groups of experts, academics who had their doctoral degrees in mathematics education, and high school mathematics teachers. Academics were from Middle East Technical University and Hacettepe University. Both are state universities in Ankara. Teachers were from TED Ankara College and IDV Bilkent High School, which are both two private schools in Ankara.

Eight academics whose academic titles range from doctor to associate professor with PhDs in mathematics education, and sixteen high school mathematics teachers participated in this research. Both teachers and teacher educators were selected to participate in this research to capture experts' opinions based on both practical classroom experience as well as depth of theoretical knowledge.

Instrumentation

The first round of this Delphi study started with a series of open-ended questions which was administered online. This questionnaire was prepared in Turkish (see Appendix A) and translated into English as seen in Table 1. It consists of seven open-ended questions. They cover advantages, disadvantages, limitations of using RWCs in mathematics, RWC examples for each high school mathematics topic, possible places of RWCs in mathematics lessons, appropriateness of RWCs to the classroom environment and the level of students, the use of RWCs in the university entrance exams in Turkey, the preparedness of Turkish high school mathematics teachers on using RWCs and experts' suggestions for the effective use of them.

Table 1
First round open-ended questionnaire

First round questionnaire

1a. Please give examples with short explanations for the advantages of using real world connections (RWCs) in high school mathematics curriculum.

2a. Please give examples with short explanations for the disadvantages and limitations of using RWCs in mathematics.

3a. Please give one or more examples of a real world connection that can be used in Turkish high school mathematics topics listed below.

3a. *Logic,*
3b. *Sets,*
3c. *Relations, functions, and operations,*
3d. *Numbers,*
3e. *Polynomials,*
3f. *Quadratic equations, inequalities, and functions,*
3g. *Permutation, combination, and probability,*
3h. *Trigonometry,*
3i. *Complex numbers,*
3j. *Logarithms,*
3k. *Mathematical induction and sequences,*
3l. *Matrices, determinants, and linear equation systems,*
3m. *Functions,*
3n. *Limit and continuity,*
3o. *Derivatives,*
3p. *Integration.*

4a. While teaching a mathematics topic, should mastering the abstract come first with application coming later; or starting with real world connections and then reaching abstract generalizations of the content? Why?

5a. Is using real world connections appropriate for all students and classrooms? For example, is it more appropriate to use real world connections with gifted students and easy-to-handle classrooms? Why?

6a. What are some ways to ensure that assessment in the university entrance exams is in line with instruction that makes effective use of RWCs in high schools?

7a. Do you believe that high school teachers in Turkey are sufficiently equipped to teach mathematics in a real world context? Please offer suggestions for teacher educators on the use of real world connections to be able to help prepare pre-service teachers?

Participants responded to this set of questions in their own words, some of them shared their reasoning. Their answers were compiled and qualitatively analyzed to capture similar themes in the responses to the first round questionnaire. In this way, it was possible to reduce the amount of data and express the ideas in the responses as 31 common themes. To illustrate, the question concerning the advantages of the use of RWCs provided themes such as increasing motivation of the students, improvement of conceptual learning, development of mathematical process skills, raising awareness of occupational fields where mathematics is used, gaining positive attitude to mathematics, and helping the abstraction of mathematical ideas. More examples from the answers to the first round open-ended questionnaire are available in Appendix C.

After analysis of the responses from the first round of open-ended questions, the list of the 31 themes deduced was converted into items with a Likert scale giving 31 in total. This list of statements from 1- 31, with options to respond in the Likert scale, was used as the data collection tool in the second round. This new data collection tool was prepared in Turkish (see Appendix B) then translated into English as seen in Table 2.

Table 2
The items used in the second round

Second round Likert scale				
Code	The use of real world connections in mathematics teaching and curriculum.	No opinion	Agree	Disagree
	<i>Advantages of using RWCs</i>			
1	Increases motivation and interest in mathematics.			
2	Helps to improve conceptual, meaningful and permanent learning.			
3	Helps the development of students' mathematical process skills (reasoning, communication, problem-solving, and analytical thinking).			
4	Makes students conscious about their future career choices by showing occupational fields in which mathematics is used.			
5	Makes students develop positive attitudes towards mathematics.			
6	Facilitates generalization and abstraction of mathematical ideas and concepts.			
	<i>Disadvantages of using RWCs</i>			
7	There is no significant disadvantage.			
8	It may result in misconceptions (e.g. the concept of similarity carries different meanings in mathematics and the real world).			
9	Makes abstract thinking difficult, some topics should remain abstract.			
10	If given examples are complex, to learn mathematics of the problem can be difficult.			
11	Gains of the lessons might be limited to the given real world problem and it might be difficult to transfer acquired knowledge to other situations.			
12	Students may think that mathematics is only limited to real life.			
	<i>Limitations of using RWCs</i>			
13	It is not suitable to use real world connections for each topic in high school mathematics curriculum.			
14	Density of the curriculum and lack of time is a kind of limitation to use connections.			
15	Lack of adequately equipped teachers and their reluctance is a kind of limitation.			
16	It is a limitation, if given examples are unrealistic and not related to students' experiences.			
	<i>Possible places of RWCs</i>			
17	Real world connections should be done before abstract generalizations.			
18	This situation is not generalizable, possible places of these connections depends on the topic and nature of the problems.			

Table 2 (cont'd)
The items used in the second round

		Second round Likert scale		
Code	The use of real world connections in mathematics teaching and curriculum.	No opinion	Agree	Disagree
19	If problems are application oriented, it is more useful to use them towards the end of the lessons. <i>Appropriateness of using RWCs to students' levels and classroom environment</i>			
20	Using these connections is suitable for any student group and always effective.			
21	More suitable for groups of students who have lack of interest towards mathematics.			
22	Problems shouldn't be complicated in less able student groups.			
23	There is no need to use these connections for very able student groups. <i>Appropriateness of RWCs to the university entrance exams</i>			
24	Real world connected problems should be included in the university entrance exams.			
25	There should be practical examples of the university entrance exams after using these connections in lessons.			
26	There might be lack of time in the exam to solve these problems. <i>Preparedness of the high school teachers for using RWCs</i>			
27	Most high school teachers are not able to use these connections.			
28	There should be elective courses in education faculties to teach student teachers how to use these connections effectively.			
29	Using real world connections and mathematical modeling should be included in in-service teacher trainings.			
30	There should be studies to develop sources of real world problems.			
31	Real world connected examples should be included in the curriculum to improve awareness of teachers.			

As shown in Table 2, experts suggested the first six items (1-6) under advantages of the use of RWCs. Items from 7 to 12 were suggested as the disadvantages of the use of RWCs, items from 13 to 16 as the limitations of the use of RWCs. Items from 17 to 19 were regarded as possible places of RWCs in a mathematics lesson, and items

from 20 to 23 as the appropriateness of the use of RWCs to students' levels and classroom environment. Items from 24 to 26 are related to the university entrance exams, and items from 27 to 31 to the preparedness of the high school teachers to use RWCs in mathematics.

For each of these, three ratings were given in the Likert scale ('agree', 'disagree', and 'no opinion'). Therefore in the second round of data collection, participants showed their agreement or disagreement on each item, unless they had no opinion.

All instruments used in this research were prepared in Turkish and participants answered the first round open-ended questionnaire and the second round Likert scale in Turkish. The researcher translated these instruments and data into English which was checked by the supervisor of the researcher.

Method of data collection

Data collection was done online using an electronic form placed on a website.

Subjects were approached by phone to elicit agreement to participate, and the link for the form was sent to those who agreed by e-mail. Completed responses were sent back to the researcher automatically by pressing the "send" button placed at the end of the form. It took approximately an hour to answer the first round open-ended questionnaire. After sending the first round open-ended questionnaire to participants, it took six weeks to collect data. Data collected from this round were open-ended statements of the experts and real world connection examples for each topic of high school mathematics curriculum.

After ten weeks, participants were sent a second round of the Likert scale, requiring approximately fifteen minutes completing and they had two weeks to answer it. Data collected from this round were rates of agreements, disagreements, and no opinion

with the elicited themes. Only panel members who responded to the preceding questionnaire received the second round Likert scale, since commitment of the participants was one of the important requirements of the Delphi method.

A possible disadvantage of this method was late responses of panel members which might slow the entire process. Follow-up and reminding of panel members were arranged via e-mail or telephone when necessary. During the process experts did not come together. The researcher was the only connection between them to find answers to the research questions.

Method of data analysis

Answers to the first round open-ended questionnaire of seven questions were analyzed qualitatively. Similar answers were collected under a theme to provide items for the second round Likert scale. To illustrate, the question concerning the limitations of the use of RWCs in mathematics lessons, provided four themes: it is not suitable to use RWCs for each topic of high school mathematics, density of the curriculum and lack of time, lack of adequately equipped teachers and their reluctance, and unrealistic nature of problems in real world context. In this way, 31 themes gave 31 items under the six original questions. They formed the second round Likert scale shown in Table 2. An inter-rater reliability test was performed by the supervisor of this research, to ensure and agree that the same themes were extracted from the qualitative data of the first round.

The question (question 3a in Table 1) concerning the RWC examples for each topic of high school mathematics, was analyzed in a different way and not incorporated into the Likert scale. Similar RWC examples were categorized under each mathematics topic, such as logic. To illustrate, the question asking for examples of

RWCs for logic provided examples such as decision making and finding gaps in reasoning in courts: n=3, computer software, algorithms and electrical circuits: n=10, legal documents, critical essays and philosophy: n=4, clarity of communication in daily conversations: n=4. Types of examples, and the number of time they were suggested, were presented in bar-graphs in Figures 1-16 in Chapter 4.

Responses to the second round of 31 items with Likert scale were analyzed qualitatively. In this way participants showed what they thought about each theme suggested for each question of the first round. The Delphi techniques produced a final set of answers from each expert for each of the original six questions. Percentages of ‘agreement’, ‘disagreement’, and ‘no opinion’ were calculated for each item by using spreadsheet. Therefore, the calculation of percentages ranged from 0% to 100% for both agreement and disagreement (see Appendix D).

CHAPTER 4: RESULTS

Introduction

The purpose of this Delphi study was to describe the feasibility of the use of real world connections in mathematics curriculum and teaching. The major question concerning whether, how, and why to use RWCs in mathematics was subdivided into eight areas: advantages, disadvantages, limitations, possible places of RWCs, appropriateness of RWCs to students' levels, appropriateness of RWCs to the university entrance exams, the preparedness of the teachers to the use of RWCs, and examples of RWC for each topic of the high school mathematics curriculum.

Two groups of experts – one group of academics and one group of sixteen teachers – responded to a series of two questionnaires following the Delphi technique. True to that technique, the second round Likert scale provided a summary of the information from the previous open-ended questionnaire so that the experts could indicate their agreement or disagreement for each idea. There is a high level of agreement among the experts for most of the items of the second round Likert scale. Thus, the Delphi method can be successfully applied as a research tool for obtaining a reliable consensus of opinion from a group of experts. Results of the Likert scale (see Appendix D), and experts' RWC examples for each topic in the high school mathematics curriculum will be reported in this section.

Results from the Likert scale

Advantages of using RWCs in high school mathematics curriculum

The overwhelming majority of the participants agreed that making real world connections in mathematics helps improve students':

- Motivation and interest in mathematics (96%)
- Positive attitudes towards mathematics (92%)
- Mathematical process skills such as reasoning and problem-solving (96%)
- Conceptual and permanent learning (100%)
- Awareness of the choice of future careers (88%)
- Ability to generalize mathematical ideas (75%)

Disadvantages of using RWCs in high school mathematics

The majority of the participants agreed that if given real world examples are complex, to learn the mathematics of the problem can be difficult (63%).

While a considerable portion of the participants *disagreed* that when real world connections are used in mathematics, the gains of the lessons might be limited to the given real world problem, and it might be difficult to transfer acquired knowledge to other situations (46%). Fewer participants agreed with this statement (42%).

Three quarters of the participants *disagreed* that using real world connections makes students think that mathematics is only limited to real life (75%) and may result in misconceptions (e.g. the concept of similarity carries different meanings in mathematics and real sense) (71%). The majority of the participants *disagreed* that using RWCs makes abstract thinking difficult and some topics should remain

abstract (58%). Finally, two thirds of the participants agreed that there was no significant disadvantage of using RWCs in mathematics (66%).

Limitations of using RWCs in mathematics

The majority of the participants agreed that the density of the curriculum and lack of time is a kind of limitation to use of RWCs (58%), and an overwhelming majority agreed that the lack of adequately equipped teachers and their reluctance was another limitation (92%).

The great majority of the participants agreed that it was a limitation, if given examples are unrealistic and not related to students' experiences (66%), and it is not suitable to use real world connections for each topic in high school mathematics curriculum (71%).

Possible places of RWCs in mathematics lessons

A considerable portion of the participants agreed that real world connections should be done before abstract generalizations (46%); however, they agreed that if problems are application oriented, it is more useful to use them towards the end of the lessons (54%). On the other hand, the great majority of the participants agreed that this situation is not generalizable, possible places of these connections depend on the topic and nature of the problems (71%).

Appropriateness of using RWCs to students' levels and classroom environment

About half of the participants agreed that using these connections is suitable for any student group and always effective (54%), and over three quarters of them think that problems shouldn't be complicated in less able student groups (79%).

On the other hand, three quarters of the participants *disagreed* that using these connections is more suitable for groups of students who lack interest towards mathematics (75%), and they also disagreed with the statement that there is no need to use these connections for very able student groups (75%).

Appropriateness of real world problems to the university entrance exams

The great majority of participants agreed that real world connected problems should be included in the university entrance exams (63%) and, after using these connections, practical examples similar to the university entrance exam questions should be given in lessons (71%).

A considerable portion of the participants *disagreed* that there might be a lack of time in the exam to solve these problems (46%), but over one third of the participants agreed with this statement (38%).

Preparedness of the high school teachers to use RWCs

The great majority of participants agreed that most high school teachers are not able to use real world connections (88%). For solutions to the problem, the overwhelming majority of the participants agreed that:

- There should be elective courses in education faculties to teach student teachers how to use these connections effectively (92%),
- Using real world connections and mathematical modeling should be included in in-service teacher training (96%),
- There should be studies to develop sources of real world problems (96%),
- Real world connected examples should be included more in the curriculum to improve awareness of teachers (96%).

Results of the RWC examples suggested by the experts

The Following section of the result chapter describes the themes of RWC examples suggested for each topic of high school mathematics curriculum. Figures 1-16 represent the frequencies of the themes of RWC examples in each topic.

Participants offered the following contexts for making connections to the real world for the *logic* as a topic of grade 9 high school mathematics curriculum, as seen in Figure 1:

- A. Decision making and finding gaps in reasoning in law courts: n=3
- B. Computer software, algorithms and electrical circuits: n=10
- C. Legal documents, critical essays and Philosophy: n=4
- D. Clarity of communication in daily conversations: n=4

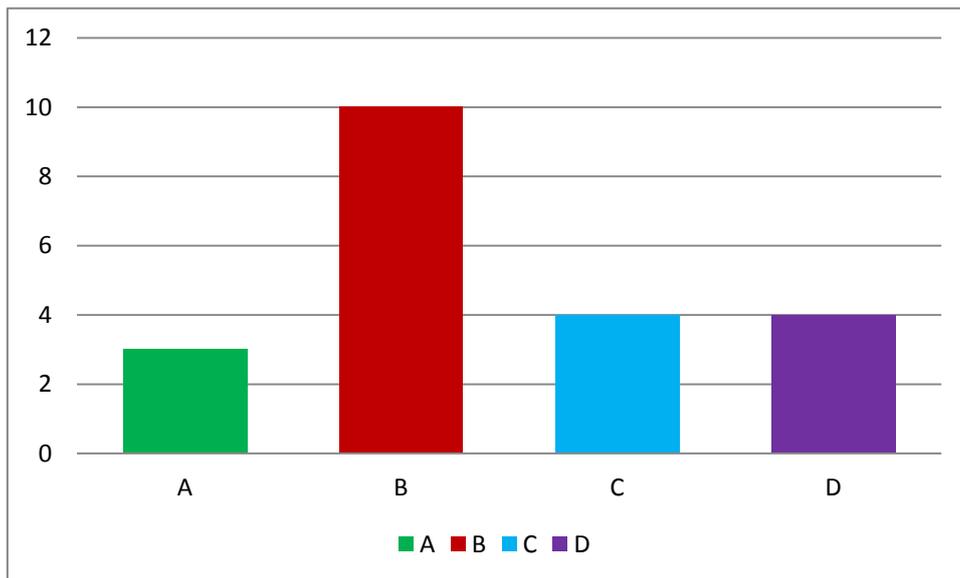


Figure 1. Frequencies of the themes of RWC examples suggested for the *logic* topic.

For this topic 15 people responded out of 24 participants, and only 6 gave multiple responses. There are four categories of given examples as shown in Figure 1 and there are 21 examples given by the participants under these categories.

Participants offered the following contexts for making connections to the real world for the *relations, functions and operations* as a topic of grade 9 high school mathematics curriculum, as seen in Figure 2:

- A. Ordered pairs (e.g. route pairs, match results, places of chess pieces) and team-fan relations: n=4
- B. Machines, input/output and factory/product relations: n=6
- C. Function analogy (children-mother/domain-range): n=1
- D. Modeling problems (e.g. weekly expense, engineering, economy problems) and billing: n=4

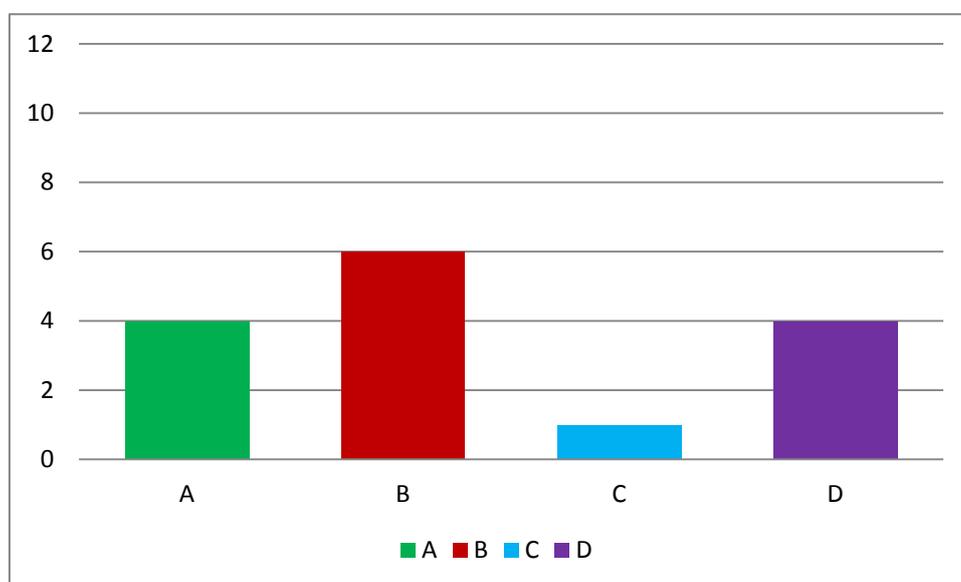


Figure 2. Frequencies of the themes of RWC examples suggested for the *relations, functions and operations* topic.

For this topic 13 people responded out of 24 participants, only 4 gave multiple responses. There are four categories of given examples as shown in Figure 2 and there are 15 examples given by the participants under these categories.

Participants offered the following contexts for making connections to the real world for the *sets* as a topic of grade 9 high school mathematics curriculum, as seen in Figure 3:

A. Word problems: $n=3$

B. Classification of distinct objects which have common properties: $n=10$

C. Databases: $n=2$

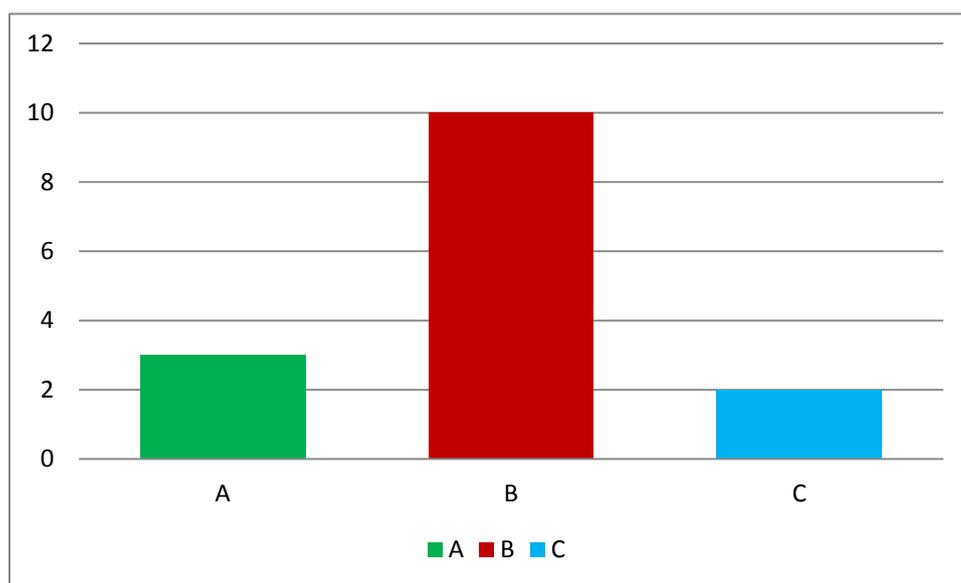


Figure 3. Frequencies of the themes of RWC examples suggested for the *sets* topic.

For this topic 14 people responded out of 24 participants, only 1 gave multiple responses. There are three categories of given examples as shown in Figure 3 and there are 15 examples altogether given by the participants under these categories.

Participants offered the following contexts for making connections to the real world for *the numbers* as a topic of grade 9 high school mathematics curriculum, as seen in Figure 4:

- A. Word problems of numbers: n=4
- B. Examples of integers in daily life: n=3
- C. Cryptography: n=2
- D. Calculations in shopping, bank accounts and grades: n=4

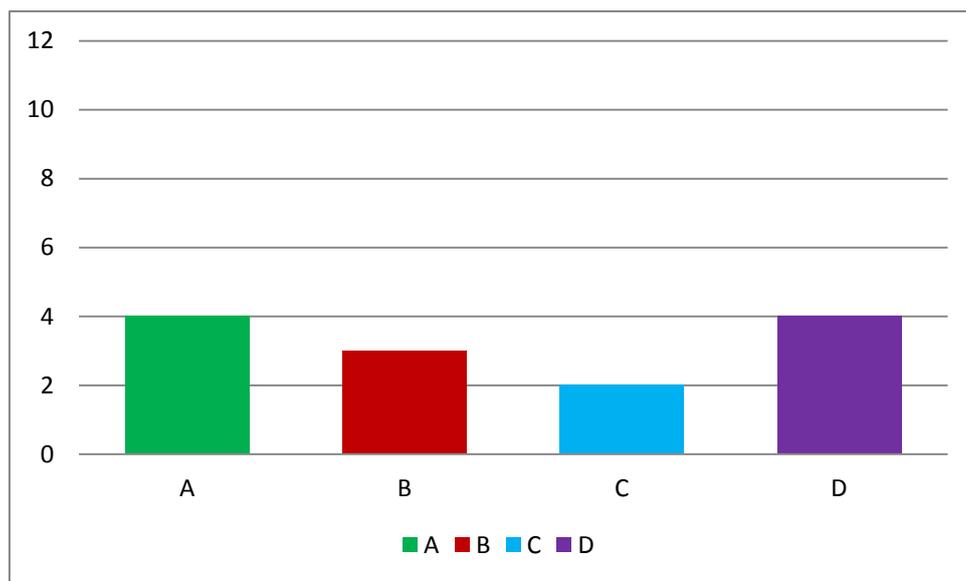


Figure 4. Frequencies of the themes of RWC examples suggested for the *numbers* topic.

For this topic 10 people responded out of 24 participants, only 3 gave multiple responses. There are four categories of given examples as shown in Figure 4 and there are 13 examples offered by the participants altogether.

Participants offered the following contexts for making connections to the real world for the *polynomials* as a topic of grade 10 high school mathematics curriculum, as seen in Figure 5:

A. Financial analysis: n=1

B. Architecture, and civil engineering: n=2

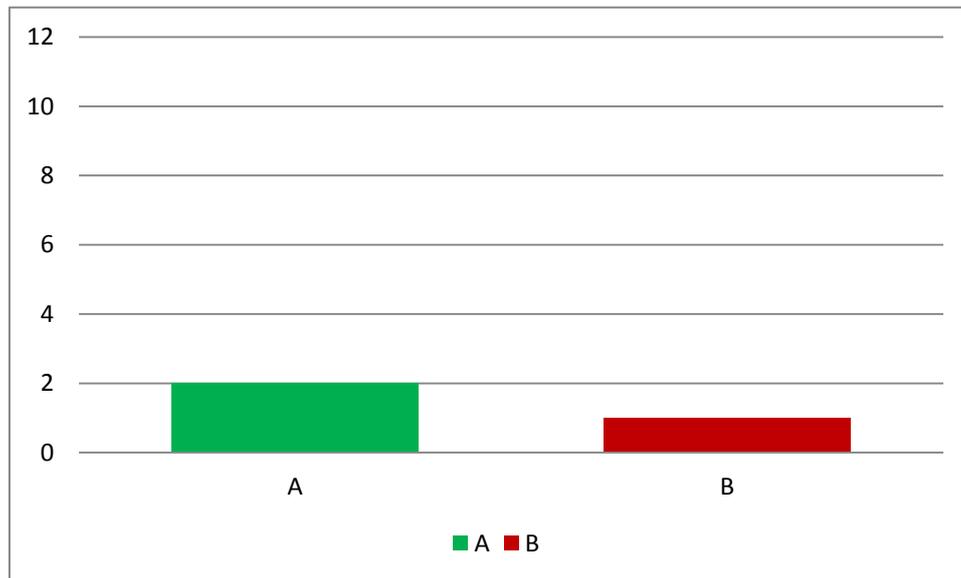


Figure 5. Frequencies of the themes of RWC examples suggested for the *polynomials* topic.

For this topic 4 people responded out of 24 participants, only 1 gave multiple responses. There are two categories of given examples shown in Figure 5 and there are 3 examples given by the participants.

Participants offered the following contexts for making connections to the real world for the *quadratic equations, inequalities and functions* as a topic of grade 10 high school mathematics curriculum, as seen in Figure 6:

- A. Share of inheritance and shopping: n=2
- B. Mathematics used in mechanics (vertical motion, speed, and velocity): n=6
- C. Profit/loss analysis=2
- D. Architectural mathematics, area, and volume of three dimensional shapes: n=5

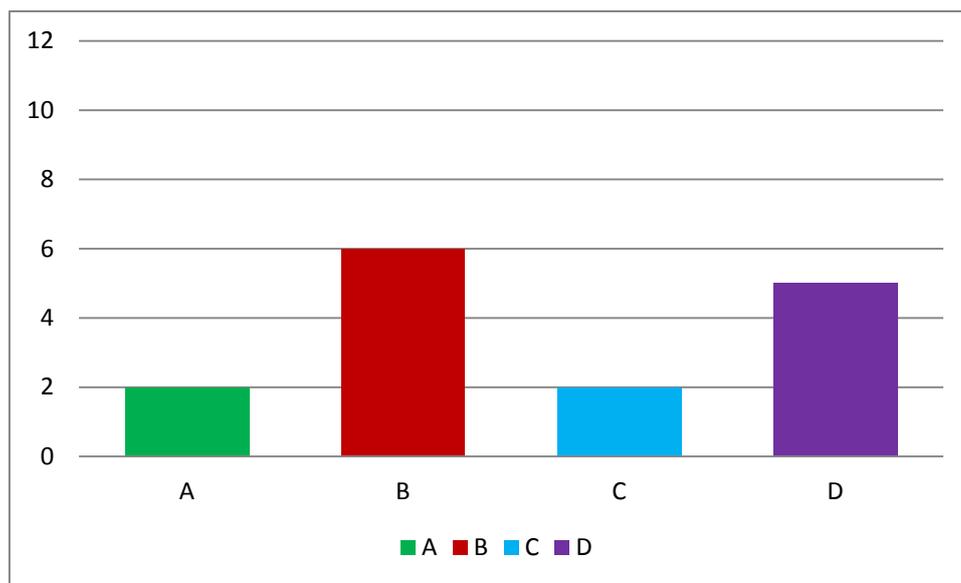


Figure 6. Frequencies of the themes of RWC examples suggested for the *quadratic equations, inequalities, and functions* topic.

For this topic 11 people responded out of 24 participants, only 3 gave multiple responses. There are four categories of given examples as shown in Figure 6 and there are 15 examples given by the participants.

Participants offered the following contexts for making connections to real world for the *permutation, combination, and probability* as a topic of grade 10 high school mathematics curriculum as seen in Figure 7:

- A. Actuary, statistics and estimation: n=7
- B. Cryptography: n=1
- C. Decisions in daily life, combinations in grouping: n=5
- D. Games of chance=5

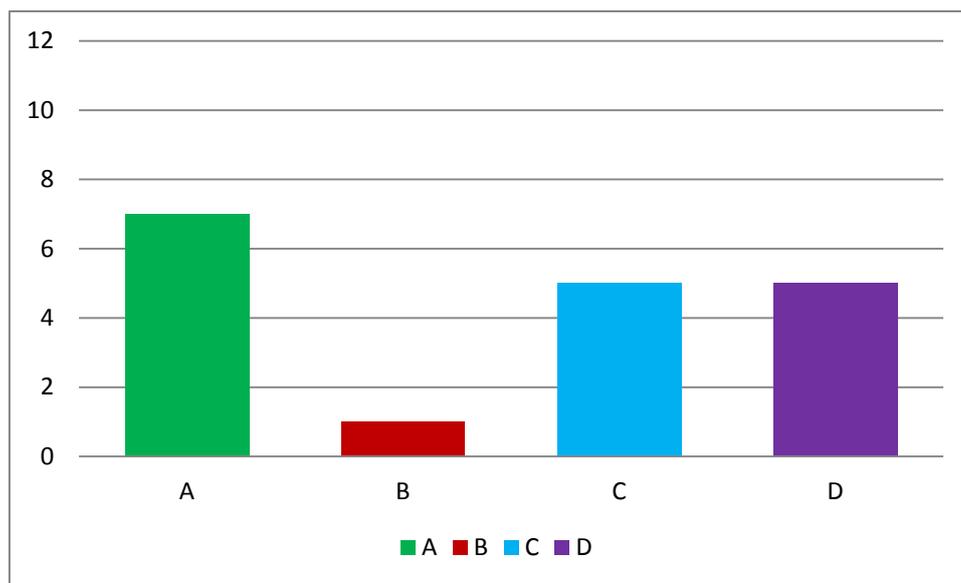


Figure 7. Frequencies of the themes of RWC examples suggested for the *permutation, combination, and probability* topic.

For this topic only 15 people responded out of 24 participants, only 5 gave multiple responses. There are four categories of given examples as shown in Figure 7 and there are 18 examples offered by the participants.

Participants offered the following contexts for making connections to the real world for the *trigonometry* as a topic of grade 10 high school mathematics curriculum, as seen in Figure 8:

- A. Architecture, engineering and measuring length of objects on earth: n=12
- B. Music and phonetics: n=5
- C. Medicine, pharmacy and optics: n=3
- D. Computer software, electronics, seismology, electronic devices that use frequency(e.g. television, MR, X-ray): n=6
- E. Cartography, navigation, and radars: n=5
- F. Astronomy and rockets: n =6

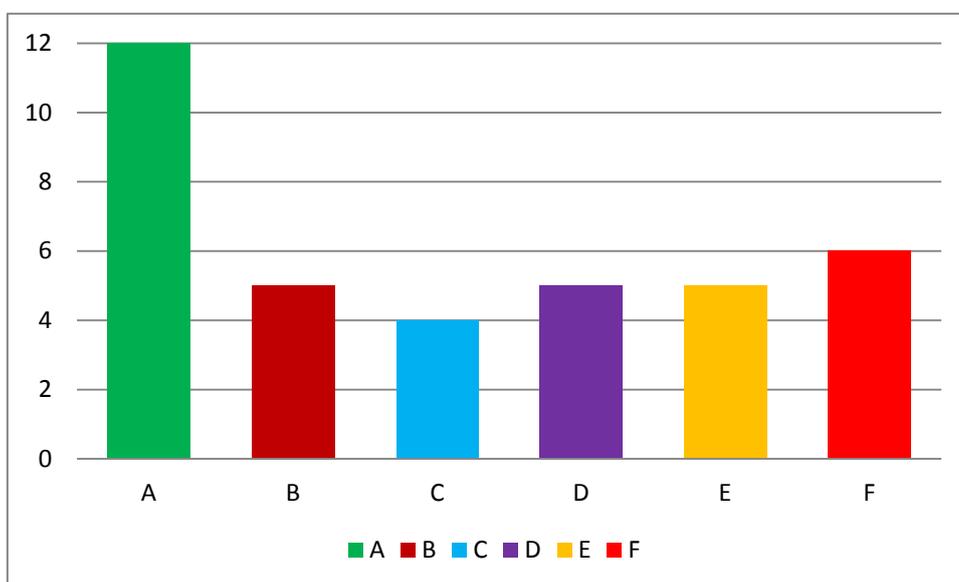


Figure 8. Frequencies of the themes of RWC examples suggested for the the *trigonometry* topic.

For this topic 15 people responded out of 24 participants, only 9 gave multiple responses. There are six categories of given examples as shown in Figure 8 and there are 37 examples given by the participants.

Participants offered the following contexts for making connections to the real world for the *complex numbers* as a topic of grade 11 high school mathematics curriculum, as seen in Figure 9:

- A. Shapes that can be represented by complex numbers (e.g. eyes of a bee): n=2
- B. Alternating current, and electricity: n=5
- C. Telecommunications, electronics and radar systems: n=4
- D. Graphical design of 3D film scenes: n=1
- E. Cartography, vectors and modelling of floating action: n=3

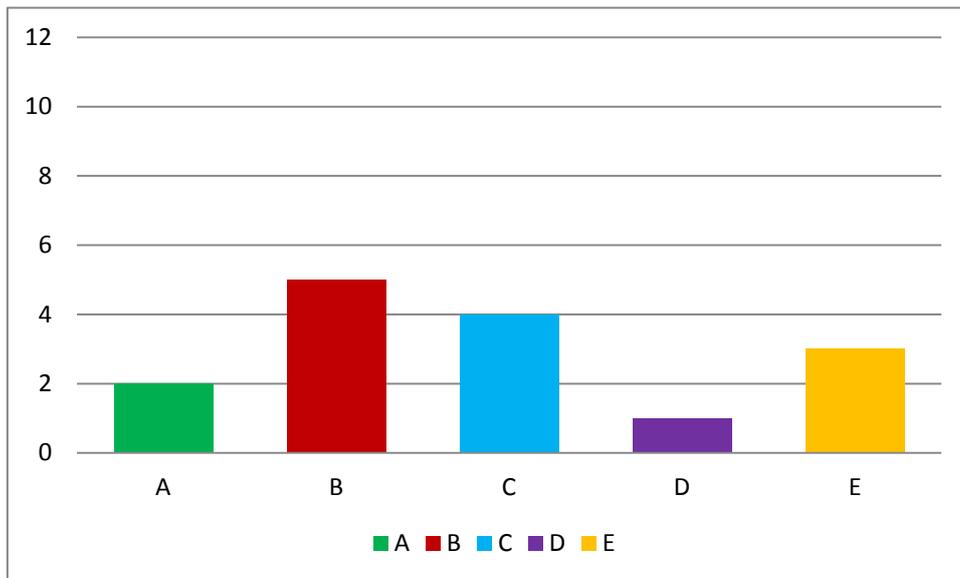


Figure 9. Frequencies of the themes of RWC examples suggested for the *complex numbers* topic.

For this topic 10 people responded out of 24 participants, only 1 gave multiple responses. There are five categories of given examples as shown in Figure 9 and there are 15 examples given in these categories.

Participants have offered the following contexts for making connections to real world for the *logarithms* as a topic of grade 11 high school mathematics curriculum, as seen in Figure 10:

- A. Financial growth: n=5
- B. Seismology and Richter scale: n=6
- C. Population growth: n=7
- D. Radioactive decay, bacterial growth, and determining age of fossils: n = 6

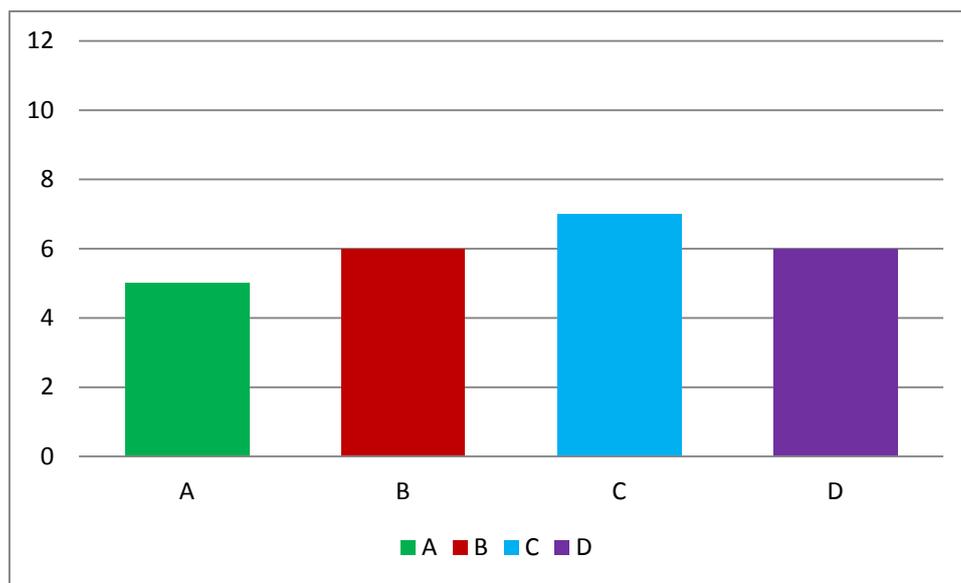


Figure 10. Frequencies of the themes of RWC examples suggested for the *logarithms* topic.

For this topic 13 people responded out of 24 participants, only 6 gave multiple responses. There are four categories of given examples as shown in Figure 10 and there are 24 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *induction and series* as a topic of grade 11 high school mathematics curriculum, as seen in Figure 11:

- A. Generalization of ideas in real life (e.g. behaviour, blood analysis, solving puzzles): n=3
- B. Population growth of animals and growth of animals (e.g. length of a snake): n=3
- C. Dominoes, part to whole technique in daily life: n=2
- D. Calculation of interest rates: n=2
- E. Electrical circuits: n=1

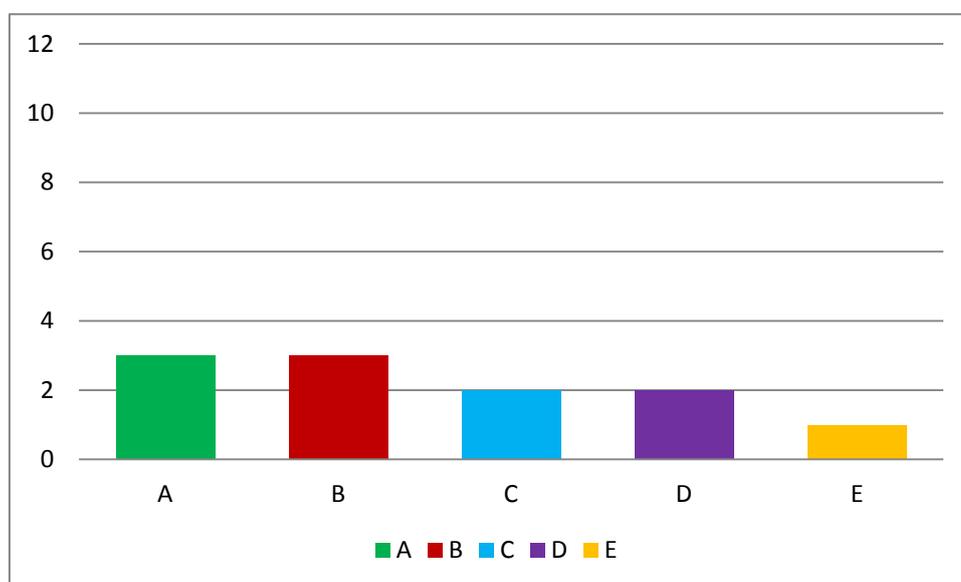


Figure 11. Frequencies of the themes of RWC examples suggested for the *induction and series* topic.

For this topic 11 people responded out of 24 participants, only 1 gave multiple responses. There are five categories of given examples as shown in Figure 11 and there are 11 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *matrix, determinant, and linear equations* as a topic of grade 11 high school mathematics curriculum, as seen in Figure 12:

- A. Excel, ordering the data: n=2
- B. Changes in the market, maximization of the profit, minimization of the cost: n=3
- C. Cryptography (e.g. in defence industry), and computer systems: n=8
- D. Solving real life related equations with multiple variables: n=7

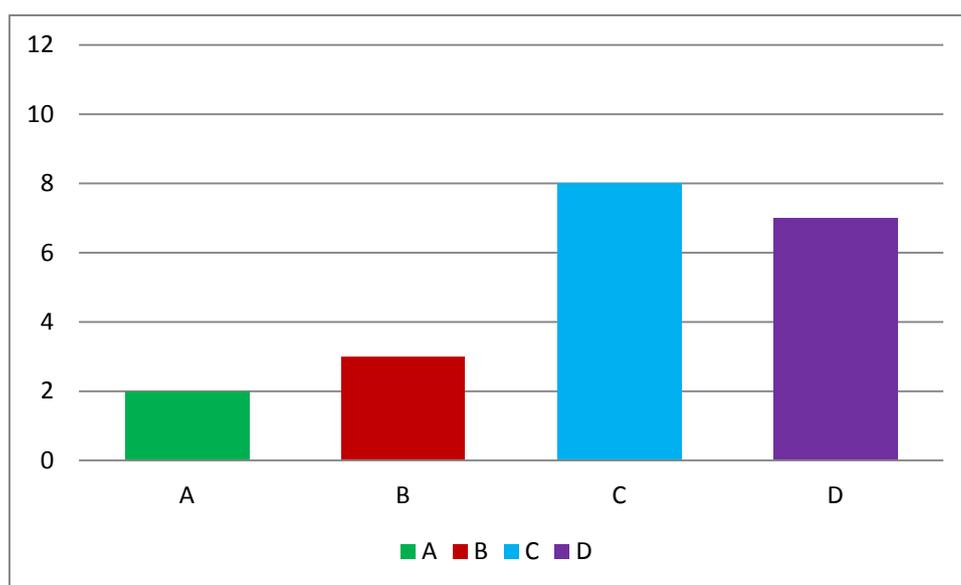


Figure 12. Frequencies of the themes of RWC examples suggested for the *matrix, determinant, and linear equations* topic.

For this topic 15 people responded out of 24 participants, only 7 gave multiple responses. There are four categories of given examples as shown in Figure 12 and there are 20 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *functions* as a topic of grade 12 high school mathematics curriculum, as seen in Figure 13:

A. Piecewise functions (e.g. prices of parking lot, grade intervals): n= 3

B. Profit/Loss problems: n=1

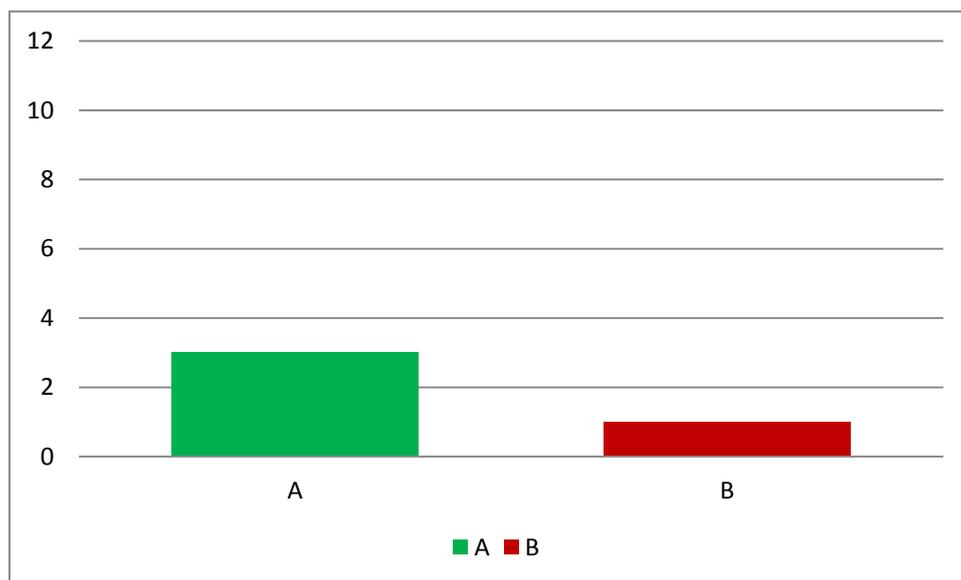


Figure 13. Frequencies of the themes of RWC examples suggested for the *functions* topic.

For this topic 6 people responded out of 24 participants, none gave multiple responses. There are two categories of given examples as shown in Figure 13 and there are only 4 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *limit and continuity* as a topic of grade 12 high school mathematics curriculum, as seen in Figure 14:

- A. Profit/loss problems and investment decisions: n=2
- B. Limit in real life (e.g. speed, temperature, height): n=4
- C. Continuity of life: n=1
- D. TV competition context describing the critical point and infinity: n=1

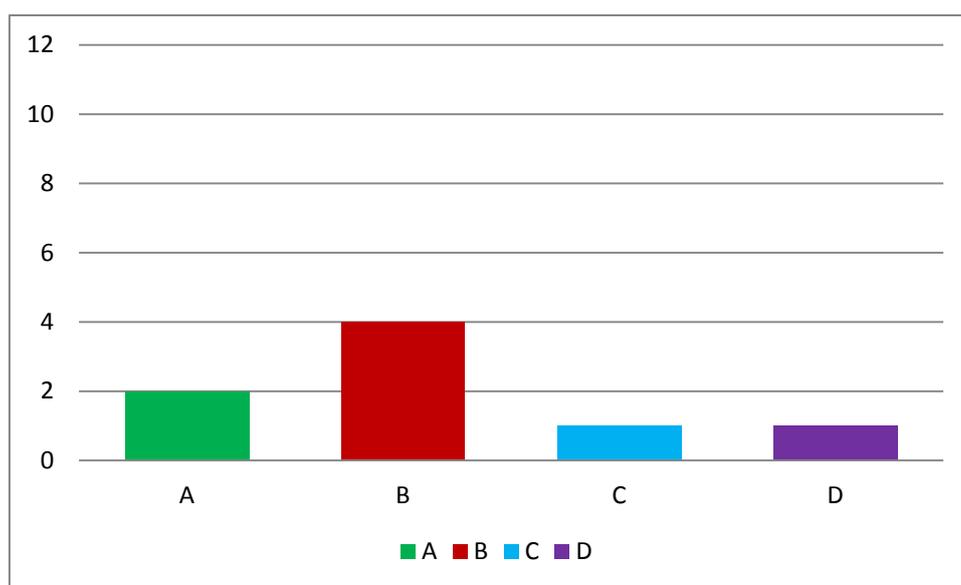


Figure 14. Frequencies of the themes of RWC examples suggested for the *limit and continuity* topic.

For this topic 7 people responded out of 24 participants, none gave multiple responses. There are four categories of given examples as shown in Figure 14 and there are only 8 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *differentiation* as a topic of grade 12 high school mathematics curriculum, as seen in Figure 15:

- A. Mechanics (time rate of change, motion in a straight line) and engineering (maximum force): n=8
- B. Optimization in volumes of three dimensional shapes: n=5
- C. Optimization in economics: n=5
- D. Rate of usage of natural resources: n=1

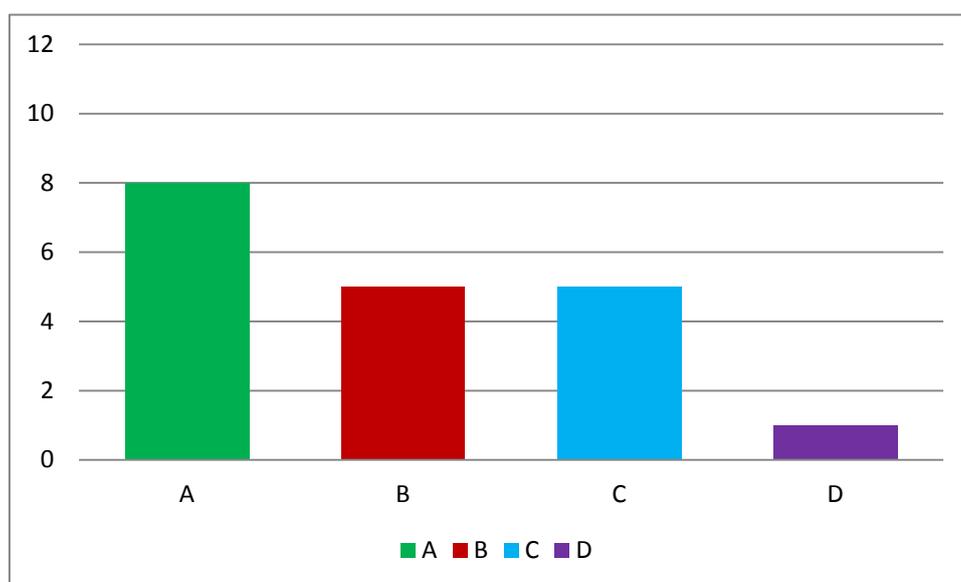


Figure 15. Frequencies of the themes of RWC examples suggested for the *differentiation* topic.

For this topic 16 people responded out of 24 participants, 6 gave multiple responses. There are four categories of given examples as shown in Figure 15 and there are 19 examples given by the participants under these categories.

Participants offered the following contexts for making connections to real world for the *integration* as a topic of grade 12 high school mathematics curriculum, as seen in Figure 16:

- A. Industrial design and architecture: n=3
- B. Finding area and volume of irregular shapes on earth: n=10
- C. Intervals of taking medicine and complicated probability: n=2
- D. Mechanics (motion problems): n=1

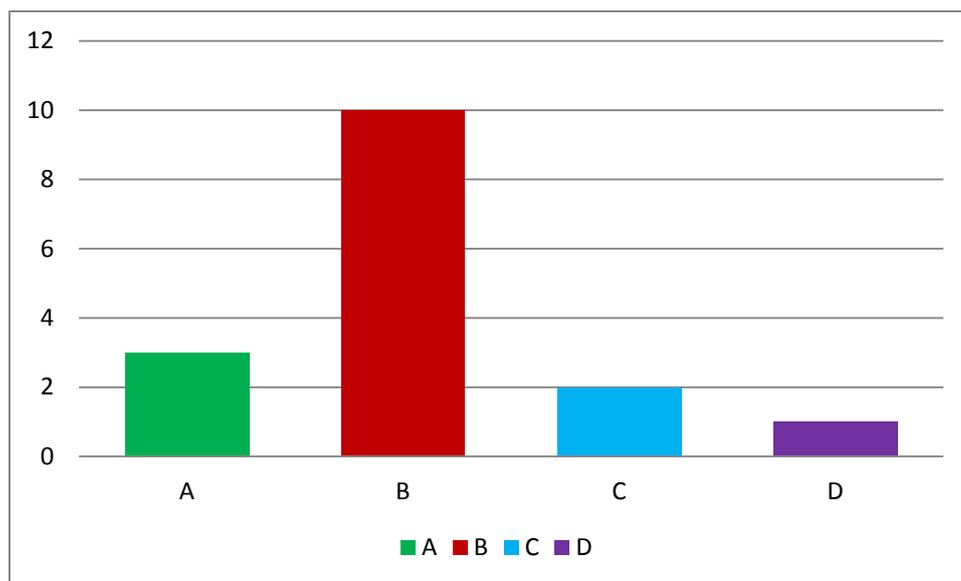


Figure 16. Frequencies of the themes of RWC examples suggested for the *integration* topic.

For this topic 15 people responded out of 24 participants, 3 gave multiple responses. There are four categories of given examples as shown in Figure 16 and there are 16 examples given by the participants under these categories.

Table 3 shows the most relevant themes of RWC examples for each topic of the high school mathematics curriculum, suggested by experts most frequently. For some topics, two different themes were suggested by equal numbers of experts, which is why both were included in Table 3.

Table 3

The most germane themes of RWC examples suggested for each topic (Figure 1-16)

Logic	Computer software, algorithms and electrical circuits: n=10
<i>Relations, functions, and operations</i>	Machines, input/output and factory/product relations: n=6
<i>Sets</i>	Classification of distinct objects which have common properties: n=10
<i>Numbers</i>	Calculations in shopping, bank accounts and grades: n=4 Word problems of numbers: n=4
<i>Polynomials</i>	Architecture, and civil engineering: n=2
<i>Quadratic equations, inequalities, and functions</i>	Mathematics used in mechanics (vertical motion, speed, and velocity): n=6
<i>Permutation, combination, and Probability</i>	Actuary, statistics and estimation: n=7
<i>Trigonometry</i>	Architecture, engineering and measuring length of objects on earth: n=12
<i>Complex numbers</i>	Alternating current, and electricity: n=5
<i>Logarithms</i>	Radioactive decay, bacterial growth and determining age of fossils: n = 6 Seismology and Richter scale: n=6
<i>Induction and series</i>	Generalization of the ideas in real life (e.g. behaviours, blood analysis, solving puzzles): n=3 Population growth of animals and growth of animals (e.g. length of a snake): n=3
<i>Matrix, determinant, and linear equations</i>	Cryptography (e.g. in defence industry), and computer systems: n=8
<i>Functions</i>	Piecewise functions (e.g. prices of parking lot, grade intervals): n=3
<i>Limit and continuity</i>	Limit in real life (e.g. speed, temperature, height): n=4
<i>Differentiation</i>	Mechanics (time rate of change, motion in a straight line) and engineering (e.g. maximum force): n=8
<i>Integration</i>	Finding area and volume of irregular shapes on earth: n=10

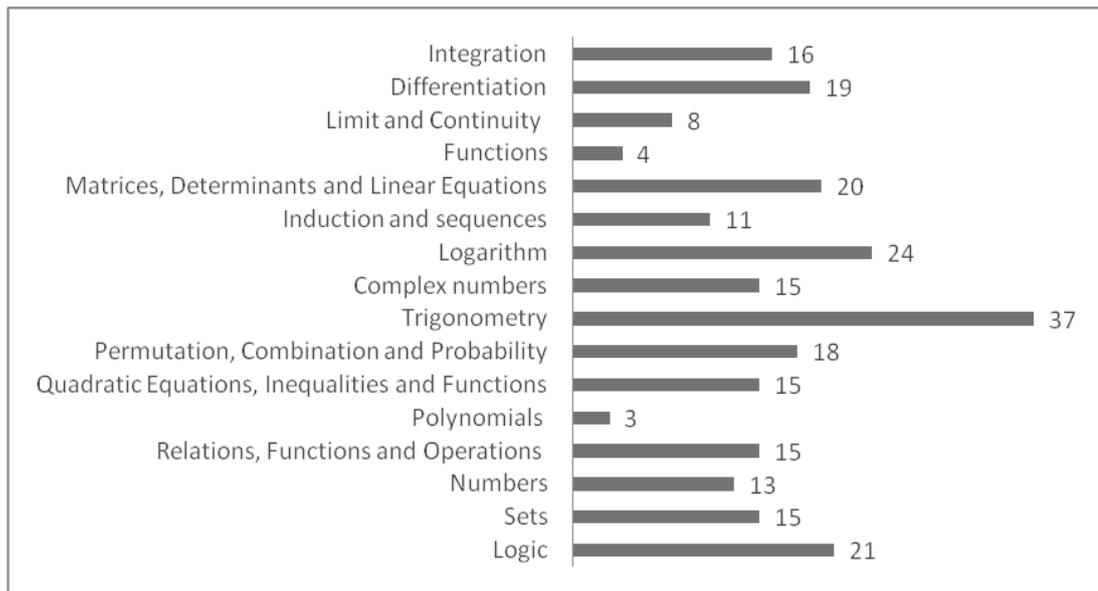


Figure 17. The number of RWC examples suggested for each topic.

Figure 17 shows the number of examples given for each topic. Experts suggested a greater number of examples for logic, trigonometry, logarithms, and differentiation topics from each grade of high school.

In the following section, there will be a comparison of the RWC examples suggested by the experts and RWC examples in the International Baccalaureate Diploma Program (IBDP) textbook for mathematics standard level (SL) which is reputed to be rich in using real world connections in high school mathematics. The aim of this comparison is to see whether there are well-known examples of RWCs that experts did not suggest. This will bring another insight into the analysis of the given examples and prevent a miss of any kind of worthwhile RWC examples, if there are such. This comparison was done only with three topics of high school mathematics curriculum from grade 10, 11, and 12, for which the greatest number of examples was suggested by the experts. Figure 17 shows that experts suggested a greater number of examples for the *trigonometry*, *logarithms*, and *differentiation* topics. The IB textbook presents the trigonometry in three different chapters, the logarithms in

only one chapter, and the differentiation in four chapters (Maenpaa, Owen, Haese, Haese, & Haese, 2009). These chapters were analyzed to find RWC examples and these examples were collected under themes similar to the suggestions of the experts. The examples are listed in the following tables and figures and it is possible to see differences and similarities between RWCs examples of the experts and examples available in the International Baccalaureate (IB) textbook for the topics chosen.

Table 4
Comparison of RWC examples of the trigonometry given by the experts and RWC examples used in IBDP-SL Mathematics textbook (Maenpaa et al., 2009, p. 202-271).

RWC examples in IBDP-SL	Experts' RWC examples	
X Duration of a flight. Area (cut from a section of cloth), property, tessellation	Architecture, engineering and measuring length of objects on earth: n=12	
Height of a flagpole, tower, tree, mountain	Music and phonetics: n=5	X
Path distance, distance between objects on earth	Medicine, pharmacy and optics: n=4	X
X Golf, football (distance, angle relations) Bearing and displacement problems (boat travel, travel on earth)	Computer software, electronics, seismology, electronic devices that use frequency(e.g. TV, x-ray): n=6	X
X Seasonal variations in our climate, Variations in average maximum and minimum temperatures	Cartography, navigation, and radars: n=5	
X The number of daylight hours at particular location, tidal variations in the depth of water in a harbour	Astronomy and rockets: n=6	
X The phases of moon, animal populations		
X Ferris wheel, cost of petrol, air pollution		

X: This symbol means on the left side of the table that the real world example in the IB textbook is not suggested by the experts while on the right side it means that this example suggested by the experts is not available in the IB textbook.

The *trigonometry* topic is presented in three different chapters in the IB textbook: the unit circle and radian measure, non-right-angled triangle trigonometry, and advanced trigonometry (Maenpaa et al., 2009, p. 202-271). As seen in Table 4, even though RWC examples in the trigonometry topic (variations in average temperatures, the number of daylight hours at particular location, tidal variations in the depth of water in a harbour, modelling periodic phenomena, such as seasonal variations in our climate) have a noticeable place in the IB textbook, these examples were not suggested by the experts. On the other hand, examples that experts mentioned for RWCs in the trigonometry topic (music, phonetics, medicine, pharmacy, optics, computer software, electronics, seismology, and electronic devices that use frequency such as television, x-ray) were not available in the IB textbook.

Table 5

Comparison of RWC examples of the logarithms given by the experts and RWC examples used in the IBDP-SL mathematics text book (Maenpaa et al., 2009, p. 120-141).

RWC examples in IBDP-SL	Experts' RWC examples
Interest rate	Financial growth: n=5
Growth of population	Seismology and Richter scale: n=6
Decay of radioactive substances	Population growth: n=7
Financial growth (period of investment)	Radioactive decay, bacterial growth, determining age of fossils: n=6

The *logarithms* topic is presented in only one chapter in the IB textbook (Maenpaa et al., 2009, p. 120-141). As seen in Table 5, for the logarithms topic, real world examples given by the experts were available also in the IB textbook. These examples were presented towards the end of the chapter after presenting the basics of the logarithms.

Table 6 and Table 7 include RWC examples available in the IB textbook and those given by the experts for the *derivatives* topic respectively. In this way, the

differences between them were found out in terms of the amount and diversity of RWC examples. This topic was presented in four different chapters (chapter 17, 18, 19, 20) in the textbook: differential calculus, applications of differential calculus, derivatives of exponentials and logarithms, and derivatives of trigonometric functions (Maenpaa et al., 2009, p. 480-578).

Table 6
RWC examples of the derivatives used in IBDP-SL Mathematics textbook

Ch17. Differential calculus

Rates of change, displacement, velocity and acceleration and optimization (maxima and minima)

The second derivative in context (time-distance travelled, instantaneous rate of change in displacement per unit of time, instantaneous velocity, acceleration)

Ch18. Applications of differential calculus

Time rate of change: functions of time, temperature varies continuously, the height of a tree varies as it grows the prices of stocks and shares vary with each day's trading, volume of water in swimming pool varies in time when it is drained.

Modelling: distance travelled by a runner, the height of a person riding in a Ferris wheel, the capacity of a person's lungs which change when the person breathes.

General rates of change: ability of a person to understand spatial concepts varies as he/she gets older, modelling cost function, the quantity of chemical changes in human body, growth in trees, growth in volumes of water in lakes, tanks, etc., population growths of animals (e.g. fish farm)

Motion in a straight line: displacement, velocity, and acceleration

Optimization (maxima and minima): maximize profit; minimize cost, surface area and volume of three dimensional shapes, designs of a pen, navigation, maximum area, maximizing the capacity of three dimensional shapes.

Ch19. Derivatives of exponential and logarithmic functions

Rates of change, displacement, velocity and acceleration and optimization: Radioactive decays, temperature, growths of plants, the speed of chemical reaction, rate of changes in velocity and memorizing ability of a child as time pass, cost control studies, maximum area, maximize profit, population growth.

Ch20. Derivatives of trigonometric functions

Optimization with trigonometry: architecture, maximum carrying capacity, rises in depth of water, voltage in circuits, and design in a car engine.

Table 7
RWC examples of the derivatives given by the experts

A. Mechanics (time rate of change, motion in a straight line), engineering: n=8
Optimization in volumes of three dimensional shapes: n=5
Optimization in economics: n=5
Rate of usage of natural resources: n=1

The following themes and specific real world examples are those given in the IB textbook but, not offered by the experts:

Time rate of change: temperature varies continuously, the height of a tree varies as it grows, the price of stocks and shares vary with each day's trading, volume of water in swimming pool varies in time when it is drained.

Examples of modelling: the height of a person riding in a Ferris wheel, the capacity of a person's lungs changes when the person breathes.

General rates of change: the ability of a person to understand spatial concepts varies as he/she gets older, modelling cost function, the quantity of chemical changes in human body, growth in trees, and growth in volumes of water in lakes, and tanks, population growths of animals.

Rates of change: radioactive decays, temperature, growth of plants, the speed of chemical reaction, memorizing ability of a child as time passes, population growth.

Optimization with trigonometry: rise in the depth of water, voltage in circuits, and the design in a car engine.

Table 8 shows the number of examples given for each topic, the number of experts who suggested RWC examples, the number of multiple responses for each topic and the number of themes elicited from the responses of the experts for each topic. In total 63 different themes of RWCs were suggested by the experts for all topics of high

school mathematics curriculum. On average 12 out of 24 participants suggested RWC examples for each topic and sometimes one expert gave multiple responses. In total 254 examples of RWCs were suggested by different experts.

Table 8
Numbers of suggested RWC examples for each topic, experts, and themes (Figure 1-16)

	Number of RWC examples	Number of experts gave examples of RWCs	Number of multiple responses	Number of suggested RWC themes
Logic	21	15	6	4
Relations, functions, and operations	15	13	4	4
Sets	15	14	1	3
Numbers	13	10	3	4
Polynomials	3	4	1	2
Quadratic equations, inequalities, and functions	15	11	3	4
Permutation, combination, and probability	18	15	5	4
Trigonometry	37	15	9	6
Complex numbers	15	10	1	5
Logarithms	24	13	6	4
Induction and series	11	11	1	5
Matrix, determinant, and linear equations	20	15	7	4
Functions	4	6	0	2
Limit and continuity	8	7	0	4
Differentiation	19	16	4	4
Integration	16	15	4	4
Total:	254	190	55	63

CHAPTER 5: DISCUSSION

Introduction

The purpose of this study was to describe the feasibility of the use of real world connections in high school mathematics curriculum based on the views of experts. The basic question concerning the feasibility of these connections was subdivided into six categories: advantages, disadvantages and limitations, possible places of RWCs, appropriateness to students' levels, appropriateness to the university entrance exams, and preparedness of teachers. Two groups of experts – one group of eight academics and one group of sixteen teachers – responded to a series of two questionnaires following the Delphi technique. True to that technique, the second round Likert scale provided a summary of the information from the previous open-ended questionnaire so that the experts could indicate their agreement or disagreement for each idea (see Appendix D).

The list of opinions of the experts described the feasibility of the use of RWCs in mathematics and examples for each topic of high school mathematics curriculum brought a practical view to this study. Information gained from this study should be of interest to curriculum developers.

Discussion of the findings

Advantages of using RWCs in high school mathematics curriculum

For the advantages of using real world connections in mathematics lessons, experts suggested six different themes. The fact that RWCs increase students' motivation and interest in mathematics was one of the themes that most of the participants

agreed on. Moreover, is that the use of these connections improves students' positive attitudes towards mathematics as another advantage of RWCs.

Motivate students and developing their interest and positive attitudes towards mathematics is not an easy thing to do. One cannot say that the use of real world connections is the only way to motivate students in math lessons, but it is obvious that the use of these connections has a positive effect on students' motivation in math lessons. One can say that using real world connections gives teachers the chance to answer the students' question "when are we ever going to use this?" This question represents a crucial moment for motivating or improving interest of our students in mathematics lessons.

A possible reason behind why these connections motivate students is that students see where mathematics is used in real life, why they learn it and why it is important to learn. Therefore, when they find satisfactory answers, it is very likely to motivate and improve their interest in math. A motivating and interesting environment for learning brings the development of positive attitudes towards mathematics which is another advantage.

Motivating students, improving their positive attitudes and interest towards mathematics are components of the affective goals of mathematics. These advantages of the use of RWCs in mathematics are in line with the findings in the literature (Sorensen, 2006; Özdemir & Üzel, 2011; Gainsburg, 2008). Research suggests that the more students are motivated, the better they perform in mathematics (Muijs & Reynolds, 2011). Moreover, since students find the abstract nature of mathematics difficult, the use of these connections give teachers a chance to open a door for students to start learning in a real world context. They can then teach the abstract

generalization of the intended mathematical knowledge of the problem under consideration.

Another finding of this study is that experts think that RWCs in math lessons actually facilitates generalization and abstraction of mathematical ideas and concepts. Even though the connections are concrete in nature, experts suggested that they help abstraction of mathematical ideas. Rather than starting with abstract mathematics, starting with these connections have a motivating effect on students as a result, and developing the abstract information after these connections becomes easier. When students understand how they are going to use mathematics in real life, they internalize the knowledge and they become eager to learn abstract compositions.

Özdemir and Üzel (2011) suggest in their research that when students engaged purely with the abstract nature of mathematics, it did not always make sense to them. Students' ideas about the use of real world connections in math lessons show that they become more interested in mathematics after the use of these connections. Clarke et al., (1966) assert that teaching in a real world context helps students investigate knowledge of mathematics and concepts that appear in reality. This way of teaching should be a key element of math lessons.

Another finding of this research is that experts think that the use of RWCs helps conceptual, meaningful and permanent learning. Solving real life mathematics problems and leaning mathematics in a real world context, involves creative thinking of students. Hence in those environments, students are not limited to procedural thinking. It is not compulsory to find exact mathematical solutions for real world problems, since the main aims are to have students think critically and analytically in order to find a variety of solutions. Finding procedural solutions and gathering

appropriate mathematical knowledge is another step of this way of teaching. That is why these problems can help students' conceptual learning.

One can say that since the use of these connections makes the learning environment accessible and dynamic, they help make learning permanent and meaningful.

Another possible reason behind its help for conceptual learning is that it makes the abstract nature of the mathematics easily reached by the help of the concrete nature of these connections. The use of RWCs help internalization of the knowledge, thus the learning of mathematics can become permanent. The findings of Dickinson et al. (2010), that realistic mathematics education has a strong characteristic of development in both conceptual and procedural aspects of mathematics, are in line with the findings of the current study.

The results of the current study showed that the use of RWCs in math lessons helps the development of students' mathematical process skills (reasoning, communication, problem-solving, analytical thinking, etc.). While dealing with real world problems, students are not just required to concentrate on finding the solutions of the problems; they are asked to show their reasoning for their solution and while doing this they need to communicate by using the language of mathematics. Real world problems are likely to have multiple solutions, and while finding strategies to solve these problems it gives students a chance to improve their problem-solving skills and analytical thinking skills. It can be said that since the use of the connections provides an environment where students bring different mathematical approaches to the real world problems; students deduce and interpret mathematical concepts and relate them to each other. If handled carefully, this way of teaching may help students become inquiring learners.

The development of mathematical process skills is one of the aims of the Turkish national mathematics education (MEB, 2005). As understood from the intended curriculum of the high school mathematics, its developers are aware that using these connections is one of the tools to achieve this goal.

Another finding of the current research indicated that experts think that the use of RWCs in mathematics can make students conscious about their future career choices by showing occupational fields in which mathematics is used. There are many examples of real world problems in mathematics which are related to occupational fields in adult life. When these problems are used in math lessons, students have a chance to see that mathematics is used in different fields of employment. To illustrate, while teaching quadratic functions, if an example from architecture is given, students see that mathematics is used in architecture. Therefore, it can help students to make conscious decisions about choosing the area in which they want to have their further education.

The goals and functions of schooling include developing students' mathematical skills and understanding required for adult life, for employment (Cockcroft, 1982; Cuban, 1976). While improving students' mathematical skills for employment it is also important to improve their awareness of their future careers. Students can have an idea about what they like to do in their future and then make more appropriate choices. When they make appropriate choices for a future career, they are more likely to be successful in employment and adult life.

Disadvantages of using RWCs in high school mathematics

Experts suggested that if given real world examples are complex, to learn the mathematics of the problem can be difficult. As experts suggested, teaching

mathematics in a real world context may not always be an optimal way of teaching. As mentioned before, the use of these connections is demanding, requiring time and skills from teachers because there is a need for choosing appropriate task that is accessible to students, a careful planning, and implementation.

Another disadvantage of the use of RWCs in mathematics is that the learning might be limited to the given real world problem and it might be difficult to transfer acquired knowledge to other situations. Actually, slightly more participants *disagreed* with this statement (46%), as compared with 42% of participants who agreed.

If the real world problems are ill-chosen, this might be a possible reason for the concern of the experts to this statement. Moving away from basic mathematics towards applied mathematics and losing the focus of the curriculum is another possible reason behind the concern of the participants.

The idea of the lesser portion of the participants who agreed with the use of RWCs might cause the learning limited to the given real world problem contradicts the findings of Dickinson, Eade, Gough, and Hough (2010) that the use of RWCs helps the development of both content knowledge of mathematics and problem-solving skills. This idea also contradicts the philosophical principles of RME as Hirsch (2007) stated the use of these connections support students' investigation of reality and helps the building of connections among mathematical concepts.

Three quarters of the participants *disagreed* that using real world connections makes students think that mathematics is only limited to real life. Therefore, experts indicated that the use of RWCs does not necessarily lead students to think that mathematics is only limited to real life. As mentioned above, this way of teaching

mathematics is not only limited to the discussion of the concrete part of mathematics, they have a function in a starting point before eliciting abstract ideas and formal mathematical information intended in given problems. Therefore, students also have a chance to see the abstract nature of the mathematics, and how it is used to understand the world around them.

Another idea about the disadvantages of the use of RWCs was that the use of these connections may result in misconceptions (e.g., the concept of similarity carries different meanings in mathematics and real sense); however, three quarters of the experts disagreed with this statement. There is no evidence in the related literature which supports the idea that the use of RWCs may result in misconceptions. Of course it is always possible in mathematics lessons that students have misconceptions, and teachers should be aware of that whichever teaching strategy they use in their lessons.

The majority of the participants *disagreed* also that using RWCs makes abstract thinking difficult and some topics should remain abstract. Results from Muijs and Reynolds (2011) support this. They suggest that the use of the real world connections helps to overcome the difficulty of the abstract nature of mathematics. In their research in Turkey, Özdemir and Üzel (2011) also suggest that since students find it difficult to think of mathematical ideas in an abstract way, the use of these connections helps change their attitudes towards mathematics in a positive way, thus supporting these participants.

Limitations of using RWCs in mathematics

Experts suggested that heavy teaching program of Turkish mathematics curriculum and lack of time is a limiting factor to the use of RWCs.

Cuban (1976) supports the notion that heavy teaching programs prevent effective implementation of the intended curriculum and this is one of the reasons causing the gap between intended and taught curriculum. Furthermore, the Smith Report (2004) suggested that to support both the development of mathematical skills and the skills of mathematical application, there is a need to allocate more time to mathematics teaching. Moreover NCTM's (2000), connection standards also point out that the use of RWCs is demanding, and requires time and patience. The evidence from the literature is that the time problem inhibits the use of innovative ways of teaching such as the use of RWCs, and is a common problem in different countries.

On the other hand, the findings of this study do not imply that using RWCs make the work of teachers easier. It is suggested that the use of these connections makes learning easier and more meaningful for students, but requires time and patience on the part of teachers.

The findings of the current study strongly indicated that most high school teachers are not adequately equipped for the use of RWCs in mathematics, and their reluctance is one limitation. Since the participants of this study are both teachers and teacher educators, this particular finding probably represents the reality of the situation in Turkey.

Cuban, (1976) asserts that inadequately trained teachers are one of the barriers that prevent teaching the contents of intended curriculum effectively. Additionally, Wubbels et al. (1997) confirm that it is not easy to prepare teachers for the use of revolutionary teaching strategies like the use of RWCs in mathematics, while they are in the habit of using traditional ways such as explaining and talking in front of the classroom, with students copying from the board and solving examples. Their

study also revealed that it is not impossible to change perceptions of student teachers by educating them in an appropriate way.

Another idea of limitation experts suggested is that if given examples are unrealistic and not related to students' experiences, their use might have little or no benefit to students. This is indeed the most common problem in the literature with the use of RWCs in mathematics. One of the aims is to make the abstract nature of mathematics concrete to students to stimulate their interest. If they cannot find any relationship in the given real world context to their experiences, background or interest, then the use of these connections might lose its meaning and not fulfil the most important purpose.

Results of Lubienski's (1998) show that students who have higher-level socio-economic backgrounds are more comfortable with solving problems situated in a real world context. They are able to make generalizations and analyze the intended mathematical ideas involved. Students who have lower level socio-economic backgrounds focus on real world constraints in the given problems and that's why they may miss some of the mathematical ideas intended. Boaler, (2002) has a similar concern about real world contexts, if students are not familiar with situations described in these problems, development of high-level thinking skills may not be possible. Muijs, and Reynolds, (2011) also suggest that effective use of real world connections requires using examples which are connected to pupils' actual experience. According to Heuvel-Panhuizen, (2003) the key idea here is how real life problems are perceived in students' minds. That is why teachers should be careful while choosing problems or real world contexts to teach mathematical topics. They should bear in mind that these problems should be connected to students' backgrounds, experiences, and interests.

Finally, another limitation for the use of real world connections is that it may not be suitable to use these connections for each topic in high school mathematics curriculum. There might be real world connection examples but they may not be suitable. This finding of the current study is not in line with Freudenthal's realistic mathematics idea, which suggested teaching mathematics by always starting with, and staying within, reality (Hirsch, 2007; Clarke et al., 1966).

Possible places of RWCs in mathematics lessons

Experts who participated in this study suggested that real world connections should be done before abstract generalizations (46%). However, they agreed that if problems are application oriented, it is more useful to use them towards the end of the lessons (54%). On the other hand, the great majority of the participants agreed that this situation is not generalizable, and that possible places of these connections depend on the topic and nature of the problems (71%).

A possible reason behind why some of the experts believe that is useful to start with RWCs and then move on to abstract generalization of mathematical ideas is that it arouses curiosity and helps individuals comprehend mathematical ideas by themselves; otherwise it leads to memorization of formulas. Teaching mathematics in a real world context contributes to the development of aimed mathematical ideas and notions and transferring the mathematical knowledge to other situations.

The second and third statements are in line with each other which are suggesting that the possible places of RWCs in lessons depend on the topic, and nature of the problems. To illustrate, if the topic is application oriented the use of RWCs should be at the end of the lesson as a real world connected application oriented problem. If not, it does not contribute to the learning of the students and they might have

difficulty in attaining the objectives of the lessons. This issue is also related to prerequisites of the lessons and the students' background knowledge, which is why the role of the teacher is crucial in deciding the places of these connections in their lessons.

Even though there are some experts who believe that the use of these connections is more beneficial at the beginning of the lessons than elsewhere, more experts suggest that possible places of the use of these connections depend on the nature of the topic. This finding of the current study contradicts the related literature, which suggests starting with a realistic example or situation which then turns into a mathematical model. In other words, Freudenthal suggests in realistic mathematics theory, that starting with and staying within reality leading to optimal teaching and learning outcomes (Altun, 2006; Reynolds, 2011; Gravemeijer & Terwel, 2000).

A possible reason behind the ideas of Turkish experts may be that it is not always possible to teach mathematics in a real world context in Turkey where a scholarly academic curriculum ideology may be seen in the high school mathematics curriculum. In other words, it is not always possible to teach mathematics in a real world context where both students and teachers are concentrated on learning mathematical formulas and applying them in given exercises and problems. There are several other reasons that might also be related to this question, which are addressed later on this chapter.

Appropriateness of using RWCs to students' levels and classroom environment

Another purpose of this study was to investigate the appropriateness of the use of real world connections to the level of students groups and classroom environment. There is not much discussion or evidence about this issue in the related literature.

The results of the current study revealed that the experts consider that the use of RWCs in math lessons is suitable for any student group and always effective. They also suggested that, while using RWCs, problems shouldn't be complicated for less able student groups. The complexity of the problems might cause less able students to struggle with given problems. The use of these connections aims to make less able students gain a concrete understanding of mathematics before making abstract generalizations. If these problems are also complex to understand, it may not be possible to achieve this goal. On the other hand, since real world problems have multiple ways of solutions and several possible answers, students from different levels have a chance to contribute to their learning by creating different solution ideas in concert with their level of mathematics achievement. The motivating effect of the use of these connections might help less able students to gain higher levels of mathematical knowledge and skills compared to teaching where no such connections are used.

Moreover, participants *disagreed* that using these connections is more suitable for groups of students who lack interest towards mathematics and they also *disagreed* with the statement that there is no need to use these connections for very able student groups. This means they believe there is not a particular group of students for whom the use of RWCs is more appropriate. Hence, it can be concluded that the use of these connections is appropriate for any kind of student group, according to experts.

A possible reason behind why they are appropriate for less able students with lack of interest in mathematics may include the motivating effect of RWCs and its positive effect on students' interest in mathematics and changing off-task behaviours of students in class discussions. Clearly, teaching mathematics in real world contexts bring an unusual classroom environment in which there is more class discussion, an

active role for students, and an increased need for different sources and materials, leading to easier classroom management. It should be easier to manage a classroom where students find connection between the content of the lesson and their experiences, with a motivating effect on them, leading to on-task class discussions rather than off-task conversations.

Patton (1997) states that teaching mathematics to students with learning disabilities should be realistic to help them to be competent in their current and adult life.

Although Patton's (1997) study asserts the use of real world connections is appropriate while teaching mathematics to such students, it is not in contradiction with the findings of the current study about the appropriateness of the RWCs to students' levels.

The goals of teaching mathematics (MEB, 2005) in Turkey are written for all student groups in high school, and the role of RWCs is discussed for achieving these goals above (using RWCs for development of skills for adult life and employment). It can be extrapolated that since these aims are for all students, these connections should be in place while teaching mathematics to every student.

Appropriateness of real world problems to the university entrance exams

Experts suggested that real world connected problems should be included in the university entrance exams, and practical examples similar to the university entrance exam questions should be given in lessons.

It can be said that education, especially in Turkish high schools, is very exam-oriented. Students always consider the benefit of the content of the mathematics and teaching to the university entrance exams, and teachers definitely consider the needs of students to succeed in these exams. Assessment strategies and intended teaching

goals are not always parallel in Turkey. It is not effective to include real world problems or context examples only in the intended curriculum. Students are assessed with multiple choice questions in the university entrance exams in Turkey. However the use of real world problems which can be classified as short essay questions can create contradiction between teaching and assessment strategies, if the connections are not addressed in assessment. That may be why teachers are more inclined to teach in traditional ways with the use of exam oriented questions. The findings of the current study revealed that this problematic side with the use of RWCs in mathematics can be solved by including both these types of questions in the university entrance exam and the use of appropriate exam oriented practical questions after teaching in real world contexts in classrooms.

Results from Vos and Kuiper (2005) report similar situations in other countries as well where assessment in mathematics education is not parallel to the instructional and other reform movements. They consider that the reason behind not achieving in international performance-based assessments like TIMMS is the mismatch of items used in mathematics assessment in schools and items used in those international tests. It can be interpreted that the achievement level of Turkey in those international tests has a strong relation with the types of the items (performance-based, real world connected, short essay items) that are used in those tests and the familiarity of Turkish students with these items. The use of these items for assessment in schools might have the benefit of raising Turkish national achievement level on international exams.

A significant portion of the participants *disagreed* that there might be a lack of time in the exam to solve these problems (46%); however, over one third of the participants agreed with this statement (38%). It is obvious that solving real world

connected problems require more time than multiple choice items, but experts who believe it is not a problem are greater than those who consider it as a problem.

Finally, it is obvious that an effective use of any strategy in a curriculum certainly needs to be parallel to assessment strategies in national and international tests.

Preparedness of the high school teachers to use RWCs

This part of the study relates limiting factors affecting the use of RWCs and suggestions of the experts for solution. Results of the current study indicate that most high school teachers are not able to use real world connections. Since there are both teachers and teacher educators in the participant group of this study, this result has a strong message.

For solution, experts suggested that

- there should be elective courses in faculties of education to teach student teachers how to use these connections effectively,
- using real world connections and mathematical modelling should be included in in-service teacher training,
- there should be studies to develop sources of real world problems,
- real world connected examples should be included more in the curriculum to improve awareness of teachers.

Wubbels et al. (1997) assert in their study that in the Netherlands where the idea of RME originated, the lack of adequately equipped teachers was a problem when real world connections in math lessons were used effectively. At first glance, changing perceptions of the teachers used to teaching in traditional ways was not easy, but in their study they showed it is possible to change teachers in the direction of using more of an inquiry-based approach.

As the findings of the current study suggest, it is possible to change perceptions of both student teachers and current teachers. There should be concrete implementations in both education faculties and in-service training to develop awareness of teachers about the value of the use of RWCs in teaching and learning mathematics. It is not enough only to explain the value of this teaching and learning strategy, but how to use these connections effectively, and possible RWCs problems should be included.

There are some examples of real world problems in the Turkish high school mathematics curriculum; still experts suggest that there should be even more examples to improve awareness of the teachers.

A final suggestion from the experts is that there should be studies to develop resources of real world problems. Since the Turkish education system is not familiar with teaching mathematics in a real world context, there is a lack of resources to meet the needs of teachers for effective use of these connections. As mentioned before, choosing problems appropriate for levels, backgrounds, and experiences of students is a key element and not easy to achieve. At this point, the role of resources becomes crucial.

The most germane themes of RWC examples suggested for each topic

Table 3 in Chapter 4 shows the most relevant themes of RWC examples suggested for high school mathematics topics. These examples might assist curriculum developers to find the most practicable RWCs for mathematics. To illustrate, computer software, algorithms and electrical circuits are the most practical themes for teaching the *logic* in real world contexts. Vertical motion, speed and velocity (mathematics used in mechanics) are the most feasible themes for making connections to real world while teaching *quadratic equations, inequalities and*

functions. Alternating current and electricity is the most practicable theme to teach *complex numbers* in real world context. Finding area and volume of irregular shapes on earth is the most feasible theme to use while teaching *integration* in real world context.

Comparison of RWC examples suggested by the experts and the ones available in the IBDP-SL Mathematics textbook

Table 4 compared the RWC examples for the trigonometry topic suggested by the experts and the ones available in the IB textbook. Even though, for the *trigonometry*, RWC examples like modelling periodic phenomena (variable behaviour repeated over time) like seasonal variations in our climate, variations in average maximum and minimum temperatures, the number of daylight hours at particular location, tidal variations in the depth of water in a harbour have a noticeable place in the IB textbook, these examples were not suggested by the experts.

Table 6 represented the RWC examples for the differentiation in the IB textbook and Table 7 showed the RWC examples suggested by the experts for this topic. There are a greater number of RWC examples in the IB textbook than the suggested themes of the experts for this topic. Even experts were not aware of these practicable RWCs and a possible reason is that there are little resources that can help people see RWC examples for high school mathematics topics in Turkish.

On the other hand, there are RWC examples of Trigonometry that experts suggested but are not available in the IB textbook and all examples suggested by the experts for the *logarithms* are available in the IB textbook. Additionally, Table 8 shows that experts suggested 63 different themes of RWC for the 16 topics of mathematics. Some experts suggested similar examples and in total 254 RWC examples were

suggested by the experts for these topics. On average, half of the participants suggested RWC examples for each topic. These numbers show that there are a remarkable numbers of themes and examples of RWCs suggested by the experts for the topics of high school mathematics curriculum. It can be concluded that asking for the use of RWCs in mathematics is not like asking for water in the Sahara desert. In other words, it is very feasible to make real world connections in most topics of high school mathematics curriculum.

Implications for practice

Curiosity and motivation are crucial elements of teaching and learning any subject. A teacher should always consider that when students are intrinsically motivated they become eager to learn. There are many ways to motivate students and improve their interest in mathematics. Results of this study showed that experts think that teaching mathematics by using RWCs is one of the ways of motivating and improving students' interest in mathematics; therefore this way of teaching could be a tool for changing students' attitudes towards mathematics positively. Moreover, the use of RWCs also facilitates abstraction of mathematical ideas which students find difficult to do. When they investigate mathematical ideas in a real world context, it can help them develop ownership of the knowledge. This obviously serves for students' permanent and meaningful learning of mathematics.

While the uses of these connections can have the benefits mentioned above, it is not always easy to use this way of teaching effectively. Teachers should be careful about complexity of real life connected problems, and appropriateness of the problems to students' experiences and backgrounds. If these issues are not handled carefully, it is likely to lose potential benefits. If students find these problems situated in real world

context not as realistic as we think, but find them to be meaningless, the use of these connections may not have a positive effect on students' learning.

Results of the current study suggest that experts think that teachers should be aware of the demanding nature of the use of RWCs in terms of time. This way of teaching also requires a dynamic classroom environment which demands careful management in terms of behaviors of students, focus of the lesson, and class discussions.

Another implication for practice is that these problems should be placed in lessons considering the nature of the topic. To illustrate, if there is a need for teaching basics of the content at the beginning of the lesson, the use of these connections is appropriate at the end of a lesson. While teaching the *logarithms* we can talk about the use of logarithm in real world situations conceptually but students probably need to know the basics of logarithms before solving a problem situated in real world context with the use of logarithms. On the other hand, while teaching the *matrices* there are no complicated rules and properties as a prerequisite of solving a real world problem. Hence a teacher could start teaching the matrices with a real world problem and help students investigate the solutions for the given problem by themselves to introduce matrices

High school students in Turkey have to take a university exam by which students' knowledge of mathematics is assessed with multiple choice questions; real world connected problems are not easy to fit with multiple choice questions. In order for real world connected problems to be incorporated into the curriculum successfully, educational policy makers should find ways to have it assessed in high stakes test such as the university entrance exams.

Implications for research

This study has tried to take a glimpse of the place of real world connections in the high school mathematics curriculum from the perspective of teachers and mathematics teacher educators. It attempts to paint a picture from both a theoretical perspective such as curriculum design and practical perspectives such as classroom dynamics and student backgrounds. The findings are limited to the views of the participants who represent classroom teachers and academics. It is suggested that, as Turkey moves to reform its high school mathematics curriculum to (hopefully) include more use of RWCs, student reactions and learning from the use of RWCs are assessed and evaluated in other studies systematically, to further look into feasibility of this approach in teaching high school mathematics.

Limitations

There are several limitations of this study. Even though the Delphi method was a practical way of gathering expert ideas to describe the feasibility of the use of RWCs in mathematics curriculum, the first round open-ended questionnaire required a relatively long time (about 45minutes) to answer for the experts. Since academics and teachers are busy in their daily professional lives, it might not have been easy for them to find time to answer all the open-ended questions. Therefore, the time it took to answer the first round questionnaire was a limiting factor for this study. Possibly due to this reason, half of the participants completed the first round quite late.

Teachers who participated in this study were from two private schools in Ankara and the perceptions and experiences of private school teachers about the use of RWCs in mathematics might be different compared to Turkish public schools.

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APPENDICES

Appendix A: Letter and First Round Open-ended Questionnaire to Participants

Letter

İhsan Dođramacı Bilkent University, the Graduate School of Education, the Delphi study in mathematics education

Dear NAME,

As a graduate student in Graduate School of Education at Bilkent University in Ankara, I am collecting expert opinions for my master thesis entitled “Real world connections in high school mathematics curriculum and teaching.” Thank you very much for your participation in this study.

A website link given below is including first round open-ended questionnaire. It probably takes 35-40 minutes to answer.

You will be asked to fill out the questionnaire then a follow-up Likert scale based on your responses. Estimated time for the second round is 15 minutes. Only participants who responded to the first round will be sent the second round Likert scale. Therefore, your commitment for participation is important. In accord with the standard scientific procedure, the identity of all participants will be kept strictly confidential.

Please find the link below with a brief description of my thesis, an online questionnaire for you to fill out at your convenience. I respectfully request that you submit your questionnaire in two weeks so we may proceed with the study. Thank you very much for your support and cooperation.

The required permission from National Ministry of Education is also available to any participants who are concerned.

Yours truly,
Gökhan Karakoç
Graduate Student
The Program of Curriculum and Instruction

The link for the questionnaire: <http://t2.ed.or.kr>
Please let us know that you had this e-mail.

Letter (Turkish)

Bilkent Üniversitesi Eğitim Bilimleri Enstitüsü Matematik Eğitiminde Delphi Anket Çalışması

Sayın İSİM,

Bilkent Üniversitesi, Eğitim Bilimleri Enstitüsü yüksek lisans öğrencisi olarak “Lise Matematik müfredatında Gerçek Hayat Bağlantılarının Kullanımı” konulu tez için Delphi yöntemiyle akademisyen ve öğretmenlerin görüşlerini derleyeceğim. Bu çalışmaya katılmayı kabul ettiğiniz için size çok teşekkür ediyorum.

Aşağıda linki verilen birinci etap anketi açık uçlu sorulardan oluşmaktadır. Cevaplamanızın yaklaşık 35-40 dakika alacağını düşünüyoruz.

Bu etabın devamında, birinci etapta verdiğiniz cevaplar temel alınarak hazırlanan Likert tipi anketi oylamanız istenecektir.

İkinci etap anketinin 15 dakikada cevaplanacağı tahmin edilmektedir.

İki etaptan oluşan bu Delphi çalışması sırasında, her bir anket internet üzerinden bir önceki etaba katılan katılımcılara gönderilecektir. Bu yüzden anketlere katılımın devamlılığı önemlidir. Katılımcıların kimlikleri kesin suretle saklı tutulacaktır.

Takip eden iki hafta içinde çalışmanın devamını sürdürebilmem için anketi doldurmanızı rica ediyorum. Katılımınız ve desteğiniz için şimdiden teşekkür ederiz.

Bu çalışma için Ankara İl Milli Eğitim Müdürlüğünden gerekli izin alınmıştır. Araştırma ile ilgili bir sorunuz olursa bize mail yoluyla ulaşabilirsiniz.

Saygılarımla,
Gökhan Karakoç
Eğitim programları, Öğretim ve Pedagojik Formasyon Eğitimi Yüksek Lisansı

Anket için buraya tıklayınız: <http://t2.ed.or.kr>
Bu maili aldığınızı bize bildirmenizi rica ederiz.

First round open-ended questionnaire

Italicized sentences under each Turkish statement are English translation of each part.

Matematik Eğitiminde Delphi Anket Çalışması

Bu anketin cevaplanması yaklaşık 35-40 dakikanızı alacaktır. Yanında yıldız işareti olan soruların cevaplanması gerekli olup, gerekli bütün alanlar doldurulduktan sonra formun gönderilmesi mümkündür.

Amaç

Bu çalışma lise matematik eğitiminde gerçek hayat bağlantılarının kullanımının Türkiye bağlamında uygulanabilirliği üzerine odaklanacaktır. Bu bağlantıların kullanımının avantajlar, dezavantajlar ve sınırlılıkları uzman ve öğretmen görüşleri ışığında irdelenecektir. Bunun yanında bu bağlantıların etkili bir şekilde kullanılmasının yolları, Türk lise matematik müfredatı konularına gerçek hayat bağlantı örnekleri ve bu bağlantıların ders sırasında kullanım yerleri de bu çalışmanın araştırma konuları arasındadır.

A Delphi study in mathematics education

*It will probably take 35-40 minutes to answer this questionnaire and it is possible to submit it when all required questions (marked with *) were answered.*

Purpose

The focus of this study is the feasibility of the use of real world connections in high school mathematics teaching and curriculum. Advantages, disadvantages, and limitations of the use of real world connections will be described by using expert opinions. Ways of effective use of the connections, examples of them for each topic of the Turkish high school mathematics curriculum, and possible places of the connections in lessons will be addressed in this study.

Lise Matematik Müfredatında Gerçek Hayat Bağlantılarının Kullanımı

Gerçek hayat bağlantıları ile matematik dersleri sırasında basit analogilerin veya metaforların kullanımı, sözel problemler (word problems), gerçek olayların matematiksel modellenmesi, gerçek hayattan verilerin kullanılması, yorumlanması ve tartışılması kastedilmektedir. Bu bağlantılarının kullanımı ile ilgili farklı uygulamalar ve fikirler bulunmaktadır. Konu ile ilgili akademisyenlerin ve öğretmenlerin görüşleri hem teorik hem de pratik uygulamalar açısından fikirleri biraya getirecektir.

The use of real world connections in mathematics curriculum and teaching

The use of simple analogies or metaphors, word problems, mathematical modeling of real phenomena and interpretation of real statistical data are some ways of the use of real world connections in mathematics. Opinions of academics and teachers about the real world connections will bring theoretical and practical views together.

Since the English version of the first round open-ended questionnaire was included in Table 1, Chapter 3, it is not placed here again.

1a. Lütfen lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın avantajlarına, kısa açıklamaları ile birlikte örnekler veriniz.*

2a. Lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın dezavantajlarına ve sınırlılıklarına kısa açıklamaları ile birlikte örnekler veriniz.*

3a. Aşağıda listelenmiş Türk lise matematik müfredatının her bir ünitesi için kullanılabilir bir ya da daha fazla gerçek hayat bağlantısı örneği veriniz.

3a. MANTIK (9.Sınıf)

3b. KÜMELER (9.Sınıf)

3c. BAĞINTI, FONKSİYON, İŞLEM (9. SINIF)

3d. SAYILAR (9. SINIF)

3e. POLİNOMLAR (10. SINIF)

3f. İKİNCİ DERECE DENKLEMLER, EŞİTSİZLİKLER VE FONKSİYONLAR (10. SINIF)

3g. PERMÜTASYON KOMBİNASYON VE OLASILIK (10. SINIF)

3h. TRİGONOMETRİ (10. SINIF)

3i. KARMAŞIK SAYILAR (11. SINIF)

3j. LOGARİTMA (11. SINIF)

3k. TÜMEVARIM VE DİZİLER (11. SINIF)

3l. MATRİS DETERMİNANT VE DOĞRUSAL DENKLEM SİSTEMLERİ (11. SINIF)

3m. FONKSİYON (12. SINIF)

3n. LİMİT VE SÜREKLİLİK (12. SINIF)

3o. TÜREV (12. SINIF)

3p. İNTEGRAL (12. SINIF)

4a. Bir lise matematik konusunu öğretirken sizce matematiğin soyut kısmı öğretildikten sonra mı gerçek hayat bağlantılı örnekler verilmeli, yoksa önce gerçek hayat bağlantılı örnekler ile başlayıp sonunda mı soyut genelleme yapılmalıdır? Neden?*

5a. Gerçek hayat bağlantılarının kullanımı her sınıf ortamı ve her öğrenci grubu için uygun mudur? Örneğin, seviyesi yüksek ve de idare edilmesi kolay sınıflarda bu bağlantıları kullanmak daha mı uygundur? Neden?*

6a. Gerçek hayat bağlantılarının kullanmanın avantajını elde edebilmek adına bu bağlantıların lise sonrası üniversiteye giriş sınavlarıyla uyumlu olması için çözüm önerileri neler olabilir?*

7a. Türkiye'deki lise öğretmenlerinin matematiği gerçek hayat bağlamında öğretme konusunda yeteri kadar donanımlı olduğunu düşünüyor musunuz? Bu konuda varsa öğretmen eğitimcilerine önerileriniz nelerdir?*

Appendix B: Letter and Second Round Likert Scale to Participants

Letter

Dear NAME,

As a graduate student in the Graduate School of Education at Bilkent University in Ankara, I collected your opinions for my master's thesis entitled "Real world connections in high school mathematics curriculum and teaching."

A website link is given below. It includes second round Likert scale to clarify your agreement or disagreement with items elicited from the first round. It probably takes 15-20 minutes to rate the second round Likert scale.

I respectfully request that you submit your questionnaire in one week so we may proceed with the study. Thank you very much for your support and cooperation.

Yours truly,
Gökhan Karakoç
The Program of Curriculum and Instruction

The link for the second round Likert scale: <http://t5.ed.or.kr>

Letter (Turkish)

Sayın İSİM,

Bilkent Üniversitesi, Eğitim Bilimleri Enstitüsü yüksek lisans öğrencisi olarak "Lise Matematik müfredatında Gerçek Hayat Bağlantılarının Kullanımı" konulu tez için Delphi yöntemiyle ilk etapta sizlerin görüşlerinizi derledim.

Aşağıda linki verilen ikinci etap (son) Likert tipi anketinin amacı ilk etapta toplanan fikirlerin oylanarak ortak bir sonuç elde edilmesidir ve cevaplanmasının en fazla 15-20 dakika sürmesini bekliyorum.

Takip eden hafta içinde çalışmanın devamını sürdürebilmem için anketi doldurmanızı rica ediyorum. Katılımınız ve desteğiniz için şimdiden çok teşekkür ederim.

Saygılarımla,
Gökhan Karakoç
Eğitim programları, Öğretim ve Pedagojik Formasyon Eğitimi Yüksek Lisansı

Anket için buraya tıklayınız: <http://t5.ed.or.kr>

Since the English version of the second round Likert scale was included in Table 2, Chapter 3, it is not placed here again.

Second round Likert scale (Turkish)

Matematik Eğitiminde Delphi Anket Çalışması 2. Etap Likert Ölçeği

Birinci etap açık uçlu sorularda belirtilen görüşler doğrultusunda hazırlanan ikinci etap Likert tipi anketi oylamanız yaklaşık 15-20 dakikanızı alacaktır. Amaç ilk etapta toplanan fikirlerin oylanarak ortak bir sonuç elde edilmesidir.

Kod	Lise matematik müfredatında gerçek hayat bağlantılarının kullanımı Bu bölümdeki sorular Lise Matematik Derslerinde Gerçek Hayat Bağlantılarının Kullanımı ile ilgilidir.	Fikrim Yok	Katılmıyorum	Katılıyorum
	<i>Lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın avantajları</i>			
1	Öğrencinin matematiğe ilgi ve motivasyonunu artırır.			
2	Öğrenmeyi kavramsal, anlamlı ve kalıcı kılar.			
3	Öğrencilerin matematiksel süreç becerilerinin (muhakeme, iletişim problem çözme, analitik düşünme vb.) gelişmesini sağlar.			
4	Matematiğin hangi meslek dallarında kullanıldığını görerek, gelecek meslek seçimlerinde bilinçli olmalarını sağlar.			
5	Öğrencilerin matematiğe karşı olumlu tutum geliştirmelerini sağlar.			
6	Matematiksel fikir ve kavramların genellenmesini ve soyutlanmasını kolaylaştırır.			
	<i>Lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın dezavantajları</i>			
7	Bence önemli bir dezavantajı yoktur.			
8	Kavram yanılgısına neden olabilir (ör: benzerlik kavramı matematikte farklı gerçek hayatta farklı anlam taşır).			
9	Soyut düşünmeyi zorlaştırabilir, bazı konular soyut olarak kalmalıdır.			
10	Verilen örnek karmaşıksa problemin içerdiği matematik			

	öğrenilmeyebilir.			
11	Kazanımlar problemle sınırlı kalabilir, edinilen bilgilerin başka durumlara transferi zor olabilir.			
12	Matematiğin gerçek hayatla sınırlı olduğu düşüncesi gelişebilir.			
	<i>Lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın sınırlılıkları</i>			
13	Her konu gerçek hayat bağlantısı kullanmaya uygun değildir.			
14	Müfredatın yoğunluğu ve zaman kısıtlılığı konuların yetişmesine engel olur.			
15	Öğretmenlerin yeterli donanıma sahip olmayışı ve isteksizliği bir sınırlılıktır.			
16	Verilen örneklerin gerçekçi olmayışı ve öğrencilerin deneyimlerine uygun olmaması bir sınırlılıktır.			
	<i>Gerçek hayat bağlantıları dersin başında, sonunda veya ortasında mı verilmeli?</i>			
17	Derslerde önce gerçek hayat bağlantılı örnek verip daha sonra soyut genelleme yapılmalıdır.			
18	Bu durum genellenemez, bağlantıların doğası ve işlenen konuya göre değişir.			
19	Örnekler uygulamaya yönelikse dersin sonuna doğru verilmesi daha uygundur.			
	<i>Gerçek hayat bağlantılarının sınıf ortamı ve seviyelerine uygunluğu</i>			
20	Her öğrenci grubu için uygundur, her zaman etkili olur.			
21	İdare edilmesi zor ve ilgisi düşük sınıflarda daha uygundur.			
22	Sınıf seviyesi düşük ise verilen örnekler karmaşık olmamalıdır.			
23	Seviyesi yüksek sınıflarda bu tarz örneklere ihtiyaç olmayabilir.			
	<i>Gerçek hayat bağlantılarının üniversite giriş sınavlarına uygunluğu ve çözüm önerileri</i>			
24	Üniversite giriş sınavlarında gerçek hayat bağlantılı problem çözmeyi öne çıkaran sorular sorulmalıdır.			

25	Derslerde kullanılan gerçek hayat bağlantılarında sonra öğrenciye pratik yapmak için sınavda çıkabilecek uygun örnekler verilmelidir.			
26	Bu tür problemler için sınavda zaman yetmeyebilir.			
	<i>Gerçek hayat bağlantılarının etkili kullanımı için öğretmenlerin yeterliliği ve öneriler</i>			
27	Lise öğretmenlerinin büyük bir kısmının gerçek hayat bağlantılarını kullanma konusunda yeterli olduğunu düşünüyorum.			
28	Üniversitelerde zorunlu veya seçmeli bir ders bağlamında gerçek hayat uygulamaları konusu öğretmen adayları ile işlenmelidir.			
29	Hizmet içi eğitimlerde günlük hayat problemleri ve matematiksel modelleme konuları işlenmelidir.			
30	Konu ile ilgili kaynak eksikliğini giderecek çalışmalar yapılmalıdır.			
31	Müfredatlara gerçek hayat durumlarını yansıtan daha çok örnek konularak öğretmenlerde farkındalık yaratılmalı.			

Appendix C: Examples of the First Round Open-ended Questionnaire Answers

Italicized sentences under each Turkish statement are a summary of each in English. Codes (1-31) in the table below correspond to the item codes in the second round Likert scale. Questions from 1a-7a are the original questions of the first round open-ended questionnaire. This appendix might help to understand how responses to the first round open-ended questionnaire were analyzed in order to capture the themes in the second round Likert scale.

1a. Lütfen lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın avantajlarına, kısa açıklamaları ile birlikte örnekler veriniz.

Please give examples with short explanations for the advantages of using real world connections (RWCs) in high school mathematics curriculum.

1.Soyut bir yapısı olan matematiğin konu ve kavramlarının günlük hayatta veya gerçekçi durumlarda ne şekilde kullanıldığı gösterildiğinde öğrencilerin "bunu neden öğreniyoruz? Nerede nasıl, kimin işine yarayacak?" gibi sorularına bir ölçüde cevap bulabilir ve öğrenmeye ilgi/motivasyon artırılabilir.

Students understand why they learn mathematics, seeing where and how mathematics is used in real life, thus it increases their motivation and interest in mathematics.

2.Matematiği ve matematik öğrenmeyi anlamlı kılar. Matematiğin kavramsal yönünü daha derinlemesine ve sağlam biçimde görmelerine yardımcı olur.

Helps conceptual and meaningful and permanent learning.

3.Öğrencilerde, anlamlandırma, çıkarımda bulunma, olaylara farklı bakabilme, ilişkilendirme gibi becerilerini kullanma ve geliştirme imkânı sağlar.

Helps the development of students' interpretation skills of mathematical ideas, and

looking at something from a different aspect.

4.Öğrencilerin gelecekte seçecekleri ve öğrenim görmek istedikleri alanları yüzeysel olarak değil de daha bilinçli seçmelerinin önü açılabilir.

Makes students conscious about their future career choices by showing occupational fields in which mathematics is used.

5.Daha olumlu tutum geliştirmelerine yardımcı olur.

Makes students develop positive attitudes towards mathematics.

6. Matematiksel fikir ve kavramların genellememesini ve soyutlanmasını daha kolaylaştırır.

Facilitates generalization and abstraction of mathematical ideas and concepts.

2a. Lise matematik müfredatını öğretirken gerçek hayat bağlantılarını kullanmanın dezavantajlarına ve sınırlılıklarına kısa açıklamaları ile birlikte örnekler veriniz.

Please give examples with short explanations for the disadvantages and limitations of using RWCs in mathematics.

Dezavantajlar (*Disadvantages*)

7.Gerçek hayat bağlantılarını kullanmanın dezavantajı olduğunu düşünmüyorum.

There is no significant disadvantage.

8.Kavram yanılgısı oluşabilir örneğin benzerlik diyoruz ama bu matematikte farklı gerçek anlamda farklı anlam taşıyor.

It may result in misconceptions (e.g. the concept of similarity carries different meanings in mathematics and the real world).

9.Matematiğin büyük oranda soyut düşünceler barındırdığı ve sürekli genişleyen bir disiplin olduğu düşüncelerinin gelişmesini engelleyebilir.

Prevent students from seeing that mathematics includes a large amount of increasingly-growing abstract concepts.

10.Zihinsel karışıklığa yol açabilir. Günlük yaşam uygulamaları gereğinden fazla karışıkça çok fazla zihinsel kaynak kullanımı gerektirebilir. Bu durum bıkkınlığa yol açabilir.

If the given examples are complex, learning the mathematics of the problem can be difficult.

11.Gerçek hayat durumları incelenirken öğrencilerin elde etmesi hedeflenen matematiksel fikirler hedefinden uzaklaşılabilir. Ayrıca, uygun gerçek hayat durumları seçilemezse öğrencilerin elde ettikleri bilgileri başka durumlara transferi zor olabilir. Bunun dikkate alınmadığı durumlarda öğrencilerin matematiksel kazanımları sınırlı kalabilir.

If real world examples are ill-chosen, the gains of the lessons might be limited to the given real world problem and it might be difficult to transfer acquired knowledge to other situations.

12.Gerçek hayat bağlantıları matematiğin sadece gerçek hayatla sınırlı olduğu kanısını geliştirebilir.

Students may think that mathematics is only limited to real life.

Sınırlılıklar (*Limitations*)

13.Matematikteki her konunun, gerçek hayat bağlantısı vermeye uygun olmaması; çarpanlara ayırma gibi.

It is not suitable to use real world connections for each topic in high school mathematics curriculum. Factorization is an example.

14.Düşündüğüm tek sınırlama müfredatta uygun zaman boşluğunun olmaması.

Lack of time is one limitation to using connections.

15.Sınırlılıkları konusunda öğretmenlerin istekliliği konu ile ilgili yeterliliği çok önemlidir.

Lack of adequately equipped teachers and their reluctance is important.

16. Matematik öğretiminde gerçek hayat durumlarını yansıtan sorular kullanılırken bu soruların öğrenciler için ne kadar gerçekçi olduğu, deneyimleri ile ne kadar ilişkili olduğu dikkate alınmalıdır.

Teachers should consider whether or not given examples are realistic and related to students' experiences.

4a. Bir lise matematik konusunu öğretirken sizce matematiğin soyut kısmı öğretildikten sonra mı gerçek hayat bağlantılı örnekler verilmeli, yoksa önce gerçek hayat bağlantılı örnekler ile başlayıp sonunda mı soyut genelleme yapılmalıdır? Neden?

While teaching a mathematics topic, should mastering the abstract come first with application coming later; or starting with real world connections and then reaching abstract generalizations of the content? Why?

17. Kişisel felsefe olarak önce gerçek hayatla bağlantı kurarak başlamayı tercih ederim. Önce gerçek hayat bağlantılı bir örnek verilmesi öğrencinin hem konuyu merak etmesini hem de soyut kısmını daha kolay kavramasını ve konuyu anlayarak öğrenmesini sağlar.

Real world connections should be done before abstract generalizations; it helps students' comprehension of mathematical ideas.

18. Ben bunun genellenebileceğini düşünmüyorum. Bazı konular için gerçek hayat örnekleri ile başlanıp soyut genellemeler ile sonlandırılabilir, bazıları için ise önce soyut başlayıp sonra gerçek hayat örneklerine geçilebilir. Bunun konunun öncesinde ya da sonrasında yer alan başka konularla ilişkisi, öğrencilerin ön bilgisi ve konunun kendisi ile şekillendiğini düşünüyorum.

This situation is not generalizable, possible places of these connections depends on

the topic and nature of the problems. It depends on the connections between other topics and students' background knowledge.

19.Eğer gerçek hayat durumu sorusu daha çok “uygulama” tipi bir soru ise matematik konusunun öğrenilmesinde yeterince etkili olmayabilir. Bu anlamda konunun sonunda verilmesi daha uygun olabilir.

If problems are application oriented, it is more useful to use them towards the end of the lessons.

5a. Gerçek hayat bağlantılarının kullanımı her sınıf ortamı ve her öğrenci grubu için uygun mudur? Örneğin, seviyesi yüksek ve de idare edilmesi kolay sınıflarda bu bağlantıları kullanmak daha mı uygundur? Neden?

Is using real world connections appropriate for all students and classrooms? For example, is it more appropriate to use real world connections with gifted students and easy-to-handle classrooms? Why?

20.Evet, gerçek hayat bağlantılarının kullanımı her sınıf ortamı ve her öğrenci grubu için uygundur. Hem “seviyesi yüksek ve de idare edilmesi kolay sınıflarda” hem de “seviyesi düşük ve de idare edilmesi zor sınıflarda” gerçek hayat bağlantılarının kullanılması her zaman etkili olabilir.

Using these connections is suitable for any student group and always effective.

21.Her türlü sınıfta kullanılabilir. Hatta idare edilmesi ve ilgili düşük sınıflarda günlük hayattan bir durumun matematiksel modellemesi bağlamında bir etkinlik öğrencileri motive etmek için çok olumlu sonuçlar vermekte (bu kendi çalışmalarımda gözlemlediğim gibi literatürde de rapor edilmekte).

The connections can be used in any classroom environment; in fact it is more suitable for groups of students who have lack of interest towards mathematics (it is reported in the literature and I know it from my own studies about the issue).

22. Bence uygundur. Sadece seviye önemli, yani eğer sınıf seviyesi düşükse o zaman vereceğiniz günlük yaşam örnekleri çok karmaşık olmamalı.

Problems shouldn't be complicated for less able student groups.

23. Seviyesi yüksek sınıflarda konuların kavranması için bu tarz örneklere çok ihtiyaç olmayabiliyor.

There is no need to use these connections for very able student groups.

6a. Gerçek hayat bağlantılarını kullanmanın avantajını elde edebilmek adına bu bağlantıların lise sonrası üniversiteye giriş sınavlarıyla uyumlu olması için çözüm önerileri neler olabilir?

What are some ways to ensure that assessment in the university entrance exams is in line with instruction that makes effective use of RWCs in high schools?

24. Test tekniğinin başarı için öne çıktığı sorular yerine problem çözmeyi öne çıkaran sorular ve bu felsefe çevresinde bir ölçme yaklaşımı olursa netice alınabilir.

Rather than multiple choice questions, assessing problem solving skills of the students should be a concern of the university entrance exams.

25. Bu tür sorular öğrencilerin konular üzerinde pratik yapacağı, elde ettiği matematiksel fikirleri kullanabileceği üniversite sınavında da çıkabilecek sorularla desteklenmelidir.

There should be practical examples of the university entrance exams after using real world problems in lessons.

26. Sınavlarda çok uzun anlatımlı sorular şekline dönüşüyor, okuma problemi yaşıyor. Zamanı kötü kullanmasına neden oluyor. Belki sosyal sorularında daha olumlu olabilir.

Since solving these problems requires time there might be lack of time in the exam to solve these problems, they might be more appropriate in social studies.

7a. Türkiye’deki lise öğretmenlerinin matematiği gerçek hayat bağlamında öğretme konusunda yeteri kadar donanımlı olduğunu düşünüyor musunuz? Bu konuda varsa öğretmen eğitimcilerine önerileriniz nelerdir?

Do you believe that high school teachers in Turkey are sufficiently equipped to teach mathematics in a real world context? Please offer suggestions for teacher educators on the use of real world connections to be able to help prepare pre-service teachers?

27. Hayır, düşünmüyorum, kendi eğitimimden hatırladığım kadarıyla böyle bir bağlantı sadece “bağlantı” olarak tanımlanan, asla örnekleri ve prensipleri verilmeyen bir kavramdı.

High school teachers are not able to use real world connections. In my education the connections were only defined as “connections”, and examples and principals of the connections were not taught any more.

28. Önerim, bununla ilgili bir seçmeli dersin açılması ya da proje dersi yapısında getirilecek bir zorunlu ders kapsamında bu tip örneklerin hem araştırılması, hem de yenilerinin ortaya çıkarılması için öğretmen adaylarına öğretmenler ve öğrencilerle birlikte çalışma fırsatı verilmesi.

There should be elective courses in education faculties to teach student teachers how to use these connections effectively; new examples of the connections should be developed.

29. Hizmet içi eğitimlerde günlük hayat problemleri matematiksel modelleme bağlamında eğitimler verilmeli.

Using real world connections and mathematical modeling should be included in in-service teacher trainings.

30. Öncelikle bu konudaki kaynak eksikliğini giderecek çalışmalar yapılmalıdır.

There should be studies to develop sources of real world problems.

31.Müfredatlara gerçek hayat durumlarını yansıtan daha çok örnekler konarak öğretmenlerde bir farkındalık oluşturmalıdır.

Real world connected examples should be included more in the curriculum to improve awareness of teachers.

Appendix D: Results of the Likert Scale

Theme	Code	Questions	Agree	Disagree	No Opinion	Total
Advantages of RWCs	1	Increases motivation and interest in mathematics.	0.96	0	0.04	1
	2	Helps conceptual and meaningful and permanent learning.	1	0	0	1
	3	Helps the development of students' mathematical process skills (reasoning, communication, problem-solving, analytical thinking, etc.).	0.96	0.04	0	1
	4	Makes students conscious about their future career choices by showing occupational fields in which mathematics is used.	0.88	0	0.13	1.01
	5	Makes students develop positive attitudes towards mathematics.	0.92	0	0.08	1
	6	Facilitates generalization and abstraction of mathematical ideas and concepts.	0.75	0.08	0.17	1
Disadvantages of RWCs	7	There is no a significant disadvantage.	0.67	0.25	0.08	1
	8	It may result in misconceptions (e.g. the concept of similarity carries different meanings in mathematics and real sense).	0.29	0.71	0	1
	9	Makes abstract thinking difficult, some topics should remain abstract.	0.33	0.58	0.08	0.99
	10	If given examples are complex, to learn mathematics of the problem can be difficult.	0.63	0.25	0.13	1.01
	11	Gains of the lessons might be limited to the given real world problem and it might be difficult to transfer acquired knowledge to other situations.	0.42	0.46	0.13	1.01
	12	Students may think that mathematics is only limited to real life.	0.21	0.75	0.04	1
Limitations of RWCs	13	It is not suitable to use real world connections for each topic in high school mathematics curriculum.	0.71	0.25	0.04	1
	14	Density of the curriculum and lack of time is a kind of limitation to use connections.	0.58	0.33	0.08	0.99
	15	Lack of adequately equipped teachers and their reluctance is a kind of limitation.	0.92	0.04	0.04	1
	16	It is a limitation, if given examples are unrealistic and not related to students' experiences.	0.67	0.13	0.21	1.01

Possible places of RWCs in lessons	17	Real world connections should be done before abstract generalizations.	0.46	0.42	0.13	1.01
	18	This situation is not generalizable, possible places of these connections depends on the topic and nature of the problems.	0.71	0.21	0.08	1
	19	If problems are application oriented, it is more useful to use them towards the end of the lessons.	0.54	0.29	0.17	1
Students' level and classroom environment	20	Using these connections is suitable for any student group and always effective.	0.54	0.38	0.08	1
	21	More suitable for groups of students who have lack of interest towards mathematics.	0.13	0.75	0.13	1.01
	22	Problems shouldn't be complicated in less able student groups.	0.79	0.17	0.04	1
	23	There is no need to use these connections for very able student groups.	0.21	0.75	0.04	1
The university entrance exam	24	Real world connected problems should be included in the university entrance exams.	0.63	0.29	0.08	1
	25	There should be practical examples of the university entrance exams after using these connections in lessons.	0.71	0.21	0.08	1
	26	There might be lack of time in the exam to solve these problems.	0.38	0.46	0.17	1.01
Preparedness of the teachers to use RWCs	27	Most of the high school teachers are not able to use real world connections.	0.88	0	0.13	1.01
	28	There should be elective courses in education faculties to teach student teachers how to use these connections effectively.	0.92	0.04	0.04	1
	29	Using real world connections and mathematical modeling should be included in in-service teacher trainings.	0.96	0.04	0	1
	30	There should be studies to develop sources of real world problems.	0.96	0	0.04	1
	31	Real world connected examples should be included more in the curriculum to improve awareness of teachers.	0.96	0.04	0	1

Appendix E: Permission from the Ministry of National Education

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T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : İstatistik Bölümü
SAYI : B.08.4.MEM.0.06.20.01-60599/79330
KONU : Araştırma İzni
Gökhan KARAKOÇ

07/10/2011

BİLKENT ÜNİVERSİTESİ
(Eğitim Bilimleri Enstitüsü)

İlgi : a) MEB Bağı Okul ve Kurumlarda Yapılacak Araştırma ve Araştırma Desteğine
Yönelik İzin ve Uygulama Yönergesi.
b) Üniversiteniz Eğitim Bilimleri Enstitüsünün 28/09/2011 tarih ve 19687 sayılı yazısı.

Üniversiteniz Eğitim Bilimleri Enstitüsü yüksek lisans öğrencisi Gökhan KARAKOÇ'un "Lise matematik derslerinde gerçek hayat bağlantılarının kullanımı hakkında uzman ve öğretmen görüşleri" konulu tezi ile ilgili çalışma yapma isteği Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

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Gülçin UYSAL
Müdür a.
Müdür Yardımcısı

EKLER :
Anket örnekleri (6 sayfa)

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