

Real-life contexts in mathematics and  
students' interests  
An Albanian study



Suela Kacerja

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# Preface

This PhD research has been an amazing journey, a life changing experience in a professional and also a personal sense, with all of the beautiful and difficult moments I experienced. There are many people I wish to thank whose help has been a continuous motivator for me to complete the study.

I want to thank my supervisors, Professor Cyril Julie and Professor Said Hadjerrouit, for their guidance and inspiration on this scholarly journey. Their wisdom and knowledge are appreciated and I am grateful for having had the honour of working with them. Their constant support has been a valuable asset for me throughout the research project.

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I want to thank the staff of the Faculty of Education at the University of the Western Cape for their hospitality during my two visits to South Africa, and for giving me the opportunity to discuss my research with them. Thanks to the mathematics departments at the University of Agder and University Luigj Gurakuqi for signing an agreement so that I could pursue my studies in Norway. Erkki Pehkonen has read and commented on parts of my thesis as an opponent during the 90% seminar. I take this occasion to thank him for his constructive suggestions that helped me towards further improvements.

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you for making it easier for me by always being so close to our parents after the first moment I left Albania!

Finally and most importantly, there are two persons to whom I dedicate this thesis, the persons who brought me up to be the woman I am, my parents, Ymer and Servet Kacerja. My deepest gratitude goes to them for their unconditioned love and support, and especially for always instilling in me the value and power of education. I know this is one more reason for you to be proud of me, so this thesis is dedicated to you!

Suela Kacerja  
Kristiansand, Norway  
April, 2012

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# 1 Introduction

## 1.1 Motivation and background

Since I started studying mathematics at the University Luigj Gurakuqi, in Albania, I knew my future led me towards teaching mathematics, in either a lower or upper secondary school. An opportunity opened up for me at the end of my four years of studies when I was offered a position to teach at the Mathematics Department at that same university. The work there is focused on education for mathematics teachers, but also in offering mathematics courses for other university departments. It was because of an agreement between University of Agder and the University Luigj Gurakuqi that I had the opportunity to pursue a doctoral in Mathematics Education in Norway.

The tradition I come from perceives mathematics as a formal science, with rules and laws. In that tradition the factors that could be studied as part of the Didactics of Mathematics had more to do with cognition, while affective factors were not considered. The decision to pursue a doctoral degree in Mathematics Education grew from the desire to learn about, and work, in an important field that is not well developed in Albania.

As a university mathematics lecturer, I have often met students from different faculties that had difficulties with mathematics concepts. One of the questions these students frequently asked concerned the use of the mathematics they were required to learn, without being able to provide an answer themselves. I have also experienced teaching mathematics to lower secondary school students who are 11-14 years old. From that experience, I know that what is taught in mathematics classrooms in our secondary schools is mathematics as a science, in traditional ways, where some students find it difficult to understand and then love it. Students saw the use of mathematics mostly in relatively obvious and superficial ways such as shopping or calculating the bill in a restaurant. During some of my discussions with students, I heard the reasoning that mathematics “is not for them” and that they “have to have a talent for it”. Because of this, they would study law or social science subjects, which, according to them, do not require mathematics. Going back to my school student years, during mathematics lessons, there were very few examples of the use of mathematics in different contexts in life.

In my work as a teacher, I did not talk about mathematics relating to real-life situations such as developing computer games, mathematics linked to music, or about mathematics that could be used to obtain the interest of students. I did my best to explain mathematics concepts in a

way that would be clearer to students, while following the mathematics program. However, as a teacher, one could stop and think: Do students understand where and how they could use the subjects I am teaching? Do they have their own opinions about what they should learn in mathematics? Are they curious to know how mathematics is used in their individual areas of interest? Are they aware that mathematics is used even in specific areas of interest that apparently do not look to have anything in common with mathematics, such as music?

I find inspiration in the reasons that Niss (2007) gives about why we conduct research in teaching and learning mathematics:

We do research in teaching and learning mathematics because there are far too many students of mathematics, from kindergarten to university, who get much less out of their mathematical education that would be desirable for them and for the society. We believe that they could learn much more, and in much better ways, if the conditions and circumstances for teaching and learning were different (p. 1293).

These are the reasons I found the topic of real-life situations, or contexts, in mathematics very interesting, and became involved in the Relevance Of School Mathematics Education (ROSME) project (Julie & Mbekwa, 2005) and, with that, a part of a research community in Mathematics Education.

## **1.2 Description of the project and research questions**

As explained above, the study included in this dissertation is part of the ROSME research project, which embarked upon a study of the notion of relevance of, and interest in, real-life situations for use in school mathematics.<sup>1</sup>

Ernest (2003) discusses utility versus relevance as two distinct ideas. Utility is more focused on usefulness that can be assessed in a short time, while an object is considered as relevant when a person or group perceives it as such in achieving a goal. Thus, if something such as mathematical knowledge is deemed relevant by the adults who lead the school system, it is not guaranteed to be relevant for students as well. In order for students to see relevance in mathematical activities:

...an open pedagogy sensitive to their expressed interests and desires is necessary. Beyond this, it also needs to make space for and to respect their voices, attitudes, concerns and even dissent. A truly relevant mathematics curriculum (i.e., seen by learners as relevant to their own interests and goals) requires negotiation to arrive at a balance between what we as mathematics educators regard as valuable, what the state requires for mathematical certification, and last but not least, learner interests, goals and own choices (p. 323).

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<sup>1</sup> The ROSME project was inspired by the Relevance Of Science Education (ROSE) project (Schreiner & Sjøberg, 2004).

Students' interests are considered by Ernest (2003) as important to take into account as are experts' opinions, and as a state's mathematics requirements. Students' interests stand at the core of the research presented in this dissertation, where students were asked to express their preferences for real-life situations, or contexts, to be used in mathematics learning.

The use of real-life situations in mathematics is a widely discussed matter in school mathematics in general. In addition, parts are seen in different mathematics curricula in one form or another, including in textbooks (COMAP, 2000; Du Toit, Human, Olivier, Nicholson and Pillay, 1991; Encyclopaedia Britannica, 2011; Lappan, Fey, Fitzgerald, Friel and Phillips, 2004; National Mathematics Advisory Panel, USA, 2008; Qualifications and Curriculum Authority, UK, 2007; Romberg, 1998).

Verschaffel, Greer, and De Corte (2000) define real-life contexts or situations as "textual descriptions of situations assumed to be comprehensible to the reader, within which mathematical questions can be contextualized" (p. v). Real-life contexts or situations constitute an important dimension in well-known international assessment programs such as the Programme for International Student Assessment (PISA) (OECD, 2010), in which Albania participated in 2000 and 2009. In the mathematics assessment, one of the three components of the Mathematics domain is 'situations or contexts' where the problems are located, together with the mathematical content and the mathematical competencies required for solving a specific problem. Problems in the test are introduced from different areas of life ranging from those very close to students' personal lives, towards educational/occupational lives, to public and then to scientific contexts. In summary,

PISA places most value on tasks that could be encountered in a variety of real-world situations and have a context in which the use of mathematics to solve the problem would be authentic. Problems with extra-mathematical contexts that influence the solution and its interpretation are preferred as a vehicle for assessing mathematics since these problems are most like those encountered in day-to-day life (OECD, 2010, p. 93).

Selection of real-life situations to address generally ignores the views of students, important stakeholders, about suitable situations to be used in the teaching-learning process. There are virtually no research studies on students' preferences for real-life situations to be used in mathematics. This lack of research was one of the primary motivations for researchers from different countries to embark on the ROSME project. At the outset, the project involved mathematics educators from South Africa, Zimbabwe, Uganda, Eritrea, Norway and mathematics teachers from South Africa and South Korea (Julie & Mbekwa, 2005). It focussed on students in grades 8 to 10, and a 61-item questionnaire was designed to collect information about students' expressed preferences for different real-life

situations to be used in mathematics. Julie & Mbekwa (2005) comprehensively discuss the development of the instrument. They highlight that the contexts were categorised around thirteen clusters and that the guiding criterion, in line with the definition given above, was that the contextual situations should allow for mathematical treatment.

Julie & Holtman (2008) provide an analysis of the functioning of the 61-item instrument. Rasch procedures were used for this analysis. The analysis revealed a redundancy in some of the items, as shown by the item-person map. Items sharing the same location on the scale were further inspected for their conceptual similarities or differences. In cases where items had conceptual differences, they were kept as such even when sharing the same location on the person-item map. As a result of the analysis, after discussions between the ROSME group participants, a questionnaire with 23 items was developed. In August 2008, the author of this thesis was part of some of the last discussions in the group, before the final version of the questionnaire was decided. Table 1 lists the groups of items from the first version that were replaced with one item in the new version. Care was taken to retain the broad categories used.

**Table 1: Replacement of items in the second questionnaire**

First version questionnaire		Second version questionnaire	
Item	Item description	Item	Item description
C3	Mathematics involved in making computer games such as play stations and TV games	C10	Mathematics used in making computer games and storing music and videos on CD's and iPods
C42	Mathematics of the storage of music on CDs		
C7	Mathematics used in making air-planes and rockets	C23	Mathematics used in construction and engineering
C25	Mathematics involved in making complex structures such as bridges		
C11	Mathematics that is relevant to professionals such as engineers		
C8	How to estimate and project crop production	C5	Mathematics used in agricultural matters
C36	Mathematics involved in working out the best arrangement for planting seeds		
C17	Mathematics involved for deciding the number of cattle, sheep or reindeer to graze in a field of a certain size		
C14	Mathematics needed to work out the amount of fertilizer needed to grow a certain crop'		
C16	Mathematics used to calculate the taxes people and companies must	C6	Mathematics used in government financial matters, such

	pay to the government		as inflation and taxes
C18	Mathematics of inflation		
C10	Mathematics political parties use for election purposes	C14	Mathematics used in national and international politics
C31	Mathematics used to calculate the number of seats for parliament given to political parties after elections		
C30	Mathematics linked to South African pop music	C13	Mathematics used in all kinds of pop music
C38	Mathematics linked to music from the United States, Britain and other such countries		
C20	Mathematics involved in determining the state of health of a person	C7	Mathematics used in health matters such as the state of health of a person, the amount of medicine a sick person must take
C22	Mathematics to prescribe the amount of medicine a sick person must take		
C56	Mathematics to describe facts about diminishing rain forest and growing deserts	C11	Mathematics used in environmental issues and climate change
C19	Mathematics about renewable energy sources such as wind and solar power		
C60	Mathematics involved in determining levels of pollution		
C47	Mathematics involved in working out financial plans for profit-making	C17	Mathematics used in managing personal and business financial affairs
C50	Mathematics used to work out the repayments (instalments) for things bought on credit		
C48	Mathematics involved in my favourite sport	C18	Mathematics used in recreation, physical exercise, sport activities and competitions
C52	How mathematics can be used by setting up a physical training program, and measure fitness		
C58	How mathematics can be used in sport competitions like ski jumping, athletics, aerobic, swimming, gymnastics and soccer		
C24	Mathematics involved in the placement of emergency services such as police stations, fire brigades and ambulance stations so that they can reach emergency spots in the shortest time possible	C19	Mathematics used in responding to emergencies and disasters
C49	Mathematics involved in dispatching a helicopter for rescuing people		

Some other items were retained in the second version. These are: “mathematics of lottery and gambling”, “mathematics used to predict the growth and decline of epidemics such as AIDS, tuberculosis and cholera”, “mathematics used in secret codes such as PIN numbers used for withdrawing money from an ATM”, “mathematics to assist in the determination of the level of development regarding employment, education and poverty of my community”, “mathematics involved in sending of messages by SMS, cellphones and e-mails”, “mathematics linked to cultural products”, and “mathematics used in planning a journey”.

The questionnaire is a closed response 4-option Likert-type scale with choices of null/zero interest, low interest, high interest, and very high interest given values of 1, 2, 3 and 4, respectively. No negative categories are taken into account due to the fact that the lower options are indicative of not being interested at all in doing something, with the other extreme of being very interested.

The second phase of this project proceeded with the revised instrument containing 23 items. It commenced in 2008 with South Africa, South Korea, and Albania participating. During 2008-2011 in the Albanian study, other methods and data in addition to the questionnaire were added as part of the research endeavour.

The aims of the research presented here are in line with those of ROSME study, stated as:

- To develop evidence-based knowledge about real-life contexts/situations grades 8 to 10 pupils would prefer to deal with in school mathematics education.
- To develop localised theory related to the mechanisms generating the particular preferences of pupils in diverse socio-economic environments.
- To obtain base-line data about the preferences of real-life contexts/situations pupils hold and use this for future trend studies on such preferences.

In order to achieve these aims, the research questions used to guide this study are:

1. What is Albanian students’ hierarchy of preferences and interests for real-life situations that can be used in mathematics and what, if any, are the differences in this hierarchy in relation to gender and school locations?
2. How does an instrument developed for measuring preferences for real-life situations work in two different countries?
3. What are Albanian students’ motives for preferring certain real-life situations?



4. To what extent can students' motives for preferring certain real-life situations be explained by Bourdieu's concepts of habitus, capital, and field?

### **1.3 The situatedness of the study within Mathematics Education as a research discipline**

In this section, a map of the research for this thesis in Mathematics Education as a research field is offered. The author pursued this direction with the idea that premises upon which research is built should be as clear as the results generated from it. Described and argued first is what the field of Mathematics Education is, what it includes, and what the objects of study and research problems are. This is followed by arguments for the positioning of the study in the field.

There is no agreed definition of Mathematics Education, probably due to the differing views scholars hold about it. Niss (1999) offers the following definitions, which, in the author's view, captures the field's character:

The didactics of mathematics, alias the science of mathematics education, is the scientific and scholarly field of research and development which aims at identifying, characterizing, and understanding phenomena and processes actually or potentially involved in the teaching and learning of mathematics at any educational level (p. 5).

Steiner (1985) points out the complexity of Mathematics Education with mathematics as a complex 'phenomenon', while Niss (2007), some years later, refers to the growing complexity of the subjects and the objects of study. In the ICMI study conference (Sierpinska & Kilpatrick, 1998), Steiner's description of the field was used as a basis in one of the discussion groups. Mathematics Education was treated as a discipline in itself, inside the field of education, and in interdisciplinary relationships with other disciplines, including mathematics itself. Similarly, Niss (1999) considers matters from psychology, philosophy, science, etc., as processes around teaching and learning Mathematics, and methods and results from these fields as important. Recently, English (2008) acknowledges the shift from a psychological and pedagogical perspective towards a broader perspective that includes, among others, social aspects of the field.

Steiner (1985) applied a systematic approach to the field, warning that it is important to take into account all of its different aspects and subsystems when doing research, and that there is a need for both micro and macro models in the field. Niss (1999; 2007) takes a similar position when reflecting about the Didactics of Mathematics as a scientific field. Otte was cited in Steiner (1985) with his definition of the scientific object of Didactics of Mathematics as:

the content related and accordingly organized system of relations between all the partners who take part in the realization of mathematics education and its integration into the comprehensive educational and societal contexts additionally determined by the aspect and task of optimization (p. 11).

Thus, there is a view of Mathematics Education as a research discipline striving to improve mathematics teaching and learning at all school levels, by investigating those directly and collaborating with other fields relevant to it (such as sociology, psychology, pedagogy etc.), in order to explain phenomena related to these activities (teaching and learning of mathematics), ranging from the personal level to the individual in the classroom or society.

Niss (2007) identifies ten major areas within which answers are sought in research in Mathematics Education. He refers to these areas as ‘problematiques’, and characterizes them as:

- the mathematics that should be taught to different people for different purposes, and the purposes for doing so;
- the learning and teaching processes that take place;
- the way mathematics serves different individuals or groups;
- preparation of teachers of mathematics and their desired competencies;
- mathematics as a subject compared to other school subjects;
- assessment of learners’ mathematical competencies and achievements;
- efficient policies for mathematics;
- the affective domain such as students’ beliefs, affects and attitudes to mathematics;
- what is the meaning of the mastery of mathematics at an overarching level; and
- what is Mathematics Education (pp. 1293-1295).

As is explicit here, Niss sees the affective domain immersed in the field of Mathematics Education as naturally as the other research domains. Many other researchers have accepted explicitly that affect is an important dimension in research in Mathematics Education. From the socio-constructivist perspective, for example, “Grounded in and bounded by the specific context and broader socio-historical contexts, affective processes, in close interaction with (meta) cognitive and motivational processes, determine students’ learning behaviour” (Op’t Eynde et al., 2006). Leder & Forgasz (2006) state that mathematics curricula also stress the importance of students’ confidence in mathematics and their positive attitudes toward it. The centrality of the affective domain in the field of mathematics education is emphasised by Goldin (2002) who asserts: “When students are doing mathematics, the affective system is not merely auxiliary to cognition-it is central” (p. 60).

The study presented in this dissertation is positioned in the affective domain. It is constructed around the concept of interest in school mathematics, and is connected to students' motivation for learning mathematics. This study considers the sociological aspects that influence students' learning of mathematics with various real-life contexts, and it is, therefore, included in the shift that English (2008) mentioned wherein more aspects of Mathematics Education are encompassed. In particular, attention is called for in the interaction between the complexity of mathematics and students' preferences for learning mathematics in context. This is a phenomenon related to the teaching and learning of mathematics, and includes one important group of participants in that process, the students.

Having situated the affective domain within the field of Mathematics Education, the next step is to situate the study within the affective domain. Therefore, a description of this domain follows. It is not possible to find an overall agreed to, and unique, definition for the components of affect in Mathematics Education, but, as Hart (1989) says, it is important to say what is meant when writing about affective issues.

In McLeod and Adams (1989), three main components related to affect are discussed: emotions, beliefs and attitudes. DeBellis & Goldin (2006) use a tetrahedral model for defining the affective domain, which is an extension of the three sub-domains offered by McLeod and his collaborators. The authors describe it as constituted by four sub-domains of affective representation (the individual affect): emotions, beliefs, attitudes, and values, ethics, and norms. These concepts differ from each other in the degree of stability, intensity, affect, and cognition they involve.

Op't Eynde et al. (2002, p. 28) describe the concept of students' mathematics-related beliefs using three components, each of them having subcomponents: beliefs about mathematics education, beliefs about self (motivational beliefs), and beliefs about the social context. Pehkonen (2004) sees beliefs as "situated in the "twilight zone" between the cognitive and the affective domain, and thus, have a component in both domains" (p. 2), and adopts a broad view of beliefs as a person's "subjective, experience-based, often implicit knowledge of, and emotions about, some matter or state of affairs" (p. 3).

According to Hannula et al. (2004), these four concepts do not cover the entire affective field. For Hannula (2007, p. 201), one of the three different ontological approaches to affect is to consider it as an aspect of human psychology and, further, as a state or as a trait, where the first one means a dynamic state that fluctuates and the second a more stable one that repeats sometimes. In this second approach, affect as a trait of human psychology, motivational orientation is one of the concepts, together with attitude, values, and beliefs.

Motivation is, therefore, another important concept in the affective domain which Hannula (2004) defines as “a potential to direct behaviour that is built into the system that controls emotion. This potential may be manifested in cognition, emotion, and/or behaviour” (p. 3). The manner in which this potential is realised is through needs and goals. Hannula (2006) puts needs at the root of motivation and defines them as “specified instances of the general potential to direct behaviour” (p. 167). He refers to Nuttin for a distinction between needs and goals based on the specificity of their direction: needs toward many objects, and goals toward a specific object.

Yet another concept in the affective domain is that of interest. The research introduced in this dissertation is devised around this concept. Here, affect is conceptualized as an aspect of human psychology and interest is an affective concept, a relatively stable one. Explanation of the notion follows in section 3.2.

## **1.4 Overview of the thesis**

This thesis consists of 10 chapters commencing with an introductory chapter. The second chapter consists of a literature review of research on real-life contexts or situations in mathematics. Here, four primary sections are included: a view on Realistic Mathematics Education as one well known approach for teaching and learning mathematics with real-life situations; studies about the effect on the use of contexts in teaching, learning or assessment of mathematics; studies found based on research about context preferences; and results obtained from scanning the Albanian mathematics curriculum and textbooks for grades 8-10.

Chapter 3 is organised in two main sections, one about interest and the other about habitus, field, and capital. This chapter contains descriptions of the theoretical concepts used in this study. The section on interest contains definitions of interest, preference, and motives, as three main concepts reflected in the research questions as well. The definition for interest is grounded in an educational-psychological theory of interest, and preference and motives are then explained in relation to it. The other main section introduces three concepts from Bourdieu (1977), namely habitus, capital, and field, which are used herein as heuristic tools for explaining students’ motives for preferences.

The paradigm on which the research was designed is a realist one, as presented in chapter 4. Matters of ontology and epistemology, and fit within the mixed methodology chosen for the study, are discussed in this chapter, followed by chapter 5 wherein matters of methodology and methods are further explored. Advantages and disadvantages of questionnaires and interviews, as two methods used in the study, are discussed, followed by a description of the teaching units and a discussion

of realistic interviews. Data for the research were collected in two stages in Albania, information on which is found in chapter 5, which concludes with a discussion of data analysis. Here, the main elements of Rasch analysis of the quantitative data are introduced, as well as the manner in which qualitative data were analysed.

In chapter 6 there is an overview of the four articles on which the thesis is based. Section 6.2 discusses matters of reliability, validity, trustworthiness, and generalization.

Chapter 7 is constructed upon answers to the research questions posed in this study. The hierarchy of preferences for contexts and its gender and school location dimensions are extracted from the quantitative data and are presented in section 7.1. The next section presents results from the two rounds of interviews about students' motives for preferences for real-life situations that can be used in mathematics. In section 7.3, results from the quantitative and qualitative sections are summarized. A discussion of the functioning of the questionnaire in different countries, based on the second article, occurs in section 7.4, and places attention on two types of real-life contexts: the ones that can be used internationally, and the others that are of a more local nature. This chapter closes with a section (7.5) where students' motives for preferences are discussed using concepts such as habitus, field, and capital.

Conclusions for the uses of contexts as based on results from this study are offered in chapter 8. Chapter 9 discusses some limitations of the study, and chapter 10 presents the relevance of the study in mathematics education in general, especially in Albania, sets forth the groups that could potentially use the findings, and introduces further ideas for future research.



## 2 Research on real-life contexts in mathematics

This section contains a description of research already completed about the use of real-life contexts in Mathematics, amongst which is the Realistic Mathematics Education (Freudenthal, 1991) as a well-known approach to teaching and learning mathematics. Other major projects that focus on context-based driven curricula are the University of Chicago School Mathematics Project (McConnell et al., 1993; Usiskin et al., 1993; 1995 etc.) and the Modelling Our World project (COMAP, 1985-1992; COMAP, 1981-1992; Garfunkel & Steen, 1991). Following is a summary of primary studies on effects of the use of contexts in teaching, learning or assessment of mathematics. Studies on preferences for contexts include the results of searching for studies similar to the one presented here. Only three articles were found in other countries, in addition to the ROSME study. A description of the placement of real-life contexts in the Albanian curriculum and mathematics textbooks closes this descriptive section.

When searching for studies in the field with the words ‘real-life contexts’, ‘real-life situations’ or ‘contexts in mathematics’, many results came to the fore, but upon review one determines different uses of them. There are two different meanings associated with the word ‘context’. One has to do with ‘situation context’ (Wedeg, 1999; Van Den Heuvel-Panhuizen, 2005; Lave, 1988; Saljö & Wyndhamn, 1993), which are contexts where the learning of mathematics takes place and can include schools or workplaces, but also educational systems and policies. This is not the type of contexts taken into account in the present study. The focus is in the second type of context found in educational research, referring to the reality of the information, situation or event, on which the task or the teaching unit relies. This coincides with the definition by Verschaffel et al. (2000) discussed in section 1.2. It will, therefore, be referred to interchangeably as real-life context or situation, meaning the extra-mathematical situation embedded in an area outside mathematics.

### 2.1 Realistic Mathematics Education

Realistic Mathematics Education (RME) is closely connected to Freudenthal (1983; 1991) and the Netherlands. In this approach to Mathematics Education, the connection of mathematics to reality is at the core. This reality does not need to be real life situations; it can also be a fairy tale world as long as it fits with students’ experiential field (Van Den Heuvel-Panhuizen, 2005). Context problems “are used both to constitute and to apply mathematical concepts” (Van Den Heuvel-

Panhuizen, 1998, p. 2). In RME, mathematics is viewed as a human activity and it should be taught as to be useful:

What humans have to learn is not mathematics as a closed system, but rather as an activity, the process of mathematizing reality and if possible even that of mathematizing mathematics (Freudenthal, 1968, p. 7)

Students are considered active participants in the teaching-learning process (Gravemeijer & Terwel, 2000). Freudenthal (1991) highlights a process of guided reinvention, in that learners working on context problems re-invent mathematics by doing it, by reconstructing it in their own terms, under appropriate guidance. There are two ways of mathematizing according to Treffers (1987; 1993): horizontal mathematizing, where the learner starts with a problem from the real world and uses mathematical tools to solve it; and vertical mathematizing, which has to do with remaining inside mathematics while finding out and using mathematical relations, or “mathematizing one’s own mathematical activity” (Gravemeijer & Doorman, 1999, p. 117). Different levels of understanding are connected to the concept of mathematizing, that start with the student solving tasks in the context they are given, followed by a schematization of it, and ending in an understanding of the general structures of the problem and the solutions, in order to use it in other situations as well (Van den Heuvel-Panhuizen, 2003).

There is a great deal of work done within this tradition since its beginnings in the 1970s (Freudenthal, 1983; 1991; Gravemeijer, 1994; Gravemeijer & Doorman, 1999; Streefland, 1991; Treffers, 1987; Van den Heuvel-Panhuizen, 1998; 2006) and it spans primary school levels to more advanced mathematics levels of undergraduate studies. De Lange (1996) discusses some problems related to the implementation of a mathematics curriculum as claimed by RME. Two of these problems which are raised by Blum and Niss (1989) are related to the time devoted to mathematics that teachers complain about, and the challenges it brings to both students and teachers. Other problems as described by de Lange (1996) are related to “the ‘loss’ of teaching, the ‘loss’ of basic skills and routines, the ‘loss’ of structure, the ‘loss’ of goal clarity, the complexity of ‘authentic’ assessment, and the use of technology” (p. 86). Delving deeper into these problems is not the focus of this dissertation.

A difference in the way contexts are treated in RME and in this dissertation is the ‘reality’ issue, which, in ROSME, relates to more authentic, everyday life situations, while in RME, there is more experiential-reality. Mathematics in itself is not a context for us. There is not, to the author’s knowledge, any study in the RME tradition or approach about what real-life contexts or situations students would prefer apart from the studies about ways of teaching mathematics according to the RME principles.



## 2.2 Studies on effects of use of contexts

In this subsection, some of the papers containing studies or arguments about the effect that the use of contexts has on students' learning are included. Related pros and cons will be discussed here.

Boaler (1994) points out the problem of real-world contexts in a small-scale study with Year 8 students she conducted in two schools, one of which operated within a process-based learning environment and the other within a content-based learning environment. The three arguments given for teaching mathematics in context at that time were formulated as: enhancing learning by giving students a familiar context; motivating them; and enhancing the transfer of mathematical knowledge from the context at hand to real life. In the study, she examines these reasons by drawing attention to important aspects that should be fulfilled by the context tasks in order to justify their purpose. One such aspect is connected to the degree of 'reality' that students perceive as useful to include in their solving of the tasks, a problem that Cooper and Harries (2002) took up as well in a study of students' answers to two realistic problems. A second facet has to do with the degree of students' connectedness to contexts taken from the adult world, thus Boaler (1993a; 1993b; 1994) refers to the oversimplified assumptions that constitute the basis of real-life contexts' use, while emphasising taking into account each student's individual experience within a context. As for the transfer of learning matter, this is related to the degree in which students are able to generalise the mathematics in context and is a result of the discussions generated by the task, its openness, negotiations and interpretations of it, and students' given degree of autonomy (Boaler, 1993b). Results from the study involving the two schools revealed that girls in the content-based learning environment school underperformed in one fashion task, most likely because they were more involved in it. Boaler (1994) interpreted it to suggest that "contexts which involve real world variables should only be used in mathematics examples and questions if they require students to *consider* the real world variables introduced in the question" (p. 563). In further studies reported (Boaler, 1997; 1998), she reinforces these ideas.

There are quite a few studies in the United Kingdom concerning the use of realistic tasks in assessment (Cooper, 1998a; 1998b; Cooper & Dunne, 1998; 2000; Cooper & Harries, 2002). The authors explored the influence that the use of realistic contexts has on students. Based on tasks where mathematics is embedded in realistic contexts given to primary school students to solve, Cooper and Dunne (1998) conclude that there are differences on performance between students from different socio-cultural backgrounds. Using the concepts of recognition by Bernstein and habitus by Bourdieu, they explain the underachievement on

assessment of working class compared to service class children (children of professionals, administrators, and officials) as related to their socio-cultural characteristics in recognizing and interpreting the demands of the realistic tasks and including the appropriate everyday knowledge in solving them. In Cooper and Harries (2002), children's inclusion of realistic considerations in solving 'realistic' test items is taken into consideration. The authors analyse the 'realistic' items used in assessment where "a child is expected to introduce only some *particular* realistic considerations into her solution but will be penalised for introducing realistic considerations *in general*" (p. 1). They further used an adjusted version of a realistic test item such that children were encouraged to include more realistic reasoning in answering it. The boundary between students' everyday reasoning and knowledge and their mathematical knowledge as used in school is more blurred. This remark is a suggestion for the appropriate use of contexts in order to avoid problems of recognition, as in Cooper and Dunne (1998).

In the RME tradition, Van den Heuvel-Panhuizen (2005) enumerated the roles that context problems may have in assessment situations as:

- Enhancing the accessibility to problems;
- Contributing to the transparency and elasticity of problems; and
- Suggesting solution strategies to students (p. 2).

However, in order for the problems to have the intended impact it is required that they be meaningful and informative. Meaningfulness is translated to the problems being accessible, inviting, and challenging for the students, allowing them flexibility in solving it in different ways and at different levels, and to reflect important goals. They should further include open-ended questions, allow teachers to see an "accurate picture of the student" (p. 3), or be informative. Van den Heuvel-Panhuizen (2005) also indicates some unsolved issues with contexts in assessment, which include students' unwillingness to take context into account, sometimes their excessive involvement with the context, and the degree of reality that is supposed to be taken into account, as discussed also by Cooper and Harries (2002).

Beswick (2011, pp. 369-371), after review of relevant literature in the field, identifies five purposes for inclusion of context problems in mathematics curriculum. Two are connected to the utility of mathematics, and the rest are connected to mathematics learning:

- Utilitarian purposes, including meeting the economic needs of the society;
- Improving students' understanding of important issues;
- Improving students' understanding of mathematics concepts;

- Enhancing students' appreciation of the nature of mathematics; and
- Improving students' affect in relation to mathematics.

The last three purposes were reviewed by Beswick, who concluded that contexts' potential to enhance understanding exists in a complex relationship with the way they are used and the context "evoked, or intended to be evoked, by the problem" (p. 379). There are no studies on students' appreciation of the nature of mathematics influenced by contexts, and apparently not enough evidence for the influence on students' affect. These last appear to be effects more assumed than studied.

As can be noted from the multiple studies in the use of real-life contexts for teaching mathematics, it is not easy to provide a general, clear answer on its effects. As the author of this thesis understands it, this is related to: what types of contexts are used and how they are chosen; how contexts are used in a lesson or test; what are the purposes for using contexts; what are students' experiences with using contexts; what is the degree of opportunities for discussions provided by the contexts; what degree of reality is included and presupposed by the problem; what is the classroom context in which context problems are introduced; and many other variables that make it a complex problem, including the degree of students' interest in the problem represented. It is, however, a handful of studies, including the ones chosen to be referred to in this section, that pinpoint the conditions and characteristics to be fulfilled, or to be avoided, with regard to the use of contexts in tasks. In addition, there is, as revealed by Beswick (2011), a dearth of studies in the affective effects of contexts. The study presented in this dissertation, even though it does not go deeply into the contexts' impact on affective components, can be considered as a close neighbour of the aforementioned missing studies as it addresses the students' interests for contexts and their motives for them.

### **2.3 Studies on preferences for real-life contexts/ situations**

One reason why the ROSME project was initiated was the lack of studies on students' voices about preferred real-life contexts with which to learn mathematics. Indeed, there are only a few studies that include results about preferences. The focus of these studies is on other matters and students' preferences are only provided as secondary results.

One of these studies is by Kaiser-Messmer (1993), in Germany, where the ranking of students' preferences was one of the components as part of gender differences in attitudes towards school mathematics. There were differences between male and female students, aged between 14 and 19 years old, that also differed according to school level. An open-ended questionnaire was used to assess attitudinal differences,

where, in one part, students were asked about their preferred real-world themes for use in their mathematical activities. At the lower secondary school, females' most preferred topics were ecology, sports, biology/medicine, and everyday life, while boys at the same level prefer mostly sports, technology, economics, and physics. Technology and physics were not chosen by girls. In the upper secondary school, differences were also found between students depending on the level of mathematics course. Girls at the basic mathematics course preferred more social topics, ecology, everyday life, technology, and sports, and boys preferred society and technology matters, followed by sports and ecology (p. 223). Last, girls following an advanced mathematics course preferred mostly technology, sports, biology/medicine and ecology, while boys preferred more technology, physics, and sports. At this level, boys and girls were both interested in technology, but biology/medicine was preferred much more by girls. Kaiser's study thus demonstrated students' high preference for contexts dealing with technology, wellness as encapsulated in the biology/medicine category, matters related to the earth and the universe, and social issues to be used in school mathematics.

In the same field, that of gender differences, Leder (1974) showed that "activities of sex differentiated interest and appeal in everyday situations could be translated to a mathematics problem setting and retain this differential appeal for boys and girls" (p. 351). In that study, 272 10<sup>th</sup> grade students were given four sets of problems, where every pair contained the same problem formulated first in a typical male context and then in a typical female context, and they were asked to rank the problems. Three hypothesis posed by the researcher were confirmed: proportionally more girls preferred the female than the male contexts, proportionally more boys than girls preferred the male contexts, and proportionally more girls than boys preferred the female contexts.

In another study, Lingefjård (2006) discusses the teaching of mathematical modelling. The author introduced eight mathematical models such as local heating, population models, harvesting, medical models, and geometrical models that he used in teaching in a teacher education program. At the end of his courses, 200 students were asked to rank the models. Medicine was their most preferred choice, perceived as the most 'real' amongst them, followed by heating-cooling problems, geometry, population models, and sports.

## **2.4 Contexts in Albanian documents**

When talking about the use of context in teaching and learning mathematics that interest students, it is important to appraise what is the actual experience of applicability of contexts in mathematics for Albanian students. This was performed by scanning mathematics curricula and

textbooks for grades 8-10 in Albanian schools. These were deemed to be the primary sources for answering the current question.

The Albanian mathematics curriculum cannot be fully discussed without thinking about it in the broader context of the socio-political context in Albania, and its influence on the school tradition, teacher education and its reforms. It is not the intention to bring here a thorough discussion of those elements, but a short introduction will do what is needed. During the communist (Marxist-Leninist) regime in Albania (1945-1990), the curriculum decisions were taken on a centralized state level, under very rigid ideological control and the teaching methods were teacher/textbook centered (Bassler, 1995; Whitehead, 2000). In teacher education, special emphasis was put on teachers' theoretic scientific knowledge, while "teaching methodology and practice of teaching were only minimally addressed" (Whitehead, 2000, p. 87). With the fall of the regime in the 1990s and the installment of a democratic system, reforms of teacher education were initiated, starting with changes in legislation. But to pass from the legislative changes into applying them to reality was not easy, as Whitehead (2000) further explains in her paper, considering that it is also a matter of changing the beliefs, attitudes, and practices inherited from the past. One of the priorities of the reforms was the introduction of pupil-centered teaching methods, and one of the fields of change includes the curricula, equipment, and textbooks (Whitehead, 2000). Reforms are still going on nowadays and in the study presented here the last years' curricula and textbooks are taken into examination.

According to the Albanian Institute for Education Development (Instituti I Zhvillimit te Arsimit, 2011) the process of curriculum development includes the design of the curricular framework, standards of learning, courses of study, and the programs of school subjects. A curricular framework includes "general principles and aims of the curricula, fields of learning, subjects and their respective aims for each level of the pre-university education" (p. 14; author's own translation). It is the basis for defining the parameters for the mathematics curriculum or the mathematics subject's program as used interchangeably in Albanian documents. The mathematics curriculum is on the other hand the main document for developing mathematics textbooks and for a teacher's work in the classroom. There exists a curricular framework for mathematics at the upper secondary education (grades 10-12 in the Albanian school system), while one was not approved for the elementary and lower secondary education (grades 1-5 and 6-9 respectively), considered as basic or compulsory education (Hamza, 2011). The lack of a curricular framework for basic education brought about, among other things, that "key skills and cross-curricular topics are not well integrated and appropriately present in all

the subjects' curricula" (p. 5, own translation) and "textbooks are in most cases difficult and loaded with a big number of concepts. They lack the necessary orientation for developing the ability of critical and creative thinking, the ability of working in group, working with projects etc." (p. 6, own translation).

In the mathematics curriculum for grade 8 (Institute of Curricula and Standards, 2006), mathematics learning is based on 4 components: problem solving, mathematical communication, argumentation, and conceptual links. Here problem solving is defined as "the process by means of which students understand and feel the power of mathematics in the world around them" (p. 2). Further, conceptual links are defined as students' need to understand that mathematical concepts are linked to each other, to other school subjects, and to situations in everyday life. An important part in the curriculum is dedicated to cross-curricular aspects where for example environmental education, environmental protection and pollution are mentioned as requiring special attention during mathematics teaching by "dressing up mathematical problems with appropriate information" (p. 12, own translation). The same idea is further emphasized: "Special attention should be dedicated to problems, the range of solving strategies and their dressing up with information from real-life and the surrounding environment" (p. 13). Here one can see the way curriculum makers conceptualize and translate the fact that mathematical problems (or word problems as called in international literature) should help students understand the links of mathematics with real life and other school subjects by 'dressing them up' with information from real life. This, in turn, brings reflection on mathematics textbooks, as it will be further explained in this discussion. Another element one can understand from the curriculum when it comes to contextualization is the reason(s) why contexts should be used in mathematics. It can be observed that this is directly conceived as a way to help students 'see' or be aware of, and understand, the links of mathematics and real life. This linkage is further conceived as a way to help students develop a positive attitude and interest towards mathematics, and especially to "feel the importance of mathematics in everyday life" (p. 13, own translation). Similar observations can be made on the grade 9 mathematics curriculum (Institute of Curricula and Standards, 2007).

Along the same lines is the grade 10 mathematics curriculum where the significance for students to recognize and use mathematics in everyday life, in other school subjects, and to make decisions with its help, is emphasized in the objectives of many of the mathematics topics. It is, for example, stated that students should be able to use trigonometric concepts to describe simple periodic events from the real world, and use geometrical concepts to solve problems from other fields such as art and

architecture and use the geometric concept of the derivative and the physical meaning of the first and second order derivative to model concrete situations from mathematics, physics, chemistry, economics, and real life in general (Institute of Curricula and Training, 2008, pp. 6–13, author’s own translation). In the Albanian situation, the concept of numeracy is introduced as “the group of mathematical concepts and skills that serve an individual in everyday life, at home, in his workplace, in community” (Institute of Curricula and Standards, Albania 2006, p. 2, author’s own translation), and literacy as the “individual’s ability to understand and use the written information in everyday life (*by using mathematics*)” (p. 12, author’s own translation). Another direction is the use of mathematics as a tool in other school subjects where “teachers should bring varied examples from concrete situations in other school subjects” (Institute of Curricula and Training, 2007, p. 11, author’s own translation) into their teaching.

It is recommended, and teachers are encouraged, to include facts and information from history, geography, demography, culture, industry, and agriculture in their free lessons<sup>2</sup>, but also in cross-curricular collaborations. In the recommendations for 9<sup>th</sup> grade teachers and textbooks writers, the need for students’ awareness of the image of mathematics as “an activity for solving problems, based on a group of procedures and concepts, but also as a dynamic discipline closely connected to society in everyday life, and its role in natural sciences, technology, and social sciences” is highlighted (Institute of Curricula and Training, 2007, pp. 11–12). In the curricular guidelines for upper secondary school teachers, one of the principles of teaching and learning mathematics is the principle of the connection of mathematics to everyday life and mathematical modeling (Institute of Curricula and Training, 2010). Explicit reasons given for the importance of the above principle are, as in the 8<sup>th</sup> and 9<sup>th</sup> grades curricula, to help students understand the links of mathematics with real life, to see the relevance of mathematics, and to motivate them in learning it. No more elements that explain what is meant or at least what is expected from mathematical modeling are found. Among the different teaching methods recommended to be used in the classroom are those of working with projects, a novelty in the last curricula, and discovery learning combined with group work (Institute of Curricula and Training, 2012). The modeling aspect found in the curricular guidelines is also reflected in the grade 10 mathematics curriculum where the same objective

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<sup>2</sup> Free lessons constitute 15% of the total lessons in mathematics at 8<sup>th</sup> grade, and 14% in the 9<sup>th</sup> grade. Their goal is to create the necessary free spaces in the school’s initiatives, as an expression of autonomy and adaptation to local needs. It is, therefore, the teacher in collaboration with the school principal and local education authorities who decide the topics and the organization of the lessons.

is placed in almost all the mathematics topics: “the student should be able to model mathematically and to solve, with or without the help of technology, not complicated problem situations simulated or from real life and with examples from other sciences” (Institute of Curricula and Training, 2008).

Textbooks are the most important source in mathematics teaching in Albanian classrooms, as stressed in a report of the World Bank Education Sector (2005). In addition: “The current ‘teaching the textbook’ approach of teaching and the lack of quality teacher training makes it imperative that good quality textbooks be developed and provided” (p. 19). In recent years the reform has included the introduction of several mathematics textbooks which different authors can present to a commission that decides then how many of them can be used as textbooks. The decision is taken based on guidelines from the Ministry of Education which focuses on 5 elements: the scientific accuracy, adaptation of the knowledge in the textbooks with the school age, presentation and illustrations, exercises and problems, and linguistic accuracy (Ministry of Education and Science, 2012). One of the questions to be answered regarding exercises and problems for example is “Does the topic and its practical applications fit with contemporary reality?” (p. 17). Some alternative texts from the different grades are then chosen by the commission, and in every Albanian school teachers then choose from among them the one(s) they find more appropriate.

A typical mathematics lesson in a textbook starts with the title of a specific topic, a few definitions, descriptions and/or formulas connected to it, theorems, a few solved examples, and a few rules written in bold. The solved examples are either mathematics exercises without any context (or in a pure mathematics context as some would call it), such as equations, for example, or word problems, sometimes in a context, that serves as an illustration or a dressing-up of the mathematics connected to the topic. Immediately after the lesson follows an exercises section, starting with the least difficult, such as only applications of the formulas learned, to the most difficult, such as word problems. Normally, the first exercises are solved in class after the teacher has explained the lesson. Regarding the context or the situations introduced in textbooks, there are a few examples from physics or other sciences, or from everyday life in a very simple form, engineering examples, a few on sports, games for probability (dices and cards), and finances. The problems from everyday life are examples from the school or classroom environment, shopping, family, and personal finances, etc. In most of the cases, these contexts only dress up the mathematics, in that what the students have to do is extract the data given and only do the mathematics associated with it. Some typical examples chosen as an illustration are:



1. "A water tank can contain 10 l of water. At a certain time, a tube begins to deposit 0.5 l water per second in the tank.
  - a) Find the formula for the water quantity  $V$  in the tank after  $t$  seconds.
  - b) Construct the graph of  $V$  as a function of  $t$  when  $0 < t < 60$ " (Lulja & Babamusta, 2007, p. 158).
2. "Two material points start, from the same point, a uniform linear motion in two directions that form an angle of 60 degrees. The first material point has a speed of 8m/s, the second 5m/s. What will be the distance between the points after 2 seconds?" (Kreci, Babamusta & Cuko, 2006, p. 38)
3. "In the beginning of 2000, a citizen deposits 20,000 Leke (Albanian currency) in a bank. The annual interest in this bank is 10%. How much money will the citizen have in a year? In 2 years? In 3 years? In  $t$  years?" (Lulja, Puka & Llambiri, 2006, p. 117).
4. "a) What is the largest quantity of pencils we can buy without spending more than 2,100 Leke (Albanian currency), knowing that the price of pencils is 50 Leke each?  
b) We want to buy some books with the price of 200 Leke and 10 notebooks for the price of 100 Leke. What is the largest quantity of books we can buy if we know that we can't spend more than 1,750 Leke?" (Lulja & Babamusta, 2008, p. 185).
5. "We throw two dice. What is the probability of the events:
  - a) "there will be two odd numbers"
  - b) "there will be two numbers smaller than 4"
  - c) "the sum of the two numbers will be 6"
  - d) "there will be two 6's" (Sela, Nikolla & Perdhiku, 2008, p. 224).
6. "The pyramid of Cheops is a regular rectangular pyramid with the height of 137 m and the length of one side of the base of 227 m. What occupies more space: this world wonder built more than 3000 years ago, or a skyscraper with 105 floors, with a length of 100 m and width of 50 m? One floor's height can be 3.2 m" (Kopliku, 2008, p. 61).

There are 3 aspects one can discuss here. The first has to do with the intended curriculum, or better with the expressed intentions about the goals for the mathematics in grades 8-10. Critical and creative thinking, problem solving, mathematical modeling, and understanding how mathematical concepts are linked to real life and using them, are all skills mentioned in the different curricula and curricular framework analyzed in this section. In this way, Albanian authorities have tried to adapt the international curricular developments to the Albanian school curriculum. In the same documents, the mathematics curricula for grades 8-10, a second aspect to be discussed is the way the goals and skills are translated by the curriculum makers into recommendations and guidelines for the mathematics textbook writers and teachers. As discussed in this subsection, problems are recommended to be 'dressed up' with information from real life and from other school subjects, to use projects and group work etc. All these elements are still part of what is called the intended curriculum, but there could be room for a different interpretation of the goals and skills. A similar goal in the Swedish curriculum for example is

interpreted by Andersson and Ravn (2012) as “mathematics teaching should give students mathematical knowledge and competencies for taking well-grounded decisions in everyday life and to interpret the flow of information and thereby follow, understand, and participate in political discussions in society” (p. 315). The questions that arise here are: Can ‘dressed-up with information from reality’ problems, as recommended by curriculum makers, really fulfill the role they are intended to, similar to the one expressed by Andersson and Ravn (2012)? Can these problems make students understand the relevance of mathematics in everyday life, the links of mathematics with other school subjects? Can they motivate students towards mathematics? Results from research indicate that such suppositions should be taken with caution. There is therefore, in the author’s opinion, a gap between the goals of the official curriculum and their interpretation in the curriculum.

Similarly with the Swedish case, the mathematics textbook in Albania is the main working tool for teachers in schools, and it will be referred to here as the potentially implemented curriculum (Johansson, 2006). As we saw in this subsection, guidelines from the Ministry of Education and Science for evaluating potential mathematics textbooks consider only one question regarding the contextualization of mathematics, even though the curriculum often draws attention on contextualization. This creates a second gap when it comes to contextualization, and it can be also observed in textbooks where very few examples of ‘dressed-up with reality’ mathematics problems are used. The gap is then transferred, and maybe even deepened, to the enacted curriculum, the one about how the teacher implements or enacts the curriculum in mathematics teaching in the classroom (Johansson, 2006). There is no research on this topic in Albania, and the study presented in this thesis has not dealt with it specifically. Relying therefore on the author’s experience as a student and then as a mathematics teacher in the Albanian schools, it can be said that there is a tendency to focus on the core content of the mathematics, to work with exercises and problems from the textbook, and adding some extra materials when time permits. There are no signs of project work in the textbooks; they are therefore left to the teacher to think about. Mathematical modeling is also missing in the textbooks. Mathematical modeling can be thought here in the same sense as Blum et al. (2003) “consisting of structuring [a problem situation], mathematizing, working mathematically and interpreting/validating” (p. 153), and even broader in the same sense as Greer, Verschaffel, and Mukhopadhyay (2007), who add to Blum’s et al (2003) another type of modelling “wherein model-eliciting activities are used as a vehicle for *the development* (rather than the application) of mathematical concepts” (p. 90). With the few contextualized problems available in textbooks the tendency is to focus on un-

derstanding the mathematics required, and model it mathematically as soon as possible without even discussing the context. Teachers use to mention that mathematics is found everywhere in order to motivate students and attract their attention into mathematics, but without referring concretely to the context.

From a philosophical perspective then, as proposed and used by Andersson and Ravn (2012), mathematics in Albania is mainly focused on the 'core' of the mathematics and the focus on 'contexts' of mathematics is weak or even missing, especially regarding the transition from the curricular framework to the mathematics curriculum, then to the textbooks and ending up in the mathematics classroom. As a result of the discussion introduced here, it can be said that the mathematics learning goals as expressed in the curricular framework and the mathematics curriculum in particular, need to be better translated into the curriculum itself. This would require both a look at the international experience in contextualization matters in curricula, but also an investigation of international research upon the same matter. Mathematical modeling should also be clearly defined in the curriculum, and considered in its broad sense, not only as the classical word problems.



## 3 Theoretical overview

The two sub-sections that follow explicate the theoretical concepts used in the study.

First, there is a discussion of the primary concept around which the instrument used for the study, the questionnaire, is built. Interest is a concept from the affective domain and its definition is found in an educational-psychological theory of interest. It serves the purpose of further delineating the research by clarifying how the backbone, interest, is defined. Other concepts used in the research questions such as preferences and motives are also defined.

Lastly, an exposition and examination of the primary concepts used for analysing the data and explaining some of the results are provided. The theory of Bourdieu (1977), as an explanatory device, is brought in with his three core concepts, namely habitus, field, and capital, which are argued as being relevant for this study.

### 3.1 Interest

#### 3.1.1 Interest

Schiefele (1991) discusses interest as a concept in its own right and not included with all its essential aspects under the notion of intrinsic motivation. One such aspect is the focus of interest on the content to be learned. In presenting a history of the concept of interest, he refers to Dewey (1913) as one of the forerunners of modern research on interest. Dewey (1913) based his book on distinguishing between interest-based learning and effort-based learning, where the first takes into account students' interests and the latter does not. According to Schiefele (1991), "he [Dewey] dismissed instructional efforts that take place without regard to the material to be learned" (p. 300). According to Dewey (1913, pp. 16-17), there are three characteristics of interest: interest is active, dynamic, i.e., we are actively concerned with interest; interest is objective, in the sense that it is directed towards an object; and interest is personal, in terms of a person's connection with the object of interest bearing important outcomes for him/her.

No common definition of interest can be found in the various research, but generally it is understood as "content specific motivational variables that have an important influence on learning and the direction of human development" and as "a multidimensional construct, which has close relationships to process-oriented motivational concepts such as intrinsic motivation or the experience of self-determination" (Krapp, 2007, 6-7). In the Person-Object Approach to Interest (POI) (Krapp, 1993, 1999; 2002b; Prenzel, 1988, 1992), the definition applied in this re-

search as well, interest is conceptualized as a person-object relationship, in that interest is always directed towards its object and is a result of a person's interaction with his/her environment (Krapp, 2002a, 2007). This directedness is what makes interest different from other motivational concepts. The object of interest can then take one of three forms: real object, activities and types of engagement, or topics (Krapp, 2002b, p. 412). Real objects are the concrete objects towards which interest is directed. For example, someone that likes music might like the piano in particular. Object of interest can also be an activity or engagement in something related to interest, for example, following the above example, playing the piano. The last kind of object of interest can be a "topic that represents a certain domain of knowledge" (Krapp, 2002b, p. 412). According to the POI approach, on the one hand there is a person's knowledge and relationship to the object and, on the other, there is the object as detached from its perceptions.

There are two kinds of interest according to Renninger, Ewen and Lasher (2002), or two different levels of interest analysis (Krapp, Hidi & Renninger, 1992): situational interest and individual interest. Situational interest is more of a short-time type, starting with an attraction; it generally comes from external situation-specific factors (Krapp et al., 1992), while individual interest is a long-time type of interest and has two components: stored knowledge and stored value. What is being discussed here is a person's interest towards a subject content and potential for re-engagement with it. The stored knowledge "refers to a person's developing understanding of the procedures and discourse (structural) knowledge of particular activities or ideas" (Renninger et al., 2002, p. 469), whereas stored value "includes feelings of competence as well as positive and negative feelings that emerge in the process of figuring out what is understood and still needs to be clarified" (ibid.).

There are two different systems that are responsible for directing one's development and maintenance of interest, called "a dual regulation system" (Krapp, 2005, p. 381): a cognitive one connected to values and goals; and an affective one connected to the experience lived during an action of interest. A combination of these two levels, a cognitive experience close to personal values and goals, and a positive affective experience, has the potential to direct a person to pursue engagement in an area or topic (Krapp, 2005, 2007).

For Schiefele (1991), individual interest has two components: feeling-related valences and value-related valences. The first is related to the feelings that accompany one's interest in a topic or object, while the latter has to do with personal significance of an object of interest. Krapp (2002b) discusses four characteristics of the interest construct. The first is "cognitive aspects": on one hand, there is the readiness to expand

one's knowledge and competencies in the field of interest, while on the other hand there is also the readiness to apply existent knowledge about interest in a new situation (Krapp, 2002b, 2007). Next, there are emotional characteristics: feelings of competence (when the person's perception of personal competence is in line with the requirements of the task), tension, autonomy (a person fulfils his/her autonomy need when he/she feels that the source of his/her actions is in him/herself, and this even when actions are influenced by others by internalizing others' values) or self-determination, and relatedness (the sense of belonging to a group, to the community, caring for and being cared by others in the community in a psychological and not a material sense). Third, value-related characteristics are feelings of personal significance, or "self-intentionality" whereby "goals and volitionally-realized intentions related to the object area of an interest are compatible with attitudes, expectations, values and other aspects of the person's self-system" (Krapp, 2007, p. 11). At the end, he discussed intrinsic quality: an interest-based activity has the quality of intrinsic motivation because one's activity to engage in a situation is compatible with what one wishes to do.

Results from research on both individual interest and situational interest show positive effects of interest in educational outcomes (Krapp, 2002b). A meta-analysis by Schiefele, Krapp, and Winteler (1992), as quoted in Krapp (2002b) also, shows that 10% of the variance on achievement comes from the level of interest, with gender as a strong variable implicated in the differences. Studies from the situational interest also show that "an interest-triggered learning activity leads to better learning results" (Krapp, 2002b, p. 420; Krapp, 2002a). Hidi (1990) shows that: "individual and text-based interest have a profound effect on cognitive functioning and the facilitation of learning" (p. 565). Positive effects of interest in different parts of the learning process are also presented in many other studies (Schiefele, 1991; Renninger et al., 2002).

### 3.1.2 Interest and preferences

Schiefele (1991) characterizes individual interest as "a relatively enduring preference for certain topics, subject areas, or activities" (p. 302). Unfortunately, no further explanations or characterizations of preference were found. Referring to the Merriam-Webster's learner's online dictionary, preference is defined as "a feeling of liking or wanting one person or thing more than another person or thing". It seems, therefore, that preferences can be expressed in choosing between two or more topics or objects, in the simplest case, or ranking some topics or objects in a hierarchical manner. From the same dictionary, interest is defined as "a feeling of wanting to learn more about something or to be involved in something; or, something (such as a hobby) that a person enjoys learning about or doing". Thinking, for example, about mathematics, one can say

that a student is interested or not in mathematics, but that (s)he prefers algebra rather than geometry.

In the special case of this study, students' interests in learning mathematics with realistic contexts are being researched. When expressing their interests on the topics given on the questionnaire, students are put in a position of giving a degree of or quantifying their interest. By doing so, during analysis it was then possible to determine what students as a group choose as contexts in which they are more interested, towards those they deem less interesting. They express preferences in relation to a list of real-life situations in response to which they indicate contexts they like more and those they like less. Therefore, the hierarchy obtained from the data analysis is a hierarchy of preferences.

### 3.1.3 Motives

According to the Merriam Webster learner's online dictionary, a motive is "a reason for doing something", as is also used in the study described herein. This is not to be confused with motivation, "a force or influence that causes someone to do something". Motives are used herein in the sense of reasons; by students' motives therefore students' reasons for preferences are meant. Motives in this study are also seen as mechanisms in terms of a realist paradigm of research, which will be explained further in section 5.2.4.

## 3.2 Habitus, field and capital

When deciding the way the study should progress with all of its parts and the tools to support and explain it, research questions were referred to as guidelines from which the study started. The last research question seeks to detect the role that society plays in influencing target group students, if any. More specifically, the role of society on students' motives for preferring certain real-life situations in mathematics is investigated. This contribution was also recognized during the first part of the study, when students were interviewed. Three conceptual tools from Bourdieu (1977) are used here as a set of heuristic tools, as one of the possible ways to look at students' preferences: habitus, field, and capital. These key concepts focus on the individual with habitus and capital, but they also allow for considering the individual within a broader framework, and the shaping of an individual's habitus in encounters with others and in encounters with fields. In this subsection, a definition and description of these concepts, as understood in the study, is followed by a delineation of their current use.

Bourdieu (1977) defines habitus as "systems of durable, transposable *dispositions*, structured structures predisposed to function as structuring structures" (p. 72). Dispositions, which are used in defining habitus, are conceptualized as:



first the *result of an organizing action*, with a meaning close to that of words such as structure; it also designates a *way of being*, a *habitual state* (especially of the body) and, in particular, a *predisposition, tendency, propensity, or inclination* (Bourdieu, p. 214).

Habitus stands at the core of Bourdieu's outline of the theory of practice, or the theory of generating of practices, "as an epistemologically grounded tool, as central to his theory of practice and thus as a way of comprehending social activity" (Grenfell & James, 1998, p. 15). It is a set of dispositions, present in everyone. This set of dispositions guides people's reaction and behaviour towards everyday life events, and lets them perceive possibilities and chances as such. In this way habitus fulfils its role as structuring structures that generate practices. The way habitus is constituted is through past experiences of participating in practices in life. These experiences shape people's views, thoughts and perceptions of specific practices and life in general, creating dispositions that constitute everyone's habitus. This last account explains the role of habitus as structured structures. As Zevenbergen (2005) asserts, *habitus* "allows the researcher to understand the dynamic structure between social reality and the individual" (p. 609). In this study, the manner in which habitus is used is to explain students' preferences and their motives for those preferences.

Another relevant notion is that of field. Bourdieu (Bourdieu & Wacquant, 2002) cautiously draws a parallel between a field and a game where there are players that compete for some stake. The state of the game, and the structure of the field, will be defined by the best and strongest players, or the social agents participating in the field. The cautious part in Bourdieu is to take into account that the field follows some "regularities that are not explicit and codified" (p.98). In addition, as Maton (2008) explains: "To understand practice, then, one must relate these *regularities* of social fields to the *practical logic* of social agents...The source of this practical logic is the habitus" (p. 54). From an analytic point of view, "a field may be defined as a network, or a configuration, of objective relations between positions" (ibid, p. 97). Education, and Mathematics Education as a part, is an example of field in Bourdieu's meaning. It is a network of relations between positions in it, occupied by social agents such as researchers, teachers, educators, and students.

Field is to be thought of in a relational way, as a concept that does not work in isolation. Habitus and field are two concepts to be examined and used together (Zevenbergen 2002; 2005) due to the dialectical relationship that exists between them. This relationship is described by Bourdieu (1977) as a conditioning one where the field shapes the habitus. This is asserted because it is in an encounter with the field that habitus is actualized or not, depending on the conditions found there. On the

other hand, it is habitus that helps to provide a sense of the field, to give it a meaning and value so that it will be worth investing some energy in.

Individuals are seen in terms of agents in the field, and:

it is knowledge of the field itself in which they evolve that allows us to best grasp the roots of their singularity, their *point of view* or position (in a field) from which their particular vision of the world (and of the field itself) is constructed (Bourdieu & Wacquant, 2002, p. 107).

Another important element influencing habitus' development is capital in its different types and amounts, which is first developed in a family. Bourdieu (2004) defines capital as "accumulated labour (in its materialized form or its "incorporated", embodied form) which, when appropriated on a private, i.e., exclusive, basis by agents or groups of agents, enables them to appropriate social energy in the form of reified or living labour" (p. 15). Bourdieu (2004) uses the example of winning in a roulette game to represent the perfect competition as ensured by the independence of its constituting events. He used the example to emphasise the role of capital that makes this competition in real life not perfect, since things are not equally probable anymore.

Capital is seen in four forms: economic capital such as property rights, which is directly convertible to money; cultural capital, such as educational qualifications or cultural goods; social capital, such as a network of family, friends and acquaintances, both convertible to economic capital in some circumstances (Bourdieu, 2004, p. 16); any of these three forms can be also considered as symbolic capital or "when differences of economic and cultural capital are misperceived as differences of honour, they function as what Bourdieu calls symbolic capital" (Weininger, 2005, p. 132).

Cultural capital can reveal itself in one of the three forms named by Bourdieu as embodied, objectified, and institutionalized states. Embodied state relates to cultural capital that people accumulate investing their time and efforts to achieve cultivation, as "long-lasting dispositions of the mind and the body" (Bourdieu, 2004, p. 17). Characteristics of this state are its connectedness to the person who has it and its dependence on the resources one has for acquiring it. Cultural capital under the forms of material objects and media or cultural goods is considered an objectified state. In this state, cultural capital is materially transmissible, but in order to be considered effective it has to be appropriated and used by agents. The institutionalized state describes the value that cultural capital obtains when recognised institutionally in, for example, a university diploma or other academic qualifications.

Social capital is what one accumulates from having a network of social relationships, or from being a member of group(s) such as family, school, neighbourhood, etc. How much social capital one has depends on two things: how large the network is, but also how large is the capital of

the group one belongs to, of which one can make use. Exchange is at the basis of the reproduction of the network of relationships. The four forms of capital are found in differing amounts in students' families.

The three concepts are closely connected to each other. One's position in a field at a point in time is relative to the quantity of the different capitals one possesses, how they are combined, and also to the extent to which these latter develop over time. Here habitus also comes to play. Wacquant, in his interview with Bourdieu (Bourdieu & Wacquant, 2002), treats habitus as a theoretical bridge between field and capital, as the mechanism that induces people to choose a certain way of behaving in the field by using their capital.

Education, and Mathematics Education in particular, is a field in which children participate equipped with their habitus. This field is like the 'game' students play, in terms of Bourdieu's writings about fields in general. Students included in the study presented here come from different parts of the Albanian district, Shkodra, some from the city and others from the surrounding villages. Their habitus is first acquired in their families and is the basis for the experiences they will encounter at school. Habitus is, therefore, transposable in that it guides reactions in new practices as well. The children's families have different economic situations, employment histories, backgrounds and types and quantities of capital. Based on capital as well, each family has its own view of life, its own values, and its own habitus that influence children's habitus. While children participate in the education field, their habitus develops continually in encounters with other children or teachers that have their own experiences and habitus. Students' experiences come from living in a family, living in a certain neighbourhood, being friends with children from other families, having gone to previous schools or having previously lived in other places, watching TV, following their favourite kind of music, their favourite artists and writers, living in a certain city, in a certain country, and broadly living in a certain society. These experiences shape and transform their habitus, and this new habitus is the basis for students' reactions in facing other fields and activities, such as education and occupation (Bourdieu & Wacquant, 2002). The common aspect of all these habitus is that they are shaped in an Albanian society, and as such, they might have areas in common. These commonalities have to do with important matters in an Albanian community such as health, future schooling, and employment of youth.

On the other hand, there might also be more individual characteristics or differences coming from different life situations, depending on capital as well. Students coming from families living in the country might develop a different habitus from those living in the urban areas. Reasons for this can be different living conditions, the cultural capital they bring

from families, their socialization, and future opportunities offered to them and perceived by them. The same thing is true of gender differences, where students' habitus guides them into following the visible possibilities offered, because "one's habitus is also gendered as a result of the possibilities available to each group" (Dumais, 2002, p. 47). The two circumstances are, in many cases, linked together. For example, in Albanian country families the role of the woman is closer to the traditional patriarchal society. Students in the rural areas may not have the same access to cultural capital as students in the urban areas have. Therefore, gender and geographical location can be factors of differentiation.

Students enter the education field and find their position in it with the capital they bring from their families and other relationships in their life. Students' first entrance in the field, and how their 'capital' evolves over time, defines their position in it (Bourdieu & Wacquant, 2002). Students, as players, 'play' to increase their capital. Being educated can be seen as a form of capital, cultural but also social, in order to achieve in life. In Albania, a good and stable life depends to a great extent on employment, and one's capital impacts one's possibilities for a good working position. This capital is cultural in terms of one's cultivation and graduating from university; it can be social in terms of networks one creates when being educated and participating in other activities, and it can also be converted into economic capital. One such capital can, for example, be students' knowledge about the subjects they perceive as interesting in terms of relevance for their following grades' studies and their future interests.

According to Bourdieu, the way people react to stimuli in life is not instantaneous, but carries some history within. As such

Knowledge of stimuli does not enable us to understand much of the resonances and echoes they elicit unless one has some idea of the habitus that selects and amplifies them with the whole history with which it is itself pregnant (Bourdieu & Wacquant, 2002, p.124).

This means that in order to understand students' reactions, in this case their level of preferences and interests, towards real-life contexts in mathematics learning, there is a need to understand the habitus they have built during their life, the conditions of production and actualization of it.

The three concepts are understood as applicable and beneficial as heuristic tools for the purposes of this study. Habitus is useful for its influence on students' reactions towards learning mathematics of different contexts, capital is the concept that can explain students' forming of habitus, and field is the concept that brings to light the working of habitus within different conditions. While the concept of capital can be more concretely found in students' words during interviews, habitus is more abstract in the sense that its presence and formation has to be detected and deduced, based on students' words. The concept of field, on the other hand, is seen more in relation to habitus, as it provides the triggers for

the functioning of habitus and for viewing its different sides. The following figure is a schematic explanation of the connections between habitus, capital and field, and the primary concepts of the study as reflected by the research questions.

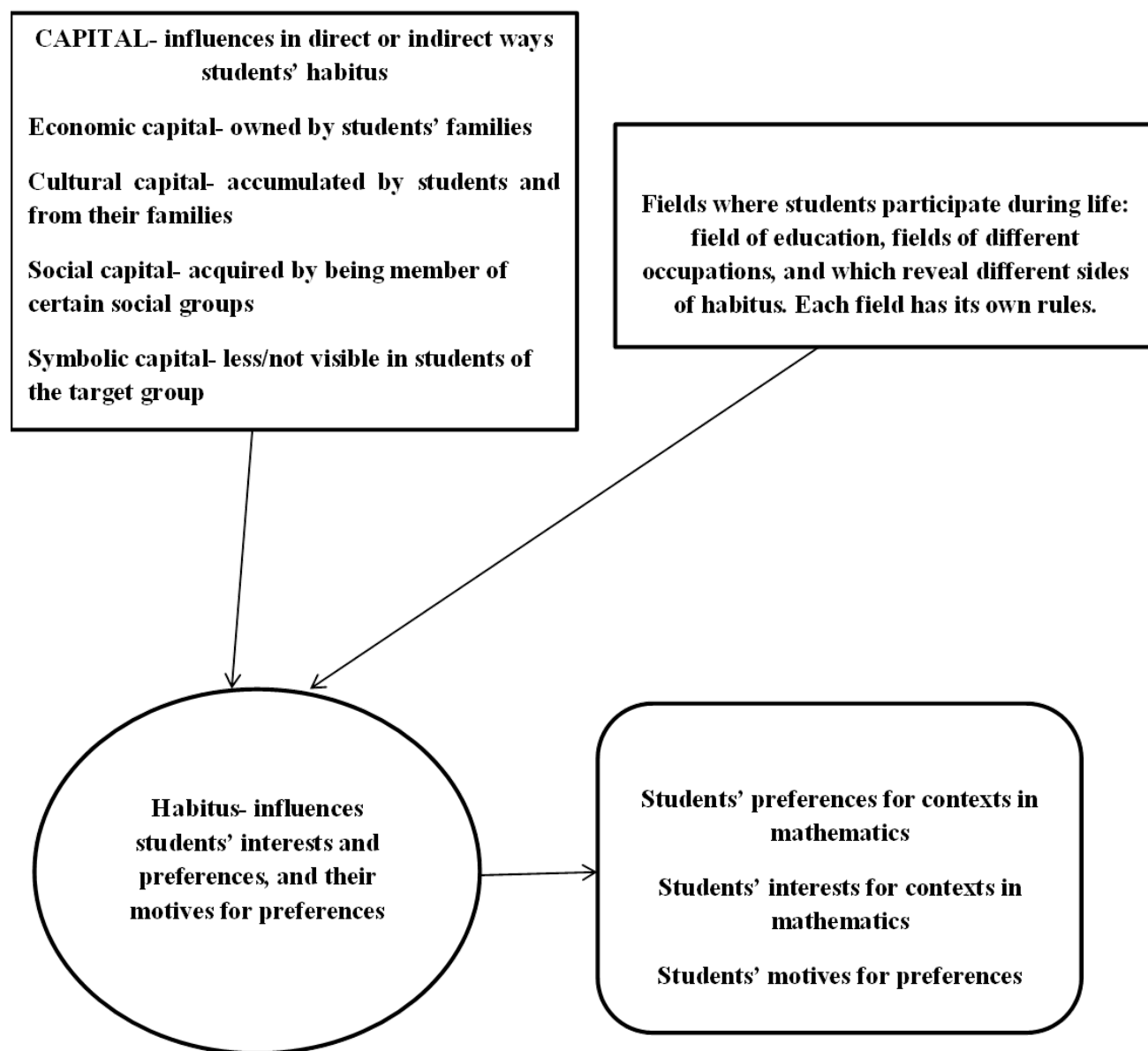


Figure 1: Connections of the main concepts in the study<sup>3</sup>

Interest is the relationship that students have towards real-life situations that can be used in mathematics. Interest is an enduring preference. Preference, on the other hand, is the feeling of liking or wanting some situa-

<sup>3</sup> In the connection between habitus, field, and capital, the arrows are two-way. This means that, for example, not only does field reveal different sides of habitus, but also habitus helps to provide a sense of the field. The same thing is to be understood with habitus and capital. However, in figure 1, the focus is on the effects of the three concepts on students' answers in the study, and on the role of habitus as a bridge between capital and field, and as the way to illustrate their effect on students' answers.

tions or contexts better than others, or choosing something over something else. Motives are the reasons students have preferences or interests. These can be influenced by students' habitus and capital they have from living in a family and in a society, in encounters with different fields.

Students from different cultural settings (such as different countries), different school locations (such as a city or a country school), and of different genders, can have different interests. This can also be explained with the help of habitus, field, and capital, as influencing students' perceptions and values about different aspects of life. This means that people in different cultural, economic, and social settings might have developed different habitus based on their different types and quantities of capitals, and this might bring different interests to specific fields in life.

Examining students' motives in the interviews, how they express their dispositions toward using certain real-life situations for learning mathematics, and how they argue about it, might also reveal some aspects of the contemporary Albanian society and its development. This can be argued as students' habitus is formed in a family, in school, and in encounters with different fields in their life, and broadly in an Albanian society. Capital is also a factor, whose presence encourages or hinders attitudes that people have towards certain types of activities or events. Both habitus and capital pertain to the field of education, but can also be seen as connected to other fields such as future occupation. It is in encounters with different fields that habitus reveals itself.

## 4 A realist paradigm of research

A research paradigm includes the researcher's beliefs and assumptions, which shape the way the research is conceptualized, the methods chosen for data collection and analysis, and how the results can be interpreted (Bryman, 2004). Two important elements in a research paradigm are the beliefs about ontology and epistemology, which should then be compatible with the methodology chosen for the study. These elements are explained in this section.

When thinking about ontology one answers questions about “the nature of social entities” (Bryman, 2004, p. 16). An answer to such questions is that reality, in this case students' preferences and interests, exists and is separated from our knowledge of it. They would still exist even if they were not examined in this study. This belief defines an objective ontological position of the study.

In discussing epistemology, an answer is provided to the question “what is (or should be) regarded as acceptable knowledge?” (Bryman, 2004, p. 11). In this study, it will be referred to as realism, which, as Bryman (2004) suggests is “an epistemological position that acknowledges a reality independent of the senses that is accessible to the researcher's tools and theoretical speculations” (p. 543). He describes its two forms, empirical or naïve realism, and critical realism. Pring (2004) also writes about ‘realism’ or ‘robust realism’, which is not to be misunderstood as ‘naïve realism’ with its one-to-one relationship of reality and our description of it. He states that “however culturally specific any one description of reality is, such a description has to come up against the hard facts of reality” (p. 62). It means, therefore, that reality is out there, and is separated from our knowledge of it. This knowledge can change, as it is a product of subjective perceptions.

Corson (1991) asserts that one of the two directions from which Bhaskar constructed critical realism is transcendental realism (or a philosophy of science) that “sustains the idea of the independent existence and action of the causal structures and things investigated and discovered by science” (p. 223). An objective ontology, as described in the previous paragraphs, fits with this epistemological position. Knowledge about the reality that is out there and independent of us can be obtained through human cognition, so it can be subjective (Au, 2007). This is captured by Au's statement that:

Critical realism simultaneously rejects both positivist objectivist *and* relativist subjectivist theories of knowledge in favour of an epistemology that in essence synthesizes aspects of both—an objectively existing world and a socially mediated understanding of that world (p. 261).

Critical realists “hold that we will only be able to understand – and so change – the social world if we identify the structures at work that generate those events or discourses” (Bhaskar, 2011, p. 2). In the current study, students’ preferences and interests for real-life situations that can be used in mathematics are investigated, together with the mechanisms or the motives that generate these preferences. Realism guides the investigation of the structures that generate the events, or the mechanisms, by providing a set of perspectives on society, because, as Bhaskar (2011) admits, “there are enduring structures and generative mechanisms underlying and producing observable phenomena and events” (ibid.). The social exists, the social structures are based on social relationships and pre-exist us, while at the same time being transformed and reproduced by us, or by human agency. According to Bhaskar (2011), in order to understand social events, it is important to understand the structures of social relationships.

What Corson (1991) has understood as a mediator between Bhaskar’s realist ontology and his ‘ever-sceptical’ epistemology is language “since it represents the set of meanings that we extract from our encounters with the material universe” (p. 235). Pring (2004) can be seen as having the same opinion when he expresses a position of ‘robust realism’ as:

[...] firmly rooted in the common sense language through which we have come to describe the natural and the social worlds we inhabit, and respecting therefore the logically different kinds of explanation which are embedded in that language (p. 88).

Knowledge is what the researcher perceives from his/her study and, as such, it is fallible, referring to Pring (2004), who emphasises that “the link between ‘knowledge’ and ‘certainty’ is broken” (p. 80).

Given these considerations, the paradigm underlying this research is realism and meaning non-naïve realism. It differs from critical realism in that, as Au (2007) states, “the use of the word ‘critical’ points to a particular set of political commitments on the part of the researcher” (p. 261), which is not the stance taken in this dissertation. Pawson (2006) refers to his paradigm as realism, “the one without the adjective [*critical*]” (p. 19), and introduces it as “another realist pathway in social science”, that tries “to develop realism as an empirical method” (p. 19), and distinguished it from critical realism<sup>4</sup>. The primary view here is that in order to understand the generative mechanisms or structures of events, it is important to include, and understand, the contexts in which these mechanisms act and produce certain outcomes. Applied to the study at

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<sup>4</sup> It is not the scope of this dissertation to delve deeper into the philosophical discussions about realism and its divisions. For a thorough discussion of the realist pathway as different from critical realism see Pawson (2006).



hand, in order to understand the motives (mechanisms) that allow students to have certain preferences, it is important to also understand the conditions and contexts under which these motives bring about high, medium, or low interest of students on real-life situations for mathematics learning. When it comes to methodology and methods, realism and realist evaluation “see[s] merit in multiple methods, marrying the quantitative and qualitative” (Pawson & Tilley, 2004, p. 10). The choice for employing both quantitative and qualitative methods to conduct the study is therefore compatible with the research paradigm. Further explanation of the methodology follows in section 5.1.



## 5 Research methodology and methods

### 5.1 Methodology

In this study, it was considered appropriate to use quantitative and qualitative methods to answer the research questions. Gorard and Taylor (2004) write about a combination of quantitative and qualitative methods where different forms of data serve to make the research more coherent, rational, and rigorous. They state that “the debate has, on the most part, moved away from *whether* data from different sources should be combined, to a much greater focus on *how*” (p. 4). One reason for combining quantitative and qualitative methods in a study is that of completeness (Bryman, 2004). Quantitative work can provide answers to what and how many, qualitative to how and why. Pring (2004) also explains his objections against a “false dualism” between the quantitative and qualitative, stating that there may be different approaches to answer different questions. In this study, both qualitative and quantitative methods are indeed used to answer the research questions posed. The quantitative aspect serves to answer questions about the hierarchical preferences of students’ interests for real-life situations that can be used in mathematics. It also helped in defining the focus of the qualitative. The qualitative aspect is to answer questions about how the interests came about, and what are the reasons, or motives that make students prefer them. The two types of methods complement each other in providing answers to complete the study undertaken for this thesis. Each of the methods will be further discussed in the following sections.

### 5.2 Methods

#### 5.2.1 Questionnaires

A questionnaire was the instrument chosen to collect data to answer the first research question: What is Albanian students’ hierarchy of preferences and interests for real-life situations that can be used in mathematics and what, if any, are the differences in this hierarchy along gender and school locations?

When discussing the variety of educational research, Pring (2004) refers to surveys as one of the possible approaches to adopt for answering the different research question(s). One of the advantages to using a survey is that “surveying does not depend upon an outside observer” (Pring, 2004, p. 37), but takes into account the views of students that, in this case, are the ‘objects’ of the research. Using closed questions in rating scales also has its weaknesses, such as not being able to know if respondents have any other opinion about the matter at hand outside of the options included in the instrument (Cohen, Manion, & Morrison, 2007).

However, these issues were dealt with during interviews in Albania where students were invited to mention any other real-life situations they would like to learn about in mathematics which were not included in the 23-item list. This was done in order to possibly add more items to the questionnaire; however, none of the students suggested other items.

One disadvantage of using a questionnaire is that it requires time for construction, piloting, and refinement. The same issues occurred with the ROSME questionnaire. It began with 65 items, then was further refined after being used in six countries. In Albania, the 23-item instrument was also piloted with 212 students, before being finally used to collect data from 825 students. However, on the other hand, a questionnaire with closed questions assists in collecting data from a large group of respondents. In this study, it was possible to include students from the entire district of Shkodra, and in a relatively short time.

There are criticisms against using a survey, such as the concern whether all the students understand the same things from the questionnaire. However, as Pring (2004) discusses, “the meanings which the respondents attribute to the questions are not something private and subjective, but the meanings which anyone conversant with the language would attribute to them” (p. 39). It is therefore important that the questions are unambiguous. In addition, as Gorard (2001) states, it is important to conduct a pilot study before performing the real data collection, especially for novices, in order to be aware of the difficulties that might arise. The pilot data collection also serves as a test for validating students’ understanding of the items. One of the things learned during that phase was how to better manage the available time in order to be efficient in the data collection.

In November 2008 and April 2010, the author was present in the classrooms in all the stages of the survey completion. She presented the project and the questionnaire in all the classes and encouraged students to ask questions in the event something was unclear. During presentation and completion of the questionnaire, the important idea that students should think about real-life situations in terms of learning about them in mathematics lessons, therefore learning about them and the mathematics that can be used in each occasion, was emphasised. Being present also enabled the author to find students who would volunteer to be interviewed.

As mentioned earlier, this project is part of a bigger one, ROSME, therefore the same quantitative survey was used for data collection. The author was part of group discussions for the final version of the questionnaire since the start of her PhD in August 2008. The questionnaire was translated from English into Albanian, the official language in Albania. An Albanian colleague from the University of Shkodra was asked to

translate simultaneously and the two versions were compared to clarify any discrepancies as much as possible. During translation, care was taken to retain the meaning of the different items while at the same time to ensure that the items were understandable for the Albanian students. One typical item that brought about such a concern was “[mathematics involved in cultural products] such as the house decorations made by Ndebele women”, which was replaced by “handmade products by the Albanian women, such as carpets”, as this was more familiar to Albanians.

Another reason for using a questionnaire, aside from the fact that the ROSME project uses it, is that the questionnaire provides a fast answer about pupils’ preferences, and provides an idea of what is considered as more preferred or less preferred. It is relatively easy to have students agree to do it, since there is not much effort required to complete it.

According to Gorard (2001), there are several ways of delivering a questionnaire, while the most used are: face-to-face, self-administered, and technology-based. The idea of technology-based questionnaires was immediately eliminated as one can reach very few students of that age (8<sup>th</sup>-10<sup>th</sup> grade), if at all, in that manner in Albania. Because of the large sample population, and the interviews following the questionnaire, the self-administered choice was more appropriate.

Students were instructed not to include their names, to ensure their anonymity. The questionnaire contained some questions about what Gorard (2001) calls background information of the participant such as age, gender, and grade. This information was asked to allow for future possible explanations of the results related to gender, age, or grade.

In the introduction to the questionnaire, there were instructions to the participants about the manner in which it should be completed. The instructions were also orally explained in front of all the students who participated. The questionnaire also stressed that there was no correct answer, and only students’ opinions were being asked. Students were asked to answer questions concerning their interest in learning mathematics involved in 23 different fields such as: lotteries and gambling, management of business and social affairs, all kinds of pop music, dances, design clothes etc., from very high interest to nil/zero interest with four choices. In some of the questions, examples were also included in order to make it easier for the pupils to understand the matters being asked, for example, item C4 referred to “secret codes such as pin numbers used for withdrawing money from an ATM”. Gratitude for their help in participating in the study was also expressed.

Permission was sought and obtained from the schools’ principals to conduct the study in their schools. Students’ consent was obtained prior to the administration of the questionnaire, in the presence of the teacher/principal who accompanied the researcher to the classrooms. There

are no written ethical guidelines for performing research in Albania, therefore, at that time teachers or school principals signed a document to confirm that students were asked if they would participate voluntarily in the study. The nature of the study, its goals, how the data collection would proceed, and how the results would be used were also explained. The school offered to talk to parents and inform them about the process. Before completing the questionnaire, students were informed that anonymity will be maintained and that they could withdraw at any time. All other ethical requirements were taken into account.

### 5.2.2 Interviews

The second research question addressed motives students provide for the real-life situations they prefer, and data were collected by means of interviews. The author of this thesis was also the interviewer. Pring (2004) claims that interviews or “letting the ‘objects of research’ speak for themselves” (p. 39), can provide an answer to the problems connected with the questionnaires. Interviews are also an effective tool for a better understanding of students’ opinions and the meanings they give to different concepts.

During the pilot data collection in December 2008, 24 students volunteered to be interviewed. The focus of the interviews was to understand the reasons why pupils preferred certain contexts and not others. It was believed that it would be useful to interview the pupils by showing them some of the contexts represented by pictures. In choosing seven of those items from the questionnaire, four most preferred and three less preferred items from pupils who participated in ROSME from other countries were used. It was impossible to know in advance if these items were preferred by Albanian students, as interviews in most of the cases were conducted immediately after the questionnaires were administered, so there was no time to analyse them. The items were: lotteries and gambling, agricultural matters, traditional artefacts, as the three less preferred, and managing of business and personal affairs, secret codes, sending and receiving of electronic messages, making computer games, and storing music and videos on CD’s and iPods as the four most preferred. The picture cards of these items are provided in Appendix 1.

Cohen et al. (2007) observe that one of the possible uses of the interviews is “in conjunction with other methods in a research undertaking” (p. 351), which was the case with the pilot study, where it was sought to ascertain the motives of the interviewees for their prioritizations for contexts to be used in mathematics. Open-ended questions were used as these types of questions are flexible and allow for deeper information, according to Cohen et al. (2007, p. 359).

As previously mentioned, some cards with pictures representing the seven contexts accompanied the interview. The cards were shown to inter-

viewees at the beginning, and they were asked to order them from the most to the least preferred one, while thinking of using them in learning mathematics. After the ordering, they were asked the reasons why they put a certain item at the first place and so forth, arriving at the last item. The questions pursued were: What kinds of motives do pupils have for their preferences? With what other matters are these motives connected? The flow of the interview was then decided case by case, which is yet another advantage of using interviews. The idea was to follow the students' reasoning, to direct the flow of the interview towards our interest with it, and to go deeper with other questions when something seemed connected to what the research was addressing.

An interview is, as Cohen et al. (2007) put it in their words: a flexible tool for data collection, enabling multi-sensory channels to be used: verbal, non-verbal, spoken and heard. The order of the interview may be controlled while still giving space for spontaneity, and the interviewer can press not only for complete answers but also for responses about complex and deep issues (p. 349).

In these interviews, the desire was to hear from students about the things they really liked and were enthusiastic about, or things that they disliked and about which they were really firm in expressing their disagreement. A tape-recorder was used, and attention was paid to students' non-verbal behaviours when answering specific questions. In some cases, it was noted, for example, that respondents gave immediate and firm answers. Attempts were made for the pupils to feel comfortable so they would share their thoughts with the interviewer. For this, the interviewer tried to use the students' everyday language, and avoid the role of 'the severe teacher of mathematics' which can sometimes be the image of the Albanian students of their mathematics teacher. It can be thought that the interviewer's (and the author's) age helped to a certain extent.

Compared to questionnaires, interviews are more time-consuming, but these two methods serve two different objectives in research, and complement each other. Another disadvantage is that it is difficult for researchers to leave out their own beliefs and understandings, that one carries and which make one see the world through those lenses (Pring, 2004).

Cohen et al. (2007, p. 364) confirm that "the interviewer should avoid giving signals of approval or disapproval of responses received". During interviews, I tried to keep this suggestion in mind. However, there were moments that were deliberately chosen at which to agree with the respondent for the sake of receiving a more detailed answer and make the interviewee 'feel at home' and talk freely without risk of being misunderstood or judged, or perhaps for not risking being misunderstood and lose the interviewee's trust. There were, for example, cases in which a student was asked about the reasons for ranking lotteries and gambling

in a low position and the respondent began talking about the negative effects of those areas. In order to understand more from the respondent the interviewer felt she had to admit sharing the same opinion, and then insisted on knowing something more from the respondent. By so doing, the student's feeling of being judged for not being on the 'right side' was hoped to be prevented, and a confident environment for the interviewee to be created. Of course, the interviewer genuinely agreed with the reasons given.

### 5.2.3 Teaching units

In this section, a description of the five teaching units for data collection is presented. From a classification scheme for modelling problems presented by Maas (2010), some elements are chosen that can apply to teaching units as well. Among those, there is the nature of context's relationship to reality with two relevant options: authentic, where an extra-mathematical situation from a certain field is described that can be recognized by experts of the field as real (Niss, 1992), or realistic units close to reality, where either data or the questions are not authentic, they might be constructed. In all the units, there are examples of both. For example, in the cell phone messages unit, information provided about the route of an SMS is authentic, and the calculations can be recognized by experts as authentic, but in one task data such as average values are given which in reality does not happen, data are invented, and thus close to reality. It is for this reason that for this category both choices will be mentioned.

Each unit contained tasks, and the openness of tasks is considered as one of the following cases: ascertaining or reversal task, where either the starting or the end point are known and the transformation is easily identifiable; ascertaining or reversal problems, where either the starting or the ending situation are known and the rest unknown; and finding a situation where a certain transformation can be used. Another kind of task used in the study is also a checking task, where one should check if the given solutions are correct. The third constituent is the type of representation in the text, which in the current case is primarily text with pictures, or just text.

The next aspect addressed by Maas (2010) is cognitive demand, skills and knowledge required from the students to complete the tasks in the teaching units, where we used: inner-mathematical working, or the kind of mathematical operations or algorithms required; and mathematical reasoning, dealing with mathematical representations, such as tables, graphs, formulas. The mathematical content of the teaching unit has to do with the mathematical area where it is located and the school level, which in our case is lower secondary. The last part was the type of teaching unit, descriptive, where a situation in reality is described, and norma-



tive, where a part of reality is defined (p. 299). The teaching units contain elements of both types.

The author of the study taught the units before the student interviews, and the teaching objective was to allow students to experience mathematics in different situations connected to real life. In each of these units, students learned about one real-life situation while at the same time they learned and used mathematics, which could be anything from applications of known mathematics to relatively new mathematics knowledge. Care was taken to consider the appropriateness of the difficulty of the level of mathematics for the students' age.

Five topics of different degrees of preferability were chosen: indexes of development, lotteries and gambling, sport tournaments, secret codes, and sending SMS's. They were taken from different positions on students' preferences' hierarchy obtained from questionnaires collected in Shkodra.

One of the most preferred items on the questionnaire was "determining the level of development regarding employment, education, and poverty of my community", and this was the realistic situation used for one of the lessons. Information from the Human Development Index (HDI), used by UNDP (2009) to measure the degree of development of countries of the world, was used and introduced to students during this lesson. They learned how the HDI for each country is calculated, they calculated their own country's HDI, and at the end another, simpler index was provided. The students' homework was then to collect data in their neighbourhood to calculate a development index for the area in which they lived, and discuss it. The main mathematics concept here was the construction of a social index, which is normally embedded in econometrics, and was introduced to them for the first time in this lesson.

"Lotteries and gambling" was one of the lesser preferred situations resulting from the administration of the questionnaire (Kacerja, Julie & Hadjerrouit, 2010) due to their negative connotations both socially and materially. The underlying mathematics was probability. Students learned to systematically find all possible outcomes of an event, then all possible results of a number of combined events, for example, various football matches as a sport bet. The part of the lesson that includes roulette starts with a quote by Einstein "You cannot beat a roulette table unless you steal money from it", which students were asked to discuss after calculating probabilities. The latter was to emphasize the objective of learning to evaluate how small the probability to win is, especially after encountering students' resistance to this topic during the first interviews. Another contextualised topic was sport tournaments as part of the item "recreation, physical exercise, sport activities and competitions". This context was ranked by the students 9<sup>th</sup> out of the 23 items. It brings to the

fore elements that have to do with the number of teams and matches in a single-elimination tournament in sports such as basketball or football. The idea was taken from Vincent and Schielack (1993). In one of the exercises students were asked to plan a tournament with the number of desired teams, to calculate the number of matches that will take place, and then discuss a rule for finding that number. The mathematics aspect deals with powers of a number and multiples, which they already knew from the school mathematics and geometric sequences that were new for them.

From the item “secret codes such as PIN numbers”, the 14<sup>th</sup> ranked item, a lesson was adapted from a chapter of COMAP (2000) on secret codes and algebra. Here students learned how to code a phrase by shifting letters or numbers, and how to decode a message coded by someone else. The mathematics used here employs elements of cryptography. Students used different linear functions that were not entirely new to them.

The last of the topics that were contextualized involved cell phone messages connected to the item “sending and receiving electronic messages”, ranked 6<sup>th</sup>. Here students learn the route traversed by an SMS while moving from one mobile phone to another, the time taken for that service, and the time to wait in queue. The information they received from this lesson was new to most of them, and the mathematics included some simple elements of queuing theory. The task was formulated by Cyril Julie.

The general impression during the lessons from the teacher’s point of view was that students were more engaged and enthusiastic during the secret codes lesson, and it appears that they understood it quickly. They were more engaged and competitive in finding the secret phrase from decoding the given message.

During the tournaments lesson boys were more enthusiastic, especially in virtually ‘organizing’ a tournament with their preferred sport teams and performing the necessary calculations. Much of the information given here about national or international sport leagues was new and this was provided an incentive to them.

In the lotteries and gambling lesson there was a certain resistance at first, mainly from girls, but this changed when the emphasis was put on its negative effects, enabling them to evaluate the probability of succeeding in a sport bet. It was necessary to repeat and discuss this emphasis many times.

The lesson about development indexes had more material, and required more time than the others, especially because students had more mathematical operations to do and went back often to check the results. It was also more difficult on a topical level, as many concepts such as life ex-

pectancy, enrolment ratios, GDP, etc., were new to them. More time would most likely be needed to teach this topic so that all students would feel more comfortable with it, considering the fact that some students need more time than others to work with mathematics. More time would also be needed to critically discuss the concept of a social index, after grasping its construction. This would introduce a new element to the mathematics lesson, that of discussing social issues in conjunction with mathematics. Because of the short time available, the teaching unit did not fully explore the potential of the topic.

The cell phone messages topic was easier to perform from the point of view of mathematics operations, but there were still some new concepts such as mean waiting time, mean inter-arrival time, mean service time, etc.

The routine followed in every lesson was similar to that which students were used to at school: first, introduce the topic with some information about it, and then proceed together into the different sections or exercises. Some of the exercises were solved by a group on the blackboard, some individually in the classroom, and others were left as homework.

#### 5.2.4 Realistic interviews

In a realist paradigm, a theory is given by the equation: *outcome* = *mechanism* + *context*, which means that:

[...] programs work (have successful 'outcomes') only in so far as they introduce the appropriate ideas and opportunities ('mechanisms') to groups in the appropriate social and cultural conditions ('contexts') (Pawson & Tilley, 1997, p. 57).

Programs considered in this study were mathematics units embedded in real-life situations, and their outcomes were the students' preferences. Realistic interviews were conducted here to explain the mechanisms and their triggering contexts.

Realistic interviews are used in this study to answer questions about students' motives for preferences for real-life situations. These motives, earlier defined as students' reasons for preferences, are seen as the mechanisms that guide students to prefer some real-life situations over others. Contexts can be conditions of Albanian society in general, but also situations and processes in Albanian schools and classrooms. The motives, or mechanisms, that influence students are evidenced by the reality of the Albanian family and society in general, their problems, values and culture. However, other mechanisms can also be related to the organization of the units embedded in real-life situations, such as the difficulty of the mathematics, the amount of calculations and concentration needed during the lesson, or the student's degree of engagement in, or perception of, the relevance of the information received. The equation used in the realist paradigm is, therefore, an instrument for answering

questions about the functioning of mathematics lessons with real-life contexts in classrooms.

Relying on Pawson (1996), given that a realistic paradigm and realistic theory were chosen as argued above, realistic interviews were considered the best path for completing the research. At this point, research information existed concerning motives for preferences, but what was achieved with the realistic interviews was a confirmation of mechanisms and contexts, a deeper understanding and most likely enrichment after the five concrete lessons using real-life situations.

Pawson and Tilley (1997) characterise the possible existent ways of conducting qualitative research interviews as the ‘paradigm wars’: that of structured interviews, where a more formal style is adopted with a prepared set of questions, versus unstructured interviews where it is more a matter of understanding the process at hand, with the ‘semi-structured’ interview as a combination of both. The difference between these qualitative research interviews and the realistic interviews is that in the latter “*the researcher’s theory is the subject matter of the interview, and the subject (stakeholder) is there to confirm, to falsify and, above all, to refine that theory*” (p. 155).

What is sought here is not a generalization, but a specification of the outcomes that can be supported by mechanisms and contexts as we understand them, or to answer “*why a program works for whom and in what circumstances*” (Pawson & Tilley, 1997, p. xvi). In the end, specifications relate to the initial theory, to either confirm or negate it, to develop parts of it, closing the full realist evaluation cycle which can then be repeated.

A realistic interview consists of elements through which conversation flows from the interviewer to the interviewee and vice versa. It starts with the researcher’s theory; it is, therefore, a theory-driven strategy. The role of the subjects, who are 8<sup>th</sup> -10<sup>th</sup> grade students, is to help with their expertise in confirming, falsifying, or modifying that theory. From that moment, the interview progresses through four stages that can then be repeated in a form of a circle (see figure 2). One part is a flow of information from the interviewer to the interviewee, and the other brings information from the interviewee to the interviewer.

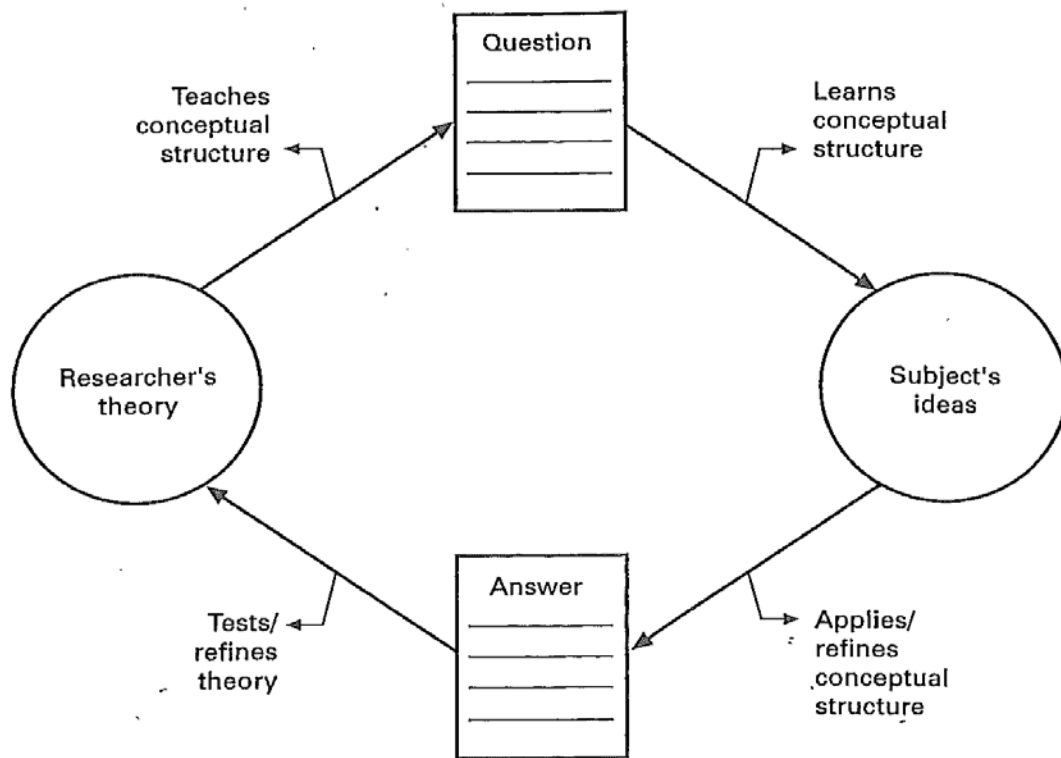


Figure 2: Basic structure of a realistic interview. (Reprinted from “Realistic Evaluation” by R. Pawson & N. Tilley, 1997, p. 165)

The first two stages have to do with a “teacher-learner function” where the interviewer’s role is to actively inform or “teaching the overall conceptual structure of the investigation to the subject” (Pawson & Tilley, 1997, p. 167). The interviewee answers the questions by keeping in mind the concepts presented by the interviewer/researcher (Pawson, 1996). In the interviews in this study explanations were given to each student, in a learner’s role, as to the study’s objectives, what the study was looking for, why there is interest in the study, who the researcher was, why the student was being asked about contexts, and what the possible outcomes meant. There is a primary reason why realists, or researchers who work within a realist paradigm, formulate such a structure of the realist interview. This is in order for both the interviewer and the interviewee to call the same things by the same names or to come to a common understanding of the same items. According to Pawson (1996), another reason has to do with the “hypothesis-seeking behaviour. The aim is not to *minimize* it (as in the structured approach), nor to *wallow* in it (as in the unstructured approach), but to *channel* it” (p. 306). Not only is the interviewer trying to understand something from an interview, but the interviewee as well has his/her own questions that he/she might try to answer. These might be questions about the interviewer, why is he/she being asked, if

he/she is expected to provide certain answers, or what Pawson (1996) called “hypothesis-seeking” behaviour. After the initial explanations, the subject would be in a situation as to say “Yes, I understand the general theoretical ground you are exploring, this makes your concepts clear to me, and applying them to me gives the following answer...” (Pawson & Tilley, 1997, p. 167).

After the second stage, that of learning of the conceptual structure, it is again the subject’s turn to apply the conceptual structure to his/her ideas and answer the questions. The two last stages are included under the label “conceptual refinement function”, where the subjects express their own thoughts, the mechanisms (M) that drive their thinking in specific contexts, to answer the researcher’s questions. The researcher/interviewer repeats and checks the questions by applying the interviewee’s answers to the initial theory. Under these circumstances the interviewee can either agree or disagree with the theory, but can also refine its conceptual basis, by saying “This is how you have depicted the potential structure of my thinking, but in my experience of those circumstances, it happened like this...” (Pawson & Tilley, 1997, p. 169). In the current study, students answered questions about their motives for preferring the five mathematics lessons with real-life situations by referring to elements of the context or the lesson, per se.

The objective of the actual interviews was to identify students’ levels of liking/disliking the five mathematics lessons with different contexts which they were taught before the interviews. The idea was to assess if there were any changes in their preferences compared to the results from the questionnaires and, if so, what it is about the lesson that made them change their mind, or what it is that drove them to like/dislike the lessons. Interviews were conducted in Albanian (for more information about realistic interviews, including issues of reliability and validity, see the 4<sup>th</sup> article “Albanian students’ motives for preferring certain real-life situations for learning mathematics”).

### **5.3 Data collection**

The data collection was organised in two phases: the pilot study in November 2008, and the main data collection in April 2010. These two phases are described herein.

In November 2008 four schools in the city of Shkodra (Shkodra district is the biggest in north Albania), consisting of two lower secondary and two upper secondary, were chosen for the study. This sample was a convenient one, based on the schools’ proximity and the researcher’s contacts with the school principals. First, a meeting with the school principals was set up where their permission to collect data in their schools was requested. Next, school visits by the researcher were organised, in

order to begin the data collection. In each of the two lower secondary schools, one grade 8 and one grade 9 class were chosen, and in each of the upper secondary schools, one grade 10 was chosen. In total 211 students, 94 males and 117 females, participated in the study. There were 68 students from grade 8, 70 from grade 9, and 73 from grade 10. The age range was from 13 to 17 with a mean age of 14.4 years.

In each of the classes the researcher was introduced by the school principal, and explained to the students about the study, its objectives, and the way the data would be collected. Students were informed it was their choice to participate or not, about the anonymity of the questionnaire and the interviews, and their right to withdraw at any time. After the questionnaires, students were also asked if they would volunteer to be interviewed. In the end, four students from each of the six classes offered, therefore 24 interviews were scheduled, each of them approximately 30 minutes long. Interviews were conducted in school offices provided by the school principals. Students were interviewed one at a time.

**Table 2: Sample of students interviewed (November 2008)**

Grade	Male	Female	Total
8	5	3	8
9	3	5	8
10	3	5	8
Total	11	13	24

In April 2010, the second, and last, phase of data collection was completed. The researcher collected the data in every classroom. Students were allowed as much time as they needed, and were informed that they could request clarifications. It was emphasised that personal opinions were sought and there was no right or wrong answer.

The sample selected was a convenient one based on access the researcher had to the schools, always keeping in mind the need for a representation of both genders and of urban and rural areas as well. This choice was also influenced by the decision to include schools that had a relatively high number of students. In some of the distant villages of the Shkodra district, there are schools with very small numbers of students. One, for example, has five students at grade 8 and five at grade 9, and these schools are logistically difficult to access. Ten schools participated in the data collection: four lower secondary (5<sup>th</sup> - 9<sup>th</sup> grade), two upper secondary (10<sup>th</sup> - 12<sup>th</sup> grade) (one of them was private), and four joint schools (from 5<sup>th</sup> - 12<sup>th</sup> grade). Table 3 presents the demographic data for the 825 students from the district of Shkodra who participated in the

study. Their ages varied from 13 to 17 years old. The procedures followed for survey completion were similar to the ones used in the pilot study.

**Table 3: Sample of students who completed the questionnaire (April 2010)**

	Location				Total
	Urban		Rural		
Grade	Male	Female	Male	Female	Total
8	71	63	68	99	301
9	51	68	77	87	283
10	38	43	70	90	241
Total	160	174	215	276	825

In this stage, in addition to the questionnaires, five teaching units were formulated, as explained earlier. A lower secondary city school was chosen for data collection on the basis of the school principal's willingness to collaborate after being contacted and provided an explanation of the study, its aims, the manner in which the data would be collected and materials to be used for this purpose. This school does not have a reputation for being the highest or the lowest quality school in the city of Shkodra. Students did not have previous experience with contextualized mathematics lessons as used in this study. Their only contact with contexts was in word problems dressed up with some information from reality in mathematics textbooks, as discussed on section 2.4. In order not to interfere with the normal lesson plans, the five teaching units were conducted after normal school hours, as extra lessons for students. The mathematics teacher who offered to collaborate with the researcher was asked to form a class with 22 students from 8<sup>th</sup> and 9<sup>th</sup> grades. She asked students for their voluntary participation, and chose them to ensure a gender balance and mixed abilities. At first, it was thought that the lessons would be taught by the teacher, and the researcher's role would be that of the observer. This was very difficult to achieve because of the teacher's normal workload and because the units were new for her as well, so the researcher taught the lessons.

After the five teaching sessions were concluded, the students were asked to volunteer to be interviewed as well, and eight of them were chosen, while keeping a gender balance. Students were interviewed individually at their school for approximately 20-30 minutes. The procedure employed in each one of the interviews was the same: students were asked to rank the five lessons in decreasing order of preference and state the reasons for liking/disliking each of them, following an approach of realistic interviews.



## 5.4 Data analysis

In this section, a description of the methods used for data analysis, and reasons for these choices are provided. First, there is a discussion of the Rasch method for quantitative data analysis and an explanation about the latent trait which the method measures. A discussion of the manner in which the interviews were analysed ends the section.

### 5.4.1 Rasch analysis<sup>5</sup>

#### 5.4.1.1 Latent variable

The study reported here is concerned with a particular aspect of interest, namely the real-life situations that students prefer to use in their learning of mathematics. As such, students' preferences for contexts to be used in mathematics are conceptualized as the latent variable. A latent variable is something that cannot be measured directly. Linacre (2011) defines a latent variable as follows:

A latent variable is something which we can have more or less of, but which we cannot measure directly. It is a variable such as "mathematics ability" or "patient quality of life". We conceptualize it to be a straight line marked out in equal-interval units. This line is infinitely long. We can always imagine something (or someone) with more of the attribute than anything (or anyone) we have encountered so far, and also something (or someone) with less of the attribute. We conceptualize each observation in the data to indicate "less" or "more" of this latent variable (p. 21).

The latent trait is not asked for directly, but other questions in a questionnaire are posed about attributes that represent different aspects or levels of the latent dimension. The interests that students express for contexts to be used in their learning of mathematics served to measure the different levels of the latent variable.

#### 5.4.1.2 Rasch models

When talking about measurement in a physical sense, Campbell (1920) referred to the concatenation idea, such as, for example, in the case when adding two segments the beginning of one segment is connected to the end of the other and the result is a sum of segments. Adding one more unit always means adding the same amount. Concatenation is the fundamental property for physical measurement (Hobart & Cano, 2009). Linacre (2005) explained measurement in social science by means of probabilistic inference, and he explicated the derivation of the dichotomous model by Rasch (1980). Rasch (1980) started his discussion about the derivation of a dichotomous measurement model, later known as the Rasch model, by discussing the need for "ascribing to every person a probability for solving each problem correctly" (p. 73). According to Rasch, one can never be sure if a person of high abilities will

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<sup>5</sup> Further detailed information about the Rasch analysis is contained in Appendix 3.

solve a difficult problem correctly, for example, or if a person of low abilities will solve an easy problem. However, what one can do is assign a probability.

Data collected with Likert scales are ordinal, which limits the researcher in terms of methods for data analysis. Means and standard deviations, and parametric statistics are, as a result, not appropriate because of the non-equality of distance between different categories of the Likert scale. This means that the distance between the categories 'very high' and 'high' interest is not the same as the distance between 'high' and 'low' interest. What Rasch models enable is the transformation of the raw data collected from the questionnaires into logit (log-odds) units and, as a result, construction of linear measures, so that one can work with them (see for example, Doig & Groves 2006; Wright & Mok, 2004). Wright & Mok (2004) state that producing of linear measures is one of the conditions that a measurement model should fulfil to make it possible to construct inference from observation, with another requirement being to give estimates of precision. This latter condition is again fulfilled by Rasch models, where each parameter estimate is associated with its standard error.

Two key propositions are taken into account in Rasch models: persons who are more able (in the case of a test, for example) have a greater probability to address correctly each item of the test compared to less able persons; and items that are easier to be endorsed have the greater chance of being answered correctly compared to more difficult ones (Bond & Fox, 2001). In the study presented here, students who are more interested in contexts, have a greater probability to endorse each item at higher level of preference compared to less interested persons; and items that are easier to be preferred have a greater probability of being endorsed at a higher level of preference compared to more difficult items. Therefore, items and persons will have a certain order or hierarchy along the latent variable, the dimension that will be measured. Their placement on the latent variable is defined by the Rasch calculation, based on logarithmic transformation of estimates of items' difficulty to be endorsed and persons' ability/availability to agree.

The Rasch model is a probabilistic model that shows how data should behave in order to measure them, therefore, data are analysed to ascertain how they fit the model. The rationale behind this is if data do not fit the model, then the assessment should be changed in order for the variable to be measured objectively according to Rasch.

Rasch himself worked with the dichotomous model, which will be explained in the following pages. However, this model was further expanded to include rating scales or Likert scales (Andrich, 1978; Wright & Masters, 1982), partial credit models (Masters, 1982), and multifacet-

ed models (Linacre, 1989). The different Rasch models, dichotomous or polytomous, are used in education in assessment tests (Black, 2008; Boone & Scantlebury, 2006; Callingham & Bond, 2006; Irwin & Irwin, 2005; Liu & Wilson, 2009), with psychological attitude tests (Bradley, Sampson & Royal, 2006; Carmichael, Callingham, Hay & Watson, 2010; Lamb, Annetta, Meldrum & Vallett, 2011; Wu & Adams, 2007), and also in health research (Block, DeSalvo, & Fisher, 2003; Hackett, Melgar-Quinonez, Perez-Escamilla & Segall-Correa, 2008; Mpofo et al., 2006), market research (Bechtel, 1985), sport competitions (Looney, 1997), etc.

#### 5.4.1.3 Rasch dichotomous model

If a person  $n$  has an ability  $B_n$  for solving item  $i$  of difficulty  $D_i$ , and  $P_{ni}$  is the probability of person  $n$  to succeed on item  $i$ , then the Rasch dichotomous model is written as:  $B_n - D_i = \log (P_{ni}/(1 - P_{ni}))$ , or conventionally as  $P_{ni} = \frac{e^{B_n - D_i}}{1 + e^{B_n - D_i}}$  (1) (Linacre, 2005, p. 4). Thus, the Rasch dichotomous model calculates a person's probability for succeeding on an item as a function of that person's ability and the item's difficulty. For a person to be successful means that he shows more of the latent variable we are measuring, such as student's ability to solve an item correctly, or student's attitude towards a specific phenomenon, while failure means showing less of the latent variable.

#### 5.4.1.4 Rasch-Andrich rating scale

Andrich (1978) extended the Rasch model from the dichotomous case to the polytomous case, which can be used for analyzing data from multiple choice tests, or attitudinal surveys. In these tests, the possible answers are not limited to correct/incorrect or agree/disagree as is the case with the dichotomous Rasch model, and more options can be offered to the participants. In the case of the research presented here, a Likert scale questionnaire with four options for answering was used. The categories were: nil/zero (1), low (2), high (3), and very high (4) interest which reflect increasing levels of the latent trait being measured, the preference for real-life contexts that can be used in mathematics.

The Rasch-Andrich Rating Scale model (Andrich, 1978) is one of the Rasch Polytomous models, and is used in this study. The model is based on differences between a person's ability (willingness) to agree and an item's difficulty to be preferred (agreed upon). On a rating scale the probability  $P_{nij}$  for person  $n$  of ability  $B_n$  to be observed in category  $j$  of likeness for an item  $i$  with difficulty  $D_i$  rather than the probability  $P_{nij-1}$  of being observed in category  $j-1$ , is a logarithmic function of the difference between a person's ability,  $B_n$ , item's difficulty,  $D_i$ , and the step's

calibration, or a ‘Rasch-Andrich threshold’ (Linacre, 2011):

$$\log_e(P_{nij}/P_{ni(j-1)}) = B_n - D_i - F_j.$$

The item’s difficulty to be endorsed,  $D_i$ , is calculated based on an item’s raw scores, and a person’s ability to endorse,  $B_n$ , is calculated based on a person’s raw scores.  $F_j$ , the Rasch-Andrich thresholds, are the points where two adjacent categories intersect, or, said differently, where the probability of choosing one category of the answer is equal to the probability of choosing the answer at the adjacent category.

#### 5.4.1.5 Unidimensionality

One of the conditions of fitting a Rasch analysis is the unidimensionality of the instrument. This is not to be confused with the idea that the items of the instrument have only one dimension and we are measuring it. Events in life have many dimensions and can be evaluated from a multitude of complex perspectives. There are, of course, items that require many different aspects of humans’ ability to endorse them. Rasch analysis requires unidimensionality, which means that what the items have in common at a high degree is one dimension, the one we are measuring, and that all other dimensions are small enough to allow us to measure the latent trait. It is similar to measuring a person’s height by using a linear scale, without pretending that other attributes are inexistent in the person that can be measured. “This focus on one attribute or dimension at a time is referred to as *unidimensionality*” (Bond & Fox, 2001, p. 24). To focus on only one attribute at a time requires items that address the latent attribute well enough to measure it. For this reason, Rasch analysis provides fit statistics that indicate how well the items fit within the underlying construct (Bond & Fox, 2001), which is crucial in assessing unidimensionality. Items that do not fit diverge from the expected dimension enough to make the measurement inaccurate, and are therefore excluded from the measuring instrument, or reformulated for the next time the test will be used. What the Rasch model does is construct an ideal measure, and then with fit statistics check how well the data fit with this ideal, or the deviations of data from the model.

In terms of the latent trait being measured here, students express their individual differences on preferences for contexts that can be used in mathematics. There are items that can be easier to endorse or prefer, and items that are more difficult to be liked by students. Therefore, the variable represented by those items is conceptualized as the hierarchy or continuum from the last preferred to the most preferred contexts. As Bejar quoted in Bond and Fox (2001), states:

Unidimensionality does not imply that performance on items is due to a single psychological process. In fact, a variety of psychological processes are involved in responding to a set of test items. However, as long as they function

in unison – that is, performance on each item is affected by the same process and in the same form – unidimensionality will hold (p. 103).

Students are asked to think of the items as if they were used to learn mathematics. Items used in this study are taken from a variety of real-life situations that can be treated from a mathematical point of view, and students employ different psychological processes to evaluate and respond to questions in the questionnaire. However, as in Bejar's discussion, performance of each item is affected by the same process, which is evaluating if an item is among students' interests or to what area of preference it belongs.

In addition to the fit to the Rasch model, the correspondence of theoretical considerations in terms of expected hierarchy of items, to empirical evidence, in terms of results of analyses, is another index for the unidimensionality.

Furthermore, in the study discussed in this thesis, qualitative methods were also used to collect more data. Data from interviews, as described in section 7.2.1., indicated that there is a clear trend of students' motives or reasons for their preferences. Students were guided by their perceived relevance, for their future studies, occupation or role in life, of knowledge connected to questionnaire items. This was discovered when students were interviewed after they completed the questionnaire. This finding is another index for the appropriate degree of unidimensionality in the data, and in this sense the qualitative data complement the quantitative and assist in verifying it as well. On the other hand, students were interviewed after being taught five mathematics lessons with real-life situations as well. In that case, as explained in section 7.2.2., they used other attributes to evaluate their preferences in addition to the relevance of knowledge in the first interviews. This time students were asked to evaluate various mathematics lessons, and the focus was, therefore, on aspects or dimensions that are important in deciding the success of lessons with real-life situations among students.

#### *5.4.1.6 Fit statistics*

There are two aspects of fit reported on a Rasch analysis, outfit and infit statistics. The infit statistics provides more weight to persons whose abilities to endorse an item are closer to the item's difficulty to be endorsed. The outfit statistics, on the other hand, is an unweighted statistic, and is, therefore, more influenced by the outlying scores (Bond & Fox, 2001). Their expected value is around 1. In general, values of fit statistics larger than 2 are considered as distorting the measurement and are excluded (i.e., persons or items showing these values are deleted from the measurement).

To investigate fit statistics, a few rules are suggested. First, high outfit MNSQ values, that indicate noise, are checked, and the causes for

these are sought on unexpected high or low responses on a rating scale. High MNSQ values indicate underfit or noise, and are checked before low MNSQ that indicate overfit or muted. In cases of overfit, i.e., low MNSQ values, persons or items patterns are very predictable, and do not offer significant information as a result.

#### *5.4.1.7 Differential item functioning (DIF)*

If DIF exists, it shows that a group of respondents is performing significantly differently than another group on an item. Amongst the explanations for this occurrence can be that one group is performing at its usual ability/attitude level, while the other is performing better or worse, or that the item is more difficult or easier to endorse for one group of respondents than for the other (Linacre, 2010). To run a DIF analysis, for example, to detect any possible female and male differences on an item, the Winsteps software estimates two difficulties for an item, a ‘male’ difficulty and a ‘female’ difficulty, while holding all the other item difficulties and person measures unchanged. A cross-plot and a table of item difficulties are two sources where we can look for significant DIF. A DIF contrast, as the difference between the DIF sizes of the two groups, males and females, is analysed regarding its significance.

To avoid DIF effects, the items of the questionnaire should be equally applicable to all target populations. Therefore, attention should be dedicated to an appropriate translation of an instrument, in this case from English to Albanian. The instrument should function equally for Albanian and all other students participating in the ROSME study. Another aspect causing DIF can be connected to cultural differences in perceiving items between different target populations, such as, for example, Albanian and South African students participating in ROSME, but also between different groups in the same population such as male versus female students in Albania. An example of DIF between different populations is mentioned in Reeve and Fayers (2005), referring to a study by Azocar et al., in which a Latino population received a higher degree of depression compare to an Anglo population. This occurred due to the fact that Latinos endorsed the item “I feel like crying” more than Anglos, as crying is socially accepted in the Latino population. “DIF occurs whenever one group consistently responds differently to an item than another group” (Reeve & Fayers, 2005, p. 68). Said differently, students belonging to different groups, such as male versus female, have different probabilities for endorsing an item even though they might have similar ‘abilities’, or ‘preference’ for contexts.

#### *5.4.1.8 The item-person map*

In Rasch models, items and persons are given a total score in logit units based on the formulas (see above the case of a dichotomous model). In the study presented here, each item of the questionnaire is given a

'difficulty to endorse' measure, and each person completing the questionnaire is given a 'willingness to agree' measure, in logits. This makes it possible to put items and persons on the same scale (see Kacerja, Julie, & Hadjerrouit, 2010; Kacerja, 2012, third article, for maps). The items placed on the top of the scale are more difficult to be endorsed, and the smaller the proportion of 'very high' or 'high' responses, the more difficult an item is. If the person and the item are located at the same point on the variable's axis on the map, then there is a 50% chance for that person to endorse that item. If a person stands lower on the axis compared to an item, that person's probability to endorse, hence to prefer, the item is less than 50%, while the person's chance to endorse items that stand lower on the scale is greater than 50%.

#### 5.4.2 Interview analyses

The first 24 interviews, conducted in 2008, were examined by listening to them several times. Then, certain parts that were judged to represent various patterns were chosen to be transcribed, and further to be translated from Albanian into English. A grounded theory approach was used for analysis. As Glaser (1996) defines:

Grounded theory is the systematic generation of a theory from data; it is an inductive process in which everything is integrated and in which data pattern themselves rather than having the researcher pattern them, as actions are integrated and interrelated with other actions (cited in Cohen et al. 2007, p. 491).

The two principal authors of grounded theory, Glaser and Strauss, expressed different opinions on the process, but both agreed that "Coding is the fundamental analytic process used by the researcher" (Strauss & Corbin, 1990, p. 12). There are critiques towards grounded theory, but what is presented here is just such an approach.

Coding, as an instance of the data analysis, was the most important here, as the focus was to develop category codes from the interviews in order to obtain an idea of the primary reasons students had for their preferences for the real-life situations with which they were faced. In short, first the transcribed data were given temporary codes, and then later were compared to each other for overlapping. Decisions to merge some of the similar codes were made after comparing the respective interview paragraphs.

The above description concerns the first interviews conducted with Albanian students. The second interviews were realistic, thus a different manner of analysis was applied. In a realist paradigm, a theory is given by the equation: *outcome = mechanism + context*, which mean that:

...programs work (have successful 'outcomes') only in so far as they introduce the appropriate ideas and opportunities ('mechanisms') to groups in the appropriate social and cultural conditions ('contexts') (Pawson & Tilley, 1997, p.57).

Programs considered in this study were five mathematics units that presented mathematics involving real-life situations, and their outcomes in

terms of students' preferences were assessed from the interviews. One important tool of the above equation was the underlying mechanism. Referring to Pawson and Tilley (1997, p. 66), to identify mechanisms in this study is to develop propositions about what it is in the mathematics lessons with real-life situations that drives students to create a positive, negative, or neutral opinion about these contextual situations. Finding the mechanism, which is itself "a theory which spells out the potential of human resources and reasoning" (ibid, p. 68), is to put together individual reasoning (choices) and collective resources (capacity).

Students included in the study are members of an Albanian society, and more locally pertain to a family, study at a certain school, are in a certain class and have, as such, their own habitus (Bourdieu, 1977) or history that shapes how they see the future, which makes them perceive opportunities as such. This highlights, as a consequence, that one should also take into account the context into which the program is introduced, namely the physical context and also the social norms, values, and rules embraced by inhabitants of that physical location, as programs are embedded in a stratified reality and a mechanism can be activated or deactivated depending on a high degree on the context (Pawson & Tilley, 1997).

In general, using a realist evaluation one tries to find out what works, for whom and under what circumstances; it is about finding a configuration CMO (context-mechanism-outcome), testing and refining it. As explained earlier (see realistic interviews), before conducting a realistic interview the researcher already has some hypotheses about what he/she is looking for. Results from the first interviews in this case were the basis for hypotheses (see Kacerja, 2011) that are further developed, confirmed or negated by the interviews. The analysis of these interviews is dependent on the way they are conducted, thus, the primary focus was to find the mechanisms that cause students' preferences and the circumstances under which these mechanisms were triggered.



# 6 Overview of the included articles and matters of reliability and validity

## 6.1 Overview of the articles

Before discussing an overview of the articles that constitute this thesis, a schematic figure is offered that represents the connections between them.

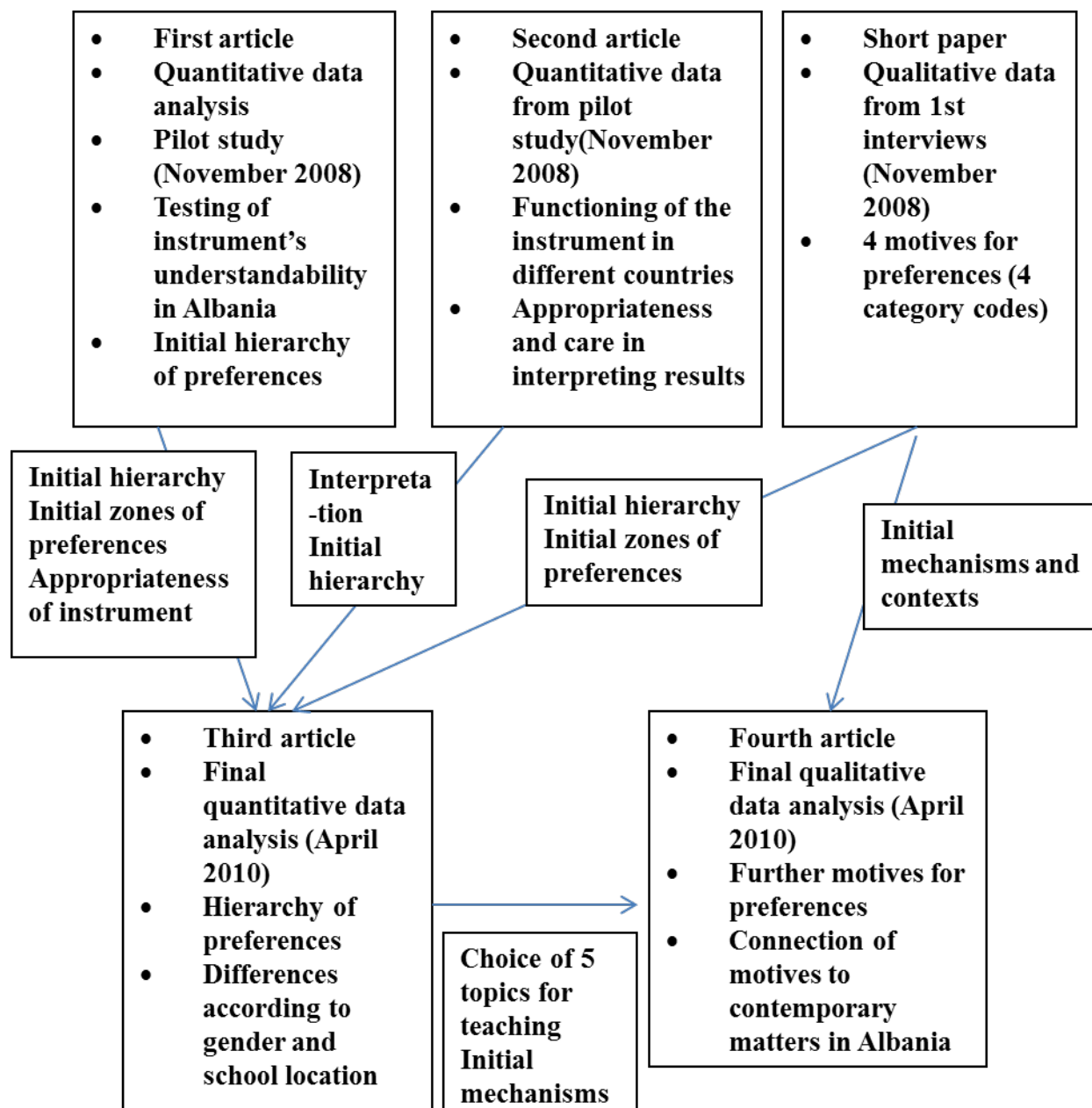


Figure 3: Connection of the articles in the thesis<sup>6</sup>

<sup>6</sup> In this figure, each article is explained in one of the large boxes. One short paper is also included, wherein some qualitative results were shortly introduced. Arrows linking the text-boxes explain the contribution of one article to another.

Four articles form the major components of this thesis. They build upon each other in the sense that in each article results from previous article(s) are used for finding further answers to the questions posed. The data used in these articles belong to different parts of the research, such as quantitative or qualitative, and pilot or final stage of the data collection.

In the first article, data from the pilot study were analysed to discuss the further use of the instrument in the primary data collection. Next, quantitative data from the pilot study were used in the second article to discuss the primary instrument, the questionnaire, and its functioning in different cultural settings as represented by two different countries where the instrument was used. The third article addresses the final quantitative section of the project by arguing about the results from the questionnaires collected during the second stage of the study. Support material from the first interviews was also used. In the end, a presentation and discussion of the results from the final qualitative section of the project was included in the fourth article.

The four articles are described below.

1. Kacerja, S., Julie, C., & Hadjerrouit, S. (2010). The contexts Albanian students prefer to use in mathematics and relationship to contemporary matters in Albania. In Mudolay, V. (Eds), *Proceedings of the South African Association of Research in Mathematics, Science and Technology Education (SAARMSTE)*. Durban, South Africa: University of Kwazulu Natal.

In this article, quantitative data from the pilot study in November 2008 were analysed and students' preferences were discussed in connection with contemporary matters in Albania. The aim of this article was to pilot the questionnaire in order to improve upon it, if needed, for use in the primary data collection, and to obtain a preliminary hierarchy of students' preferences for contexts for use in further planning of this research.

A definition of context as used in this study was elaborated on, as well as providing a short introduction of the ROSME project. Arguments were given for the use of the Rasch rating scale model for analysis, and its main characteristics were summarised in the paper. It was argued that the instrument fulfilled one basic condition to measure students' preferences for contexts: the outfit and infit values were deemed productive. Considerable space was given to the person-item map where one can see the 212 persons and the 23 items placed on the same axis. This map was analysed in terms of the gaps between items and the distribution of persons and items. Added to the table of the items' measures, the map was

used to present and discuss the hierarchy of students' preferences for contexts. Items sharing the same location in the map, for example "latest design clothes" and "government financial matters", were argued to be conceptually different, thus they could not be replaced by a single item. The data analysis highlighted that the three most preferred items were "determining the level of development regarding employment, education and poverty of my community", "making computer games and storing music and videos on CD's and iPods", and "planning a journey". The three least preferred items, on the other hand, were "cultural handmade products by Albanian women such as carpets", "agricultural matters", and "lotteries and gambling".

In the discussion section, the hierarchy of the items was interpreted in connection with the Albanian reality. The interest in "determining the level of development regarding employment, education and poverty of my community" was seen as related to actual issues in the Albanian society where unemployment is a problem. The students' affinity for modern technologies and their desire to travel was also linked to contemporary issues in Albanian society. Students' low endorsement of "lotteries and gambling", "agricultural matters", and "cultural products" were explained in terms of the negative perceptions of gambling in Albanian society, the hard conditions of engaging in agricultural production, and to the population's loss of interest in cultural products in general. Recommendations were made for using the most preferred contexts in textbooks, and also for the less preferred ones. The latter can be introduced in a way that overcomes the negative associations students have with agricultural matters and cultural products, and to provide students with some form of quantitative resource to manage the unlikelihood of being successful in lotteries and gambling. The recommendations contained a suggestion for an expanded use of real-life contexts, in addition to the traditional ones where the context is used only as a dressing for the mathematics, or only as an application of mathematics concepts.

From the analysis of the quantitative data as described in the article, no other problems were seen. During interviews at the same stage, students were asked to add any other real-life situation they thought about that was not included in the questionnaire. Ultimately, the decision was made to use the same questionnaire for the primary data collection, considering that the students did not provide other suggestions. In matters of authorship, guidelines for research in social sciences were followed (National Committee for Research Ethics in the Social Sciences and in the Humanities NESH, 2006). All three authors have contributed in conceptualizing the paper; Julie assisted the primary author with his expertise in processing and analysing the data with Rasch methods, and both Julie and Hadjerrouit have critically read and contributed comments and sug-

gestions for writing the paper. Translation of the instrument used here, the data collection in Albania, data processing, and writing of substantial parts of the article were performed by the main author.

One direction for improvement in this article would be in the manner in which results were deemed appropriate according to the measures. A Differential Item Functioning (DIF) analysis could be included to investigate for a gender effect. With this analysis, the discussion concerning the appropriateness of the instrument for the final data collection would be more complete, due to the fact that questionnaire items showing DIF effect would either be formulated differently or replaced in order to avoid possible bias in the use of the instrument in the future. The advantage for the research would be that items would not have to be separated as was done in the third article with the final data.

2. Kacerja, S., Julie, C., & Hadjerrouit, S. (Submitted in December 2010). Rasch modelling to assess Albanian and South African learners' preferences for real-life situations to be used in mathematics: a pilot study. *Journal of Applied Measurement*.

The aim of this paper was to investigate the functioning of the rating scale used for collecting data and its operation in two different countries. The reason for writing such a paper and including it in the thesis was, first of all, that ROSME is an international project and versions of the same instrument are being used in different countries. It was therefore relevant to discuss to what extent use of the same questionnaire was appropriate in two distant and culturally different countries such as Albania and South Africa in order to answer the questions posed by the project. This discussion would be in terms of the robustness of the instrument in measuring students' interest in real-life situations that can be used in mathematics, and in terms of the differences in the results from students in the two countries. Such a discussion is also relevant when thinking about large-scale international assessments in mathematics, where the same tests are used in different countries.

Quantitative data from Albania and South Africa collected from grades 8 and 9 students were used and analysed in this paper. The Albanian part of data was collected in 2008 during the pilot study. In the introduction section, concerns about students' interests in contexts chosen by adults and the use of contexts in simplistic ways in mathematics were seen as problematic. The relevance of the focus of this research on individual interest for contexts to be used in mathematics was, therefore, argued.

Since the focus of the paper was the functionality of the instrument, an historical description of its reduction from 61 items to 23 items was

included. The Rasch method's characteristics were presented which are helpful in ascertaining the instrument's functionality. Infit and outfit statistics, and person-item maps were introduced in order to discuss the instrument. Gaps between items' locations as well as items' redundancy from the person-item map were explained.

Hierarchies of preferences of the Albanian and South African students are provided. There were similarities in preferences for some contexts of a global nature such as health and safety, future employment, modern technologies, etc. Differences in preferences for other items are seen as being related to the different situations and priorities in the societies in the two countries. It was concluded that preferences for contexts are not the same in the two countries, and implications point to the care with which use of contexts in international assessment tests should be handled. Another implication is for similar preferred items to be used in joint cross-country learning resource development.

Results from this article are important for the entire thesis, as the questionnaire is the primary instrument for data collection in order to answer the questions posed by the research. It provides information about the extent to which the same instrument can be used with students from two different cultural settings, and brings into light the care needed for interpreting the data coming from different countries.

With respect to ethical guidelines regarding authorship (NESH, 2006), all three authors collaborated in conceptualising the structure of the paper. Julie was responsible for the South African data and Kacerja for the Albanian data. Julie interpreted the South African results and Kacerja interpreted the Albanian results. Data were processed in collaboration, and results were compared. Julie and Hadjerrouit read drafts of the paper, and contributed with critiques and suggestions about the content of the paper.

Similar to the first article, including a DIF analysis for the two different nationalities groups of students in the paper would have added some important information to the discussion of the instrument. That analysis would highlight if there are items that function differently for the different groups. In this overview, a DIF analysis is included to determine if there are significant differences in the way students from South Africa and Albania perceive the items in the questionnaire. From the plot (figure 4) items C2, C5 and C21 show the largest differences for the two groups of students. The DIF table 4, which presents DIF measures for both Albanian and South African students, and DIF contrasts, provides more detailed information about the size of the DIF.

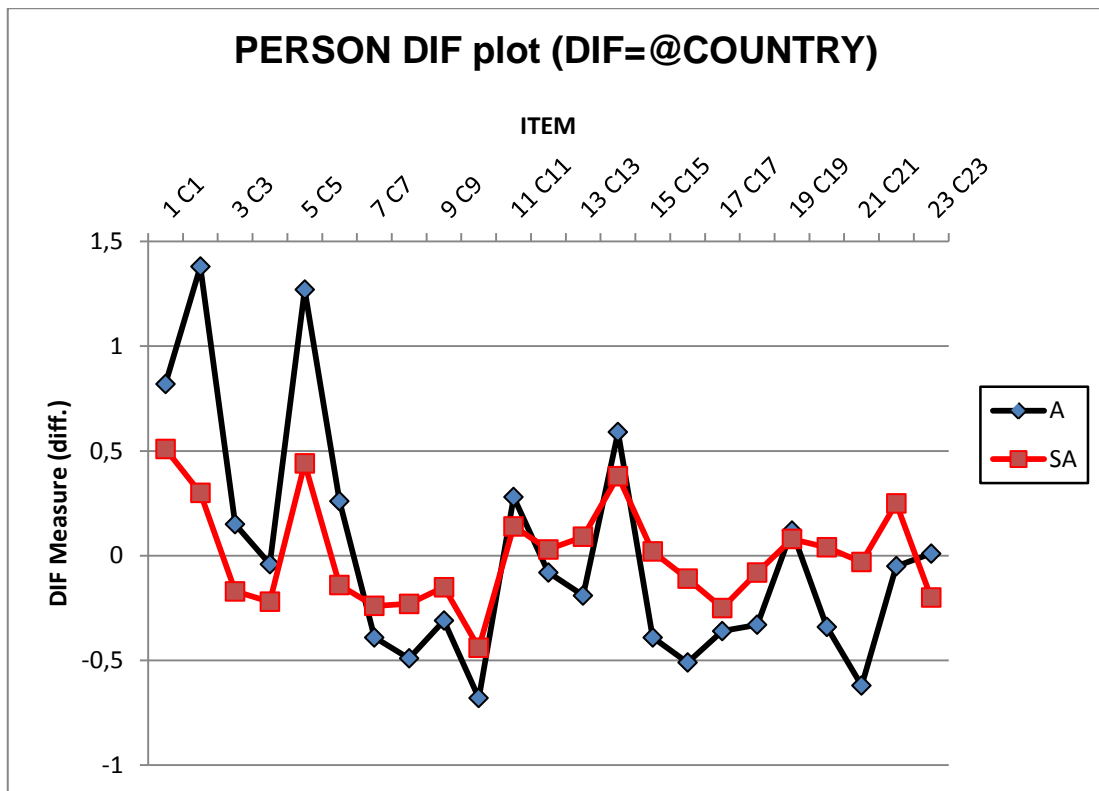


Figure 4: The DIF plot for Albanian and South African students

From the table it is evident that item C2 shows a 1.08 contrast and item C5 has a contrast of 0.83 in favour of the South African students, while item C21 shows a contrast of -0.60 in favour of Albanian students. Therefore, items C2 and C5 are easier for South African students to endorse, and item C21 is easier for Albanian students. Item C2 in the South African questionnaire is formulated as “cultural products such as the house decorations made by Ndebele women” and in the Albanian version of the questionnaire is “handmade products made by Albanian women such as carpets”. This item was discussed in the article as one where students from the two countries differed in their hierarchy of preferred contexts, and it was explained by the priority given to cultural products in South Africa and their inclusion in the school curriculum. This was not the case with the Albanian situation, where cultural products are seen by students as old-fashioned and not profitable. The DIF contrast in favour of South African students reinforces the explanation given in the second article.

Table 4. DIF measures for Albanian and South African students

Person country	DIF measure	Person country	DIF measure	DIF contrast	Prob.	Item
A	0.82	SA	0.51	0.31	0.0077	C1
A	1.38	SA	0.30	1.08	0.0000	C2
A	0.15	SA	-0.17	0.32	0.0040	C3

A	-0.04	SA	-0.22	0.17	0.1128	C4
A	1.27	SA	0.44	0.83	0.0000	C5
A	0.26	SA	-0.14	0.41	0.0002	C6
A	-0.39	SA	-0.24	-0.15	0.2016	C7
A	-0.49	SA	-0.23	-0.27	0.0278	C8
A	-0.31	SA	-0.15	-0.17	0.1601	C9
A	-0.68	SA	-0.44	-0.23	0.0538	C10
A	0.28	SA	0.14	0.14	0.2225	C11
A	-0.08	SA	0.03	-0.11	0.3115	C12
A	-0.19	SA	0.09	-0.28	0.0095	C13
A	0.59	SA	0.38	0.21	0.0589	C14
A	-0.39	SA	0.02	-0.41	0.0001	C15
A	-0.51	SA	-0.11	-0.39	0.0010	C16
A	-0.36	SA	-0.25	-0.11	0.3068	C17
A	-0.33	SA	-0.08	-0.25	0.0247	C18
A	0.12	SA	0.08	0.04	0.7286	C19
A	-0.34	SA	0.04	-0.38	0.0008	C20
A	-0.62	SA	-0.03	-0.60	0.0000	C21
A	-0.05	SA	0.25	-0.30	0.0056	C22
A	0.01	SA	-0.20	0.21	0.0425	C23

The other item, C5, was “agricultural matters”, which for Albanian students was more difficult to endorse. In the other articles constituting this thesis the issue of agriculture, its difficult situation and its low status in Albanian society was previously discussed.

The final item showing significant DIF contrast is C21, “planning a journey”, which was easier for Albanian students to endorse. This item was also discussed in the second article, referring to the cultural differences between the two countries that result in differences in perceptions when it comes to items that are of a more local nature. Therefore, DIF analysis again confirmed the discussion in the second article. As can be noticed, items which we in the article considered as having a global nature show no differential item functioning. It can be concluded that the DIF analysis run better supports the results obtained in that article.

3. Kacerja, S. (Submitted in May 2012). Albanian students’ preferences for real-life situations to be used in mathematics and its gender and school location dimensions. *International Journal for Studies in Mathematics Education*.

Data used for this paper were taken from the 825 questionnaires collected in Albania in 2010. The aim of this article was to obtain a final and accurate idea of students’ interest in real-life situations in mathematics

and motives for that, a hierarchy of their preferences for contexts, and to assess the functionality of the items for different groups participating in the study.

The research presented in this thesis contributed one major addition to the ROSME study, which was not a part of ROSME I, a qualitative section. Interviews were used for the first time to ask students for their motives for preferences of real-life situations. Seven pictures representing seven different contexts were introduced to illustrate the questions. The primary categories developed from this part of the study were presented in a short oral communication (Kacerja, 2009). These categories were useful in the current article described herein for constructing an expected hierarchy for the latent variable, students' preferences for contexts (real-life situations). Other sources for the hierarchy were a few similar studies in the field. For further understanding students' preferences and their motives, Bourdieu's concepts of habitus, field, and capital were referred to.

Six items functioning differently for the different groups of students resulted from the DIF analysis, four showing gender DIF and two showing school locations DIF (urban versus rural schools). This means that those items were functioning differently for the different groups, which distort the measurement. After separating items to repair the DIF effect, the analysis showed differences in the hierarchy of preferences in "cultural products" (more preferred by country girls), "construction and engineering" (more preferred by boys), "the latest designer clothes" (more preferred by girls) and "agricultural matters" (more preferred by country students than city students, and more preferred by city boys than city girls). While items' infit and outfit values were within the accepted range recommended in Rasch models, we had to eliminate 23 students whose infit and outfit values were outside the accepted interval from the Rasch rating scale method. Possible explanations for the high misfit values were offered when looking at the scalogram for answers.

The four most preferred items were "making computer games and storing music and videos on CD's and iPods", "planning a journey", "being productive with the doing of tasks in a job", and "determining the level of development regarding employment, education and poverty of my community". The four least preferred items were "agricultural matters" for city girls, "cultural products such as handmade carpets" as a male item, "cultural products such as handmade carpets" for city girls, and "agricultural matters" for city boys. "Lotteries and gambling" was also low on the hierarchy list.

In general, three areas for preferences were detected. Matters representing an affinity for modern technologies, a safe economic future and upward mobility, and entertainment are in the high preferences area. In



the middle range, preferences are matters of a more global nature, while in the low preferences area are matters students' perceive as not profitable and not relevant for their future. Recommendations were made about the care with which contexts should be presented and raising students' awareness of the importance of less or moderately preferred items before using them in the classroom. The use of the concepts of habitus, field, and capital from Bourdieu as heuristic tools to explain students' motives for preferences revealed that being educated is seen as necessary capital for a good position in students' future fields of higher education and employment.

Results from this and the first article were used to choose five real-life situations of different degrees of interest for formulating lessons for collecting more data. The analysis of those data is found in the last article, presented below.

4. Kacerja, S. (2011). Albanian students' motives for preferring certain real-life situations for learning mathematics. *Pythagoras* 32(2), Art.#50, 9 pages.  
<http://dx.doi.org/10.4102/pythagoras.v32i2.50>

The paper was based on qualitative data from the realistic interviews conducted in Albania in 2010 with eight students, and the goal was to investigate students' motives for their interest in real-life situations after they experienced five mathematics lectures with five selected contexts. The relevance of this piece of research for the study presented in this PhD thesis is in providing a more informed, complete and accurate answer to the research questions posed regarding students' motives for preferences of contexts and their connection to present matters in Albania. Students were asked during the first interviews about motives for their preferences for real-life situations that can be used in mathematics. Results from those interviews were used here as initial contexts and mechanisms for use with the realistic interviews, which were conducted as a result of the realist research paradigm approach. The primary idea for these second interviews was to add, if possible, other motives that could grow from students' encounter and engagement with mathematics in contexts, and to either confirm or modify the initial motives.

Some categories were extracted from the data, as mechanisms or motives for students' preferences. Students recognized new knowledge received from the lesson, everyday use of a context, relevance and usefulness of it for their personal present or future life, personal interest in a context, perceived entertainment value from the lesson, community matters, and distance from gambling as motives. Some of these motives were uncovered during the first interviews also such as the distance from

gambling, everyday use of the context, etc. Other motives were added from students' engagement with the lessons, for example new knowledge and perceived entertainment value. The mathematics inherent in the lesson was revealed to be an important mechanism that appeared in this stage only as it is closely connected to the lessons and the difficulty of the treated mathematics. These mechanisms were then combined with contexts to configure the context-mechanism-outcome relationship. The mechanism "community matters", for example, was perceived as generally relevant, but when combined with a mathematical treatment that is perceived as difficult or tricky by students, resulted in decreased interest. Further research would be needed in order to explain the role of mathematics, which in some cases overrode the choice of contexts.

The discussion section addressed the research questions and argued strong points of the realistic interviews, such as the possibility to consider not only the students' motives for preferences, but also influences that society exercises on students, and the ability during interviews for explaining and understanding concepts between the interviewer and interviewee. Possible explanations were provided for the differences between results from this data and the initial model of contexts and mechanisms.

## **6.2 Matters of reliability and validity of the study**

### **6.2.1 Reliability**

Important matters in a measuring instrument are a number of sufficient items of different degrees of difficulty to be endorsed, and a variety of persons of different degrees of ability/willingness to agree. Two indexes of reliability are produced by the Rasch analysis.

The person reliability index "is an estimate of how well one can differentiate persons on the measured variable" (Bond & Fox, 2001, p. 207). This index is influenced by targeting items at the ability level and by the spread of the ability across the sample of persons. The person separation index, on the other hand, is used to define the number of ability strata in the sample.

The item reliability index estimates the replicability of the items' hierarchy when the same set of items is given to other persons with similar abilities. This is influenced by targeting persons at the difficulty level and by the spread of difficulty across the group of items (Linacre, 2011).

With the Albanian data from 2010, as explained in article three, both indicators were high for the sample of students in this study: person reliability was 0.81, which means that there is enough to distinguish between students of different levels of preferences, and item reliability was 0.99. There is no need, according to Rasch analysis, to make decisions about a larger sample of students or a larger number of items. The person separation index was 2.07 and the item separation index 11.12.

### 6.2.2 Validity

For Bond and Fox (2001), an important aspect is the construct validity, which is based on the fact that “the recorded performances are reflections of a single underlying construct: the theoretical construct as made explicit by the investigator’s attempt to represent it in items or observations, and by the human ability inferred to be responsible for those performances” (p. 26). In the ROSME study presented in this thesis, as can be further read in the third article, a hierarchy of students’ preferred real-life situations that can be used in mathematics was constructed beforehand based on available data from experience, articles and books in the field. The latent trait’s validity, or the construct’s validity, was then discussed as compared to the actual hierarchy obtained by analysing students’ answers with Rasch models.

According to Wright and Stone (1999), internal validity can be assessed by a mean-square test of fit to define to what extent data on each item fit the latent variable, and to what extent a person’s performances fit the model. This test was used with the data collected for this project and appropriate measures were taken to remedy large misfit problems (see Kacerja, article 3). The test of fit identifies items that may not be working the way they were supposed to, and persons that may not have taken the questionnaire the way they were expected to. Once identified, items and persons showing misfit can either be excluded from the analysis, or reviewed for the next data collection, depending on the timing of the study and different objectives of it. In the case of this study, all items had appropriate fit statistics, while 23 students were excluded from the analysis because of large misfit values.

### 6.2.3 Trustworthiness

One section of the study, as explained further in the thesis, was based on qualitative methods. Matters of reliability and validity on qualitative research can be translated into matters of trustworthiness, with its four criteria: credibility, transferability, dependability, and confirmability (Bryman, 2004). Regarding credibility, students were continuously asked during the interviews in the study to confirm or deny if the interviewer’s perception of their opinions was correct. In order to ensure transferability, attempts were made to provide rich descriptions from the different time of interviews. To help in the dependability matter, descriptions about selection of research participants and data analysis decisions, as well as interview transcripts were offered. As explained in section 5.2.2., and related to confirmability issues, the researcher attempted to not allow personal values “to sway the conduct of the research and findings derived from it” (Bryman, 2004, p. 276).

To add to the first paragraph’s discussion, some practical matters are also discussed here. First, interviews were conducted during the data col-

lection with 24 students from grades 8 - 10 to assess students' motives for their interest in some of the contexts that can be used for learning mathematics. The outcomes of the interview significantly depended on the communication between the interviewer, in this case the researcher, and the participant, in this case the student. There were some factors that helped in this direction, such as the interviewer's experience in teaching mathematics to students in the target age group for 2 - 3 years. Further, the interviewer's age was advantageous in allowing students to feel comfortable in talking about things they like/dislike to do and sharing their opinions. Interviewing abilities were improving from one interview to the next as the number of interviews, 24, allowed more time and space for improvement. These interviews were also very helpful in preparing for the second interviews, the eight realistic interviews, where the experience and ability of the interviewer is also crucial in directing the conversation and completing the interviewing cycle, and to obtain answers for the primary questions raised in order to conduct the study. Another advantage that helped with interviewing, and also in interpreting the results of the interviews, were the five teaching units conducted with the students from where the sample to be interviewed was chosen. During the lessons good communication was established, and the goals of the lessons and of the entire study were explained to the students. This made it easier afterwards to ask the students for voluntary participation in interviews, to interview them and rely on their openness and willingness to communicate.

#### **6.2.4 Generalization**

Matters of generalization are concerned with questions if "findings can be generalized beyond the confines of the particular context in which the research was conducted" (Bryman, 2004, p. 76). The data for this study were collected in only one district in Albania, the one from where the researcher comes, which was done for convenience reasons. When addressing generalization, one can ask to what extent are the results generalizable to the Albanian population of grades 8 - 10 students. In 2009, there were a total of 9623 students in grades 8 -10 in Shkodra, and 825 of them participated in the study. This choice of sample was based on the researcher's access to the schools. However, care was taken to include as many different schools, in terms of location, as possible from the ones where the researcher had access. A considerable number of both male and female students were included. Given these considerations, we conclude with some caution that the results are generalizable to Albanian population of grades 8 -10 in Shkodra.

## 7 Results and discussion

In this section, results of the study will be presented as answers to the research questions posed in the beginning.

### 7.1 Albanian students' hierarchical interests and preferences for real-life situations

The first research question concerns Albanian students' hierarchy of preferences and interests for real-life situations that can be used in mathematics. Results from the quantitative part of the study provide an answer to this question.

From the analyses of the two data sets, collected in November 2008 and April 2010, respectively, slight changes appeared in items' reciprocal positions in the hierarchy of preferences; however, a trend can be discerned. There are matters that are given high priority, or preference, from students. One of these is connected to technology, that can be represented in items such as C10 "making computer games and saving music and videos on CD's" and C16 "sending and receiving messages such as SMS". These two items were ordered 2<sup>nd</sup> and 6<sup>th</sup> in the pilot study and 1<sup>st</sup> and 9<sup>th</sup> in the final study.

Community matters are also matters of high preference, as reflected in item C8 "determining the level of development regarding employment, education and poverty of my community", ordered 1<sup>st</sup> and 4<sup>th</sup>, respectively, in the two studies, and health concerns such as C7 "health matters such as the state of health of a person, the amount of medicine a sick person must take", ordered 4<sup>th</sup> and 7<sup>th</sup>, respectively. Sports and travel belong to this group, in addition to items C21 "planning a journey", and C18 "recreation, physical exercise, sport activities and competitions" which are placed in the 3<sup>rd</sup> and 8<sup>th</sup> positions, respectively, in the pilot study, and 2<sup>nd</sup> and 5<sup>th</sup>, respectively, in the final study.

Other matters that can be seen as community matters, but also as global matters, such as C19 "responding to emergencies and disasters", C20 "the spread and decline of epidemics such as AIDS; tuberculosis and cholera", C22 "crime fighting, warfare and military matters", and C11 "environmental issues and climate change" are found in a middle position in the hierarchy of preferences (see article three for the hierarchy). Therefore, there appears a tendency that items about environment, emergencies, and epidemics define a moderately high to a moderately low preferred area. On the high side of this area, there are items such as C17 "managing personal and business financial affairs". On the other extreme, there are C6 "government financial matters, such as inflation

and taxes” and C14 “national and international politics”, or political and governmental matters.

The items that were always positioned low in students’ preferences as can be seen from the two sets of data are C1 “lotteries and gambling”, C2 “cultural handmade products by Albanian women such as carpets”, and C5 “agricultural matters”. These matters define the area of low preferences as matters that recall low interest to students. These were called low return traditional activities and undesired social and material consequences.

Another research question addressed differences in the hierarchy of preferences according to gender and school location. A DIF analysis was run in the third article to detect items that were functioning differently for different groups. There were four items showing a significant gender DIF effect, and two items showing a DIF effect according to whether the school was located in the country or in the city. After separating these items to eliminate the bias, differences were noted according to gender and school location of the students participating in the study.

The context of “construction and engineering” was preferred more by boys than girls, and the item was ordered as 6<sup>th</sup> and 19<sup>th</sup>, respectively. “The latest designer clothes” was a matter of interest more for girls, who ordered it 10<sup>th</sup>, than boys, who ordered it 24<sup>th</sup>. “Cultural products” was separated twice, where girls from the rural schools ordered it 21<sup>st</sup>, girls from the urban schools ordered it 27<sup>th</sup>, and boys in the city schools ordered it 28<sup>th</sup>. Rural school students ordered “agricultural matters” 22<sup>nd</sup>, liking it better than urban school students. There was a difference in gender between girls and boys in the city schools, where boys ranked the item 26<sup>th</sup> while girls ranked it 29<sup>th</sup>.

## **7.2 Albanian students’ motives for real-life situations preferences**

In this section, results related to the research question “What are students’ motives for preferring certain real-life situations?” are presented. Sections 7.2.1. and 7.2.2. provide results from the first and the second interviews, respectively.

### **7.2.1 Motives resulting from interviews with pictures**

In the first interviews, it appeared that students were providing more general answers for the contexts they liked compared to the answers for the second interviews. More reference to mathematics showed in the second interviews.

From the first interviews, four category codes were depicted:

1. Undesired consequences of lotteries and gambling:
  - a. negative material consequences; and

b. negative social consequences.

One of the most discussed items was lotteries and gambling, and all discussions pointed to the negative effects that gambling has on people's lives. The following excerpts from students' answers about ranking the item at the end of their interests, illustrate this category code:

A: It's a big problem for society because they lose a lot there. They have good economic conditions but they can become poor just by practicing gambling to the extremes. Because they believe in it, they believe they can achieve more, that they can win from those. But this is a bad thing, because they lose many things there. It means one becomes...even the character changes, one becomes nervous because of losing...I don't think this is a good thing for society (girl, 10<sup>th</sup> grade).

S: I put lotteries and gambling (*at the end*). To say the truth, I am not interested in lotteries and gambling, not at all. I've met people, I've seen people who ended up bad from these (*lotteries and gambling*). And since I'm not interested at all I put it at the end because I wouldn't like mathematics to have...examples from it (girl, 10<sup>th</sup> grade).

E: I say that this is not good for them. They lose their time, their money which is important for them, and maybe they lose friendship as well, because they don't accept people like that. Or the one who plays can make his friends play as well (boy, 9<sup>th</sup> grade).

2. Affinity for modern technologies

This category came forth from discussing two items with students, making computer games, which were always among the most preferred, and sending and receiving SMSs. Following are extracts of interviews to illustrate this code:

E: This (*computer games*) is my hobby since I was 7 years old (boy, 10<sup>th</sup> grade).

E: I send a lot (*SMS*); I send those to my friends, boys and girls. I spend a time ...well, I have a reserved time for SMSs.

I: It would have been nice to have in the textbooks sending and receiving of messages so mathematics would move forward with our steps, with our time (girl, 9<sup>th</sup> grade).

N: This is the last word of technology. Every child plays with computer games. There are many iPods. More than 60% of children in my age have an iPod or an MP3 at home (girl, 9<sup>th</sup> grade).

3. Need for a safe economic future and upward mobility

It was appealing to hear students formulate their preferences for the given contexts and explain their reasoning. Students referred to their future very often and connected their discussions to important things in life:

L: Of course I do (*connect everything to my future*), because we must work since it is very difficult nowadays to assure our future. When I think of a lot of students finishing university and having difficulties in finding jobs, it's normal that the future becomes important for me. Because you need to assure your life, then your family's life, you will have a role in your life, you won't be a parasite that does only harm to society (girl, 8<sup>th</sup> grade).

That girl expressed her concern for the future, the importance of having a job to have a safe life, and being a responsible citizen.

Many students talked about their future professions and their plans for life. One of the most distinct aspects was the connection they made between having a safe future and having a solid economic position. Therefore, the need for a safe economic future was described as a category code. G, a boy from 10<sup>th</sup> grade, expressed this:

G: I put the management of personal and business financial affairs (*at first place*) because it is a direction that I like for my future. And I find this more important, because this is my aim, for my business.

But this was not the only aspect, as students do not just want a good economy; they are also ambitious in studying further and achieving important things in life. The same boy explained that his father is an electrician, but he wants to be an electrical engineer:

G: I like electrical engineering, and I thought I like more managing financial affairs, to establish my personal business.

This upward mobility came to the fore in the following excerpt as well, with a girl from 10<sup>th</sup> grade, who was explaining how she thought about her future:

A: Last year we were talking about what my older sister should study at university, so I started thinking about my future as well. What kind of studies would be best for me that would help me have a good future, have a good job? And also what economic possibilities do my parents have to help me in that. Why? Because I would have liked for example to follow my studies in England, but my parents can't afford that. So normally I like this mathematics (*mathematics for managing personal and business affairs*) because if I didn't know this kind of mathematics then I wouldn't know how to do these calculations.

That girl thought about the economy because she saw it as very important for having a better future:

A: ...this is the thing people talk mostly about; it's something that anyone thinks about. All the studies we do...you [*talking to the interviewer*] have studied for 16 years for example, and what is the reason? For the simple reason of having a better future. I want the same as you, have a better future. This is the thing that pushes me more. And since this is a very important thing in my life, it is normal that mathematics which has to do with finances attracts me.

#### 4. Negative attitudes towards unprofitable activities, out-of-date activities

Two items were included under this category: agricultural matters and cultural handmade products. These items were often at the end of the



lists of students' interests to be used in mathematics. They were generally associated with tedious or hard work, out-dated activities, absence of public interest but also involving scarce, economic and not economic, outcomes from dealing with them. L from 8<sup>th</sup> grade was one of the girls who explained this effectively:

L: I don't like to work with cultural handmade products because it is not...it doesn't offer you many possibilities...I think that someone who doesn't like school so much can deal with cultural handmade products. On the other hand there are machineries today, and you don't need to hire many people. There are specialised machineries, everything is industrialised.

E, a boy from 8<sup>th</sup> grade, refers to agriculture as hard work, and thus not interesting for him:

E: This is something that grown up people do and I am not interested so much in it. (*In the future I do not like to have a job connected to agriculture because*) it is tedious work.

J (girl, grade 9) is also not attracted to agricultural matters:

J: Because no one wants to work [with agriculture]...If one talks about agriculture, everyone thinks about working with a shovel and a mattock...

Yet another girl explains her detachment from cultural handmade products:

I: My mother knits sweaters and she asks me if I want to learn. I say no. I'm not interested. It is a good thing to know, but previous generations have worked more. Now the following generations, I don't think they are strongly interested. There are shops open, there is no need to [*use the handmade products*] (8<sup>th</sup> grade).

### 7.2.2 Additional motives resulting from doing contextually-driven mathematics

Realistic interviews were conducted the week after students participated in the five lessons with mathematics in real-life contexts. During these interviews some of the above category codes were confirmed, while others were not mentioned, as some of the five topics differed from the seven topics used in the first interviews. At this stage, it was noticed that students provided more specific answers compared to the above answers, and focused more on some aspects of the lesson, the teaching and the mathematics.

A complete presentation of the results can be found in Kacerja (2011). The mechanisms or motives for students' preferences were identified as:

1. New information that students gain from the real-life topic, which is valued;
2. Everyday use of the topic, which is often a positive incentive for preference;
3. Usefulness and relevance of the topic, which is connected to students' present and future life; this code is connected to

- the third code above, the need for a safe economic future and upward mobility, and is also more specific;
4. Personal interest in a context, such as interest in sports, is a mechanism that attracts students towards a topic;
  5. Perceived entertainment value of the topic, as a characteristic of the lesson. This mechanism was displayed in a few cases in the first interviews as well;
  6. Community matters was a sensitive matter to the students in interviews; these matters did not show in the first interviews as the item C8, “determining the level of development regarding employment, education and poverty of my community”, was not included in the first interviews;
  7. Negative consequences of gambling was one of the confirmed mechanisms; and last, but not least
  8. Mathematics revealed itself to be a powerful mechanism in directing students’ interests towards a mathematics lesson with contexts. Often, mathematics that was tricky, difficult and that required many calculations diminished or hindered students’ interest in the topic. Easier mathematics was also given as a reason for liking a topic, amongst other reasons.

As uncovered in the fourth article (Kacerja, 2011), the outcomes of these mechanisms are different when combined with each other, thus the same mechanism can produce different outcomes in the presence or absence of other mechanisms. A discussion concerning this is included in the same paper. The following table 5 summarizes the discussions.

**Table 5: CMO configurations**

<b>Context (Albanian society situation related to the lesson)</b>	<b>Mechanism (students’ motives)</b>	<b>Outcome (degree of interest in the lesson)</b>
Extensive use of mobile phones in Albania Knowledge of modern technologies (mobile phones)	Students’ everyday use of modern technologies for communication New information for students (the route and times of sending an SMS) Lack of perceived relevance (not so needed information)	Disinterest toward a topic (Sending SMSs)
Relevance of safety matters in Albania (related to PIN codes) Knowledge of modern technologies (PIN codes used in the ATMs)	Everyday use of modern technologies (PIN codes) New information (about the use of codes) Utility value perceived (speak in codes with friends)	Increased interest in the lesson (coding and decoding messages) Enthusiasm and engagement in mathematical activities (more involved in the secret codes’ les-

	Entertaining way of learning (attractive lesson, makes you want to solve)	son)
Significant issues of Albanian society: health, education, unemployment, poverty. Important future objectives: higher education, good profession, stable job, safe future.	Community matters (know the development of my community) New information (never known before how to calculate development) Usefulness for future education and occupation (things one needs to know)	Elevated interest in lessons (high ranking of the lesson on development indexes)
Significant issues of Albanian society: health, education, unemployment, poverty. Important future objectives: higher education, good profession, stable job, safe future.	Community matters (know the development of my community) New information (never known before how to calculate development) Usefulness for future education and occupation (things one needs to know) Difficult mathematics, tricky calculations	Lost level of interest compare to previous existing interest (high interest on the topic, which decreased because of difficult mathematics)
Widespread boys' engagement in football teams in Albania Popular sport, followed mainly by male individuals	Everyday use of sport topics (playing football, talking about it often with friends) Personal interest of boys (participate in football teams, football dreams for the future) New information (about sport tournaments) Relevant topic Entertaining topic (enjoyed the concretization with different teams)	High level of interest for boys (in the topic of sport tournaments-one of the lessons enjoyed the most)
Widespread boys' engagement in football teams in Albania Popular sport, followed mainly by male individuals	Not an everyday topic for girls (we don't talk about sports with friends) Lack of personal interest for girls (I watch sometimes sports, but not so often) New information (about sport tournaments)	Low level of interest for girls (I learned the mathematics, but I was not so interested in the topic)
Widespread gambling phenomenon Regulated by law Social problems as a con-	Negative material consequences (loss of money) Negative social consequences (addiction, loss of	Low level of interest, but not a well-defined trend (Girls: we will never use it; Boys: mixed opinions)

sequence of gambling in Albania the last years	friendship) New information (curiosity) Negation of everyday use ( I do not use them, but I know friends who do)	
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During the realistic interviews, students were also asked about real-life situations different from those in the five teaching units. One girl (G, grade 8) expressed her extreme disinterest in learning mathematics connected to agricultural matters as a result of low income and low status that society ascribes to agriculturists in Albania:

G: [*Agriculture*] it is not for girls, I won't deal with it when I grow up. I don't even think I will ever need it...It is lowest in income, lowest [*status*] for example in the city those who deal with agriculture are called 'yokels' ('hicks').

This further reinforces the fourth code from the first interviews, and provides more explanation for the reasons for students' interests.

For A (boy, grade 9), agriculture and cultural products are activities he will never perform in the future, and therefore he is not interested on these topics, while topics connected to his future studies, such as economics, are very interesting for him:

A: I will study economics. But to achieve a high level I need to study a lot, and I am ready to learn everything, every lesson that is [connected to it]... [I am not interested in agriculture] Because it is not so important to me, I don't think I will ever deal with it in the future.

This can be further added to the third code in the first interviews, the need for a safe economic future and upward mobility. Students are, therefore, attracted to topics that they see connected to what they would like to do in the future.

A male student (M, grade 9) explained his interest in economic matters in the following excerpt:

M: We hear about a declining economy...I am interested in economy because in Albania...It is calculated that emigrants bring money here, but they can stop sending that money. And there are many poor families, as there are rich families. For example some families are not touched by the decline of the economy. But another part is more vulnerable.

The interviewee is talking about the remittances which have declined from 12-15% in 9% of the Albanian GDP in 2009 (Central Intelligence Agency, 2011), an important source of finances for many Albanian families. Students are, in general, informed and interested in knowing facts about their country and society.

### 7.3 Scheme of summarized results

The scheme presented here is a summary of the above results that provide answers to the research questions. The separation into three zones of preferences based on results from questionnaires, and real-life situa-

tions are provided for each zone of preference. Motives in the third column are extracted from the two rounds of interviews as described above.

<b>Zones</b>	<b>Real-life situations</b>	<b>Motives for interest</b>
Zone of high interest	Making computer games Planning journeys Being productive in doing tasks Level of development of community Health matters Recreation and sports Construction & engineering (boys) Designer clothes (girls)	Affinity for modern technologies Upward mobility Safe economic future Health concerns High perceived usefulness and relevance High perceived entertainment value High personal interest Community matters Everyday use Connection to future studies and occupation + Not-so-tricky mathematics
Zone of medium interest	Dancing and music Epidemics Emergencies & disasters Crime fighting & military matters Environment & climate change Construction & engineering (girls) Government financial matters	Medium perceived entertainment value Global issues Public matters not-so-close to students Medium perceived usefulness and relevance Expanding knowledge about things around us
Zone of low interest	Cultural products (country girls) Politics Agricultural matters (country students) Designer clothes (boys) Lotteries and gambling Agricultural matters (city boys) Cultural products (boys and city girls) Agricultural matters (city girls)	Low perceived usefulness and relevance Distance from unbecoming behaviours Undesired material and social consequences Tricky mathematics Lack of perceived entertainment value Low personal interest Low economic returns (unprofitable activities) Out-of-date activities Activities that give a low status in society Distance from student's future studies and occupation

**Figure 5: Scheme of summarized results**

## **7.4 How does the main instrument work in two different countries?**

In the second article (Kacerja, Julie & Hadjerrouit, submitted in 2010), a discussion of the questionnaire used for collecting data in Albania and South Africa was the main focus.

Similarities were found in the two data sets regarding matters of: health and safety, modern technology, future employment and related financial success, the physical universe, and the socially unbecoming. These matters are of a global nature and, to a certain extent, enjoy high cross-country visibility due to all forms of globalisation. Thus, there were no fundamental differences in how students experience these issues in their respective countries.

Students' expression of a preference order for contexts to be used in school mathematics is influenced by different experiences, perceptions and values that students from different cultures and environments ascribe to the different items. This was apparent in item C2, "cultural handmade products", where differences appeared in the two data sets. That item was easier for South African students to endorse and more difficult for Albanian students. In South Africa, indigenous knowledge is given high priority and is expressed in school mathematics curriculum. This is not the case in Albania.

Another item presenting the DIF effect was C5, "agricultural matters", which was easier for South African students to endorse. This was explained by the difficult conditions and the low societal status in working with agriculture in Albanian society. Item C21, "planning a journey", was easier for Albanians and more difficult for South African students to endorse, which was connected in the second article to the actual attitude towards travelling in other countries as dictated by the two societies' conditions.

As a result, it can be said that for items of a more local nature, differences can be noted between students' interests from different countries, reflecting that they are living in different cultural, social, and economic settings.

## **7.5 Using Bourdieu's concepts of habitus, capital, and field to explain students' motives**

As can be seen from the quantitative results of the study, one item concerning "national and international politics" is ordered in the low extreme of the medium range preferences (20<sup>th</sup> and 23<sup>rd</sup> in the first and final data collection, respectively). It is possible that students' low interest in politics can be related to the general apathy and the difficult, and often contradictory, political developments in Albania, and also to politics as

an activity that is distant from students' activities at their age. In contrast to other distant activities such as development indexes, politics is not a subject discussed at school. One can, therefore, surmise here that a type of disposition, or habitus, is present where politics is not a visible option for students, and therefore does not belong to the fields they look at for their future.

The field of higher education, and also that of occupation, is often referred to by students. As discussed in section 7.2.2., from an interview excerpt with a 9<sup>th</sup> grade male student (M), he is aware of the remittances and their importance to an economy. Another student (A, girl, grade 10) pointed clearly to the importance of a stable economic situation for a better future for her as something she talks about with her parents (section 7.2.1.). She saw a stable economic situation as connected to higher education followed by a good job. This was found in many other interviews. Here, the field of higher education and, further, that of a special occupation is revealed in the girl's words. She explained the rules of the field (or the 'game') where in order to achieve a good occupation in life, you have to achieve at school. She is focused on following the rules with the capital she already possesses. The girl further revealed a normal routine in her family where members make decisions together, with the different capitals they possess, and in this way influence each other in shaping and transforming what Bourdieu called habitus. Therefore, the question she asked at the end is not just "What would I like to study in the future" but "What kind of studies would be best for me that would help me have a good future, have a good job? And what kind of economic possibilities do my parents have to help me in that?" Thus, it can be suggested that her habitus shapes her experiences, depending on the capital she and her family possess. In the actual case, economic capital is presented as important for her future decisions, and also cultural capital as expressed in a parent's wish to see their daughter successful and in secure economic conditions in the future by choosing the appropriate higher education. Therefore, the economic situation of the Albanian state, expressed partly through the economic situation of the girl's family as well, appears to influence her experiences, habitus and decisions, in this case by limiting the possibilities she can consider for her future: "I would have liked for example to follow my studies in England, but my parents can't afford that". The economic situation has influence in the boys' words as well. One such example comes from a boy (L, grade 8): "I wanted to be a lawyer in the future, but there are too many of them now, I must find something else...in order to be able to find a job in the future". As a result, it appears that his wishes are, to a certain degree, driven by the thought of a safe future. This is in line with Bourdieu (1977), who indicated that habitus shapes what one perceives as possibilities. The boy is

referring to the field of justice as an occupational field, as something he would have liked to do in the future. It also appears that he is aware of the difficulties in the field where there are many ‘players’, or lawyers, that compete for the stakes of the field, such as ensuring a job in it.

The data from interviews seem to indicate that a good future is seen as being closely related to a higher education, which agrees with other studies conducted with Albanian students (World Bank, 2005). Another example of this is shown in the excerpts of an interview with L, a grade 8 girl (section 7.2.1.), who explained her reasons for connecting her discussion of preferences with a safe economic future. Clearly, being educated is seen as capital for a better future, in that it can ensure economic, cultural, symbolic, and social capital. Furthermore, it appears from the students’ interview responses that family is still the most stable and important institution for Albanians. One girl interviewed (G, grade 8) ordered her relevant areas in life, and family is amongst them: “To be in good health conditions, with my family, to be a good student, and to have more or less the future I like”.

Students’ dispositions to prefer higher education to achieve higher status and income in life are also seen as related to their dislike of real-life situations connected to activities that are deemed as not highly profitable and have a low status, or that have negative effects on income and societal status. Such activities are represented by the three low-preferred items from the questionnaires having to do with agricultural matters, cultural handmade products, and lotteries and gambling. An excerpt from a grade 9 girl (section 7.2.1.) confirmed the data related to Albanian agriculture. In the interviews, students revealed their opinions about farming as requiring hard and tedious work, not providing them a desired status in society, and even encountering prejudice from other members of society and, therefore, not providing the social capital they want for their future. One girl interviewed (G, grade 8), was direct in expressing this latter tendency of the Albanian society as influencing her dispositions, and her habitus as a result, on farming, added to hard work and low income (section 7.2.2). This item displayed a gender and geographical location DIF effect, i.e., the item appears to be easier to endorse for country students than for city students, and it was easier for city boys than for city girls. It is important to note here that interviews were conducted only with students in the city schools; however, some of those students either come to school every day from the countryside where they live or their families have recently moved to the city. The girl mentioned above, who addressed the fact of prejudice, informed the interviewer that she comes from a family who worked with agriculture before. She indicated she knew much more about agriculture as compared to her school friends, but she was still not interested in learning about it: “it is not for girls, and



when I grow up I will not work with agriculture” (G, grade 8). There is no clear answer from the interviews about the possible reasons for this item showing gender and school location DIF, but it can be surmised that agriculture is closer to students from country schools, as it is something they see or even perform themselves in their families. In addition, as it is considered hard work, then girls in the city also might find it more difficult to endorse that item, compared to boys.

During the pilot interviews, many students were against the idea of learning the mathematics of lotteries and gambling, based on their personal experiences or, more often, friends’, families’ and neighbours’ experiences. Some of them reasoned on a general basis about the negative effects of gambling, and others even provided unsuccessful and sad stories of people they knew, caused by gambling problems. In Albanian newspapers, there is often information about gambling problems and it is becoming a social problem. It was seen as negative by the students because it could damage economic capital, but also social capital or the relationships one has with friends and family (section 7.2.1.). One boy E (grade 10), also pointed to the losses brought by gambling: “They lose their time, their money which is important for them, and maybe they lose their friendship as well, because they don’t accept people like that”. After the lesson about lotteries and gambling, students were still reluctant to learn about it, even though their reluctance was less obvious compared to the pilot interviews. Some of them even saw it as a good way to learn a lesson by all the young people to be aware of the consequences of gambling.

Another element that was often articulated during these interviews was females’ improbability to ever deal with lotteries, as a taken-for-granted ‘rule of the game’ or of the field. This was expressed openly, especially by male students, such as, for example: “Maybe they don’t like to deal with them [*lotteries*], or to know about them, they have no interest in the field because girls for example they don’t have any problem with lotteries since they don’t...during their life they won’t have the possibility to deal with lotteries and gambling” (A, boy, grade 8), but even by girls such as, for example, “Hmm, I do not use those myself...(chuckle) I am not one of them...those are more used by boys” (B, girl, grade 10). As can be noticed here, in addition to the fact that lotteries are perceived as a negative influence in one’s life, they are also perceived as a gender issue with which females do not deal. In students’ dispositions, gambling is not an option for girls, and it should not be an option for boys either. In addition, students often said they do not gamble, or that they make, rarely, only sport bets, but that they know friends who either gamble regularly, or more often than they do, for example “It’s not that I can use it [*knowledge about lotteries*], but there are others

who might. For me it's just some more knowledge for my general background" (A, boy, grade 8). This could be expected considering that students already expressed an awareness of the loss of capital, economic and social, as a result of gambling activities.

Another element that is highlighted by some students is a type of social capital, for example, when one girl talks about choosing friends that do not gamble in order to not be drawn into that problem

Ad: Since I don't like these things, I have tried to choose friends with the same ideas, so they don't practice gambling, we have the same preferences. Because if a friend of mine, boy or girl, goes there [*in the betting shops*], then I will also be attracted by those and will join: that's why I have chosen friends more or less like me" (grade 10).

That girl seems to be aware of the capital coming from belonging to a group of friends and she does not want the outcome to be something damaging to her. In the current situation, when students express examples of the negative effects of gambling in Albanian people's lives, they also show how their habitus is shaped by their experiences in life, by others' experiences (those who gamble, for example), and by their families' values. This habitus is also, somehow, influenced by the loss of capital, both economic and social, that comes as a result of gambling. One example of a student talking about a transformation of his habitus as a result of life experiences is from a boy (L, grade 8): "I used to bet on sport matches before, I used it many times. But I saw I cannot win with them, I never won, and I stopped".

Another less preferred item was "cultural handmade products" which, again, can be viewed as belonging to the group of not-so-profitable activities, as not ensuring sufficient economic capital and also cultural capital (see section 7.2.1., L grade 8 girl). This item also showed DIF effect according to gender and geographical location, and it was ranked higher for country girls than for city girls, and in the end for boys in general. In the interviews, boys often spelled out the idea that these products relate to women, and not men, while others said it was not to their interest and they had no talent for it. Such an example was "I am not so much interested in those [*cultural handmade products*]. They don't seem... Women at home deal with these" (E, boy, grade 10). When I insisted in obtaining additional reasons for this dislike, the student answered: "Maybe... boys have other things to do, girls can spend their spare time learning how to do these, boys cannot, because they have friends and they can go out. I am not saying that girls cannot go out and have friends, but in our conditions... it's not so..." As a result, it seems that the student's habitus in this situation is still influenced by the roles assigned to genders in Albanian society, including equity issues as well.

Students' affinity for modern technologies, as established during the interviews, comes from the fact that they use them every day, and also

because they perceive technological developments as relevant for their future. Several boys from grade 10 explained that they already study software that is relevant for their future desired profession of an architect or engineer. Another boy mentioned a practice he has with some friends: when one of the friends obtains a computer, then they gather at his house to play computer games, or to learn more about using the computer. This points to a type of social capital, when being part of a group of friends allows you to use the resources of the group, in this case learning how to use the computer. Girls also mentioned that they exchange their gadgets with each other; they talk about and exchange music on CDs, etc. One girl (N, grade 9) commented: “This is the last word of technology. Every child plays with computer games. There are many iPods. More than 60% of children in my age have an iPod or an MP3 at home” (see section 7.2.1.). Some other students related that they already own a computer or other electronic gadgets which allows them to explore them at home. This indicates that there are differences in economic and also cultural capital between families of the different students, in the sense that some might be able to afford to buy electronic gadgets for their children. In addition, it appears that their habitus is not only shaped by the family, but also by encounters with friends at school, when they enter the education field and other fields in life.

In addition to their personal advancement in life, students’ preferences and interests are also directed towards matters to do with their country. One of the items on the questionnaire addressed measuring the development of the country, and it is one of the most preferred items. To illustrate this, one grade 8 girl, A, who was interviewed, explained: “Development indexes were very attractive. I think they are useful for life; I like to know about my country’s development”. Their country’s development, therefore, is perceived as relevant on one’s personal future in that country. To add to this, some students saw the interest about a country’s development as something everyone should have, as does B (girl, grade 9):

We live in this country and we should know the economic percentages, indices, the state of health (*as expressed by life expectancy at birth*), how developed is education. We should know about our country’s development and how to calculate it.

The picture students are creating here is that of a responsible citizen who is informed about important matters in their community and society. Politics, on the other hand, does not seem to be such a matter for students.

Among the middle ranged preferred real-life situations are issues related to emergencies and disasters, epidemics, crime fighting, environment, governmental issues, etc. During an interview, an 8<sup>th</sup> grade girl, G, mentioned the “spread and decline of epidemics” as relevant. First, she

did not have information about it, and therefore she did not think it was so important. However, in her biology textbook, she learned that “AIDS is a sickness that is a risk for all. It is also connected to our school lessons, for example in biology textbook we had a lesson about it, about the HIV virus which is worrying”. This is an example of how students can potentially be influenced in their dispositions, and habitus, by discussing important topics at school in connection with different subjects. On the other hand, some students were able to relate known local or international issues connected to the different items of the questionnaire, such as the volcano in Iceland in 2010 as a disaster that could be calculated in terms of damages it caused, or the flooding that happened in Albania in 2010 as a result of too much rain. The use of such examples in explaining mathematics could be an effective way to increase students’ interest and excitement.

In general, it can be said that there is an image that students reveal about the field of mathematics education, and education in general, in secondary school. The field, according to students, should be the one where they learn about subjects that help them prepare for the future, useful knowledge that can help them gain more cultural capital to ensure a good position in a future occupation, and therefore a good position in society. There are positive dispositions toward such topics. Low interest, and even resistance, to learn can accompany other topics that are perceived as leading to a different, or opposite, direction than the one described.

## **7.6 More on contexts and contextualization**

Contextualization, in terms of using real-life elements, in mathematics has shown to be a complex problem, not as easy as ‘dressing up’ mathematics problems with some information from reality, as recommended in Albanian curricular documents. Many of such problems are ‘pseudo-realistic’ (Palm, 2009) and often perceived as not having any connection to reality (Verschaffel, Greer, & DeCorte, 2000). The school word problems are therefore very limited in their functioning (see for example English, 2009), since one reason for using them is the hope that students will be able to ‘see’ the connections of mathematics with real-life and other school subjects. According to Gerofsky (2009) another problematic issue with mathematics word problems is that many researchers in Mathematics Education assume “an unproblematic transparency of language and a one-to-one matching or mapping models of the relationship between mathematical representations and ‘reality’ ” (p. 22).

It is known as a problem that often students give unrealistic answers to the so-called ‘realistic’ problems such as the famous problem “L’âge

du capitaine” (Verschaffel et al., 2000). The culture of the classroom has an influence in this, since students often experience problem solving by focusing only on the mathematics part while ignoring any realistic consideration of the problem. Further, “the word problems are surrounded by tacit assumptions such as that every problem is possible to solve, all information given should be used, there is only one possible solution and only one correct answer” (Säljö, Risebeck, & Wyndhamn, 2009, p. 191). Another explanation for this is brought by Gellert and Jablonka (2009) based on the notion of recontextualisation of discourse from the everyday or out-of-school to the classroom (Bernstein, 1996). They draw attention to the implicitness of the recontextualisation principle in the classroom where “discovering the principle is left to the students’ aptness of guessing the criteria for what counts as a legitimate school mathematics text” (p. 51). The discourse used in everyday situations is different from the one used in mathematics reasoning, and it can be difficult for students to move from one discourse to another, a move that is defined as inter-semiotic work, when solving problems (Säljö, Risebeck, & Wyndhamn, 2009). Inoue (2009) presented yet another side of the ‘unrealistic’ answers problem arguing from interviews with students about the reasons for their answers. Some students consciously ignored reality to conform expectations to use only the numbers in the problem, but some others showed idiosyncratic interpretations of the situation given in the problem as a cause for their answers, and the rest showed “purely calculational answers” (p. 197) with no sensible rationale.

Contextualized problems are used in assessment tests also. Cooper and Harries (2009) found that certain contextualized items in tests disadvantage working-class students because of the differential validity. This means that working-class students had more difficulties in defining the ‘right’ quantity of reality to take into account for solving the problems compare to other students. Cooper and Harries (2009) recommended as a result that test developers should “pay greater attention to relevant sociological accounts of cultural differences when making decisions about the nature of contextualized assessment items, since there clearly are predictable social class differences in predispositions to respond in one mode rather than another to such items” (p. 108). Said in Bourdieu’s (1977) terms, to which Cooper and Harries (2009) also refer, not all the students have the same feel for the game.

All the above results from different research warn about a cautious contextualization of word problems with situations from real life. But different researchers have also brought several recommendations and solutions for this problem. Palm (2009) offered a local theory of authentic task situations where important elements are: the event should be ‘real’ or possible to happen, the question asked by the problem could also

be found in reality, the information and values given in the problem could also be found in out-of-school situations etc.

Gerofsky (2009) further suggested leaving apart the image of mathematics as “a realm of absolute clarity and certainty” (p. 36), accepting the multiplicity of interpretations for word problems, and making it possible to acknowledge and develop students’ awareness of the generic nature of word problems in school. Gellert and Jablonka (2009) argued for teachers’ strategies that can help students overcome difficulties connected to the implicitness of the recontextualisation principle, such as: openness in discussing the context before going to the mathematics, accepting non-mathematical solutions, critically discussing results with students’ personal experience etc., “in contrast to a strategy which attempts to disguise the disruption between different discourses by introducing a series of “translation steps””(p. 51).

In a broader sense contextualization of elements from real life into mathematics can be found on mathematical modelling. Modelling is to be understood as “consisting of structuring [a problem situation], mathematizing, working mathematically and interpreting/validating” (Blum et al., 2003, p. 153), but also as the process “wherein model-eliciting activities are used as a vehicle for *the development* (rather than the application) of mathematical concepts” (Greer, Verschaffel & Mukhopadhyay, 2007, p. 90). Researchers argue about the potentials of modelling in understanding and making critical decisions in real life with the use of mathematics. Bonotto (2009) for example discussed her research in realistic mathematical modelling in Italian classrooms as a successful experience of working with students. Some factors which she described as significant for success were: the use of artefacts which children are familiar with, interactive instructional techniques, introducing and making explicit for students some particular norms in the classroom, and also using problem posing together with problem solving. Bonotto (2009) suggested that in her approach of teaching mathematics teachers are required to be very flexible and prepared to handle different unexpected situations.

Some of the recommendations from the researchers as discussed in this subsection can be confirmed from the study presented in this thesis also. Students referred to the 5 contextualized mathematics lessons as their first experience with such lessons. Word problems from their textbooks were not mentioned as such. Students were given the possibility to discuss about the context before and after using the mathematics. This was for example the case with the context ‘lotteries and gambling’, where students’ distance from, and a certain unwillingness to interact with, the specific context were expected. During interviews preceding the lesson’s formulation the negative outcomes of dealing with lotteries

and gambling were brought as arguments for students' low degree of context preference. Allowing students to discuss the context for finding reasons about its usefulness, and especially to discuss the mathematics results to support those good reasons, helped in overcoming a possible first resistance.

Since the same person who formulated the lessons also taught them, the requirement for the teacher to be prepared to answer about the context and the tasks in general did not come to the fore as a problematic one. But, even then, it took a long time to decide upon the contexts to use, to find the appropriate information to put in the lessons, to think about its mathematics, to formulate the lessons and so on, and on the other role, that of the teacher, it took time to plan how to complete the lesson with the students, what to discuss about and so on. By this it is meant that both the one who formulates the tasks and the one who teaches them have an important responsibility in the process. Matters of time that a teacher has available for working with students in the classroom are equally important to be considered as they can hinder achievement of the expected results with contextualized lessons.

There were items in the questionnaire used in the study that showed differential item functioning according to gender, i.e. some of them were more preferred by boys, and some others more preferred by girls. Using interviews as a part of the data collection helps in understanding the reasons for these differences and to better plan the lessons in order to avoid problems of alienating one category of students, or individual students. That an item of the questionnaire is ranked higher than others means that most of the students were interested upon it, but this does not ensure that all the students would be interested. When deciding about the contexts to use in a textbook for example, one has to make some choices, and it can of course be such that the most preferred items will also be used more (or accommodating collective before individual interests). The teacher in the classroom then who knows his/her students beforehand can help individual students in meeting their interests as well.

Even with all the problems discussed in this subsection, it seems that many researchers agree that contextualization in mathematics and mathematical modelling are worth all the work done since "an understanding of the very idea that mathematics can be used to model aspects of reality, and that this process is complex, and has many limitations and dangers, is essential to effective and responsible citizenship" (Greer, Verschaffel, Van Doren & Mukhopaydhay, 2009, p. xxv). Research on these matters continues.





## 8 Conclusion

The study detailed in this thesis was designed to develop knowledge about students' interests and preferences for possible real-life situations to be used for learning mathematics. Further matters of importance here were the motives for the preferences, and how these motives came about. As presented in chapter 7, answers to the research questions were found using a combination of methods. In terms of research questions, the answers provided from this study point toward the most interesting, or the easiest to like, real-life situations that can be used in teaching mathematics in grades 8 -10 (section 7.2.1). As discussed in the different articles noted in this thesis, these findings are important, as addressing real-life situations taken from students' areas of preference has the potential of helping students engage and find their motivation for engaging in mathematics. This is supported by research on interest as a psychological concept (Hidi, 1990; Krapp, 2002a; Krapp, 2002b; Renninger et al., 2002; Schiefele, 1991; Schiefele et al., 1992).

In the first article, preferred topics such as mobile communication or development indexes were recommended to be used in teaching, as topics that carry mathematical treatment and possible critical engagement with it. This suggestion was used during the final data collection, where in these topics were used in two of the lessons with real-life situations. Although both items were highly preferred as was seen from the questionnaire analysis, other issues having to do with the lesson, per se, were disclosed in interviews after the teaching. One such important issue was the type of mathematics included with its degree of difficulty, and the complexity of the calculations. This was one of the significant findings, pointing toward the importance of carefulness and awareness in choosing examples and formulating problems using real-life situations in mathematics. Using these in simplistic ways, assuming that students will be attracted, without further thinking of other possible scenarios that can happen in the classroom, is warned against in this finding.

The real-life situations that were less preferred, or those that were considered as medium preference levels, can also be used in teaching. As discussed above, students revealed a certain image of the field of mathematics education in secondary school as being connected to important and useful knowledge about future positions in fields of university studies and occupations. Thoughtful incorporation of the medium preference or low preference level contexts in learning mathematics might assist students in developing their interest in such situations. With actual knowledge of the fields of lotteries, agriculture, and cultural products, students have created their dispositions which tend to exclude these fields from their lives. Knowing the reasons, or motives, for students'

resistance to the use of particular contexts in their mathematical learning experiences might help avoid undesired effects of alienating students during the lessons. One such example was the lesson about “lotteries and gambling”, formulated with a focus on measuring and discussing its negative effects, taking into account students’ motives for the low preference of this topic. Although the topic remained a lower preference in comparison to the others, students were able to find the positive side of dealing with the topic to be that of understanding more and learning a valuable lesson about this negative phenomenon. On the other hand, students have little knowledge about the topics that were considered a medium level of preference, or are perceived as distant from their immediate fields. It can be surmised that offering students more information about such fields can assist them in changing their dispositions. For these items, such as environmental matters, using local examples near students’ experiences could be recommended, to address the issue as it really is. Another recommendation could be the collaboration between different teachers, for example biology and mathematics teachers, in formulating and then teaching such topics together. This can allow students to reveal multiple uses of mathematics, and make it easier for teachers to formulate the topics.

From the differences found in preferences for contexts of students from two different settings, Albania and South Africa, attention should be directed to uses of contextualized problems in international mathematics tests. Sometimes, it happens that students’ achievement on such embedded problems is influenced not only by their mathematics abilities, but also by their emotional reaction to the items. The so-called global matters reflected in items used in this thesis, items of a global nature for students from different settings or countries, can be used in developing cross-country resources for mathematics teaching. When it comes to local matters, those of a country-specific character, a more circumspect manner is required to be used and interpreted. This recommendation can be made based on the fact that students from different countries might have different perceptions and approaches to problems embedded in these contexts.

In the quantitative part of the study, the latent trait, preferences for contexts, was delineated as a trait guided by students’ perceptions of the relevance of contexts for their safe and stable future. This finding was based on students’ prioritization of contexts that they perceive as helping their desired future while at the same time ranking low in the list those contexts that represent obstacles for their desired future. Formulating and teaching lessons with real-life situations, and interviewing afterwards, was a helpful decision that revealed another aspect of the latent trait, preferences for contexts to be used in mathematics. This other aspect has

to do with the lesson, how it is formulated and the degree of offered entertainment as perceived by students, the degree of difficulty of the mathematics and the complexity of the calculations, and even the degree of students' engagement with it. It would only be evident in the conditions when students were able to see and experience how such a lesson could be developed. Therefore, the step taken to collect data after five mathematics lessons with real-life contexts, and the findings provided by means of it, provide a more complete view regarding the motives for students' interests.

Formulating mathematics topics with contexts is not an easy task. It requires care to first find the appropriate mathematics associated with the topic, to formulate it in an appropriate way as dictated by students' age and previous knowledge, and to connect it with the rest of the curriculum. One challenging aspect is the choice of the 'right' amount of new concepts, both mathematical and non-mathematical, to be introduced in a lesson, and to maintain the focus on both the mathematics and the context. As the researcher herself could state, one of the most important components in such a lesson is a discussion in which many students should be involved. Meanings of numbers obtained and mathematical concepts used during the lessons, and implications in broader contexts, are useful components for critical discussion.

In terms of Bourdieu's concepts employed in this study, habitus, field, and capital, such were, to a certain degree, present in students' answers to many of the interview questions. Habitus is mostly seen in how students see and think about their future, when they talk about pursuing higher education studies in order to have a good working and social position when they grow up. Students are more interested in learning mathematics that can be used in situations having to do with their future professions, or interests or hobbies. Therefore, these systems of dispositions that form their habitus serve as structuring structures in the sense that students tackle new situations and answer new questions, thinking of them in terms of usefulness of contexts for their future. This is clear, especially in those excerpts of interviews where students reason about their desired field or place of study having to fit with their actual possibilities and future profits. On the other hand, it is through going to school, spending time with friends, and learning new things, that students change their perceptions about the future possibilities. They have, for example, learned about computers and technology, which have become part of their lives and enlarged their visible possibilities.

In many cases, students expressed their views about different events in life as part of their habitus, shaped either in their families or in society, e.g., when students were asked about real-life situations that have to

do with professions or hobbies that are either unprofitable, both economically and socially, or even negatively influencing their future. In addition to being objective in choosing contexts by judging their relevance, students pointed out other factors influencing their preferences. These were elements of the lesson, such as the entertaining portion, or the difficulty of the mathematics. They even changed the order of the preference for lessons based on these aspects. Lessons that contained information about relevant issues for students' future were ranked lower just because they were not as entertaining as others containing less relevant information. As Bourdieu (Bourdieu & Wacquant, 2002) said: "We must think of it [habitus] as a sort of spring that needs a trigger and, depending upon the stimuli and structure of the field, the very same habitus will generate different, even opposite, outcomes" (p. 135). When students were exposed to other conditions, experiencing lessons with contexts, other matters surfaced which were guided by personal interest and enjoyment. The answers were not only based on *what is the best thing to do, what is more valuable for my future*, but also on *how entertaining can this be, how tiring this can be*.

Another concept that is present in students' reasoning is that of capital. Economic capital is expressed when students talk about a safe economic future, as they all think about jobs that pay well. This type of capital showed itself in students by also limiting their choices for the future. Cultural capital is considered important to gain status in society for their future, and being highly educated is considered as such as it brings not only education, but also a good job. Therefore, cultural capital also is at the basis of students' reflections about their habitus. Cultural capital should also be seen in connection with students' interests in learning about the mathematics of other real-life situations that they believe are relevant in life. They wanted to learn about health matters or the developments of their country, for example, because they believe these are relevant matters, even if they personally would not choose to work in a health service or economic direction. The expression they used was "to enlarge their horizons", which means that they want to know things, as part of their cultural capital, of their cultivation.

Compared to economic capital and cultural capital which were often evident in students' reasoning, social capital was more evident in two unique moments. One of these moments was noticed when students explained their affiliation for modern technologies, as explained in the results section. Another such moment showed while discussing lotteries and gambling, when students do not want to have their friends use betting shops as this could induce them to gamble.

When it comes to the notion of field, there are several fields included in students' reasoning. However, the most important is that of mathemat-

ics education in secondary school and the field of higher education with their rules, followed by the fields of different occupations that students talk about for their future. One expression of this is when students discuss their ideas of proceeding with higher education in order to have more possibilities for a future occupation. In actuality, students discuss the field of higher education and the field of occupation, judging from their position in the field of education in secondary school.

Another characteristic of the habitus students have developed is their tendency to blend what they would like to do with what are the 'real' possibilities in life. These 'real' possibilities are seen in terms of what students can achieve with the capital they possess, in terms of what is best for them, what would give them a better and more stable situation in life. In this study, students explaining their motives for preferring certain real-life situations in mathematics learning often referred to some systems of dispositions, which constitute their habitus.

Further, another important element was the connection between habitus, capital, and field. Using and understanding this connection can be an efficient tool for researchers to study, for example, what is the view students have for the school system, why certain or real-life situations in mathematics education are more popular than others, why students make certain choices for their preferred contexts, how habitus, capital, and field influence their choices, how can changes be brought about so that important, but not so attractive, contexts can be more inviting for students.

Finally, on the basis of this study I am not suggesting that all mathematics has to be taught in contexts. The target students in the study are students from grade 8 - 10, and they have already learned a great amount of mathematics at school. I personally see the use of real-life situations as a way to avoid students' creating the idea of mathematics as a 'dull' and 'dry' school subject, but also as a way to learn how to practically solve problems in real-life situations. There are different ways to do this, either that such topics are presented in the form of projects now and then during the school year, or there can be topics in the textbooks, or materials can be developed to be used as extra topics. The effect of these lessons requires more research to be assessed. This study is a step forward in understanding students' world(s) of interests and it assists in choosing topics and presenting them in ways that interest students, without risking the opposite effect which can happen when students are not interested in the topic itself.



## 9 Limitations of the study

The generalizability issue is discussed in section 6.2.4. Another issue to consider is that of bias. Students were asked to volunteer for participating in the teaching units and after that for being interviewed. This might have resulted in only students who like mathematics volunteering to participate. In order to decrease this bias, students were chosen with different mathematics ability levels, according to their mathematics teacher.

In the ROSME questionnaire used in this study, students are required to answer only multiple choice questions about their interests. Open questions that ask them to provide reasons for their answers would be informative. In the first version of the ROSME study in the other participating countries, the use of such questions was not of any value, and they were, therefore, left out. The same lack of desire/motivation for writing longer answers was noticed in Albanian students who, at the end of each of the five teaching units were required to express their opinions on the lessons. Typical comments were that they liked the lesson, and that they learned things they did not think they would ever learn in mathematics, or other not-so-enthusiastic comments when the lesson was not interesting. Perhaps group discussions with students would have been more fruitful in this case.

When the collaborating teacher was first contacted, she was provided with the entire study details and especially its objectives. The fact that the teacher and the researcher were friends also helped the teacher to be open and avoid giving the picture of the ‘perfect’ school with the ‘perfect’ students who give the ‘right’ answers. Instead, she chose students to participate in the five lessons based on their different degrees of interest and results in mathematics, as requested. When the lessons were concluded, volunteering students of different levels of interest as observed during the lessons were chosen for interviews.

In order to ensure the collection of the information needed for students’ motives for preferences, interviews were conducted as tools, which offer more insight possibilities. However, the primary limitation with interviews is that they require time, and, therefore, only some of the items (seven of them) from the questionnaire were chosen to be discussed with 24 students during the pilot study. Regardless, in many interviews, when there was time remaining, students were also asked about other items on the questionnaire. Another question posed was if they had any suggestion for more real-life contexts that they would like to learn about in mathematics. However, none could provide different items from those on the questionnaire.

Due to time restrictions not only in formulating but also in teaching units with real-life situations, a decision was made on the number and topics of the lessons. Information from interviews conducted after the teaching units would perhaps be more complete if a lesson was formulated for each of the items. However, the fact is that the data coming from the realistic interviews are not the only ones; they come together with data from questionnaires, from previous interviews and from the researcher's experiences and observations.

A DIF analysis was not included in the first article. It is noted here that in that article data from the pilot study were used, wherein the idea was to decide upon possible changes to the questionnaire for use with the primary data collection. In the event the DIF analysis would have shown items that functioned differently for males and females, then these items would have been deleted, or replaced with other more neutral items, or would be formulated differently.

It would have also been valuable to use the respective real-life contexts from the items that show differences in genders as topics for the teaching units or in the interviews, in order to gain a deeper understanding of the reasons for the differential functioning. This was not possible as the quantitative and qualitative data were collected in the same period, and there was no time remaining to first analyse the quantitative data.

Another matter to be discussed in this section is that of the time when students participated in the teaching units. All such participation occurred after standard school hours in order to not interfere with their normal lessons. Generally, after a school day students can be tired, and this could affect the data collection. Students were informed that they could withdraw from participation at any time, but none did. There were two or three students that were not present in one or two lessons, but this was because they were absent from school for that day. In addition, when students were asked to volunteer for interviews most of them were ready to do so. Compared to the author's experience as a teacher, during the lessons students were not especially quiet and tired, and they completed the exercises with a kind of enthusiasm.

The order of the lessons was chosen with the purpose of presenting a lesson that did not have difficult mathematics in the first lesson, so that students could have the time to get used to the novelty. The lesson that was more complicated, on development indices, was placed in the middle to ensure that there would be time to continue discussion the next day if needed. The lesson on sport bets and gambling placed last, knowing that it would evoke discussions which would ensure that the enthusiasm and motivation of the students would not fall that last day. In this manner, equal engagement during the entire period was more or less ensured. Students seemed more enthusiastic during the "secret codes" lesson;



boys were the more enthusiasts on the “sport tournaments” lesson; while the lesson on “development indices” appeared to demand their attention more than others.

Interviews were conducted when the lessons were finished. In order to remind students about the lessons, copies were offered during the interviews, in order to ensure that students would not remember only the last lesson.

The fact that the lessons were held during extra hours not during the school day and that there was another teacher (not their usual teacher), to teach and interview, were positive factors in allowing the students to be more comfortable and open. If the teacher was the same as during normal school hours then the students would feel more the pressure on grades and would, perhaps, try to give the ‘right’ answers.

One of the mechanisms that define students’ preferences for learning mathematics in different contexts as was presented in article four (Kacerja, 2011) was the type of mathematics involved. The degree of difficulty, quantity of calculations, etc., were mentioned as causes for decreasing students’ interest in a topic. However, it is impossible to find a connection between students’ characteristics and lowered interest because of difficult mathematics, or between the type of mathematics and the degree of interest, from the data obtained. Further research is needed to explain this relationship.



## 10 Research impact and further research

This research is important as it brings students' voices before a bigger audience. The latter is not a novelty in itself; students have been previously involved in research in our field. There are examples of research on students' cognitive processes during learning, using both qualitative and quantitative methods. Research exists on the affective domain, where students' voices are heard or measured by different means, on beliefs, attitudes, or motivation in mathematics lessons. The presented research is located in this last field. It happens often, being aware of it or not, that things are taken for granted. In deciding to use examples to illustrate a lesson, it can be taken for granted by teachers that the students will understand it, and will further be interested in it. The well-known Realistic Mathematics Education in the Netherland claims that real examples can be used in the classroom to teach mathematics. They further claim that these examples can be realistic or fantasy ones, but the important aspect is that they need to be real for the students, close to them. However, on the other hand, a question legitimately rises: Who decides what contexts are real for students? Who has the legitimate power to say that one certain real-life example is real enough for, and close enough to, the students? The answer seems to lie in the published research. Those who formulate the examples are the teachers, the textbook writers, the curriculum makers, etc. What about the audience to whom these examples are addressed? Are students' voices heard in this case?

What this piece of research achieved was to explore concretely what contexts or, to express it better, real-life situations can be closer to the students, what they really like and what they are interested in learning and how they think about this. This research has also attempted to bring forth the careful ways this information should be used. In the form of a realistic theory, where certain mechanisms give some results when put into certain specific contexts, this research tries to offer to potential stakeholders, or anyone interested in students' learning of mathematics, the ways in which these preferences can be used in order to have productive and satisfactory results. What really is new in this piece of research is that the students' voices are directly involved in decision making about the learning process, as they are treated as equal partners in the process by bringing their own expertise that the researcher then tried to channel in the right way.

The research presented here conveys some results. It was able to reveal what students' interests and preferences are for real-life situations to use in mathematics learning, and the motives or mechanisms that drive their reasoning, together with the contexts that help or hinder those

mechanisms. These results may be used by groups of people who are directly involved in students' learning processes.

One such group can be mathematics teachers who are inclined to use examples to explain different mathematical concepts to their students during the lessons. In this way, teachers can be aware of the preferences when they choose examples. This means that teachers can use the most preferred real-life situations by already having some expectations about how to catch students' attention and teach them something helpful. However, teachers can just as well use the less preferred items with the condition of introducing them in a reflective way that can neutralize the negative aspects that students have detected in their reasons for not preferring some items. It can also provide teachers some ideas about hearing students' voices themselves.

Another group who might be interested in these results is textbook writers and curriculum makers. Perhaps it is time to include some new examples into the Albanian textbooks, which will probably require more time and effort, but will also bring more satisfaction to them and to the students as well.

This type of study is new in Albania. In fact, there is not much research in Mathematics Education, which is called Didactics of Mathematics (Didaktike Matematike), which is still treated as secondary to mathematics. Knowledge of mathematics is still the primary aspect in preparing mathematics teachers in Albania, and only the last year of a four year study program of teacher education is dedicated to didactics, pedagogy, psychology, and teaching practice as well. To the author's knowledge, there is little or no research on textbooks, no evidence-based reforms, and very little or non-existent research in classrooms. Teachers in Albania are not in a position to be informed about new worldwide developments in the teaching and learning of mathematics. There is an institution called Instituti i Kurrikulave dhe Trajnimit (Institute of Curricula and Training) composed of specialists of education in different fields whose mission is to offer expertise and consultancy to the Ministry of Education or other educational institutions in Albania based on research results and education practices. Their work is relatively new. On the other hand, the Albanian state is a poor one, and as a result its budget for education and training does not allow many extra programs. In the conditions of a world economic crisis, the budget the Albanian government planned for education in 2012 is 2.8% of the GDP. Therefore, in the author's personal opinion, examples of research by Albanians and for Albanians are very important. The next step would be to publish this research in Albanian journals (and language) to make it more widely accessible.

In addition to the above explained fact that research in mathematics education is new in Albania, this study is new in considering students' voices about their interests in the learning process as well. The primary focus in the Didactics of Mathematics in Albania is on teaching methods or problem solving by students. The affective domain is not considered as important as finding ways to explain exercises to children. It gives the impression that positive results in school are seen as part of a relationship between the right knowledge, a good explanation, and a willing listener, while students' motivations, beliefs, attitudes and values are left outside this picture.

On the broader research front, what this study contributes to the affective domain is one dimension of it, namely students' interests. As discussed in section 2.3., there are very few studies focused on students' preferences for real-life situations in mathematics, or further focused on determining the reasons for the preferences. The research brought here therefore constitutes a contribution to research in the affective domain, and further in Mathematics Education. A new paradigm is explored, the realistic one, which comports new theoretical and methodological choices. This does not mean that the paradigm is invented in this research, but it is relatively new in Mathematics Education, or at least in the affective domain. Further, this study is concentrated on sociological concepts for explanation as this direction was argued as being helpful from the results. This can be seen as another input to the trend in mathematics education towards incorporating social aspects.

The originality of this piece of research as a part of the ROSME project stands on the combination of methods used to answer the research questions posed for this study. The ROSME questionnaire was used in order to have a basis for possible future comparisons between countries participating in the project. The 24 interviews with students about reasons for preferences were used in Albania for the first time in the ROSME multi-country project. The formulation of the teaching units and their teaching in the schools was a new decision made during further development of the study in Albania. Realistic interviews following the teaching units were also new. A deeper connection of the concepts of habitus, field, and capital in explaining the results and answering the research questions is reflected in this thesis. The discussion of gender and school location (in terms of different settings within one country), and cultural, social, and economic settings (in terms of different settings in different countries), as possible factors for explaining differential item functioning was also brought for the first time, and adds to the originality of the research.

The study brought to light certain topics that could be further explored. It sets some ground for what type of real-life situations students

are interested in, and also how these contexts should be used. Further research could be in formulating additional topics for mathematics in context the way this research did with the five teaching units, and analysis of their use in school mathematics, and how this could also fit into the curriculum requirements in mathematics.

From the results presented here emphasis was placed on the role of mathematics in students' interests for real-life situations with which to learn mathematics. It was found, in some cases, that when mathematics was complicated, or contained too many calculations, students' interests tended to decline. The nature of this relationship cannot be determined from the current data. It would be of interest to focus on this matter and further explore it.

Efforts were made to portray the study as clearly as possible, such that it is open to critiques, discussions, further explorations and explanations.

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# 12 Appendices

## Appendix 1: Cards used for first interviews (November 2008)

Lojrat e fatit dhe lotaritë e ndryshme (Lotteries and gambling)



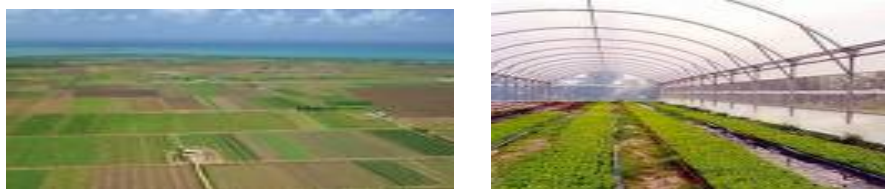
Produktet artizanale si qilimat, çentrot për zbukurim etj (Cultural products such as carpets made by Albanian women)



Kodet sekrete si numrat PIN që përdoren për të tërhequr para nga ATM (automatet e bankave) (Secret codes such as PIN numbers used to retrieve money from ATM machines)



Çështje të bujqësisë (Agricultural matters)



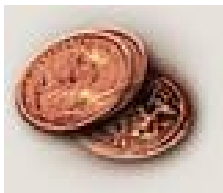
Bërja e lojërave kompjuterike dhe ruajtja e muzikës dhe videove në CD dhe I-pod (Making computer games and saving music and videos on CD's and Ipods)



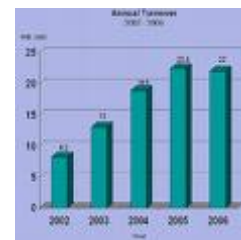
Dërgimi dhe marrja e mesazheve si SMS apo e-mail (Sending and receiving sms and e-mails)



Menaxhimi i çështjeve financiare personale apo të biznesit (Managing personal and business financial matters)



**Biznesi**



## Appendix 2: The Albanian version of the questionnaire

KODI:.....



### RËNDËSIA E DIDAKTIKËS SË MATEMATIKËS SHKOLLORE (ROSME)

Tetor 2008

#### Gjërat që më interesojnë të mësoj në Matematikë

Unë jam:                      mashkull .....    femër .....

Unë jam ..... vjeç/e

Jam në klasën e .....

Për cilat gjëra do të donit të mësonit në Matematikë? Disa nga mundësitë i gjeni në listen e mëposhtme. Për secilin nga elementet në listë, vendosni një x mbi ose pranë një prej fjalëve në kutinë ngjitur me elementin për të treguar se sa jeni i/e interesuar në atë çështje. Ju lutem përgjigjuni për të gjithë elementet dhe zgjidhni vetëm një nga fjalët për çdo element.

Nuk ka përgjigje të sakta: ne duam që të na tregoni atë çfarë ju preferoni.

Shembuj:

Nëse jeni pak i/e interesuar për matematikën që përdoret në “ndërtimin e shtëpive”, atëhere vendosni një (X) tek kutia “I pakët” si më poshtë.

Interesi im për të mësuar për matematikën që përdoret në						
CEx1		Ndërtimin e shtëpive është	Shumë i madh	I madh	I pakët <b>X</b>	Asnjans/Zero

Nqs ju jeni i/e interesuar të mësoni për matematikën që përdoret në “lyerjen e një makine”, atëhere vendosni (X) në kutinë “shumë I madh” si më poshtë.

Interesi im për të mësuar për matematikën që përdoret në						
CEx1		Lyerjen e një makine është	Shumë i madh <b>X</b>	I madh	I pakët	Asnjans/Zero

Faleminderit për pjesëmarrjen!

Interesi im për të mësuar mbi matematikën që përdoret në

C1	lojërat e fatit dhe lotaritë e ndryshme është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C2	produktet artizanale si qilimat, çentrot për zbulim etj është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C3	dizajnin e rrobave është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C4	kodet sekrete si numrat PIN që përdoren për të tërhequr para nga ATM (automatet e bankave) është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C5	çështje të bujqësisë është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C6	çështje financiare qeveritare, si inflacioni dhe taksat është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C7	çështje të shëndetit si gjendja shëndetësore e një personi, sasia e ilaçeve që duhet të marrë një person I sëmurë është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C8	përcaktimin e nivelit të zhvillimit për sa i përket punësimit, arsimit dhe varfërisë në komunitetin tim është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C9	të qenit produktiv në kryerjen e detyrave të ndryshme në punë është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C10	bërjen e lojërave kompjuterike dhe ruajtjen e muzikës dhe videove në CD dhe I-pod është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C11	çështje të mjedisit dhe ndryshimit të klimës janë	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C12	përcaktimin e origjinës dhe moshës së universit është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C13	të gjitha llojet e muzikës pop është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C14	politikat kombëtare dhe ndërkombëtare është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C15	vallëzimet si disco, hip hop etj është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C16	dërgimin dhe marrjen e mesazheve si SMS apo e-mail është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C17	menaxhimin e çështjeve financiare personale apo të biznesit është	Shumë i madh	I madh	I pakët	Asnjanës/Zero
C18	kohën e lire, ushtrimet fizike (fizikultura), aktivitetet sportive	Shumë i madh	I madh	I pakët	Asnjanës/Zero



	dhe konkurimet sportive është				
C19	përgjigjen ndaj rasteve urgjente dhe fatkeqësive natyrore	Shumë i madh	I madh	I pakët	Asnjans/Zero
C20	përhapjen dhe luftimin e epidemive si SIDA, tuberkulozi dhe kolera është	Shumë i madh	I madh	I pakët	Asnjans/Zero
C21	planifikimin e një udhëtimi është	Shumë i madh	I madh	I pakët	Asnjans/Zero
C22	luftën kundër krimit, çështje ushtarake dhe të luftës është	Shumë i madh	I madh	I pakët	Asnjans/Zero
C23	ndërtim dhe inxhinieri është	Shumë i madh	I madh	I pakët	Asnjans/Zero

## Appendix 3: Rasch models

### Rasch dichotomous model

In this section Linacre's arguments are brought to follow the mathematical derivation of Rasch model.

Linacre (2005) brings together two persons,  $n$  and  $m$ , and a dichotomous item  $i$ , denoting  $B_{ni}$  and  $B_{mi}$  each person's ability on solving item  $i$  respectively, and  $P_{ni}$  the probability of person  $n$  to success on item  $i$  where  $0 \leq P_{ni} \leq 1$ . In a dichotomous item there are only two options, one is when the person solves the item correctly, therefore scores 1, or is successful, or shows more of what we are looking for. The other option is when the person does not solve the item scoring 0 and failing, therefore showing less of what we are looking for, less of the latent variable. In order to fulfill the Campbell concatenation it is necessary that **outcome** ( $B_{ni}$ ) + **outcome** ( $B_{mi}$ ) = **outcome** ( $B_{ni} + B_{mi}$ ).

The probability  $P_{ni}$  is then transformed into a log-odds ratio:

$$-\infty \leq \mathbf{log} (P_{ni}/(1 - P_{ni})) \leq +\infty$$

Therefore, if **outcome** ( $B_{ni}$ )  $\equiv$   $\mathbf{log} (P_{ni}/(1 - P_{ni}))$  and **come** ( $B_{mi}$ )  $\equiv$   $\mathbf{log} (P_{mi}/(1 - P_{mi}))$ , where by outcome it is meant log-odds of coincident scored observations, then the sum of outcomes would be (Linacre, 2005, p. 2):

$$\mathbf{log} (P_{ni}/(1 - P_{ni})) + \mathbf{log} (P_{mi}/(1 - P_{mi})) = \mathbf{log} (P_{ni} * P_{mi}/((1 - P_{ni}) * (1 - P_{mi})))$$

As a result:

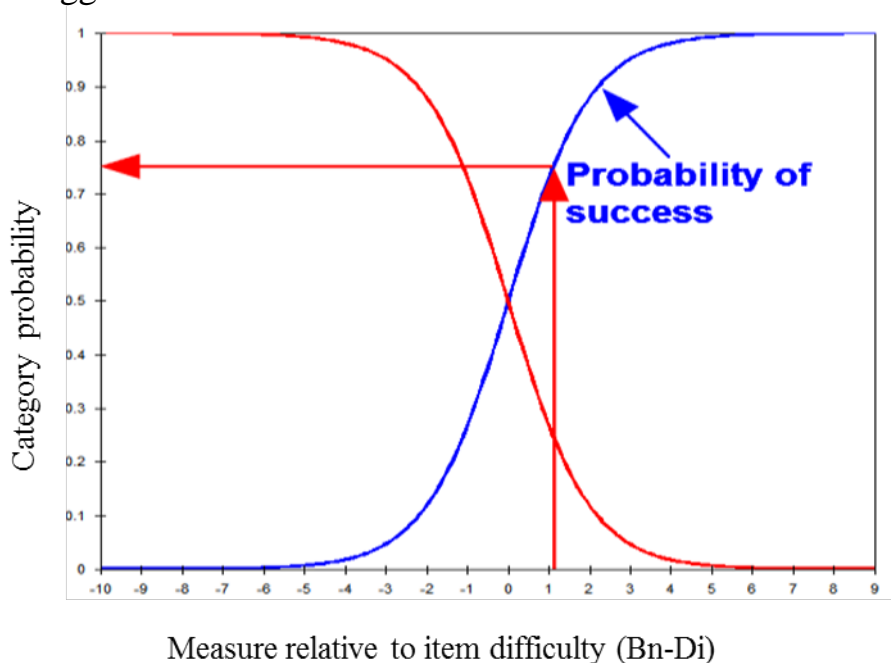
$$\mathbf{outcome} (B_{ni}) + \mathbf{outcome} (B_{mi}) = \mathbf{log} (P_{ni}/(1 - P_{ni})) + \mathbf{log} (P_{mi}/(1 - P_{mi})) = \mathbf{log} (P_{ni} * P_{mi}/((1 - P_{ni}) * (1 - P_{mi}))) = \mathbf{outcome} (B_{ni} + B_{mi})$$

Further, person's  $n$  ability to succeed on item  $i$ , **outcome** ( $B_{ni}$ ), is conceptualized as the difference between the ability  $B_n$  of the person  $n$  and the difficulty  $D_i$  of the item  $i$  (Rasch, 1960). For a person being successful means that he shows more of the latent variable we are measuring, such as student's ability to solve an item correctly, or student's attitude towards a specific phenomenon, while failure means showing less of the latent variable. The dichotomous Rasch model then is written as:  $B_n - D_i = \mathbf{log} (P_{ni}/(1 - P_{ni}))$  or conventionally as:

$$P_{ni} = \frac{e^{B_n - D_i}}{1 + e^{B_n - D_i}} \quad (1) \text{ (Linacre, 2005, p. 4).}$$

In general  $\ln \left( \frac{\text{Probability of success}}{\text{Probability of failure}} \right) = \text{ability} - \text{difficulty}$  (Panayides, Robinson & Tymms, 2010, p. 616). It can be said thus that the Rasch dichotomous model specifies the probability, P that the person  $n$  of ability  $B_n$  has to correctly solve item  $i$  of difficulty  $D_i$ . In the case when the probability of success is the same as the probability of failure on a dichotomous item,  $P_{ni} = 1 - P_{ni} = 0.5$ , then the difficulty of the item  $D_i$  is equal to the ability of the person  $B_n = D_i$ . On the other hand, the probability of person  $n$  to answer incorrectly to item  $i$  is  $1 - P_{ni} = \frac{1}{1 + e^{B_n - D_i}}$ .

In the case when the probability of a person to succeed is the same as his/her probability to fail, then:  $B_n - D_i = \log(P_{ni}/(1 - P_{ni})) = \log(0.5/0.5) = 0$ , therefore the ability of the person  $B_n$  is the same as the difficulty of the item  $D_i$ . For each item of the instrument the Rasch model gives the category probability curve as well, where the probability of success or failure is expressed as a function of the measure relative to item difficulty. The figure 1 following represents the two curves of probability towards an item. If the measure is 0 ( $x=0$ ), then the two curves intersect and the probability of failure is the same as probability of success. For a measure ( $B_n - D_i$ ) of 1.1 logits, the probability of success is 0.75, while for a negative measure ( $B_n < D_i$ ) then the probability for failure is bigger than that of success.

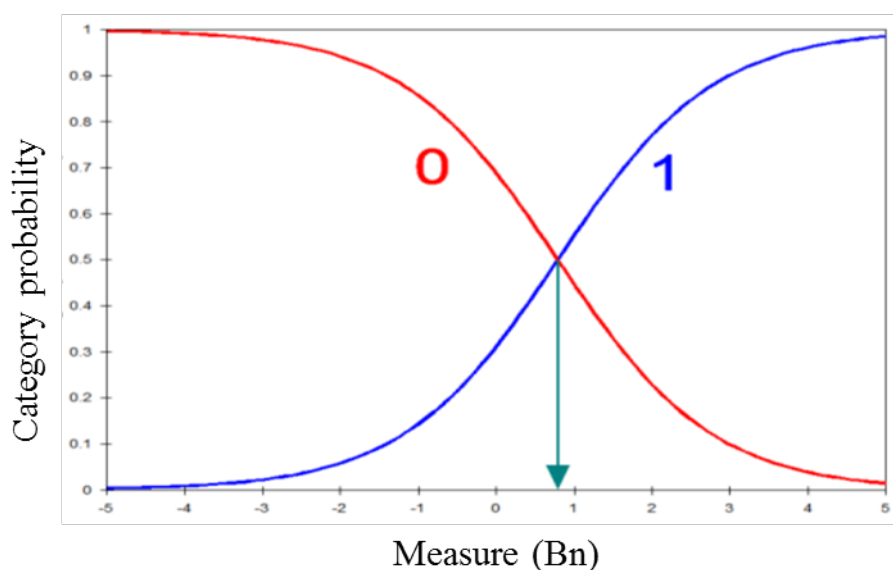


**Figure 1: A dichotomous item's category probability curve (Linacre, 2011, lesson 1, p. 23)**

Bond and Fox (2001) described how the Rasch analysis proceeds in a dichotomous case. First, based on raw scores, the percentage of correct answers for each item as the number of correct answers given to the item divided by the total number of the persons is calculated. In the same way the percentage of correct answers is calculated for each person. Then this percentage is transformed into log-odds as the ratio of the percentage of correct to the percentage of incorrect answers, and the natural logarithm of the value is calculated and considered as the item ability estimate,  $D_i$ . For each of the persons, the natural logarithm of the ratio of percentage of the correct answers by the percentage of incorrect answers is considered the estimation of the person's ability,  $B_n$ . The process is an iterative one. After the final estimation of  $B_n$  and  $D_i$ , the probability of correctly answering an item is calculated based on the formula (1).

### Rasch-Andrich rating scale

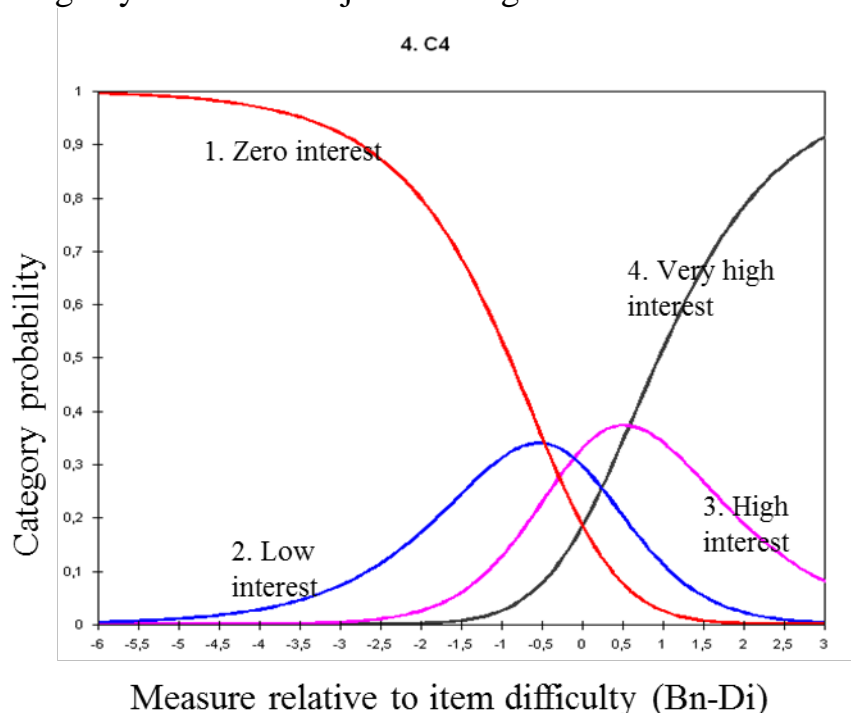
Andrich (1978) perceived a rating scale as a series of Rasch dichotomies.



**Figure 2: A dichotomous item's category probability curve (Linacre, 2011, lesson 2, p. 10)**

In figure 2 there is the category probability curve for a dichotomous item expressed as a function of the measure. For a student of low ability the probability of scoring the right answer is low (the blue line) and the probability for scoring the wrong answer is high (the red line). For a student of high ability then the situation is reversed. But for a student whose ability is the same as the item's difficulty both options (success and failure) are equally probable (the green arrow) and the two curves intersect. Exactly the point where the two probability curves intersect is a Rasch-

Andrich threshold. In the polytomous case Andrich conceptualized the rating scale as defined by some thresholds. For example in this study's case with 4 categories of the Likert scale there are 3 thresholds: between the 1 (null/zero) and 2 (low), between 2 (low) and 3 (high), and between 3 (high) and very high (4). Each item threshold has its own estimate of difficulty,  $F_j$ , and it is the point where a person has a 50/50 chance for choosing any of the two adjacent categories at the threshold.



**Figure 3: Category probability of item C4**

Now an explanation of the polytomous model as presented on Linacre (2011, lesson 2) follows. It can be thought of the polytomous case as a series of dichotomous cases, starting with the first two categories, 1 and 2 (null/zero and low) where the model tells that:  $\log_e \left( \frac{P_{ni2}}{P_{ni1}} \right) = B_n - D_i - F_1$ .

The relationship between the category 1 and 2 (the red line and the blue line in figure 3) is similar to the dichotomous case: where the two curves intersect, which is the first Rasch-Andrich threshold, then the probability of choosing category 1 and 2 is the same. The corresponding value on the x axis is the item difficulty  $D_i$  + the first threshold  $F_1$ . For points lying at the left of the  $F_1$ , the probability for choosing category 1 is higher than the probability for choosing category 2. After the first threshold  $F_1$ , the probability for choosing category 2 increases, and then falls. The same discussion can be followed when analysing the 2 other categories: 2 (low) and 3 (high). Here the model can be written:

$\log_e \left( \frac{P_{ni3}}{P_{ni2}} \right) = B_n - D_i - F_2$ . At the intersection of the two categories

there is the second threshold,  $F_2$  where probability for a person to choose category 2 is the same as to choose category 3. And at the intersection of categories 3 (high) and 4 (very high) there is the 3<sup>rd</sup> threshold  $F_3$  such that  $\log_e \left( \frac{P_{ni4}}{P_{ni3}} \right) = B_n - D_i - F_3$ . In the case of the study presented here there are 3 dichotomous relationships, and  $P_{ni1} + P_{ni2} + P_{ni3} + P_{ni4} = 1$ . The item difficulty,  $D_i$ , is placed at the intersection of the lowest and the highest category, categories 1 and 4 in our case. The origin 0 logits on the x axis is set at the items' average measure. It follows then that for items less difficult to be endorsed will the intersection between category curves 1 and 4 be on the left of the 0 point, and for more difficult to be endorsed items it will be on the right of the origin. In general,  $F_j$ , or the Rasch-Andrich threshold or the step calibration or step difficulty, is “the point on the latent variable (relative to the item difficulty) where the probability of being observed in category j equals the probability of being observed in category j-1” (Linacre, 2011, lesson 2, p. 13).

### Fit statistics

Each of the fit statistics is expressed as a combination of the observed value,  $X_{ni}$ , the expectation,  $E_{ni}$ , and the model variance of the observation around its expectation,  $W_{ni}$ . If the residual is,  $R_{ni} = X_{ni} - E_{ni}$ , then for each observation  $X_{ni}$ , there is a residual. But in the Rasch models the fit diagnosis is summarized in a fit statistic, expressed as a mean square (MNSQ) value or a standardized value (Bond & Fox, 2001). Further, a standardized residual  $Z_{ni}$  is expressed as:  $Z_{ni} = R_{ni} / \sqrt{W_{ni}}$  and it “quantifies the unexpectedness of the observation as a ‘unit normal deviate’” (Linacre, 2011, lesson 2, p. 24).

The average of the square standardized residual for a person or an item is the outfit statistics for the person/item. If there are L items and N persons, then the outfit MNSQ for each person and each item is expressed as:  $U_n = \sum_{i=1}^L Z_{ni}^2 / L$ ,  $U_i = \sum_{n=1}^N Z_{ni}^2 / N$ . Infit statistics on the other hand is the “information-weighted average of the squared residuals” (Linacre, 2011, lesson 2, p. 25) and is expressed for persons and items respectively as:  $U_n = \frac{\sum_{i=1}^L Z_{ni}^2 W_{ni}}{\sum_{i=1}^L W_{ni}}$  and  $U_i = \frac{\sum_{n=1}^N Z_{ni}^2 W_{ni}}{\sum_{n=1}^N W_{ni}}$ .

The Rasch model softwares (Winsteps in this case) calculate the standardized values (ZSTD) for each MNSQ value of fit statistics as well to show the “probability of the MNSQ as a unit-normal deviate” or the significance of misfit.

There is a scalogram for unexpected responses in the options offered by Winsteps where one can look for explanations for unexpected high or low responses on a rating scale. The scalogram orders persons in rows

from high to low measure, and items in columns from easy to difficult. The following is a part of the scalogram from Albanian data collected in 2010 with 825 students.

GUTTMAN SCALOGRAM OF ORIGINAL RESPONSES :									
PERSON	ITEM								
		12	21	2111121121	2	221	2	2	
		01983875765309221466784315429							
		-----							
29		+44444444	*444444444444	*4**4444	*4*				
787		+4444	*44444444444444444444	*4****					
521		+43444444	*4434444443	*3*3443	**3*				
605		+44444443	*4444344433	*4*3344	**3*				
439		+4344	*4444344444444444342	*1****					
423		+4*444444	*3344334433	*3*4343	**4*				
24		+4444	*444434444444414	**4*3*1*1					
		-----							
488		+1111	*2*21111111124211	**1*4*2*4					
		-----							
636		+1111141	*1441111111*1*1111	**1*					
373		+1111	*111111141114211111	*1****					
394		+1111111	*111111111*1*2111	**1*					
729		+1111111	*111111111*1*1111	**1*					
731		+1111111	*111111111*1*1111	**1*					
505		+1111	*111111111111111	**1*1*1*1					
		-----							
		12	21	2111121121	2	221	2	2	
		01983875765309221466784315429							

**Figure 4: The scalogram of Albanian students' responses (825 students, 29 items)**

In a scalogram in the top left corner there are the more 'able' ('willing') persons who endorse the 'easier' items, towards the top right corner with more 'difficult' to endorse items. In the bottom right corner there are the less 'able' (willing) persons (students) answering to the most 'difficult' to be endorsed items. In this case the student numbered 488, placed in the last rows of the scalogram (i.e. a 'less willing to like contexts' person), who has an outfit of 5.98, has given some unexpected answers, such as the answer 4 (very high interest) on a 'difficult to endorse' item such as C29 'agricultural matters (for city girls)'. The student is therefore deleted from the analysis. In general students showing unexpected responses can be excluded from the analysis if this action improves the fit statistics, or some unexpected answers can be reported as missing.

### Differential item functioning (DIF)

In the figure 5 there is the DIF plot for Albanian data collected from 825 students with a 23-items questionnaire (as explained in article 3). Here a DIF analysis is run for gender. The plot, together with DIF table, represents the measure for each of items according to gender. There it can be seen the DIF contrast, which is considered as a DIF effect when it is bigger than 0.5 logits. As it is clear from the plot and the table, items C2, C3 and C23 respectively ‘cultural products’, ‘designer clothes’ and ‘construction and engineering’ show a significant DIF effect. The first two items are easier for girls to endorse, and the last one is easier for boys. Table 1 gives the exact measures where the DIF effect can be examined further.

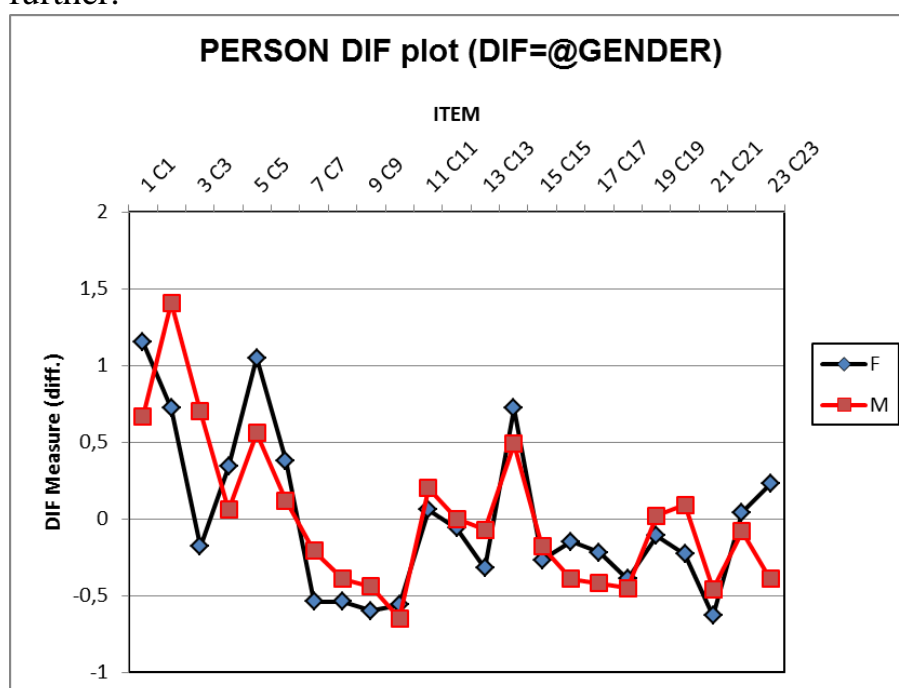


Figure 5: The gender DIF plot (825 students, 23 items)

Table 1. The gender DIF table for Albanian data (825 students, 23 items)

Person Class	DIF Measure	Person Class	DIF Measure	DIF Contrast	t-stat prob.	Item Name
F	1.15	M	.67	.48	.0000	C1
F	.72	M	1.41	-.70	.0000	C2
F	-.18	M	.70	-.88	.0000	C3
F	.34	M	.06	.27	.0003	C4
F	1.05	M	.56	.48	.0000	C5
F	.38	M	.12	.27	.0007	C6
F	-.54	M	-.21	-.33	.0001	C7
F	-.54	M	-.39	-.15	.0944	C8
F	-.60	M	-.44	-.15	.0977	C9
F	-.56	M	-.65	.10	.2603	C10
F	.06	M	.20	-.14	.1098	C11



F	-.06	M	.00	-.06	.4585	C12
F	-.32	M	-.07	-.25	.0013	C13
F	.72	M	.49	.23	.0054	C14
F	-.27	M	-.18	-.09	.2216	C15
F	-.15	M	-.39	.25	.0023	C16
F	-.22	M	-.42	.20	.0185	C17
F	-.39	M	-.45	.06	.4921	C18
F	-.11	M	.02	-.13	.1147	C19
F	-.23	M	.09	-.31	.0000	C20
F	-.63	M	-.46	-.16	.0656	C21
F	.04	M	-.08	.12	.1289	C22
F	.23	M	-.39	.63	.0000	C23

# **The contexts Albanian students prefer to use in Mathematics and relationship to contemporary matters in Albania**

**Suela Kacerja<sup>1</sup>, Cyril Julie<sup>2</sup>, Said Hadjerrouit<sup>3</sup>.**

<sup>1,3</sup> *Department of Mathematical Sciences, University of Agder, Norway.*

<sup>2</sup> *School of Science and Mathematics Education, University of Western Cape, South Africa.*

<sup>1</sup> [suela.kacerja@uia.no](mailto:suela.kacerja@uia.no); <sup>2</sup> [cjulie@uwc.ac.za](mailto:cjulie@uwc.ac.za); <sup>3</sup> [said.hadjerrouit@uia.no](mailto:said.hadjerrouit@uia.no)

Studies in Mathematics Education concerned with affective domain issues concentrate primarily on students' attitudes towards and interest in Mathematics. Such studies are necessary to give a broad sense of students' disposition towards school mathematics. However, it is contended that there are also other issues in school mathematics which learners have some views and feelings about. One such issue is the contexts being dealt with, for various purposes, in school mathematics. Albanian students' preference for contexts to be used in school mathematics was investigated using survey research. Rasch techniques were used to analyse the data. Results indicate that students accord a high preference to contexts related to community development, issues related to technology, planning a journey and health issues. A medium level of preference was expressed for issues related to economic matters. Contexts related to traditional crafts, lotteries and gambling and agricultural matters received the lowest endorsement. The students' ranking of the contexts is explained in terms of contemporary issues in Albanian society. It is concluded that knowledgeability of students' preferences opens space for introducing mathematical topics different from the traditional ones in the school mathematics curriculum.

## **Introduction**

In this paper we report on the contexts student in grades 8 to 10 in an urban area in Albania would like to deal with in school mathematics. The study reported here is concerned with issues in the affective domain, which Niss (2007) identifies as an area of neglect in research in Mathematics Education. Instead of concentrating on larger issues, such as students' attitudes towards or interest in mathematics, in the affective domain the focus of the study is on a fairly under-research topic. In the section that follows, we present the background and motivation for the study. This is followed by a description of the sample and the data collection method used. In the third section the analysis of the data is presented. Furthermore, a discussion of the viability of the instrument is presented. The possible reasons for these students' ranking the contexts the way they do is discussed in the penultimate section. This discussion is done in the light of contemporary matters prevalent in Albanian society as forthcoming from Albanian newspapers and Web sites dealing with issues in Albania. It is concluded that the school mathematical enterprise such as curriculum-making and mathematics learning resource development could benefit by also attending to contexts that learners prefer.

## **Background and motivation**

The contexts that learners would like to deal with in school mathematics is a fairly under-researched area. It is well known that the contexts that students meet in their mathematics lessons and textbooks are driven by the mathematics curriculum. Textbook writers, test designers and other school mathematics resource developers, using the official curriculum as their guide, choose the contexts they consider students will find of interest. Teachers also select contexts as examples to, amongst others, introduce topics, illustrate mathematical concepts and use for applications-driven mathematical problems. There is nothing wrong with these stakeholders selecting contexts that they deem appropriate for use in school mathematics. Interest and motivation theory, with interest

conceptualised “as a specific relationship between a person and a topic, an object, or an activity, which is characterized by *positive emotional experiences* and feelings of personal relevance (*value commitment*)”, suggest that “Higher levels of interest in a domain are associated with functional and persistent learning behaviours in that domain” (Kunter et al., 2007, p.495). Thus knowledgeability about the contexts that learners have an interest in has the potential for enhancing their interest and engagement with school mathematics.

Using Wedege’s (1999) notion of context as task context—context connected to reality in tasks, textbooks, examples, exercises, etc.—a literature review reveals that there is a paucity of research dealing with the contexts that learners prefer to deal with in school mathematics. A rare study was conducted by Kaiser-Messmer (1993). This study was on gender differences in school mathematics in Germany and as part of this study she investigated learners’ preference ranking of certain contexts. She reports that for lower secondary grades “Girls favour very strongly the topic ecology, followed by sport, biology/medicine and every-day life.” and “The most dominant themes for boys are sport, technology, the economy and physics, with big gender differences in technology and physics, which are hardly ever chosen by girls.” (Kaiser-Messmer, 1993, p. 224). For the basic level mathematics course at upper secondary level she found that “girls indicate a high interest in social topics, followed by ecology, every-day life topics, technology and sport. The boys’ order of interest is slightly changed, with more boys choosing society and technology” (Kaiser-Messmer, 1993, p. 223). Kaiser-Messmer’s (1993, p. 224) study also found that at the “advanced level [course] the majority of girls and boys list technology as the topic that interests them most [and] biology/medicine is named by significantly more girls than boys.” However, there are significant differences along gender lines related to this high preference across different grades and the level of course taken at the upper secondary school level. Kaiser’s study thus demonstrated learners’ high preference for contexts dealing with technology, wellness as encapsulated in the biology/medicine category, matters related to the earth and the universe and social issues to be used in school mathematics.

Other studies on contexts and school mathematics deal with issues such as the effects of contexts, especially realistic contexts, in learning (e.g. Boaler, 1994; Meaney, 2007), how teachers use contexts in teaching (e.g. Chapman, 2006) and teachers’ reasons for choosing contexts to include in their teaching (e.g. Pierce and Stacey, 2006).

Based on the above narrative a multi-country project, the Relevance Of School Mathematics Education (ROSME), was initiated in 2003 to ascertain the contexts learners in grades 8 to 10 would prefer to deal with in school mathematics. For ROSME data were collected in Zimbabwe, Uganda, Swaziland, South Korea, South Africa and Norway (Julie & Mbekwa, 2005; Julie, 2006; Julie, 2007; Julie and Holtman, 2008). ROSME was followed up by the Relevance Of School Mathematics Education II (ROSME II) with the objective of ascertaining whether there are any substantive changes of learners’ preferences for contexts to be used in school mathematics between the ROSME (data collected in 2004) and ROSME II cohort of learners. Due to mainly financial constraints only South Korea and South Africa are continuing their participation with Albania participating for the first time. The study reported here is thus situated within the broader ROSME II project.

### **Study participants and data collection**

The ROSME II project focuses on students in the 8<sup>th</sup> to 10<sup>th</sup> grades. These are the last two years of compulsory schooling and the start of the final school phase in most countries. For the current study, Albanian data were collected in the city of Shkodra (North Albania). The sample was a convenient one and four schools, 2 lower secondary and 2 upper secondary schools, were involved. Six classes were randomly chosen—a grade 8 and a grade 9 class from each of the 2 lower secondary schools and a grade 10 from each of upper secondary. The sample is thus restricted to an urban environment. However, it should be borne in mind that Albanian families have migrated from the small towns and the rural areas to bigger cities during the last 20 years. Data from INSTAT (National Statistics Institution) indicate that in 1989 population in urban areas was only 35.8 % of the total population and in 2004 it was 45%. Furthermore, children from the rural areas

attend school in the cities and it is possible that participants in this study are also from the rural areas. In total 211 students, 94 males and 117 females, participated in the study. There were 68 students from grade 8, 70 from grade 9 and 73 from grade 10. The age range was from 13 to 17 with the mean age 14.4 years.

The survey method was used and as Pring (2004, p. 37) states 'surveying does not depend upon an outside observer', but it takes into account the views of pupils that in this case are the 'objects' of the research. With surveys one can get answers from a large group of pupils. There are criticisms against using surveys but as Pring (2004) asserts, 'the meanings which the respondents attribute to the questions are not something private and subjective, but the meanings which anyone conversant with the language would attribute to them' (p. 39).

The data collection instrument was a questionnaire (Appendix I). It was based on the questionnaire used in the first ROSME project whose analysis indicated that a reduction of the number of items would not affect the validity of the questionnaire (Julie & Holtman, 2008). Respondents were requested to express their interest on 23 items representing different contexts to be used in mathematics lessons on a 4-point Likert scale ranging from 'very high interest' to 'nil/zero interest'. The questionnaire was translated from English to Albanian by one of the authors. Another colleague from Albania was also asked to translate it and the 2 versions were compared. During translation care was taken that the meaning would be retained and the items would be understandable for the Albanian students. The item 'mathematics involved in cultural products such as the house decorations made by Ndebele women' was translated as 'handmade products by the Albanian women, such as carpets' for the Albanian version. One of the authors collected the data and she was present in the class when the students completed the questionnaire in case the respondents had any queries. In a few cases students did enquire about the connections that Mathematics has with items such as music, dance and health matters. The researcher did give them an indication of mathematics relevant to these contexts without trying to express her preference for it as a desirable context.

### **Rasch Analysis of Albanian data**

In this section we report on the functioning of the questionnaire and its suitability for measuring the construct under consideration. In addition, the hierarchical ranking of the items is also established.

Rasch procedures were used to analyse the data. These procedures are generally recommended for analysing ordinal scales (Bond and Fox, 2001). For ordinal scales it is well known that the response categories are not necessarily linear in the sense that the distances between subsequent responses, such as 'strongly agree' and 'agree' are not equal. Rasch procedures solve this problem by transforming the data so that the linearity issue is addressed. The transformed data are used to determine how closely the data fit the Rasch model. Thus a model is not sought to fit the obtained data with the Rasch model taken as the ideal. The Winsteps programme (Linacre, 2008) was used to analyse the data and the statistics of interest for this article are the measures of the items and the fit statistics. The statistics are reported in logits (log-odds unit) in Rasch analysis which results from the transformation of the data by the formula  $\log(P_{nij} / P_{ni(j-1)}) = B_n - D_i - F_j$  where  $P_{nij}$  is the probability that person  $n$  encountering item  $i$  is observed in category  $j$ ,  $B_n$  is the "ability" measure of person  $n$ ,  $D_i$  is the "difficulty" measure of item  $i$ , the point where the highest and lowest categories of the item are equally probable and  $F_j$  is the "calibration" measure of category  $j$  relative to category  $j-1$ , the point where categories  $j-1$  and  $j$  are equally probable relative to the measure of the item. The measures of the questionnaire items and their fit statistics are presented in Table 1.

The measures give an indication of how the items are endorsed by the respondents. It thus provides a hierarchy of endorsement or agreement of the items. In the Table 1 the items are ranked from hardest to easiest to endorse. For the ROSME instrument the measures of the items, calculated according to the formula, fall in the range 1.53 to - 0.71.

#### **Table1. Measure Table and Ranks**

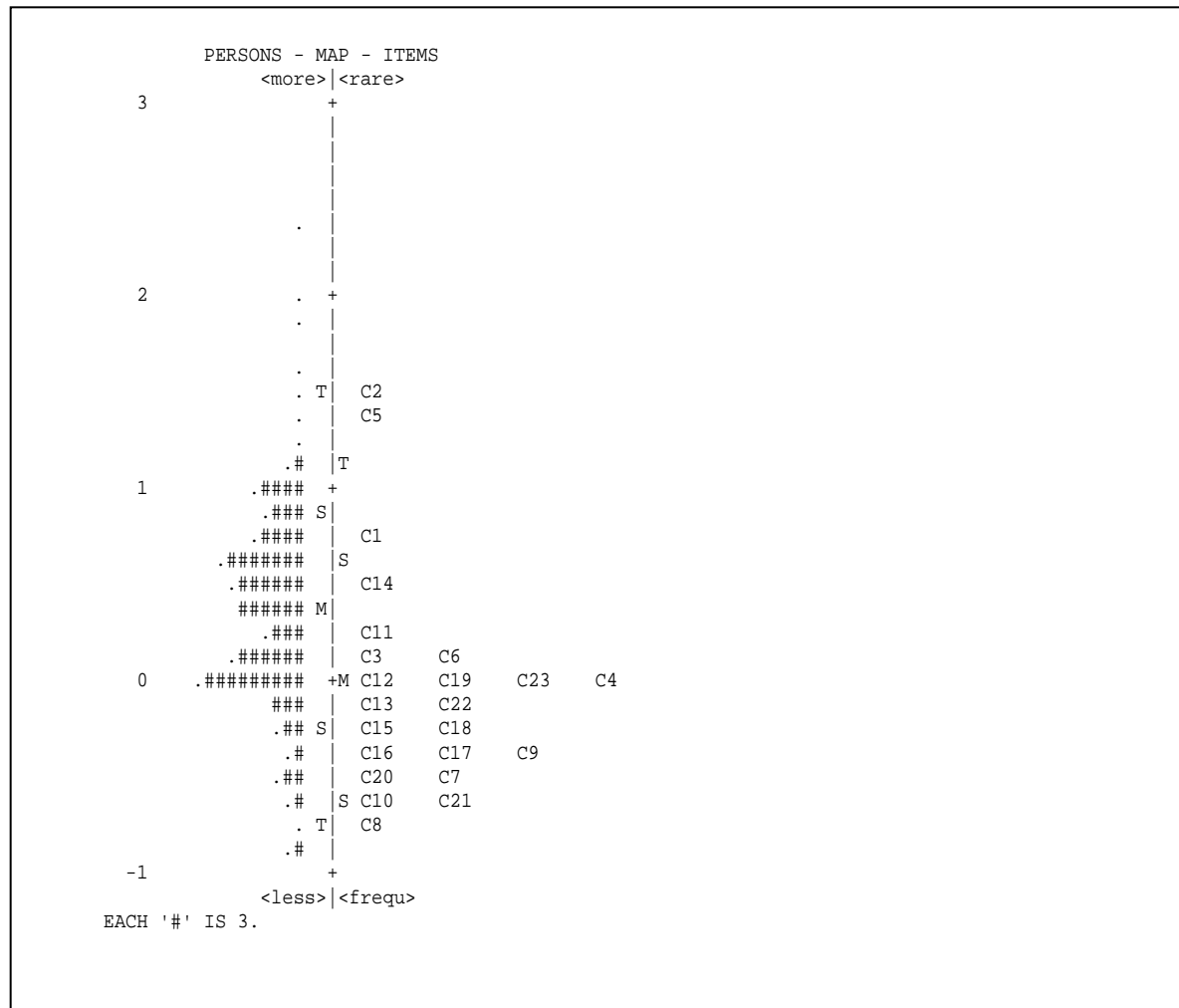
ITEM	MEASURE	INFIT MNSQ	OUTFIT MNSQ
C2	1.53	0.98	0.97
C5	1.32	1.06	1.14
C1	0.81	1.29	1.36
C14	0.55	0.99	1
C11	0.28	0.8	0.82
C3	0.18	1	0.97
C6	0.16	1.13	1.12
C23	0.03	1.37	1.41
C19	0.01	0.85	0.84
C12	0	1.01	1.02
C4	-0.05	1.04	1.02
C13	-0.07	0.97	0.95
C22	-0.09	0.87	0.85
C15	-0.21	1.01	1.01
C18	-0.28	1.06	1.05
C9	-0.32	1	1
C17	-0.41	1.03	1
C16	-0.43	0.96	0.93
C20	-0.46	0.87	0.8
C7	-0.55	0.92	0.93
C21	-0.64	0.92	0.99
C10	-0.66	0.99	1.01
C8	-0.71	0.93	0.91
MEAN	0	1	1
S.D.	0.58	0.13	0.14

The fit statistics are used to ascertain whether there are distortions in the data. Using the negative Linacre (2008, 306) asserts that “Misfit means that the reported estimates, though effectively linear, provide a *distorted picture of the data*”. Reeve and Fayers (2005) assert that for an acceptable instrument constructed according to Rasch modeling, the fit statistics should fall within the range 2 logits to -2 logits. Linacre (2008) states that a mean-square (MNSQ) infit statistic “substantially less than 1 indicate dependency in your data” and mean square outfit statistic is “more sensitive to unexpected behavior by persons on items far from the person's measure level.” (Linacre (2008: p 221). Infit and outfit mean square values in the range 0.5 - 1.5 is deemed to be “Productive of measurement”. (Linacre, 2008, p. 221). Table 1 indicates that all the items fall within the range for both the infit and outfit mean square. The instrument to ascertain students’ context preferences for use in mathematics is thus well within the range of acceptable values according to Rasch modelling and hence there are no misfitting items.

Another representation of the transformed data generated by Winsteps is the person-item map. The person-item map for the data in this study is presented in Figure 1. It simultaneously provides an estimate of the respondent’s level of endorsement and the item’s rank in the same metric. The items are given to the right of the vertical line and the persons to the left. The items are assigned the measure given in Table 1 but for its location, some clustering is done to essentially fit the scale of the vertical axis (Personal e-mail communication with Mike Linacre, August 2008). The M indicates the average level of endorsement for the items, S one standard deviation and T two standard deviations.

The person-item map allows for direct comparison of respondents to items. C11, for example, has measure of 0.28. There are at most 11 respondents (the left-hand side of the vertical axes with “.” indicating at most 2 and “#” 3) with the same measure. These respondents have a 50% chance of endorsing item C11, a less than 50% chance of endorsing the items (C2, C1, C5 and C14) with a

measure higher than that of C11 and a more than 50% chance of endorsing the other items with a lower measure.



**Figure 1.** Person-item map of Albanian students' preference for contexts to be used in Mathematics

Inspecting the upper end of the map indicates that only a maximum of 12 respondents have a 50% or more chance of endorsing item C5 and only a maximum of 10 item C2. This cements the placements of C2 and C5 as the lowest-preferred contexts for this cohort of pupils. A similar cementation comes forth from the inspection of the lower end of the map. There are only 5 pupils who have a less than 50% chance of endorsing item C8 and at most 9 learners have a less the 50% chance of endorsing items C10 and C21.

The person-item map also indicates that there are gaps (C5 and C1 (0.51), C1 and C14 (0.26) and C14 and C11 (0.27)) in the spread of items. The gaps between the last two sets of items are small (less than 0.30 from Table 1) (Reeve and Fayers, 2005) and do not indicate a “poorly defined or tested regions of the variable” (Linacre, 2008, p. 206). For the remaining gap there is a possibility of the items mistargeting the respondents or respondents not aligning with the items. This would require further analysis through administering the instrument to a larger set of learners to ascertain the origin of the mistargeting.

Also observable are items sharing the same location such as C3—the latest designer clothes and C6— government financial matters, such as inflation and taxes. This normally indicates

redundancy of items. However, as is clear from the items they are not conceptually linked and thus indicate more a nearness of the measures and its graphic representation on the map.

We thus conclude that the questionnaire reasonably represents the latent variable, contexts learners in grades 8 to 10 prefer to deal with in mathematics, of our study. Given the appropriateness of the instrument, it follows from the hierarchical ordering in Table 1 and person-item in figure that the following items are some of the contexts that learners would most prefer to deal with in Mathematics:

- C8—determining the level of development regarding employment, education and poverty of my community,
- C10—making computer games and storing music and videos on CD's and I-pods, and
- C21—planning a journey.

Those that learners least prefer to deal with are as follows:

- C2— cultural products such as the house decorations made by Ndebele women,
- C5— agricultural matters, and
- C1— lotteries and gambling.

## Discussion

Learners demonstrated sensitivity towards general community conditions such as the level of employment, education and poverty. They ranked this item as their most-preferred. Unemployment is a much discussed topic and it touches every family. Data from INSTAT (2007) show that the biggest percentage of unemployed people is the category of those who have only finished upper secondary school followed by those who have finished high school with those who finished university a much smaller percentage. In 2005, it was estimated that 18.5% of the Albanian population was poor, with the biggest percentage in the mountainous (25.6%) and in the rural areas (24.2%) (Varferia ne Shqiperi, 2005). A lot of Albanian young people prefer to study at West European universities which are considered to offer a higher quality of education compared to the Albanian universities. They thus accept that this would offer them more possibilities for the future and would like to have these issues as contexts to be used in the mathematics lessons.

The second most preferred item in the questionnaire is the one that has to do with computer games and other modern technologies such as Ipods. Albanian students are in contact with computers in one way or another; they use computers at school, at home (if they are available) or in Internet centres. Only 9.5% of Albanian families have a personal computer at home (Nika, 2009). There are also Internet centres where children, mostly male teenagers, usually go to navigate the Internet or to play games. Young people are generally interested in music and movies, and very passionate about new technologies such as mobile phones, I-pod's, MP3's, MP4's, etc. They use those to save and listen to their favourite music, to film short events from their daily life, and so on. Children are very curious about these technological advancements, they hear every day about it through aggressive advertising campaigns and they like to use it, and this can explain the fact that this item is in the second place of their list.

Linked to the curiosity about technologies above, students ranked "sending and receiving of electronic messages such as sms's and emails" only in the 6<sup>th</sup> place. Almost every student has a mobile phone which he/she uses to communicate with friends and family. For the parents, to buy a mobile phone to their children is a way to stay in contact with them during the day and be sure that everything is all right with them while they are at school. The Albanian daily newspaper "Shqip" (2009) reported that during 2008, 20% of every Albanian's income was for communication. As regards e-mails not all 13-16 year old children have their own e-mail addresses or the possibility to check it. In fact, only 18.5% of Albanian population has Internet access (Nika, 2009). Short messages by mobile phone are used more. The fact that this item is sixth on the list, compared to computer games which are second, might be linked to students' inclination towards entertainment

for which computers offer more. Maybe sms's are 'old news' for them and e-mails are something they do not as yet see as indispensable. Another reason might be that students see computers as more involved with mathematics judged against sms's and e-mails.

The third most preferred context is "planning a journey". Before the 1990's Albania was a closed country and very few Albanians were able to travel abroad. After the decline of the communist regime it became possible, but yet very difficult, to go abroad. Many Albanians emigrated illegally mostly in neighbouring countries such as Italy and Greece, but also to other countries in the world (England, Germany, USA, etc), to find a job and improve their life. An estimation of the Greek Ministry for Foreign Affairs and the Albanian Ministry of Labour in 1998 showed that 20% of the Albanians have emigrated (Papanagos & Sanfey, 2001). There are a few neighbouring countries for which Albanians do not need a Visa to enter. Albanians travel more on vacations, mostly during summer time, and less during winter vacations. Those families who are in the higher income brackets prefer to spend their vacations abroad. Many other Albanians spend one or two weeks on the Albanian coastline. Doing a journey is something that Albanian children, as maybe all children of the world, are very fond of. And since not all Albanian families are able to do it we surmise that the high ranking accorded is more related to a desire to travel. We surmise that it is this desire which fuels their wanting to engage with contexts of this nature in their school mathematics.

The fourth item on the list has to do with health matters. Albania is one of the poorest countries in the European region according to the World Health Organization (WHO, 2005) and this influences the budget that the Albanian government is able to allocate to the health system. People who are ill prefer foreign hospitals to get cured if they can afford it economically. There are some kinds of illnesses that can be cured only abroad for lack of facilities and expertise. Furthermore, there are often appeals on Albanian television for donations to assist people who are very ill. This might influence the public opinion, including students, about health matters. On the other hand, one of the most preferred professions from Albanians is that of a medical doctor and the number of places at public universities is heavily oversubscribed every year. Linked to the health issue is the item ranked fifth, "the spread and decline of epidemics such as AIDS, tuberculosis and cholera". Epidemics such as tuberculosis and cholera are not very widespread in Albania. AIDS also is not so widespread, in November 2008 there were only 291 cases (Shqip, 2008) but it is increasing as a result of unprotected sex and drugs. Many Albanian families are now touched by it. There are NGOs (Non Governmental Organizations) that operating in the field and they organize campaigns to inform young people about the risks of AIDS. This, we assume, explains students' awareness and their willingness to know more about HIV/AIDS.

An issue that needs to be mentioned is the ranking of issues related economic conditions. The seventh ranked item is 'managing personal and business financial affairs' and it shows how important it is for Albanians to be wealthy enough to afford a good life. During the years of the communist regime, all families had more or less the same income, they were all poor, with a few people who had important functions in the government or administration the exceptions. The biggest part of Albanians worked in public factories as private enterprises were not allowed. With the decline of the regime then in the 1990's, almost everything that was public declined with the exception perhaps of schools and hospitals. The factories closed down one by one, and many people were made redundant and had to find jobs for themselves to survive. Many of them chose to deal with retail business and the first foreign investors arrived in Albania to open their enterprises because the labour costs were cheaper compared to other European countries. Other Albanians went abroad to improve their income to support their families. Having a business for Albanians means to have a good and stable life—a means to have their children educated abroad, for travel abroad, to possess a beautiful and comfortable house and a car, and so on. Children's tendency to want to learn about managing personal and business financial affairs, in our opinion are influenced by the trends of thinking of the Albanian society in general where people do not want to be poor anymore.

Albania has a rich biodiversity, but 'the environmental policy is unclear and it is not followed by a total respect of the laws. Pollution caused by industrial activities has damaged the environment.



Administering the trash is also a problem, since those are just taken away and not totally eliminated' (INSTAT, 2005). "Environmental issues and climate change" is ranked 19<sup>th</sup> in the list, and there are two possible explanations for this low ranking. One is that Albanian students are not aware of the environmental issues whose problematic consequences are loudly discussed by environmentalists. Another explanation is that they may have heard about these issues but they feel they are not capable of resolving anything in this direction.

"Lotteries and gambling" is one of the least preferred items. These activities were strictly prohibited and illegal during the communist era in Albania and it was also considered as a negative behaviour by the public. Lotteries and gambling are now legal and there was a 70% growth in the industry from 2007 to 2008 (Nika, 2009). Gambling is regulated by law and it is illegal for people under 21 years old to enter a casinos or gambling establishments. But still, it seems like this rule is not respected and teenagers do engage in gambling activities in betting shops. An investigation by the daily Albanian newspaper, 'Shqip' (2009), revealed that upper secondary school children do frequent lotteries and gambling establishments. The same investigation exposed that some of these students easily resort to crime to feed their gambling habit. We conclude that the low ranking of lotteries and gambling as a context to be used in school mathematics is a result of it generally being perceived as an unbecoming activity with negative consequences.

Even less preferred than lotteries and gambling is the item "agricultural matters". In 2004, 55% of the Albanian population lived in the countryside. In 2007, the income from agriculture is only 18.9% of the total Albanian income, decreasing by 48.3% compared to 1996 (INSTAT, 2007). The breakdown of collective farming in the 90's, with the fall of communism, had devastating effects in agriculture. In 2007, 113 384 out of 369 598 farms were fallow. A division of the farms by the way of ploughing the fields by INSTAT (2007) shows that 211 112 farms are ploughed by hand only, 76 205 with animals and 274 960 with tractors. This data demonstrate that agriculture in Albania is a very hard work and we conjecture that it is this unappealing aspect of farming, amongst other things, that motivates students' disliking for agricultural matters.

The least-preferred contexts for Albanian students are "culturally handmade products by Albanian women such as carpets", even though Albanians are known for a long tradition of handmade products. In the last years their production has fell because Albanians are not so much interested in it anymore and it is difficult to find markets for export. It seems that handmade traditional products are not so convenient from an income point of view since they have been replaced by cheaper technologically-produced good. Young people seem to be aware of this development and hence they accord the lowest preference to culturally-produced artefacts.

## **Conclusions**

This study revealed the contexts that Albanian students highly prefer and those they prefer to a lesser extent to deal in school mathematics. It was also explained how these context preferences were probably the outcome of the issues of importance in Albanian society. This is not so far-fetched if Bourdieu's notion of habitus as is kept in mind.

A reasonable question to ask is what are possible implications of students expressing these hierarchical preferences for contexts to be used in school mathematics? As stated before dealing with contexts in school mathematics that learners prefer has the possibility of enhancing their level of engagement and interest in mathematics.

A cursory perusal of mathematics learning resources indicates that some of these contexts do appear in these resources. However, they are still used with the traditional mathematical topics either as conceptual carriers of these topics or as domains of application for these topics. For example, mobile telephones are normally used as a context to introduce to set up and solve simultaneous linear equations by using the pricing configurations of two mobile telephone companies. We contend that school mathematics can be moved beyond this kind of traditional use of contexts. Taking mobile telephones again as an example, mathematics related to communications can be introduced.

There are also topics which are highly preferred by learners but which are not currently being dealt with in school mathematics. The level of development of a community is one such. Here we foresee that mathematics related to the construction of indexes can be introduced. Not only is this pregnant for mathematical treatment but it also holds promise for critical engagement with mathematics since social indexes are by nature controversial.

It is not suggested that contexts for which learners express a low preference should be excluded. Skilful mathematical handling of such contexts can contribute to learners' engaging with them in a more informed manner. If, for example, lotteries are taken then understanding how low the likelihood is of winning when one has to select six from forty-nine numbers.

Lastly it is not recommended that school mathematics should solely be driven by the interest of learners. As Julie (2007, p. 201) asserts the need is for "for a curriculum sense where the interests of learners and those determined by curriculum, learning resources and test designers are balanced."

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Appendix I

CODE:.....

**RELEVANCE OF SCHOOL MATHEMATICS EDUCATION II (ROSME II)**

October 2008

Things I am interested to learn about in Mathematics

I am: a female ..... a male .....

I am ..... years old

I am in Grade .....

Which things would you like to learn about in mathematics? Some possible things are in the list below. Beside each item in the list, make a cross over or next to one of the words of in the box next to the item to say how much you are interested in the issue. Please respond to all the items and choose only one of the words for every item.

There are no correct answers: we want you to tell us what **you** like.

Examples:

If you are a little interested to learn about the mathematics involved in “building houses” then you will make a cross (X) next to or over “low” in the box as shown below.

My interest in learning about mathematics involved in						
CEx1		building houses is	Very high	High	Low <b>X</b>	Nil/Zero

If you are very interested to learn about the mathematics involved in “painting a car” then you will make a cross (X) next to or over “Very high” in the box as shown below.

My interest in learning about mathematics involved in						
CEx2		painting a car is	Very high <b>X</b>	High	Low	Nil/Zero

We thank you for your participation.

<b>My interest in learning about mathematics involved in</b>					
C1	lotteries and gambling is	Very high	High	Low	Nil/Zero
C2	handmade products by the Albanian women, such as carpets, is	Very high	High	Low	Nil/Zero
C3	the latest designer clothes is	Very high	High	Low	Nil/Zero
C4	secret codes such as pin numbers used for withdrawing money from an ATM is	Very high	High	Low	Nil/Zero
C5	agricultural matters is	Very high	High	Low	Nil/Zero
C6	government financial matters, such as inflation and taxes is	Very high	High	Low	Nil/Zero
C7	health matters such as the state of health of a person, the amount of medicine a sick person must take is	Very high	High	Low	Nil/Zero
C8	determining the level of development regarding employment, education and poverty of my community is	Very high	High	Low	Nil/Zero
C9	being productive with the doing of tasks in a job is	Very high	High	Low	Nil/Zero
C10	making computer games and storing music and videos on CD's and I-pods is	Very high	High	Low	Nil/Zero
C11	environmental issues and climate change is	Very high	High	Low	Nil/Zero
C12	determining the origin and age of the universe is	Very high	High	Low	Nil/Zero
C13	all kinds of pop music is	Very high	High	Low	Nil/Zero
C14	national and international politics is	Very high	High	Low	Nil/Zero
C15	dancing such as rave, disco and hip-hop is	Very high	High	Low	Nil/Zero
C16	sending and receiving of electronic messages such as SMS's and e-mails is	Very high	High	Low	Nil/Zero
C17	managing personal and business financial affairs is	Very high	High	Low	Nil/Zero
C18	recreation, physical exercise, sport activities and competitions is	Very high	High	Low	Nil/Zero
C19	responding to emergencies and disasters is	Very high	High	Low	Nil/Zero
C20	the spread and decline of epidemics such as AIDS; tuberculosis and cholera is	Very high	High	Low	Nil/Zero
C21	planning a journey is	Very high	High	Low	Nil/Zero
C22	crime fighting, warfare and military	Very high	High	Low	Nil/Zero

	matters is				
C23	construction and engineering	Very high	High	Low	Nil/Zero

Rasch Modeling to assess Albanian and South African learners' preferences for real-life situations to be used in Mathematics: A pilot study

Suela Kacerja

University of Agder, Norway & University Luigj Gurakuqi, Albania

Cyril Julie

University of the Western Cape, South Africa

Said Hadjerrouit

University of Agder, Norway

Author note

Suela Kacerja, Faculty of Technology and Science, University of Agder, Serviceboks 422, 4606, Kristiansand, Norway. Tel.: +47 3814 1604. E-mail: suela.kacerja@uia.no

Cyril Julie, School of Science and Mathematics Education, University of the Western Cape, Private bag X17 Bellville, 7530, South Africa. Tel.: +21 959 2861. E-mail: cjulie@uwc.ac.za

Said Hadjerrouit, Faculty of Technology and Science, University of Agder, Serviceboks 422, 4606, Kristiansand, Norway. Tel.: +47 3814 1793. E-mail: said.hadjerrouit@uia.no

**Abstract**

This paper reports on an investigation on the real-life situations students in grades 8 and 9 in South Africa and Albania prefer to use in Mathematics. The functioning of the instrument used to assess the order preference learners from both countries have for contextual situations is assessed using Rasch modelling techniques. For both the cohorts, the data fit the Rasch model. However, only 48% of the items fulfil the invariance criterion of a less than 0.3 logits difference between paired items for the two cohorts of students. For the 52% of the items not meeting the invariance criterion explanations are provided in terms differences in experiences learners in the two have related to some of the contextual situations. Implications for interpretation of international comparative tests are offered as are the possibilities for the cross-country development of curriculum materials related to contexts that learners prefer to use in Mathematics.



## Introduction

Since about the early 1990's there has been a shift in school mathematics curricula towards more contextually-driven school mathematics curricula. This shift is evident in the titles of school mathematics textbooks series such as *Mathematics in Context* (Romberg, 1998), *Introducing Algebra (Connected Mathematics)* (Lappan, Fey, Fitzgerald, Friel and Phillips, 2004), *Modeling Our World: Course 1* (COMAP, 2000) and *Mathematics at Work* (Du Toit, Human, Olivier, Nicholson and Pillay, 1991). In curricula this shift is encapsulated in statements such as “the application of Mathematics to physical, social and mathematical problems” (p. 8), “Pose questions relating to real life situations e.g. situations affecting the number of children in families” (Department of Basic Education, Republic of South Africa, 2010, p.30), “in order for pupils to understand mathematics, they must see it in context, and this can be achieved by pointing the attention toward different uses of mathematical skills and concepts in other subjects” (p.12), “to use in Mathematics, in other subjects and in real life situations [mathematical notions]....” (Institute of Curricula and Trainings, Albania, 2008, p.5), terms such as ‘numeracy’ defined as “the group of mathematical concepts and skills that serve an individual in everyday life, at home, in his workplace, in community” (Institute of Curricula and Standards, Albania, 2006, p.2, own translation).

Various rationales are offered for incorporating contextual situations in school mathematics. The most common version dealing with such contexts is the widely-known word problems and its use in school mathematics is seen as providing learners the opportunity to experience the application of mathematics in extra-mathematical situations. Presumably, this addresses the perennial question learners ask about the relevance of the mathematical work they are doing and would motivate them to

develop more positive attitudes towards mathematics. Another motivation for the use of contextually-driven school mathematics is the basis for the Realistic Mathematics Education (RME) programme. The underlying philosophy of this programme is captured as “mathematics – in order to be of human value – must be connected to reality, stay close to children and should be relevant to society [and make] use of realistic contexts...” (Van Den Heuvel-Panhuizen, 2003, p. 9). This perspective for contextually-based school mathematics entails the application of mathematics in extra-mathematical situations, but it insists that the development of mathematical concepts and procedures should start with contextually-based situations in the experiential field of the learners. A third rationale proffered for using real-life contexts in school mathematics is that it is a viable way to develop critical skills for dealing with beneficial and detrimental mathematically-driven installations which govern much of present day societal affairs. (Skovsmose and Valero, 2002). Lastly, contextually-embedded school mathematics opens the possibility for learners to experience mathematics in its wider mathematical sciences context and not solely as Pure Mathematics. This is so due to learners being explicitly offered the opportunity to engage in mathematical modelling which by definition implies the resolutions of real-life situations by mathematical means with a reasonable degree of fidelity between the real-life situation and the mathematical model that describes the contextual situation.

Despite these laudable motivations, there is an underlying notion that the embedded contexts are of interest to the learners. That this is not necessarily the case is captured by Lesh (1980, p.13) in his reference to an applications-embedded school mathematics program where they found that "Our ideas about real-world problem situations [are] not necessarily wrong. But our ideas about the real world were

somewhat different from our student's ideas." Choike (2000) vividly refers to a classroom incident where a 9<sup>th</sup> grade girl completely detached from engagement with a mathematical problem dealing with sheep farming, but when the context was changed to horticulture, an interest of the girl, her attitude towards the problem situation changed to one of active engagement. Zevenbergen, Sullivan and Mousley (2002, p.8) also raise concern about contexts outside the realm of interest of learners by stating that "... the use of contexts in school-going mathematics can enhance the learning for students, however, there is considerable cause for concern when such a strategy is used simplistically..." A simplistic use of contexts in school-going mathematics is the use of contexts not in the domain of interest of learners.

Contexts that learners prefer to deal with in mathematics is a fairly under-researched area. If it is accorded attention to learners, then it is normally a peripheral part of some other area of a research pursuit. Kaiser- Messmer (1993), for example, researched gender differences in attitudes towards mathematics and includes in her study the differences in ranking of specific contexts by female and male students. Lingefjärd's (2006) research focused on mathematical tasks students engaged with and in his deliberations he draws attention to students' liking and their motivation for such of the embedded contexts of the modeling tasks.

This paper reports on a study which specifically investigated the contexts learners are interested in to be used in school mathematics. In particular, the research reported here deals with the functioning of an instrument used to measure learners' preferences for contextual situations to be used in mathematics. Furthermore, it reports on whether or not the scale operates differentially or not for Albanian and South African learners in grades 8 and 9.

### **Theoretical considerations**

The underlying construct of the study reported here is interest. Specifically, it is interest in contextual situations used in school mathematics. Although no single definition of interest can be found in research on mathematics teaching and learning, it is understood as a “content specific motivational variables that have an important influence on learning and the direction of human development” and as “a multidimensional construct, which has close relationships to process-oriented motivational concepts such intrinsic motivation or the experience of self-determination” (Krapp, 2007, p.6- 7). With this conceptualisation interest is viewed as a person-object relationship and hence interest is always directed towards its object and it comes as a result of a person’s interaction with his/her environment (Krapp, 2002a, 2007).

According to Renninger, Ewen, and Lasher (2002), there are 2 kinds of interest or two different levels of interest analysis (Krapp, Hidi,& Renninger, 1992): situational interest and individual interest. Situational interest is more of a short-term kind, starts with an attraction and comes mostly from external situation specific factors (Krapp et al., 1992). While individual interest is a long-term kind of interest and has 2 components: stored knowledge and stored value. The stored knowledge refers to “a person’s developing understanding of the procedures and discourse (structural) knowledge of particular activities or ideas” (Renninger et al., 2002, p. 469), whereas stored value “includes feelings of competence as well as positive and negative feelings that emerge in the process of figuring out what is understood and still needs to be clarified” (Renninger et al., 2002, p.469).

Results from both individual interest and situational interest research show positive effects of interest in educational outcomes (Krapp, 2002b). A meta-analysis

of research about the relation between individual interest and academic achievement by Schiefele et al. (1992), as quoted in Krapp (2002b), shows that 10% of the variance on achievement comes from the level of interest, with gender as a quite strong present variable in the differences. Studies from the situational interest also show that “an interest-triggered learning activity leads to better learning results” (Krapp, 2002b, p. 420; see also Krapp, 2002a). Hidi (1990) showed that “individual and text-based interest have a profound effect on cognitive functioning and the facilitation of learning” (p.565). Positive effects of interest in different parts of the learning process are also present in other studies (Schiefele, 1991; Renninger et al., 2002).

In this study, the focus is on individual interest for contexts to be used in school mathematics. Thus, on the one hand there are the students as individuals with their “characteristics, attitudes and general orientations” (Krapp, et al. 1992, p.8); on the other hand the real-world-embedded objects or activities which are being used (and not) in school mathematics to enhance students’ learning of the subject.

Given this view and underpinning it is clear that learners have some order preferences for contexts they would like to be included in their experiences with school mathematics as is also evidenced from the studies (Lesh, 1980; Kaiser-Messmer, 1993; Choike, 2000; Lingefjärd, 2006).

The development of an instrument to ascertain the order preference learners have for different contextual situations to be used in school mathematics and its implementation in two different cultural conditions are discussed in the next section.

### **Instrumentation and Method**

Although research of this nature normally employs existing instruments, the object of study here is relatively under-researched and the researchers virtually had to develop an instrument from scratch to capture the order preference learners have

contexts used in school mathematics. Julie and Mbekwa (2005) describe the development and piloting of a 61-item instrument for ascertaining the order preference learners accord to contexts to be used in school mathematics. This instrument was developed through competitive argumentation by mathematics educators from Zimbabwe, Uganda, South Africa and Norway. Post-graduate students in Mathematics Education from South Africa, South Korea and Swaziland also contributed to the deliberations. One criterion used for the inclusion of items in the instrument was that they should be amenable to mathematical treatment. In this regard literature and textbooks on mathematical modelling, the applications of mathematics and word problems in mathematics were mined to extract real-life situations.

After piloting and revising the preliminary instrument, data were collected in 2005 in Norway, South Africa, South Korea, Swaziland, Uganda and Zimbabwe. Data were collected from 3964 (1963 boys and 2011 girls) learners in grades 8 to 10 in the 6 countries. The data obtained from this cohort of learners were analysed using Rasch modelling procedures and one of the results was that the instrument contained redundant items (Julie & Holtman, 2008). Through a process of discussion between some of the participants involved in the design of the 61-item instrument and a post-graduate student from Albania studying in Norway, the instrument was reduced to a 23-item one. The major consideration that drove the reduction of the instrument was the retention of the broader categories that were used and the sharing of the same location of the items on the Rasch person-item map. The contextual category retention implied that items that shared the same position on the person-item map, but were not conceptually linked, were not replaced. This 23-item questionnaire, given in the appendix, was used for the study reported here. It is a Likert-type scale ranging from 4 (*very high*) to 1 (*null/zero*) for interest in dealing with particular contexts in school

mathematics. High endorsement of the items produces high scores and indicates greater preference for the underlying contextual situation.

Data were collected in South Africa and Albania during the end of 2008 and the beginning of 2009 respectively. For the South African cohort, the learners were from low socio-economic status background on the outskirts of Cape Town and the Albanian cohort was from the second largest city, Shkodra, and its environs. The initial instrument was in English and was translated into Albanian and Afrikaans. South African learners completed the English and Afrikaans versions and the Albanian learners the Albanian one. The normal process of ensuring translation compatibility and obtaining ethical clearance from school authorities were followed and the demographic information of the participating learners is presented in Table 1.

Rasch analysis of the questionnaire was done using Winsteps 3.65.0 (Linacre, 2008). For the construction of a rating scale instrument the interest is in developing a robust enough instrument which “contain the possibility of *invariance* over a useful time and space” (Wright and Masters, 1982, p. 5). Rasch modelling allows this, and was thus deemed an appropriate method to analyse the instrument’s functioning and its outcomes for the latent trait, students’ preferences for contexts to be used in Mathematics.

### **Results**

According to Linacre (2008, p. 393) “‘person reliability’ is equivalent to the traditional ‘test’ reliability.” The person reliabilities are 0.69 and 0.77 for the South African and Albanian cohorts respectively. These reliabilities are low, but given the homogeneity of the groups and the nature of the trait being investigated it is reasonable to assume that there will be minimal disagreement regarding the level of endorsement of items.

The hierarchical ordering of the items is given in Table 2. For both countries the items are ordered from the least preferred to the most preferred based on their measures (estimates of difficulty of items' endorsement). The difficulty estimates are raw scores converted to logits by the logarithmic transformation according to the Rasch-Andrich rating scale model. For Albanian students the items measures range between from -0.7 to +1.47 logits, and for South African students the range is between from -0.45 and +0.53 logits. With this transformation 1 logit difference is the same everywhere, which cannot be said for the difference in the raw scores.

At the same time with items' difficulty to be endorsed, for every person participating in the study a measure of willingness to agree is calculated, in logit units, with the same idea.

### **Infit and outfit statistics**

Mean Infit Mean Square (MNSQ) and mean Outfit MNSQ statistics have an expected value of 1. Fit statistics gives an indication of whether there are distortions in the data. The MNSQ infit and outfit statistics between 0.5 and 1.5 are considered as 'productive of measurement' (Linacre, 2008, p. 221). This condition is satisfied for both cohorts except in one case in the Albanian data where the outfit MNSQ for item C1 is 1.51 logits which indicates a misfit item. This item's measure is within the acceptable range and since the outfit is  $< 2$  this parameter is not deemed degrading.

### **The person-item map**

The person-item maps are shown in Figure 1. Items are on the right of the map and ranked from the easiest (bottom of the map) to the hardest (top of the map) to endorse by students. Respondents are on the left of the map ranked according to their tendencies to prefer the contexts with those less predisposed to prefer contexts in the bottom and those more predisposed in the top. The respondents at the same logit level



of an item have a 50% probability of preferring that item, respondents placed higher than the item have a more than 50% chance to prefer it and respondents placed lower than an item have a less than 50% chance of preferring it. From the location in the Albanian map, the mean of the persons is bigger than that of the items which suggests that the items were relatively easy for the respondents to agree with. This is similar for the South African cohort. From the maps, we can see that there are at most 39% of the South African students that find all the items easy to endorse and at most 5% of them find all the items difficult to endorse. In the Albanian data at most 3% of the respondents find all the items difficult and at most 3% find them all easy.

One of the issues that the person-item map brings to the fore is the presence of poorly-defined regions of the variable. This is indicated by the gaps between items on the map. For the South African cohort there is only one gap—between C10 and the cluster of items C17, C4, C7 and C8. However, the differences between measures of these items are smaller than the suggested cut-off difference of 0.30 (Reeve & Fayers, 2005) and hence there are no “poorly defined or tested regions of the variable” (Linacre, 2008, p.206). The gap between C2 and C5 is 0.16 logits, between C5 and C1 it is 0.54 logits and between C14 and C6 it is 0.37 logits for the Albanian cohort. The last two gaps being larger than 0.30 logits indicate insufficient item mapping. Normally this means that there is a construct deficiency (Hudgens, Dineen, Webster, Lai & Cella, 2004), so the latent trait, preferences for contexts, is insufficiently covered by the questionnaire for the Albanian cohort.

The person-item map also brings the fore redundancy of items. This is indicated on the map by items sharing the same location. For the Albanian situation there are 8 pairs of items sharing the same location such as for example item C10, “making computer games and saving music on CD’s and Ipod’s” and item C21,

“planning a journey” share the same location. Normally this indicates that both items are measuring the same dimension of the latent trait, preferences for contexts to be used in mathematics. But for this instrument these two items are too different in meaning, so the sharing of location is considered as closeness of the measures. This also holds for the South African cohort where conceptually different items share the same location as is evident from C13, “all kinds of pop music”, C19, “responding to emergencies and disasters” and C20, “the spread and decline of epidemics such as AIDS, tuberculosis and cholera”. In addition to these reasons, Hudgens et al. (2004, p. 955) assert that redundancy “does not impact the overall measures noticeably”.

Miller, Rotou & Twing (2004) recommend that for the evaluation of whether an instrument is invariant across different cultural contexts, the differences between paired items of the scale should not exceed 0.3 logits. This criterion is only met for 11 (C1, C4, C7, C9, C10, C11, C12, C17, C18, C19 and C23) of the 23 items of the scale.

### **Discussion**

The aim of this article was to investigate the functioning of a rating scale and its operation in two different countries. For this reason the differences and similarities between them will also be brought to the fore. Items’ measures and fit statistics were analysed and showed a fit of the data to the Rasch model for both countries.

Not all items met the criterion for invariance of differences between measures for paired items for the two groups. The 11 items satisfying the criterion can be divided into 5 broad categories. These are: health and safety (C7, C18, and C19), modern technology (C4, C10), future employment and related financial success (C9, C17, and C23), the physical universe (C11, C12) and the socially unbecoming (C1). These issues are of a global nature and to a certain extent they enjoy high cross-

country visibility due to all forms of globalisation. Thus there are no fundamental differences in how learners experience these issues in their respective countries.

For paired item differences not satisfying the criterion of less than 0.3 logits it is generally assumed that “failure to...meet this criterion may be due to non-equivalence in translation or to more fundamental differences between the populations...” (Casillas et al., 2006, p.477). In the translation of the instrument care was taken that the items convey what it was supposed to convey and a language expert and practising teachers at the grade levels were involved in translation activity. Furthermore, the instrument was administered by the primary researchers in their different countries and respondents were afforded the opportunity to, at any stage during completion of the questionnaire, ask for clarifications. Given these circumstances, it is contended that non-equivalence in translation is minimal and that fundamental differences between the underlying cultures of the two countries are a more plausible reason. Thus learners’ expression of an order preference for contexts to be used in school mathematics is influenced by the different experiences, perceptions and values that students from different cultures and environments attach to the different items. In the case of C2, “handmade products by Albanian women such as carpets” in the Albanian questionnaire or “cultural products such as the house decorations made by Ndebele women” in the South African one, there is a difference of 1.17 logits between the measures. For the South African situation indigenous knowledge is given high priority and finds expression in school mathematics curriculum. This is not the case in Albania.

Another example bringing to the fore the different underlying conditions is C21, “planning a journey”. Albania has a long history of restrictions to travel abroad first in the communist era during the period 1945-1990 and then during the last 20

years of a democratic society. One of the biggest dreams of Albanians is to be free to experience more developed European countries and be part of the European Union. During the last 2 years there have been numerous public discussions of these issues and as from 15 December 2010 Albanians will be able to travel without a visa in the Schengen area. Beside the abroad travels children also have excursions with their class and teachers in cities of Albania, and they sometimes travel with their parents during summer to spend some time at the beach or the mountains. We think that all these factors explain Albanian students' enthusiasm for travelling that account for ranking it as 2<sup>nd</sup> most preferred item. On the other hand, South African students are not overtly exposed to issues related taking journeys. South Africa is much more developed than the surrounding countries and travelling to the more developed regions of the world is just too expensive for the cohort of learners involved in the study.

### **Conclusion**

As alluded to above the rating scale for preference of contexts to be used in school mathematics, divides into two sections in terms of invariance across the two groups with 0.3 logits as the criterion for acceptable differences for paired items. Crudely, this can be related to items referring to issues that have high visibility at a global level (48% of the items) satisfying the criterion and those that are linked to issues of a more local, country-specific character (52% of the items) which does not satisfy the criterion. This indicates that the instrument does not operate with complete invariance across the two countries. Based on this the overall results confirm the hypothesis argued for by Jablonka (2007) that preferences for contexts to be used in school mathematics differ across countries.

One implication of the major result of this study is that much care must be taken in interpreting the results of international non-high-stakes tests such as TIMSS and PISA with respect to the contextually-embedded items. Learner achievement on such items might be more an issue of learners' emotional attachment to the contexts than their ability to deal with the mathematics involved in the assessment items. For example, Albanian learners might have a higher level of motivation to engage in the contextually-driven mathematics problem in Box 1 below, dealing with planning of journeys, because of their higher preference than South Africans for situations of this nature.

Even with respect to ascertaining the frequency of dealing with real-life situations in classrooms such as the TIMSS item, "Applying mathematics real-life contexts" (Mullis, et al., 2004, p.180), should be interpreted with the necessary care. If "real-life contexts" in this case is interpreted by learners in terms of "local contexts" the response might or might not be different from when the interpretation is in terms of "global contexts". It is not suggested that international comparative surveys should not be done. Such surveys do give a macro perspective of the issue being surveyed. Rather, the call is for dealing with the results emanating from these international comparative comparisons with circumspect since micro perspectives, as ascertained by the instrument in this study whose implementation in two different contexts is the focus, render differential invariance across the countries.

A second implication is that items which are invariant across countries offer the possibility for cross-country mathematics resource development. C4, "secret codes such as pin numbers used for withdrawing money from an ATM", is an example of such an invariant item. The mathematics underlying this is cryptography, a mathematical topic which is not explicitly dealt with in most school curricula across

the world. Given that it is an issue that is invariant across the two countries, it opens the opportunity for joint cross-country learning resource development for this topic and, obviously, the accompanying benefits that accrue from such collaborative work.

The use of contexts in school mathematics has been around for some time. Within modern developments related to the relevance of mathematics in real-life situations it has received increased attention at the level of policy, international mathematics assessments and the development of school mathematics learning resources. It is reasonable to assume that this development is more than just of a temporary nature. This does not imply that the preferences of learners should be the only yardstick for identifying appropriate contexts. Preferences of other stakeholders in the school mathematics enterprise are also important. This is particularly the case for contextual situations for which learners have a low preference. Thoughtful incorporation of such contexts in the mathematical learning experiences might just excite them to develop interest in such situations. However, a starting point to working mathematically with contextual situations that learners find interesting has a greater chance of engendering strong motivation than those for which they have low preference. Given this scenario, there is a need to ascertain, in a valid and reliable manner in an easy and fairly inexpensive way, the contexts that learners would prefer to deal with in their mathematical experiences. What is presented in this paper is a step in that direction and would necessarily require further development with more learners from more diverse countries since the two countries under view in this paper are by all accounts late developing countries.

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Table 1

*Demographic characteristics of learners*

	South Africa		Albania	
	Gender			
	Girl	Boy	Girl	Boy
Grade 8	129	93	34	34
Grade 9	76	94	36	34
Missing	2			
Total	207	187	70	68
	Age			
Age	Grade 8	12 - 22	Grade 8	13-14
Range	Grade 9	13 - 19	Grade 9	14-16
Mean Age	Grade 8	14.8	Grade 8	13.3
	Grade 9	15.7	Grade 9	14.4

Table 2

*Hierarchical ordering of the items*

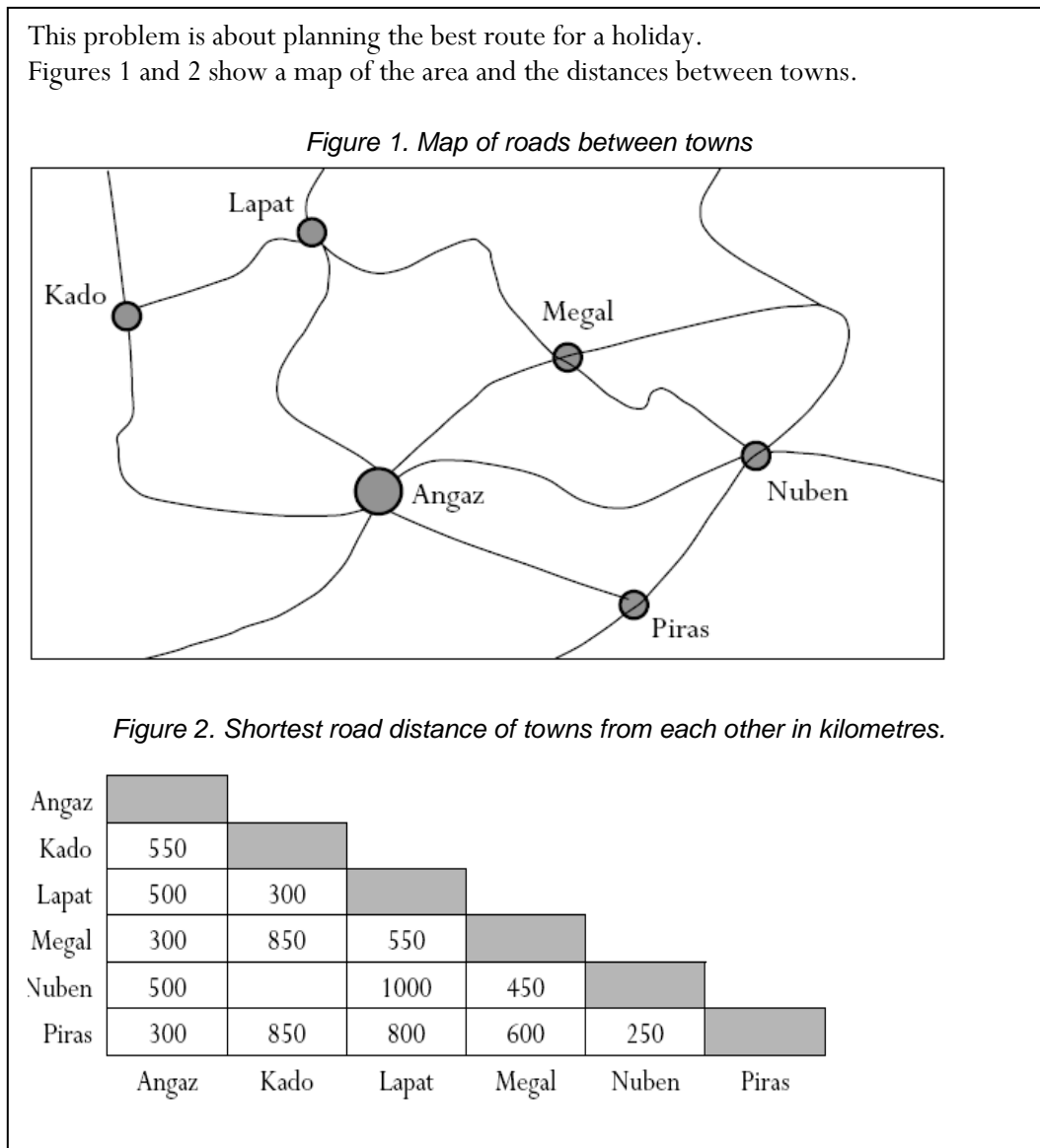
Albania						South Africa					
Item	Raw Score	Measure (Logits)	Model S.E.	Infit MNSQ	Outfit MNSQ	Item	Raw Score	Measure (Logits)	Model S.E.	Infit MNSQ	Outfit MNSQ
C2	236	1.47	0.12	0.92	0.94	C1	884	0.52	0.06	1.04	1.04
C5	237	1.31	0.12	0.99	1.03	C5	937	0.44	0.06	1.04	1.03
C1	288	0.77	0.1	1.42	1.51	C14	950	0.36	0.06	1	1
C14	307	0.68	0.1	1.08	1.09	C2	985	0.3	0.06	0.98	0.98
C6	342	0.31	0.09	1.14	1.15	C22	1021	0.26	0.05	1	1
C3	352	0.21	0.1	1.01	0.98	C11	1047	0.18	0.06	1.01	1
C11	342	0.2	0.1	0.77	0.78	C13	1075	0.1	0.05	1.08	1.08
C19	367	0.12	0.1	0.84	0.84	C19	1088	0.07	0.06	0.91	0.89
C23	380	0.03	0.09	1.39	1.41	C20	1118	0.06	0.06	1.02	1.03
C4	374	-0.03	0.09	1.04	1.04	C12	1091	0.04	0.05	0.93	0.94
C22	379	-0.06	0.09	0.85	0.82	C15	1103	0.01	0.05	1.06	1.05
C12	383	-0.11	0.1	1.01	1.01	C21	1103	-0.04	0.06	0.93	0.92
C13	401	-0.22	0.1	1.02	1	C18	1158	-0.08	0.06	0.95	0.93
C9	405	-0.24	0.1	0.95	0.95	C16	1169	-0.12	0.06	1.01	1.01
C15	425	-0.33	0.09	1.05	0.98	C9	1134	-0.17	0.06	0.95	0.94
C18	423	-0.34	0.1	1.01	0.97	C3	1101	-0.19	0.06	1.01	1.01
C17	418	-0.39	0.1	1.05	1.04	C6	1160	-0.2	0.06	1.01	0.99
C20	417	-0.44	0.1	0.82	0.77	C8	1183	-0.21	0.06	0.94	0.94
C16	437	-0.46	0.1	0.95	0.92	C23	1197	-0.21	0.06	1.06	1.05
C7	428	-0.48	0.1	0.89	0.9	C7	1210	-0.21	0.06	1.1	1.1
C8	427	-0.64	0.12	0.94	0.91	C4	1182	-0.23	0.06	1	1.08
C21	437	-0.66	0.12	0.92	1.02	C17	1209	-0.24	0.06	0.98	0.97
C10	465	-0.7	0.11	0.95	1.02	C10	1293	-0.44	0.06	1.01	1.06
Mean	377	0	0.1	1	1	Mean	1104	0	0.6	1	1
SD	60.7	0.58	0.01	0.15	0.17	SD	96.9	0.24	0	0.05	0.05

PERSONS - MAP - ITEMS	
ALBANIA	SOUTH AFRICA
<p>2 &lt;more&gt;   &lt;rare&gt;</p> <p>. +</p> <p>.  </p> <p>.  </p> <p>. T   C2</p> <p>#  </p> <p>#   C5</p> <p>.   T</p> <p>1 # +</p> <p>.##### S  </p> <p>###   C1</p> <p>#####   C14</p> <p>.##### S  </p> <p>.#####  </p> <p>### M   C6</p> <p>.##   C11 C3</p> <p>#####   C19</p> <p>0 ##### +M   C23 C4</p> <p>#####   C12 C22</p> <p># S   C13 C9</p> <p>.#   C15 C18</p> <p>.#   C17 C20</p> <p>.##   C16 C7</p> <p>.#   S   C8</p> <p>.   C10 C21</p> <p># T  </p> <p>-1 # +</p> <p>&lt;less&gt;   &lt;frequ&gt;</p> <p>EACH '#' IS 2.</p>	<p>3 &lt;more&gt;   &lt;rare&gt;</p> <p>. +</p> <p>.  </p> <p>.  </p> <p>.  </p> <p>2 . +</p> <p>.  </p> <p>#  </p> <p>#  </p> <p>. T  </p> <p>##  </p> <p>.#  </p> <p>.#  </p> <p>1 .## +</p> <p>.# S  </p> <p>.##  </p> <p>#####  </p> <p>.####  </p> <p>#####  </p> <p>####   T C1</p> <p>.##### M   C5</p> <p>.#####   C14 C2</p> <p>.##### S   C22</p> <p>.#####   C11</p> <p>.#####   C13 C19 C20</p> <p>0 ## +M   C12 C15 C21</p> <p>.## S   C16 C18</p> <p>.###   C3 C6 C8 C9</p> <p>.## S   C17 C23 C4 C7</p> <p>.  </p> <p>#   C10</p> <p>. T T  </p> <p>.  </p> <p>.  </p> <p>-1 . +</p> <p>.  </p> <p>.  </p> <p>-2 # +</p> <p>&lt;less&gt;   &lt;frequ&gt;</p> <p>EACH '#' IS 4.</p>

Figure 1: Item maps for contexts to be used in school mathematics.

Box 1

Example of PISA problem (OECD, 2004, p.17)



Appendix

The questionnaire used for the data collection

RELEVANCE OF SCHOOL MATHEMATICS EDUCATION II (ROSME II)

CODE:.....

October 2008

Things I am interested to learn about in Mathematics

I am: a female ..... a male .....

I am ..... years old

I am in Grade .....

Which things would you like to learn about in mathematics? Some possible things are in the list below. Beside each item in the list, make a cross over or next to one of the words of in the box next to the item to say how much you are interested in the issue. Please respond to all the items and choose only one of the words for every item.

There are no correct answers: we want you to tell us what **you** like.

Examples:

If you are a little interested to learn about the mathematics involved in “building houses” then you will make a cross (X) next to or over “low” in the box as shown below.

My interest in learning about mathematics involved in					
CEx1	building houses is	Very high	High	Low <b>X</b>	Nil/Zero

If you are very interested to learn about the mathematics involved in “painting a car” then you will make a cross (X) next to or over “Very high” in the box as shown below.

My interest in learning about mathematics involved in					
CEx2	painting a car is	Very high <b>X</b>	High	Low	Nil/Zero

We thank you for your participation.

<b>My interest in learning about mathematics involved in</b>					
C1	lotteries and gambling is	Very high	High	Low	Nil/Zero
C2	handmade products by the Albanian women, such as carpets, is	Very high	High	Low	Nil/Zero
C3	the latest designer clothes is	Very high	High	Low	Nil/Zero
C4	secret codes such as pin numbers used for withdrawing money from an ATM is	Very high	High	Low	Nil/Zero
C5	agricultural matters is	Very high	High	Low	Nil/Zero
C6	government financial matters, such as inflation and taxes is	Very high	High	Low	Nil/Zero
C7	health matters such as the state of health of a person, the amount of medicine a sick person must take is	Very high	High	Low	Nil/Zero
C8	determining the level of development regarding employment, education and poverty of my community is	Very high	High	Low	Nil/Zero
C9	being productive with the doing of tasks in a job is	Very high	High	Low	Nil/Zero
C10	making computer games and storing music and videos on CD's and I-pods is	Very high	High	Low	Nil/Zero
C11	environmental issues and climate change is	Very high	High	Low	Nil/Zero
C12	determining the origin and age of the universe is	Very high	High	Low	Nil/Zero
C13	all kinds of pop music is	Very high	High	Low	Nil/Zero
C14	national and international politics is	Very high	High	Low	Nil/Zero
C15	dancing such as rave, disco and hip-hop is	Very high	High	Low	Nil/Zero
C16	sending and receiving of electronic messages such as SMS's and e-mails is	Very high	High	Low	Nil/Zero
C17	managing personal and business financial affairs is	Very high	High	Low	Nil/Zero
C18	recreation, physical exercise, sport activities and competitions is	Very high	High	Low	Nil/Zero
C19	responding to emergencies and disasters is	Very high	High	Low	Nil/Zero
C20	the spread and decline of epidemics such as AIDS; tuberculosis and cholera is	Very high	High	Low	Nil/Zero
C21	planning a journey is	Very high	High	Low	Nil/Zero
C22	crime fighting, warfare and military	Very high	High	Low	Nil/Zero



	matters is				
C23	construction and engineering	Very high	High	Low	Nil/Zero

# **Albanian Students' Preferences for Real-Life Situations in Mathematics and Its Gender and School Location Dimensions**

**Suela Kacerja**

## **Abstract**

This study reports the investigation of students' preferences for real-life situations used in mathematics. Participants were 8<sup>th</sup> -10<sup>th</sup> grades students from different lower and upper secondary schools in the district of Shkodra, Albania, with balanced gender participation. Rasch rating scale methods were used to analyse the data collected with a questionnaire. This method allowed the investigation of whether the data fit the Rasch model according to the appropriate criteria. It concluded that students revealed a hierarchy of preferences of contextual situations used in Mathematics. Items related to students' affiliation with modern technologies were highly preferred, followed closely by items perceived as connected to a safe economic future and upward mobility and entertainment. At a middle range were items about more global concerns such as environmental matters. The least preferred items represent activities perceived as unprofitable in the current stage of the Albanian societal development. Four items exposed differential item functioning for girls and boys, and two items exposed differential item functioning according to school location. The use of the concepts of habitus, field, and capital from Bourdieu as heuristic tools to explain students' motives for preferences revealed that being educated is seen as necessary capital for a good position in students' future fields of higher education and employment. Therefore students show positive dispositions toward items that are perceived as helpful in this direction.

*Keywords: students' interests, real-life situations, Rasch methods, habitus, gender.*

## Introduction

The use of real-life situations or contexts in mathematics is a widely discussed matter in school mathematics in general and this is seen in different mathematics curricula and textbooks (Romberg 1998; Lappan, Fey, Fitzgerald, Friel and Phillips 2004; COMAP 2000; Du Toit, Human, Olivier, Nicholson and Pillay 1991; Qualifications and Curriculum Authority 2007; National Mathematics Advisory Panel 2008; Encyclopaedia Britannica 2011; Julie, Holtman and Mbekwa 2011). Contexts constitute an important dimension in well-known international assessment programs such as the Programme for International Student Assessment (PISA), (OECD 2006). In the PISA mathematics assessment, one of the three components of the Mathematics domain is 'situations or contexts' where the problems are located, the other components are the mathematical content and the mathematical competencies required for solving a specific problem.

Similar notions are present in the Albanian school mathematics curriculum where importance is placed on the need for students to recognize and use mathematics in everyday life and in other school subjects (Institute of Curricula and Training 2006; 2007; 2008; 2010). The concepts of numeracy and literacy are introduced in curricula respectively as 'the group of mathematical concepts and skills that serve an individual in everyday life, at home, in his workplace, in community' (Institute of Curricula and Standards, Albania 2006 p. 2, author's translation), and "individual's ability to understand and use the written information in everyday life (*by using mathematics*)" (p. 12). Mathematics teachers are recommended and encouraged to include facts and information from everyday life, and cross curricular links, in teaching.

A great deal of work about realistic contexts in mathematics learning is done within the tradition of Realistic Mathematics Education (Freudenthal 1983; 1991; Treffers 1987; Streefland 1991; Gravemeijer 1994; De Lange 1996; Gravemeijer and Doorman 1999; Van den Heuvel- Panhuizen 2006), where connection of mathematics to reality is at the core. This reality is the one that fits with students' experiential world, and mathematics is conceptualized as a human activity. Researchers working in this tradition suggest a broad use of realistic contexts from primary to more advanced mathematics levels of undergraduate studies.

Other researchers have pointed towards the problems of learning mathematics in context. Boaler (1993a; 1993b; 1994) discussed one such problem connected to the degree of 'reality' that students perceive as useful to include while solving tasks. Boaler (1994) suggests that 'contexts which involve real world variables should only be used in mathematics examples and questions if they require students to *consider* the real world variables introduced in the question' (p.563). She also drew attention to the oversimplified assumptions that constitute the basis of real-life contexts' use. Transfer of learning is presumed to result from the discussions generated by the task, its openness, negotiations and interpretations of it, and students' given degree of autonomy (Boaler 1993b)

On the use of realistic tasks in assessment in the UK (Cooper 1998a; 1998b; Cooper and Dunne, 1998; 2000; Cooper and Harries, 2002) researchers explored influence of context on students. Cooper and Dunne (1998) found differences in performance between students from different socio-cultural backgrounds in solving contextualized tasks. These differences in performance come from problems in recognizing and interpreting the demands, and including the appropriate everyday knowledge, in solving realistic tasks. Cooper and Harries (2002) report that tasks which require students' deeper consideration of the realistic context in

responding, as suggested by Boaler (1994), were important to help students avoid the problems of recognition reported by Cooper and Dunne (1998).

Van Den Heuvel-Panhuizen (2005), from the RME tradition, discussed important characteristics that realistic mathematics tasks in assessment should possess, these are: being accessible, inviting and challenging for the students, allowing flexibility in solution, reflecting important goals, including open-ended questions, allowing teachers to see an 'accurate picture of the student' (p. 3). Van Den Heuvel- Panhuizen indicated some unsolved issues with real-life contexts in assessment including students' unwillingness to take context into account, their excessive involvement with the contexts, and the degree of reality supposed to be taken into account as in the above discussions.

The effects of using real-life situations in mathematics depend on many factors, among them can be how a context is chosen and students' degree of interest in it. The study presented here belongs to the affective domain, and it explores students' hierarchy of preferred contexts to use in mathematics. The view taken here is that knowledge from specific fields of students' interest can be introduced and discussed in mathematics lessons or tasks where the aforementioned suggestions from different researchers can be taken into account. Students' voices are important to hear, and there are virtually no research studies on students' preferences for real-life situations to be used in mathematics (Julie and Mbekwa 2005). There are indeed a few studies that include results about students' preferences for real-life situations as part of other projects (Kaiser-Messmer 1993; Lingefjard 2006). The lack of research was one of the main motivations for researchers from different countries to embark on a project, the Relevance of School Mathematics Education (ROSME) (Julie and Holtman 2008). At the outset, the project involved mathematics educators from South Africa, Zimbabwe, Uganda, Eritrea, Norway and mathematics teachers from South Africa and South Korea (Julie & Mbekwa 2005). It focused on students in grades 8 to 10, and a 61-items questionnaire was designed to collect information about students' expressed preferences for different real-life situations to be used in mathematics. The questionnaire was then modified into a second version with 23 items.

In August 2008 the author started conducting the study with Albanian students. The project in Albania used both quantitative and qualitative methods to explore students' preferences for real-life situations to be used in mathematics and their motives for preferences. The target groups are students in grades 8 to 10 (13-16 or 17 years old). In this article the quantitative part of the Albanian study is presented in detail, and excerpts from interviews are used to discuss students' motives for the preferences they expressed. The research questions that guided the study are:

1. What is students' hierarchy of preferences for real-life contexts that can be used in mathematics?
2. Are there differences in students' preferences in relation to gender or school location?
3. What are students' motives for their preferences for real-life contexts that can be used in mathematics?

In the following sections the theoretical underpinnings, the research procedure, the Rasch method for data analysis and the results are presented.

## **Theoretical situatedness and tools**

### **Interest as a latent trait**

In this section there is first a definition of interest, the main concept upon which the study is developed. A discussion of the latent trait follows as defined by the items' hierarchy, and an expected hierarchy is constructed beforehand.

As mentioned above the study is about students' preferences for contexts to use in learning Mathematics, and as such it is connected to the construct of interest students have in learning mathematics in some contexts of their preference. Studies on interest fall within the affective domain. In this research, interest is conceptualized as a person-object relationship, as in the "Person-Object Interest" (POI) theory (Krapp 2007). In POI interest is defined as "content specific motivational variables that have an important influence on learning and the direction of human development" (Krapp 2007, pp. 6- 7). Thus interest is always directed towards an object and it comes as a result of a person's interaction with his/her environment (Krapp 2002a; 2007). This directedness is what makes interest different from motivational concepts in the affective domain. The object of interest can be one of three forms: real object, activities and types of engagement or topics that "represent a certain domain of knowledge" (Krapp 2002b, p. 412). Krapp (2007) refers to two levels of analysis. At one level interest is conceptualized as the "dispositional (or "habitual") motivational structure of an individual" (p. 9), where it is a stable tendency to deal with the object of interest, and it is about individual or personal interest (Renninger, Ewen and Lasher 2002). At the other level it is about "a state or an ongoing process during an actual interest- based activity" (Renninger et al. 2002, p. 9). The cause of this other interest can be either "an already existing dispositional interest (individual or personal interest)" or "special conditions of a teaching or learning or work situation (interestingness)" (p. 9). Results from both individual interest and situational interest studies show positive effects of it in educational outcomes (Hidi 1990; Krapp 2002a; 2002b; Renninger et al. 2002; Schiefele 1991).

The study reported here is concerned with a particular aspect of interest, namely the real-life situations that students prefer to use in Mathematics. As such students' preferences for contexts to be used in Mathematics are conceptualized as a latent variable, something that cannot be measured directly. Linacre (2011) defines a latent variable as follows:

A latent variable is something which we can have more or less of, but which we cannot measure directly. It is a variable such as "mathematics ability" or "patient quality of life". We conceptualize it to be a straight line marked out in equal- interval units. This line is infinitely long. We can always imagine something (or someone) with more of the attribute than anything (or anyone) we have encountered so far, and also something (or someone) with less of the attribute. We conceptualize each observation in the data to indicate "less" or "more" of this latent variable (n.d).

The interests that students express for contexts to be used in their learning of mathematics will serve to measure the different levels of the latent variable. In measuring a latent variable, an expected hierarchy is constructed beforehand by researchers using different available resources. The expected hierarchy is a preliminary idea about the order of preferences that students will express. In measuring the latent trait, students' preferences for contexts to use in Mathematics, the expected hierarchy is compared with the one resulting from students' responses. This comparison is the basis for discussion and evaluation of the latent trait's validity. From the comparison the expected hierarchy can either be supported, or contradicted, and in this latter case it is either improved or the quality of the data is discussed. For the construction of the expected hierarchy, it is natural to refer to literature of similar studies in the field and the researcher's own experience of the environmental milieu of the students involved in the study.

Two studies of direct importance were found in a literature search. Kaiser-Messmer (1993) conducted an empirical study into gender differences in attitudes towards mathematics with 748 German students aged 14-19. One part of the questionnaire used in the study was about students' interests in real world examples that can be used in mathematics teaching.

Results from the questionnaire revealed differences between boys and girls in their preferences for themes from the real world in mathematics. Kaiser-Messmer (1993) found that girls at lower secondary school prefer topics such as ecology, sports, biology/medicine and everyday life, while boys at the same level prefer mostly sports, technology, economy and physics. In general it can be concluded that Kaiser-Messmer's study demonstrated learners' strong preference for contexts dealing with technology, biology/medicine, and matters related to the earth and the universe and social issues to be used in school mathematics. In an article by Lingefjärd (2006) five mathematical modeling areas are discussed: geometry, heating-cooling, medicine, population and sports. Students participating in a mathematical modeling course in teacher education would in the end of the course evaluate it. Based on 200 students' preferences, Lingefjärd (2006) reported that medicine was the most preferred real-life situation that students dealt with, followed by population matters and sports.

Preceding the study reported in this paper, a pilot study was conducted in December 2008, one part of which were interviews with Grades 8 – 10 students that set out to explore the reasons for their preferences of some contexts compare to some others (Kacerja 2009). Twenty-four students of the target age-group were interviewed after they completed a 23-items questionnaire previously within the pilot study. Students were provided with 7 cards with images depicting different real-life situations. They were asked to order the cards from those they would most prefer to deal with to those they would least prefer to deal with in their mathematics lessons. After rank ordering, questions probed for the reasons for their choices. The results of the interviews indicated that agriculture, cultural products, and lotteries and gambling were not appealing for students. On the other hand, computer games, sending and receiving sms's, secret codes, and the management of personal financial or business matters were real-life situations that received high endorsement. For the purposes of an expected hierarchy of contextual situations to be used in mathematics, it seems that students' least preferred situations can be connected to undesired material or social consequences (such as lotteries and gambling) and those viewed as non-modern and unprofitable activities (such as cultural products or agricultural matters). The real-life situations most preferred are those that can conceivably contribute to a secure economic situation and upward mobility in life (such as financial affairs, and health matters), and modern technologies which they already use or would like to use.

As a result it can be expected that real-life situations dealing with technology, those that are indicative of upward mobility, and health matters, will be accorded high preference by students and amongst the most likely to be chosen by them. In the middle range preferences it is postulated that situations related to financial matters, dealing with emergencies and disasters and environmental issues including climate change will be less likely to endorse by students than those mentioned in the former sentence. Lastly, those that are unlikely to be endorsed in relation to the former two categories will be situations that are deemed not modern and of low economic return, in terms of the input that is required, and those that might contribute towards undesirable social behaviours in society. This then is the expected hierarchy of preferences Albanians might have for contextual situations to be included in their learning of Mathematics (table 1).

Table 1. Expected hierarchy

Preference level	Real-life situations
High	Technology Upward Mobility

	Health
Medium	Financial matters Emergencies and disasters Environment
Low	Traditional activities of low economic returns Undesirable social behaviors

It is this hierarchy that will be tested against the empirical data that were collected for this study.

### **Habitus, field and capital as heuristic tools**

Three conceptual tools from Bourdieu (1977) are used here as heuristic tools, as one of the possible ways to look at students' preferences: habitus, field and capital. These key concepts focus on the individual with its habitus and capital, but they allow consideration of the individual within a broader frame also, and the shaping of individual's habitus in encounters with others in different activities in life.

Bourdieu (1977) describes habitus as "systems of durable, transposable *dispositions*, structured structures predisposed to function as structuring structures" (p. 72). Habitus is a set of dispositions, present in everyone, that guide people's reaction and behaviour towards everyday life events, that make them perceive possibilities and chances as such, fulfilling in this way their role as structuring structures that generate practices. The way habitus is constituted is through the past experiences of participating in practices in life. These experiences shape people's views, thought and perceptions of specific practices and life in general, creating dispositions which constitute everyone's habitus. As Zevenbergen (2005) asserts, *habitus* "allows the researcher to understand the dynamic structure between social reality and the individual" (p. 609). In this study habitus is used to explain students' preferences for real-life contexts that can be used in mathematics.

Students participating in the study have their own habitus, formed from participation in past experiences, which are transposable in that they frame reactions in new practices as well. Here the notion of field comes into play as a "network, or a configuration, of objective relations between positions" (Bourdieu and Wacquant, 2002, p. 97). Education, and in particular mathematics education, is an example of field in Bourdieu's meaning, as a network of relations between positions that are occupied by social agents such as researchers, teachers, educators, and students. It is in an encounter with a field that habitus is actualized or not, depending on the conditions found there. But on the other hand, it is habitus that helps to have a sense of the field, to give it a meaning and value so that it will be worth investing some energy on it.

Habitus is first formed in families, but it is continuously shaping when in contact with other people's habitus through participation in further practices within different fields during life, such as education and occupation. Habitus' further development is influenced by the different types and amounts of capital one has as well, which are first developed in a family. Bourdieu (2004) defines capital as "accumulated labor (in its materialized form or its "incorporated", embodied form) which, when appropriated on a private, i.e., exclusive, basis by agents or groups of agents, enables them to appropriate social energy in the form of reified or living labor" (p. 15). Capital is seen in four forms: economic, cultural, social and symbolic.

Economic capital, together with cultural capital, such as educational qualifications or cultural goods, social capital, such as a network of family, friends and acquaintances, and symbolic capital, such as honour, are found in different amounts in students' families. Wacquant (Bourdieu & Wacquant, 2002) treats habitus as the mechanism that induces people to choose a certain way of behaving in the field by using their capital. Based on capital as well, each family has its own view of life, and its own values, which influence children's habitus. These views and values are to a certain degree shaped by life in Albanian society, and therefore some parts of habitus can be similar.

On the other hand, there might also be more individual characteristics or differences coming from different life situations, depending on capital as well. Students coming from families living in the country might develop a different habitus from those living in the urban areas. Reasons for this can be: their different living conditions, the cultural capital they bring from families, their socialization, and future opportunities offered to them and perceived by them. The same thing is true of gender differences, where students' habitus guides them into following the possibilities offered, because "one's habitus is also gendered as a result of the possibilities available to each group" (Dumais, 2002, p. 47). Therefore gender and school location can be factors of differentiation.

## **Instrumentation, data collection and data analysis procedures**

### **Instrumentation**

For data collection a 23-item questionnaire was used. The questionnaire was developed by the multi-country ROSME group (Julie & Holtman 2008). It is a 4-point Likert-type instrument which asks students to express their level of interest for wanting to deal with specific contexts in their learning of Mathematics. Demographic data such as age, grade and gender were also collected. Figure 1 shows how the items were formulated.

My interest in learning about mathematics involved in					
C7	health matters such as the state of health of a person, the amount of medicine a sick person must take is	Very high	High	Low	Nil/Zero

Figure 1. Formulation of an item

Permission was sought and obtained from the schools' principals to conduct the study in their schools. Students' consent was obtained prior to the administration of the questionnaire. They were informed that their participation was voluntary, and that anonymity would be maintained, before completing the questionnaire. All the other ethical requirements were taken into account.

For interviews, 24 students from the city of Shkodra, in grades 8-10, were included in a first round in November 2008, and 8 other students from grades 8-9 participated in the second round, in April 2010.

### **Data collection**

Quantitative data for this research were collected in April 2010 in the district of Shkodra, in the northern part of Albania. The researcher herself collected the data in every classroom. Students were allowed to use as much time as they needed, they were informed that they



could request clarifications and it was emphasised that personal opinions were asked and there was no right or wrong answer.

A convenience sample was selected based on possibilities for access that the researcher had to the schools, however, representation of both genders and of both urban and rural areas were sought. The choice was also influenced by the decision to include schools that had a relatively high number of students. In some of the remote villages of the district of Shkodra, there are schools with a very small number of students, one for example has five students at grade 8 and five at grade 9, and these schools are difficult to access for infrastructural reasons. Ten schools participated in the data collection: four lower secondary (5<sup>th</sup>-9<sup>th</sup> grade), two upper secondary (10<sup>th</sup>-12<sup>th</sup> grade) one of them was private, four mixed lower and upper secondary (from 5<sup>th</sup>-12<sup>th</sup> grade). One class for each target grade, 8, 9 and 10, from the selected schools was randomly chosen to complete the questionnaire. Table 2 presents the demographic data for the 825 students from the district of Shkodra who participated in the study. Their ages varied from 13 to 17 years old.

Table 2. Students' sample

	Location			
	Urban		Rural	
Grade	Male	Female	Male	Female
8	71	63	68	99
9	51	68	77	87
10	38	43	70	90
Total	160	174	215	276

For the qualitative part, in the first interviews four students were taken from each of the six classes (8-10 grades), to answer questions about seven different real-life contexts focusing on reasons for liking or disliking them. In the second round, eight students from grades 8-9 were interviewed from an urban school to answer questions around their preferences (author 2011).

### Data analysis

Methods of data analysis are somewhat constrained because the data does not arise from measurements on an interval scale. Rasch models were chosen in this study since they make it possible to transform the raw data into logit (log-odds) units and, as a result, construct linear measures to operate with (see for example Doig and Groves 2006). With Rasch models each person completing the questionnaire receives a measure of the level of preferences, person's willingness to agree, and each item of the questionnaire receives a measure of difficulty to be endorsed. One important characteristic is that persons' and items' measures are converted into the same unit, and persons and items are therefore placed on the same scale along the latent variable (Bond and Fox 2001). On a variable map is possible to see how the latent variable is defined, how well the items cover it, and how items and persons are placed in relation to each other.

To bring together observations from the Likert scale questionnaires the Rasch-Andrich Rating Scale (Andrich 1978) was chosen. This is a polytomous model based on differences between a person's ability (willingness) to agree and the item's difficulty to be endorsed (agreed upon). Let  $n$  be a person of ability  $B_n$  answering on an item  $i$  of difficulty  $D_i$ . Let

$P_{nij}$  be the  $n$ 's probability to choose category  $j$  ( $j=1,2,3,4$ ) of likeness for item  $i$ , and  $P_{ni(j-1)}$  probability for choosing category  $j-1$ . On a rating scale the following formula is used for constructing measurement from observations (Linacre 2004):

$$\log_e(P_{nij}/P_{ni(j-1)}) = B_n - D_i - F_j.$$

An item's difficulty to be endorsed,  $D_i$ , is calculated using the item's raw scores and a person's ability to endorse,  $B_n$ , is calculated based on the person's raw scores.  $F_j$ , the Rasch-Andrich thresholds, are the points where the probability of choosing one category of the answer is equal to the probability of choosing the answer at the adjacent category. The unit obtained for measures of both items and persons is logit (log-odds).

Rasch analysis was done using the Winsteps 3.65.0 software (Linacre 2008).

## Results

In Rasch methods some elements are considered as core in the data analysis process and these elements are presented here. After ensuring that the indicators show a good functioning of the instrument, the analysis further produces an answer to the research questions posed about students' hierarchy of preferences for contexts to be used in mathematics, and its different dimensions.

### Differential Item Functioning

A differential item functioning (DIF) analysis is a tool to explore whether the instrument functions the same way for different groups participating in the study. During this analysis two DIF measures are calculated for each item with data from the two different groups, with all else held constant. A DIF contrast is then calculated as a difference of the two DIF measures which is considered as significant when it exceeds 0.5 logits with a probability  $p < 0.05$  of observing that contrast by chance. DIF was run for three variables: gender, grade, and school location, i.e. city or country. Existence of DIF effect means that an item is easier to be endorsed, or preferred, for one group of respondents compared to another group. No DIF effects were found according to grades. Table 3 presents the items showing DIF effects.

Table 3. DIF report

Person Class	DIF measure	Person Class	DIF measure	DIF contrast	Item	Description
F	0,72	M	1,41	-0,7	C2	Cultural products
F	-0,18	M	0,7	-0,88	C3	Latest designer clothes
F	0,23	M	-0,39	0,69	C23	Construction and engineering
City	1,21	Country	0,52	0,78	C5	Agricultural matters
City	1,17	Country	0,39	0,78	C24	Cultural products (girls)
F	1,44	M	0,85	0,59	C5	Agricultural matters (city students)

Three items were problematic in terms of DIF effect according to gender: item C2 has a DIF contrast -0.70 which means that this item is easier for girls than for boys to endorse; item C3

with a DIF contrast of -0.88 is also easier for girls and item C23, with DIF contrast 0.63 is easier for boys to endorse. In order for the instrument to measure all the participants' preferences in the same way, one recommendation is to divide the items into two other items, one for boys and one for girls. So the item 'cultural products such as handmade carpets' is divided into C2 'cultural products such as handmade carpets (a boys' item)' and C24 'cultural products such as handmade carpets (a girls' item)', the item C3 'the latest designer clothes' is divided into C3 'the latest designer clothes (boys)' and C25 'the latest designer clothes (girls)', and the item 'construction and engineering' is divided into C23 'construction and engineering (boys)' and C26 'construction and engineering (girls)'. In each of these items data from the other gender are treated as missing.

After these changes, another DIF analysis showed 2 items causing DIF effects for students from the country and the city schools. In order to avoid the instrument to work differently for these two groups the following changes were considered: item C5 'agricultural matters' was divided into C5 'agricultural matters (city students)', and C27 'agricultural items (country students)', while item C24 became 'cultural products (city girls)', and C28 'cultural products (country girls)'. After dividing again item C5 into C5 'agricultural matters (city girls)' and C29 'agricultural matters (city boys)' no further DIF effects were noticed, thus the adapted instrument was considered suitable for further analysis.

### Fit statistics

In a Rasch analysis data are sought to fit the model, and the fit statistics indicate to what degree the data fit the model's requirements. The infit mean square value (MNSQ) indicates how unexpected one person's answers are to items near his/her ability levels, while the outfit MNSQ value indicates unexpected answers to items that are very hard or very easy for one person's abilities. In this study item infit and outfit mean square (MNSQ) values were in a range of 0.89-1.17 and 0.92-1.56 logits respectively, therefore within the recommended interval (Linacre 2008).

It was not the same with the persons' fit statistics. There were 23 students that had fit values bigger than 2 logits, which can give a distorted picture of the data. These are problems of underfit i.e. the data are too unpredictable by the model. High outfit values can be caused by unexpected answers to items that are far from students' measured ability (in this case likeability of contexts). An outfit of 2.3 for example means that there is 130% more noise than expected in the data. The decision taken in this study to impede these 23 'problematic' persons' answers to deform the measurement was to delete them from the data and perform the analysis without them. The analysis is further performed with 802 students.

A look at the scalogram for the answers can help understanding the reasons for high outfit values. Two of the most misfitting persons are student 584 (female, country), and student 413 (male, city). Their answers to the items from the most (left) to the least preferred (right) looked like this (table 4):

Table 4. Scalogram of two students' answers

Item	Person 584	Person 413
C10	1	1
C21	1	1
C9	1	2
C8	1	3
C18	-	4
C23	1	1
C7	1	3

C17	1	-
C16	1	4
C25	1	1
C15	1	1
C13	1	1
C20	4	1
C19	1	1
C12	1	3
C22	1	2
C11	4	2
C4	2	3
C26	1	-
C6	1	-
C27	1	-
C28	1	4
C14	1	4
C3	-	4
C1	1	-
C5	-	2
C24	-	-
C2	-	-
C29	-	-

In the table, the sign ‘-’ stands for a missing answer, 1 means null/zero interest, 2 means low interest, 3 means high interest, 4 means very high interest.

Student 584 was amongst the ones with lowest measures (preferences), and as such one would expect the left part of the answers’ row, but an unexpected high score given to low preferred items (or difficult items) such as C20, C11 and C4 can be noticed. This explains her high outfit value. Student 413 has higher preferences than student 584. His answers reveal an unexpected low score for the most preferred item C10 and for C21, and unexpected high scores for less preferred items such as C1, C5, C6, and C14. High outfit values are indicators of different possible factors such as carelessness in completing the questionnaire or reading the items properly, failure to understand it correctly, influence by other peers participating in the study, the time pressure students perceived by having a researcher in the classroom together with a teacher, or even the dilemma between giving an answer that is expected or giving the answer that one thinks is the ‘truth’.

After the deletion of the 23 students, the persons’ misfit table showed that fit statistics were improved. Therefore 802 students were definitively included. For this new analysis item fit statistics were also improved: the outfit values range from 0.90-1.19 and infit from 0.91-1.17, showing a good fit of the items’ data to the Rasch model (Table 5).

Table 4. Items' measures

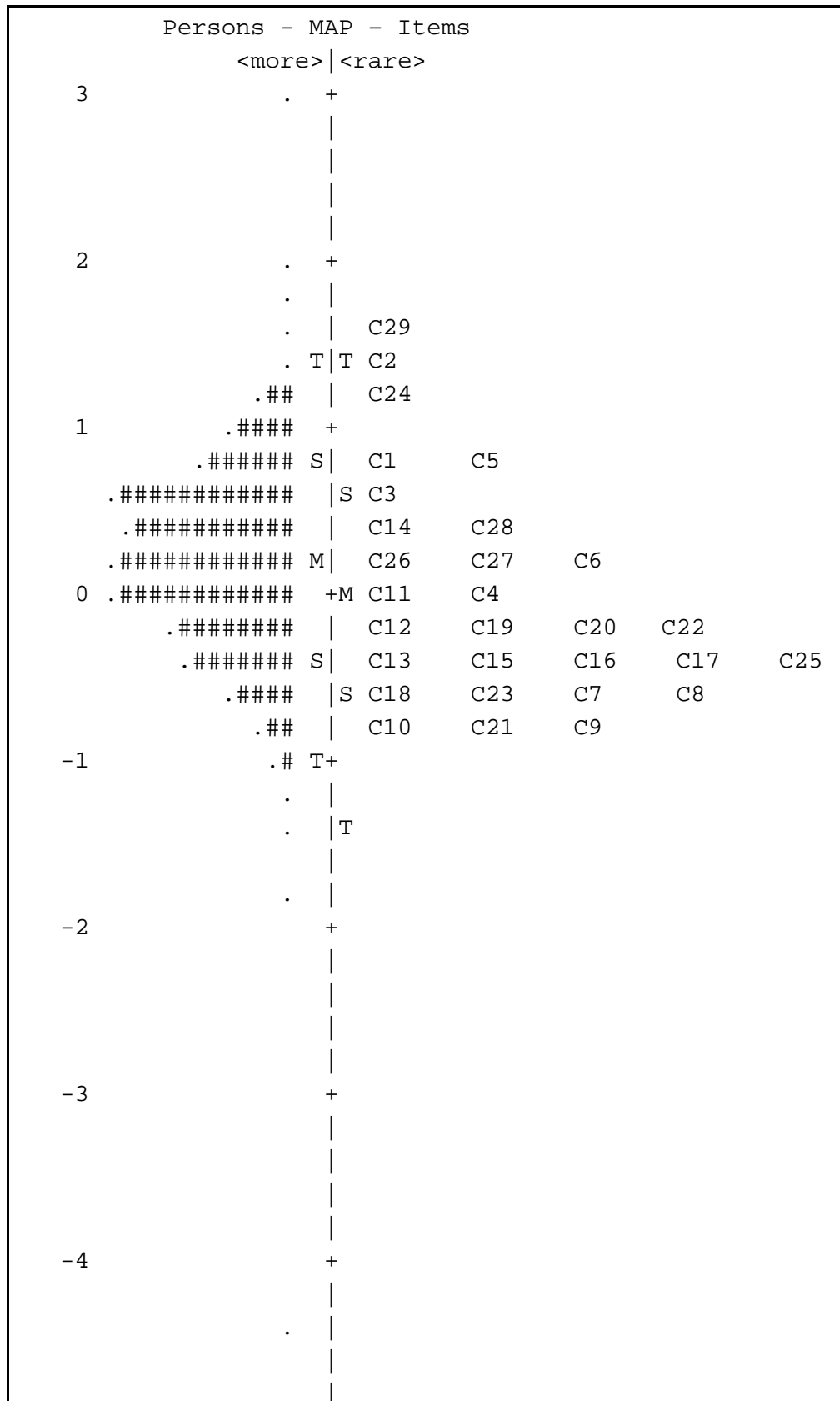
Rank	Measure	Infit MNSQ	Outfit MNSQ	Item	Description
1	-0,79	0,95	0,92	C10	making computer games, storing music
2	-0,76	0,98	0,98	C21	planning a journey
3	-0,73	0,97	0,97	C9	being productive in doing tasks in a job

4	-0,68	0,95	0,95	C8	level of development of community
5	-0,62	1,03	1,02	C18	recreation, physical exercise, sport
6	-0,61	1,17	1,12	C23	construction and engineering (boys)
7	-0,57	0,96	0,95	C7	health matters (state of health of a person)
8	-0,48	0,99	0,98	C17	managing personal and business finances
9	-0,45	0,94	0,94	C16	sending and receiving electronic messages
10	-0,45	1,1	1,12	C25	the latest designer clothes (girls)
11	-0,41	1,04	1,04	C15	dancing such as rave, disco and hip-hop
12	-0,38	1,01	0,99	C13	all kinds of pop music
13	-0,27	0,93	0,95	C20	spread and decline of epidemics (such as AIDS)
14	-0,24	0,91	0,9	C19	responding to emergencies and disasters
15	-0,2	0,95	0,94	C12	determining the origin and age of the universe
16	-0,17	0,97	0,98	C22	crime fighting, warfare, military matters
17	-0,06	0,95	0,95	C11	environmental issues and climate change
18	0,09	1,05	1,06	C4	secret codes such as PIN numbers
19	0,1	1,08	1,15	C26	construction and engineering (girls)
20	0,13	1,03	1,03	C6	government financial matters (such as taxes)
21	0,25	1,09	1,13	C27	cultural products (country girls)
22	0,41	1,1	1,19	C28	agricultural matters (country students)
23	0,48	0,97	0,96	C14	national and international politics
24	0,55	1,13	1,19	C3	the latest designer clothes (boys)
25	0,84	1,12	1,13	C1	lotteries and gambling
26	0,88	1,01	1,02	C5	agricultural matters (city boys)
27	1,14	1,09	1,06	C24	cultural products (city girls)
28	1,47	0,97	0,99	C2	cultural products (boys)
29	1,52	1,05	1,07	C29	agricultural matters (city girls)
MEAN	0	1,02	1,02		
S.D.	0,66	0,07	0,08		

### Variable map

Another element to check the instruments' functioning is the variable map, which verifies if there are gaps between the different items. The variable map (fig. 2) presents persons on the left, and items on the right, ordered along the latent trait. Persons located on the same line with an item have a 50% chance of endorsing it; they have a more than 50% chance for

endorsing items with a lower measure and less than 50% chance for endorsing items with a higher measure. From the map (fig. 2) it can be seen that the items are spread and they cover the sections of the latent variable, and there are no gaps harming the working of the instrument.



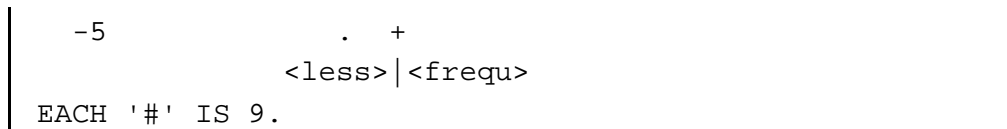


Figure 2. Variable map

The broader variable map with 4 columns was also checked, and further insured the working of the instrument. The most preferred items are located in the lower end of the map, C10, C21, C9, and the least preferred at the top C29, C2, and C24.

### Reliability

The reliability coefficient tells about the sample functioning. Both measures of reliability were high for the sample of 802 students in this study: person reliability was 0.81, which means that it is enough to distinguish between students of different levels of preferences, and item reliability was 0.99. There is no need thus, according to Rasch analysis, to make decisions about using a bigger sample of students or a larger number of items.

### Items' hierarchy

In Table 5 items are ordered from the most to the least preferred based on calculations according to the Rasch rating scale model. The 4 items chosen as most preferred by students were: C10 'making computer games and storing music and videos on CD's and I-pods'; C21 'planning a journey', C9 'being productive with the doing of tasks in a job', and C8 'determining the level of development regarding employment, education and poverty of my community'. The 4 least preferred items were C29 'agricultural matters (City Girls)', C2 'cultural products such as handmade carpets' as a male item, C24 'cultural products (City girls)', and C5 'agricultural matters (City boys)'. These were followed closely by C1 'lotteries and gambling'.

This hierarchy allows seeing differences in preferences according to gender and school location. The context of 'construction and engineering' was more preferred by boys than girls, and the item was ordered as 6<sup>th</sup> and 19<sup>th</sup> respectively. 'The latest designer clothes' are a matter of more interest for girls, who ordered it 10<sup>th</sup>, than boys, who ordered it 24<sup>th</sup>. 'Cultural products' was an item separated twice, where girls from the rural schools ordered it 21<sup>st</sup>, girls from the urban schools ordered it 27<sup>th</sup>, and boys in the urban schools ordered it 28<sup>th</sup>. Rural school students ordered 'agricultural matters' 22<sup>nd</sup> and liked it better than urban school students. There was a difference in gender between girls and boys in the urban schools, where boys ranked the item 26<sup>th</sup> while girls 29<sup>th</sup>.

### Discussion

The first two subsections discuss two important matters when using a Rasch method: first, how the latent trait functions, what is the expected hierarchy's connection to the hierarchy of students' preferences obtained from data analysis; second, differences on preferences for contexts according to gender and school location. The third subsection discusses students' motives for preferences using Bourdieu's concepts of habitus, field and capital.

### Latent trait's functioning

One important tool in Rasch rating scale methods to analyze the validity of the construct underlying the instrument being used is a comparison between an expected hierarchy that is *a priori* hypothesized (see table 1), and the results forthcoming from the empirical data collected through the administration of the instrument. The expected hierarchy was devised in

terms of areas of preference for the contexts presented by the questionnaire. Looking at the current hierarchy, most preferred items chosen by students are in line with the expected hierarchy. The items that are easy to endorse are those items that relate to students' affiliation with modern technologies, such as C10 'making computer games, saving music on CD-s, iPods etc.', the ones linked to students' idea of a safe economic future and upward movement such as C9 'being productive in doing tasks in a job', C17 'managing business and personal financial affairs' without neglecting entertainment such as C18 'recreation, physical exercise, sport activities'. Thus the latent variable in the less difficult to endorse area is expressed as a combination of items about computers, development, health matters, sports and recreations and journeys.

From the item C8, ranked 4<sup>th</sup>, it can be observed that part of students' personal advancement in life is connected to the development of their community. Other community or more global topics, such as environment, fighting epidemics and fighting crimes, are on another level of preference that could be middle range preferences, as in the expected hierarchy. It requires more from the latent variable to arrive at this level of preference. The item C8 is 'measuring the level of development of my community regarding employment, education and poverty' which connects this item to students' future lives. In the interviews with students, especially with 10<sup>th</sup> grade students, one of the topics that emerged was their future, their choices of subjects for university studies and careers. Other community matters are not connected directly to students' personal interests, or they are not perceived as very close to students. But their relevance can be connected to what students themselves call 'enlarging their horizons', meaning enlarging or expanding their knowledge about things around them and not only those of direct interest. The axis underlying the latent variable as seen from students' answers is the relevance they give to the contexts as connected to their personal and future professional interests, as well as to their actual preferred activities. This way of reasoning is revealed from the questionnaire and it is supported by interviews with students.

The zone of low preferred contexts also, or difficult to endorse items, fits the expected hierarchy. If one lives in a country where the primary concern of a family is employment and income to support the family, then issues such as 'government financial matters' (C6) or 'national and international politics' (C14) are not perceived as very important. In the same group of preferences are items such as 'cultural products' (C2), 'agricultural matters' (C5), and 'lotteries and gambling' (C1) which in the actual stage of development cannot be considered as profitable activities, and especially children do not consider the possibility of their use in any way in the future.

### **Differences between boys and girls and between rural and urban school students**

As discussed above, there were 6 items which showed significant DIF effects and made it necessary to separate them into items for girls and items for boys, and also items for rural and city school students. The analysis was therefore performed with 29 items. All the other items were functioning the same way for all the groups in the study.

There were ranking differences (0.71 logits) between boys and girls on 'construction and engineering', respectively 6<sup>th</sup> and 19<sup>th</sup>, and in 'the latest designer clothes' ordered as 24<sup>th</sup> and 10<sup>th</sup> respectively (1 logit). 'Cultural products' also were easier for girls, but there is a difference of more than 1 logit between girls in the urban and rural schools also. The item remains in the low preference zone, ranked 21<sup>st</sup> for country girls, 27<sup>th</sup> for city girls, and 28<sup>th</sup> for boys. Further differences were found on preferences for 'agricultural matters' where the item was 22<sup>nd</sup> for country students, and differs with more than 1 logit with the other students. This item showed differences (0.64 logits) between city boys (26<sup>th</sup>) and city girls (29<sup>th</sup>). Gender differences in preferences for real-life contexts that can be used in mathematics were



exposed mostly in relation to the expected gender roles, i.e. the activities connected to those items are considered as male or female activities in Albanian reality.

The Trends in Mathematics and Science Study (TIMSS) (Mullis et al. 2008) revealed that a bigger proportion of males plan to study engineering and computer and information science with a biggest proportion of girls choosing to study health science and social science. A study by Ceci and Williams (2010) reports on a meta-analysis of studies discussing gender differences in youth career choices. The study showed that adolescent girls clearly prefer to be medical doctors, veterinarians, biologists, psychologists or lawyers versus engineers or physicists. Similar results were obtained by Kaiser-Messmer (1993) as cited earlier. Thus the gender difference expressed in the 'construction and engineering' item is on line with the other international trends. In Albania there are many more male students in different engineering faculties than females.

Cultural products in Albania are usually carpets worked on a loom, handmade embroideries, knitting, etc., all made by women. One of the boys of 10<sup>th</sup> grade in a city upper secondary school answered: "These are things women deal with, not men". The same thing is true about 'the latest design clothes' where girls tend to pay more attention to clothes and fashion than boys. Over the last 20 years in Albania one of the work sources for women has been in factories sewing clothes for export to the Western countries. Men are employed in these factories mostly as mechanics for maintenance of the machinery.

'Agricultural matters' were placed higher in rural school students' list of preferences compared to students from the city schools. This is understandable if one knows that the main source of living and work for many Albanian families in the rural areas is agriculture. There is, on the other hand, a view that agriculture is not a very profitable activity in economic and also not esteemed in social terms.

There were no other items that showed significant DIF effect. Based on DIF measures boys find were slightly more likely to express an interest in secret codes, sending and receiving messages, government financial matters, managing finances, politics, and crime fighting and military matters. Girls on the other were slightly more likely to express an interest in social and human issues, such as the level of development of the community, health matters, being productive in a job, environment, music, responding to emergencies, epidemics and planning journeys. This seems to fit with the results mentioned by Mullis et al. (2008) in gender differences. But it has to be kept in mind that the differences shown in this paragraph are not significant according to Rasch analysis.

### **Students' motives for preferences**

When students were asked to provide some motives for their preferences for real-life situations to be used in mathematics, two fields were mostly mentioned: the field of higher education and that of future occupation. Students often discussed their preferences in connection with their future, as the girl L explained:

L: Of course I do (*connect everything to my future*), because we must work since it is very difficult nowadays to assure our future. When I think of a lot of students finishing university and having difficulties in finding jobs, it's normal that the future becomes important for me. Because you need to assure your life, then your family's life, you will have a role in your life, you won't be a parasite that does only harm to society (girl, grade 8).

The girl expresses her concern for the future, the importance of having a job for a safe life, and being a responsible citizen. Another girl (A, grade 10) argued like:

A: Last year we were talking about what my older sister should study at university, so I started thinking about my future as well. What kind of studies would be best for me that would help me have a good future, have a good job? And also what economic possibilities do my parents have to help me in that. Why? Because I would have liked for example to follow my studies in England, but my parents can't afford that.

She tells of the importance of a stable economic situation for her future, and sees it as connected to higher education followed by a good job position, a trend which is found in many other interviews. The girl explains the rules of the field (or the 'game') where in order to achieve in life with a good occupation, one has to do well at school. Two kinds of capital that influence her dispositions, and decisions, are important here: the economic capital her family possesses, but also cultural capital as expressed in her parent's wish to see their daughter successful and in safe economic conditions in the future by choosing an appropriate higher education. One expression of this is the question the girl asked "What kind of studies would be best for me that would help me have a good future, have a good job? And what kind of economic possibilities do my parents have to help me in that?" instead of just "What would I like to study in the future". In shaping her experiences and dispositions, her family and the capital they possess influence the possibilities she can consider for her future: "I would have liked for example to follow my studies in England, but my parents can't afford that". Such examples of dispositions toward a safe future are found in other interviews also: "I wanted to be a lawyer in the future, but there are too many of them now, I must find something else...in order to be able to find a job in the future" (L, boy, grade 8). As Bourdieu (1977) indicated, habitus shapes what one perceives as possibilities. In the boy's case, the the legal profession is seen as an occupational field he would like to work in the future. But it seems that he is aware of the difficulties of the field also: many 'players', or lawyers, competing for the stakes of the field, such as ensuring a job in it. Since this does not fit with his idea for a safe future, then he does not think of this as a good possibility for him anymore.

There are other studies about Albanian students that also indicate a general trend of seeing a good and stable future as connected closely to higher education (World Bank 2005). Thus it can be said that being educated is considered as capital which can ensure a higher status and income in life, or economic, cultural, symbolic, and social capital. One element that further supports the above statement is students' dispositions to dislike real-life situations connected to activities that bring about different or opposite effects. Activities presented in the items about agricultural matters, lotteries and gambling, and cultural products are perceived as having low or even negative profit both in income and societal status. During interviews students talked about farming as hard and tedious work, giving a low status and being prejudiced in society. One girl interviewed (G, grade 8) explained this latter tendency of the Albanian society as influencing her dispositions, and her habitus as a result, in the context of farming:

G: [*Agriculture*] it is not for girls, I won't deal with it when I grow up. I don't even think I will ever need it...It is lowest in income, lowest [*status*] for example in the city those who deal with agriculture are called 'yokels' ('hicks').

The item was easier to endorse for country students, and for city boys as compared to city girls. It can be surmised that agriculture is nearer to students from the country schools as something they see or even do themselves in their families. It fits also with the gender role expectations in Albanian reality.

The fit with gender roles, influencing students' habitus, showed in lotteries and gambling, and cultural handmade products also:

A: ... girls for example they don't have any problem with lotteries since they don't...during their life they won't have the possibility to deal with lotteries and gambling (boy, grade 8).

B: Hmm, I do not use those [*lotteries*] myself...(chuckle) I am not one of them...those are more used by boys (girl, grade 10).

L: I don't like to work with cultural handmade products because it is not...it doesn't offer you many possibilities (girl, grade 8).

E: I am not so much interested upon those [*cultural handmade products*]. They don't seem...Women at home deal with these (boy, grade 10).

In students' words, females' improbability for dealing with lotteries is seen as a taken for granted rule of the 'game' or of the field. Students explained their dispositions, as part of their habitus, for not wanting to learn about lotteries and gambling by bringing examples of their own experience, or more often their friends', families' and neighbors' negative experiences. Gambling was seen as negative because it could damage economic capital, but also social capital or the relationships one has with friends and family: "They lose their time, their money which is important for them, and maybe they lose their friendship as well, because they don't accept people like that" (E, boy, grade 10). As for the cultural products, besides the gender issue expressed by E above, the girl L points to the activity as not providing possibilities for her, in terms of economic and cultural capital.

In the middle range preferred real-life situations are issues about emergencies and disasters, epidemics, crime fighting, environment, and governmental issues which do not belong to students' immediate experience. During an interview, an 8<sup>th</sup> grade girl, G, mentioned the "spread and decline of epidemics" as relevant. She referred to it as something she did not have information about at first, therefore not that important to her. But then in her biology textbook she learned that "AIDS is a sickness that risks all. It is also connected to our school lessons, for example in biology textbook we had a lesson about it, about the HIV virus which is worrying". This is an example of how students can possibly be influenced in their dispositions, and habitus, by discussing important topics at school in connection with different subjects. During interviews some students related the items of the questionnaire with national or international examples such as the volcano in Iceland in 2010 as a disaster that could be calculated in terms of damages it caused, or the flooding that happened in Albania in 2010 as a result of excessive rain.

## Conclusions

In general it can be said that there is an image that students reveal about the field of mathematics education, and education in general, in secondary school. This image fits with that of a field where they obtain useful knowledge to help them gain more cultural and social capital, to ensure economic capital and a good position in a future field of occupation, and a good position in society. Towards such topics, students display positive dispositions. Other topics that are perceived as not leading to the same direction, obtain low interest or even resistance to be learned.

Preferred topics such as mobile communication or development indexes can be used in teaching, as topics that carry mathematical treatment and possible critical engagement. As discussed in Kacerja (2011), other important matters to be taken into account, and that can influence students' preferences in such lessons, are the difficulty of mathematics, the complexity of the calculations, and the amount of new information brought.

For the contexts that are preferred the least it is still possible to find some stimuli in order to make them likable for the students. Here the idea is that not only the most preferred contexts could be used in mathematics, the other less preferred could be used as well, but in a cautious way. One characteristic of habitus is that it reveals certain outcomes only in certain conditions related to certain structures, which means that the same habitus can give different results depending on the stimuli it finds (Bourdieu & Wacquant 2002). Being aware of the reasons why some contexts are not preferred can help in finding a possible way to find the right stimuli for students so that habitus can produce the desired results. This could help all the actors in the process: textbook writers, curriculum makers, teachers, and test formulators etc. Emphasis in this matter is also supported by the work done on the topic of interest as an important component of students' motivation in learning (Krapp 2002a; Krapp 2002b; Schiefele 1991; Renninger et al. 2002; Hidi 1990). One of the less preferred item for example, C1 'lotteries and gambling', could be introduced in a way that emphasises the remote chance of winning with gambling. This was tried in another part of the Albanian study where slight differences were noticed in students' reactions toward the context since they focused more on learning a lesson for life from their mathematics lesson (Kacerja 2011). Some of the topics could also be used in integrated ways between some of the teachers, for example recreation and sports could be introduced by a collaboration of the teachers of mathematics and those of physical education so that each expert could contribute to it, and students could experience the use of mathematics.

As it looks from the results of this study, it is easier to talk to students about the mathematics of computers or other topics that are highly preferred, actual matters, with which students deal every day. For other matters that Albanian students perceive as less relevant, such as environmental matters or government finances, in order to interest students about their mathematics, some more work is necessary. In the case of environmental matters for example, to make it relevant, one could first raise students' awareness by using local examples to make present the issue as socially vital as it really is, and to bring it closer to students' experiences. Students themselves were able to discuss about local examples to illustrate some of the contexts during interviews. As discussed in the introduction, consistent with the recommendations of other researchers on the use of real-life contexts in mathematics lessons, it is important that lessons or tasks give students the opportunity for being involved in critical discussions about the matters at hand. This is even more important given the role of education in Albania as capital for students towards occupation and future life.

The gender and school location differences exposed by the study presented here draw attention toward potential misunderstanding or biases when using real-life situations in mathematics teaching. Deeper insights about this matter are found from interviews with students to realise the motives behind their thinking in this direction (Kacerja 2009; 2011). Understanding the local context, that of the school and the community, and its influence on students' reasoning and behaviour helps in formulating appropriate tasks or lessons using real-life situations in mathematics.

Ernest (2003) discussed the importance of a balanced curriculum in terms of students' interests, mathematics educators' evaluations of content, and the state's requirements for certifications in order for students to understand the relevance of mathematical activities. The work presented in this paper can be seen as concentrated upon one of the stakeholders of the learning process, and it has the aim of assessing students' interests on real-life situations to use in mathematics. As Ernest (2003) suggests, there is the need for an active participation by all the stakeholders in order to achieve a balanced curriculum. This means that with the current study it is not in any way assumed that students' interests alone should be taken into account when discussing curriculum.

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# Albanian students' motives for preferring certain real-life situations for learning mathematics

**Author:**Suela Kacerja<sup>1,2</sup>**Affiliations:**<sup>1</sup>Department of Mathematical Sciences, University of Agder, Norway<sup>2</sup>Department of Mathematics, University Luigj Gurakuqi, Albania**Correspondence to:**

Suela Kacerja

**Email:**

skacerja@yahoo.com

**Postal address:**

St Olavs vei, 41-43, 4631 Kristiansand, Norway

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This article reports on a qualitative investigation of Albanian students' motives for preferring certain real-life situations to be used in school mathematics, and possible connections of these motives to characteristics and issues within Albanian society. It is based on realistic interviews with students from Grades 8 and 9 in a school in the district of Shkodra in northern Albania. Interviews were conducted after students experienced five teaching units which dealt with mathematics embedded in real-life situations. Results are expressed in terms of context-mechanism-outcome configurations as proposed by critical realist theory. Most of the results are supported by those from a previous quantitative study which found that students prefer real-life situations which deal with computer games, being productive in a job, community development, and recreation, physical exercise and sport. An important mechanism uncovered in this study was the role of the mathematics that the topic introduced; degree of difficulty of the mathematics influenced the choice of preferred contexts by students. Preferences expressed by students are therefore to be considered with care.

## Introduction

Inclusion of real-life situations in school mathematics textbooks and other teaching materials is discussed the world over (e.g. Department of Basic Education, 2010; Encyclopaedia Britannica, 2011; Julie, Holtman & Mbekwa, 2011; National Mathematics Advisory Panel, 2008; Organisation for Economic Co-operation and Development, 2006; Qualifications and Curriculum Authority, 2007). Similar trends are emerging in the Albanian school mathematics curriculum, where importance is placed on the need for students to recognise and use mathematical concepts in everyday life and in other school subjects (Institute of Curricula and Training, 2008). The concepts of numeracy is introduced as 'the group of mathematical concepts and skills that serve an individual in everyday life, at home, in his workplace, in community' (Institute of Curricula and Standards, 2006, p. 2). Teachers are encouraged to bring examples from other school subjects into their mathematics teaching (Institute of Curricula and Training, 2007).

These latest changes in the Albanian school mathematics curriculum should be reflected in mathematics textbooks and other teaching materials, and by the teachers who are expected to introduce these changes to students in the classroom. However, during selection of the real-life situations to use in teaching mathematics, students' opinions are not usually taken into account.

It is important that students' voices are heard, yet there are virtually no research studies on students' preferences in terms of the real-life situations to be used in mathematics (Julie & Mbekwa, 2005). There are indeed a few studies that include results about students' preferences for real-life situations as secondary ones. One study is presented by Kaiser-Messmer (1993) on gender differences in school mathematics in Germany, and one part of it deal with students' preferences for different contexts. She not only found differences in preferences according to gender but also according to grade and level of course taken in upper secondary schools. In general girls were more inclined toward social topics and boys toward sports and technology.

Other studies on contexts in school mathematics deal with matters such as the effects of realistic contexts on learning (Boaler, 1994; Cooper, 1998; Meaney, 2007) and assessment (Van den Heuvel-Panhuizen, 2005), and how teachers use or choose contexts in teaching (Chapman, 2006; Pierce & Stacey, 2006).

## Background of the study and research questions

The study presented is part of a multi-country project, Relevance of School Mathematics Education (ROSME), and is focused on Grade 8–10 Albanian students' preferences of real-life situations to be used in mathematics. The target students in Albania are 13–15 years old. The ROSME project (Julie, 2007; Julie & Holtman, 2008; Julie et al., 2011; Julie & Mbekwa, 2005) aims to ascertain which



real-life situations students in Grades 8–10 are interested in dealing with in mathematics. A pragmatic outcome of the project will be research-based information on real-life situations that students find attractive for learning resources, which curriculum developers and other interested parties dealing with development of meaningful mathematical activities for students will be able to use. However, it does not hold that mathematical activities should only be driven by students' interests.

Quantitative results of the ROSME project in Albania were reported in Kacerja, Julie and Hadjerrouit (2010), where a hierarchy of students' preferences for real-life situations in mathematics was obtained. In that earlier stage 24 interviews were held with students, referred to here as the 'first interviews', to ascertain their motives for preferences. Results discussed in this article are from a second stage of the study that was informed by earlier results. In this stage the students participated in lessons with various real-life contexts before being interviewed. Students' motives for preferences are explained using the realist research paradigm. The current study sought to answer the following research questions:

1. What are students' motives for preferring certain real-life situations for learning mathematics?
2. How, if at all, are these motives connected to contemporary issues in Albanian society?

## Theoretical foundations

This research is situated within a non-naïve, realist paradigm. This is different from naïve realism, in which a one-to-one relationship of reality and our description of it are assumed (Pring, 2004). The main reason for choosing this paradigm was the belief that reality, that is, that students' preferences for contexts exist, and thus an objectivist ontology is accepted. This reality is separated from our knowledge of it and is obtained through human cognition, so is subjective (Au, 2007).

In a realist paradigm a theory is given by the equation  $outcomes = mechanism + contexts$ , which mean that:

'outcomes' (are realised) only in so far as they introduce the appropriate ideas and opportunities ('mechanisms') to groups in the appropriate social and cultural conditions ('contexts').

(Pawson & Tilley, 1997, p. 57)

In this study students were taught five mathematics units dealing with real-life situations. The outcomes were students' preferences as assessed through interviews, and the underlying mechanisms were students' motives for their preferences. Referring to Pawson and Tilley (1997, p. 66), to identify mechanisms in our study is to develop propositions about what it is in the mathematics lessons with real-life situations that drives students to have a positive, negative or neutral opinion about them. Finding the mechanism, that is itself 'a theory which spells out the potential of human resources and reasoning' (Pawson & Tilley, 1997, p. 68), is to put together individual reasoning (choices) and collective resources (capacity).

The starting point in finding a configuration of context-mechanism-outcome and testing and refining it is to conjecture about what might work, for whom and in which contexts, which is tested during data collection. Students were asked directly about reasons for their preferences, but we cannot pretend that they are totally aware of the bigger picture; it is required of the researcher to conjecture about students' reasoning in a wider and more complete context.

Students included in the study were members of Albanian society, members of various families, studying at a certain school, belonging to certain groups and therefore having their own habitus (Bourdieu, 1977) or history that shapes how they see the present and the future, which makes them perceive opportunities in specific ways. Hence one should also take into account the context in which the units are introduced, not just the physical context but also the social norms, values and rules embraced by inhabitants of that physical location, since a mechanism can be activated or deactivated depending to a high degree on the context (Pawson & Tilley, 1997). In considering students' motives for their preferences it was therefore important to refer to the Albanian social environment where their habitus were shaped.

## Research design

### Research approach

The study presented used realistic interviews to gather data in order to answer the research questions. These interviews followed the experiences the students had with five teaching units of mathematics in real-life situations.

### Data collection and participants

**The teaching units:** The students participated in five units of mathematics embedded in real-life situations. In each of the units students learned about one real-life situation whilst using mathematics; this varied from application of known mathematics to relatively new mathematical knowledge for the students. Five contexts were selected for the units: development indexes, lotteries and gambling, sport tournaments, secret codes and sending SMSs. These were chosen from different positions in the hierarchy of preferences that arose from the quantitative data analysis in 2008, from highly preferred to moderately preferred and least preferred items (Kacerja et al., 2010).

The most preferred item of the questionnaire was 'Determining the level of development regarding employment, education and poverty of my community', and this was the realistic situation for one of the lessons. In this lesson information from the Human Development Index (HDI) used by the United Nations Development Programme (2009) to measure the degree of development of countries of the world was introduced to students. They learned how the HDI for each country is constructed, calculated Albania's HDI, and their homework was to collect data in their neighbourhood to calculate a simpler development index for



the area they live in and to discuss it. The main mathematics concept here was the construction of a social index, which is normally embedded in econometrics and was in a sense new mathematics to them.

One of the lesser preferred situations, ordered as 21st amongst 23 items in the 2010 questionnaire (Kacerja et al., 2010), was 'lotteries and gambling'. During the first interviews (Kacerja, 2009) students referred to the negative material and social consequences of gambling. Therefore one part of the lesson included a discussion of the following quote by Einstein: 'You cannot beat a roulette table unless you steal money from it', after doing the mathematics and calculating different probabilities.

One of the moderately highly preferred topics contextualised was about sport tournaments as part of the item 'recreation, physical exercise, sport activities and competitions', ranked 9th. The lesson brought to the fore elements that had to do with the number of teams and matches in a single-elimination tournament in sports such as basketball or football. The mathematics dealt with powers of a number and multiples, which they already knew from school mathematics, and geometric sequences, which were new to them.

One of the medium-preferred items was 'secret codes such as PIN numbers', ranked 14th on the questionnaire. A lesson on secret codes and algebra was adapted from a chapter of the Consortium for Mathematics and its Applications 1998 book *Modeling our world: Course 1*. Students learned how to code a phrase by shifting letters or numbers, and how to decode a message coded by someone else. Elements of cryptography were employed. Students used different linear functions that were not totally new to them.

One of the highly preferred items, 'sending and receiving electronic messages' (ranked 6th) was used for one topic about cell phone messages. Students learned the route traversed by an SMS as it moves from one mobile phone to another, the time taken for the call to be serviced, and the waiting time in a queue. The information students received from this lesson was new to most of them. The mathematics included some simple elements of queuing theory.

### Participants and procedures

A lower secondary city school was selected for data collection on the basis of the school principal's willingness for collaboration after being contacted and having the study, its aims, the way the data would be collected and materials to be used for this purpose explained. The school was selected for convenience, and does not have a reputation for being the highest or lowest quality school in the city of Shkodra.

The mathematics teacher who collaborated with the researcher was asked to form a class with 22 students from Grades 8 and 9, from amongst those who volunteered to participate. Students were selected to ensure a gender balance and a mixed-abilities group in terms of their mathematical skills, so that the group would be as diverse as possible.

In order not to interfere with normal school lesson plans, the five teaching units were conducted after normal school hours as extra lessons for students. Each of the five teaching units lasted 45 minutes. The researcher was also the teacher of the lessons. The routine followed in every lesson was similar to that which the students were used to at school: the topic and some information about it were introduced, then the different sections or exercises were completed. Some of the exercises were solved jointly on the blackboard, some individually in the classroom, and others were given as homework.

After the five teaching sessions students were asked to volunteer to be interviewed. Eighteen students volunteered and eight of these were selected to be interviewed. The gender balance was again a factor for selection, together with different degrees of students' engagement during the lessons. Students were interviewed individually at their school by the researcher for not more than 30 minutes. The procedure employed in each interview was the same: students were asked to place the five lessons in decreasing order of preference and to state the reasons for liking or disliking each of them.

### Ethical considerations

Since no ethical guidelines exist for research in Albania, both the school principal and the teacher were present when the project was explained to students and they were invited to volunteer to participate. All students who volunteered to participate signed a declaration that they understood the project and what was required of them, and they also informed their parents. In the excerpts from interviews below the initials used are pseudonyms to ensure students' anonymity.

### Research method

#### Realistic interviews

Realistic interviews seek to answer as to what works for whom in which circumstances (Pawson, 1996). Realistic interviews are in line with the realist paradigm that guides the study. The researcher already had an initial theory or conjecture about the matter at hand, from previous stages of the study, in terms of initial mechanisms and contexts. The strategy followed was therefore theory-driven: 'The researcher's theory is the subject matter of the interview, and the subject (stakeholder) is there to confirm, to falsify and, above all, to refine that theory' (Pawson & Tilley, 1997, p. 155).

The aim was to assess Albanian students' opinions of the five mathematics units which they were taught, and to establish the motives that guided their choices. Interviews were conducted in Albanian.

A realistic interview starts with the researcher's theory and goes through four stages that can be repeated in a cyclical way. The first two stages have to do with a 'teacher-learner function'. Here the interviewer's active role is to inform



or teach the interviewee the conceptual structure of the interview, its purposes and meanings, in order to have a common understanding. By doing so the interviewee will understand the nature of the information being sought, and why it is sought (Pawson, 1996). In the introduction the researcher declared the object of the interview and explained its general aim as follows:

I would like to know about the activities we did together, what are your interests, how did you like those, why do you like something and not something else. The idea in this interview is that I want to know from you why you like some ... i.e. what interests do you have to learn the mathematics that is used in some fields, that is applied in these fields, and why do you like it, or what are the fields you like more, why do you like those, what do you connect those with.

The two main concepts of the study, students' interest in real-life contexts in mathematics lessons and the reasons for their preferences, were introduced to the interviewee. It was emphasised that it was the students' opinions that were being requested.

Using the five units as a common basis for interviewing contributed towards mutual understanding, gave students some examples to think about, and made it possible to move from specific to more general discussions. Teaching of the conceptual structure during the first two stages continued, by stressing the significance of students' openness in declaring their liking or disliking of any or all of the lessons, offering them a conceptual structure in answering, and clarifying the interview structure:

I want to know what you really think about these, so if you don't like something you are free to say 'I don't like this because...' and you tell your reasons. If you like something you normally say it with the reasons too.

After the students ordered the five lessons from the most to the least preferred, the researcher went through each of the topics. In all of the following interview excerpts the notation R is used for the researcher, and A, B and so on for the individual students.

R: Good, let's start with 'sending SMSs', which you ordered first. Why is that?

The students then answered questions about the reasons for their preference, keeping in mind the concepts mentioned earlier by the researcher. In this instance student B responded as follows:

B: This is the topic I liked more because we use mobile phones every day and we send SMSs, but without knowing the time which we wait or the time when the SMS arrives, how it arrives. I liked it very much because ... I have learned something new about sending SMSs and I have some more knowledge than I knew [*before*] about this topic ... that's all about it. (Girl, Grade 9)

In this way the student goes from the second stage, where a conceptual structure is learned, to the third stage, where she applies this structure to her answers.

The two last stages are included under a 'concept refinement function', where the students express mechanisms, that is,

motives that drive their preferences for specific contexts, to inform the researcher's theory. The researcher applies these mechanisms to the initial conjectures and presents the finding to the students, who can then agree, disagree, or refine the theory's conceptual basis. At this stage explanations, checking and repeated questions are important elements. The following is an example of the researcher applying the student's reasoning to the theory, extracted from her previous answers, and offering it to the student to comment upon:

R: So in order for a topic to be attractive, interesting for you, should it be something you do?

B: Hmm, there are also some things that one doesn't do and which one is interested to know, but things one does in everyday life are more interesting to know compared to others.

Here the researcher was trying to clarify the role of the 'everyday use' as a mechanism in the student's preferences. The student's answer refined the researcher's understanding about the connection between everyday life situations and interest in learning the mathematics used in these situations. The interviews continued like this in a cyclical manner until the researcher had clear answers to the questions and conjectures she had.

### Reliability and validity

To ensure reliability, care was taken to formulate questions as clearly as possible for every student. Considerable time was taken during the whole study to emphasise the need for the students' input on their reasons for preferences. Anonymity of the interviews was ensured and students were informed in advance about the aims and objectives of the study. The interviewer was careful to avoid as much as possible any judgement of students' answers, and to create a feeling of confidence during the interviews. Reliability in interviews is related to ability to replicate the findings at other times, by other researchers (Kvale & Brinkmann, 2009). One thing that might put reliability at risk is that preferences can be time-bound but, as this study tries to show, preferences are influenced to a great degree by the societies in which individuals live. Thus huge changes are not to be expected in short periods such as the time needed for this study.

Referring to Pawson and Tilley (1997), in a realistic interview the question of validity is not whether the data reproduce exactly the students' beliefs, but whether they capture the relevant concepts for the researcher's theory. During interviews the students' thoughts and the researcher's interpretations were continuously validated by the researcher, whilst applying students' answers to the initial conjectures and asking repeated questions to check meaning.

### Initial mechanisms and contexts

In realistic interviews the researcher already has some initial conjectures about possible mechanisms, that is, motives, which drive students' preferences and the context in which the teaching takes place, but also the broader context of the community. The following mechanisms are based on



data collected from the first interviews with students and on the ROSME study in South Africa (Julie, 2009), and are accompanied by some contexts within Albanian society.

'Lotteries and gambling' are deemed an inappropriate real-life context to be used in mathematics because of their undesirable effects (both social and material) on people's lives. This is supported by a general negative opinion about the topic in Albanian society, which is hypothesised as a possible mechanism for low preference for use of this real-life context in mathematics.

Albanian students participating in the first interviews expressed great interest in a secure future economic situation and upward mobility in life; thus connectedness of real-life situations to their future interests is a possible mechanism for preference. Most parents want their children to achieve at school in order to have better possibilities for the future, and high school students themselves want to achieve in order to find a good job and attain a higher standard of living by studying further at university (World Bank, 2005).

Students' affiliation to and use of modern technologies for communication, such as 'sending and receiving SMSs' or for safety in transactions such as 'secret codes such as PIN numbers', is a mechanism that can make a topic interesting for them.

In the South African ROSME study a mechanism that came across was 'community matters' (Julie, 2009); that is also important in Albania, a country with a developing economy. Regarding the general context of Albanian society, there are three important aspects: transition from a 45-year-old communist totalitarian system to a market economy in 1990, with all the changes and challenges it carried; an economy where high poverty and unemployment rates predominate, especially in rural areas; and internal and external migrations (Sultana, 2006) which have changed the structure of cities and brought phenomena such as brain and skills drains.

## Findings

Interviews were audio-taped, transcribed and analysed to identify categories which would characterise mechanisms driving the students' preferences for real-life situations to be used in mathematics. These mechanisms, defined as students' motives for preferences, are now described and illustrated.

### New knowledge

In many cases students mentioned that much of the information they received whilst participating in the lessons was new to them. For example, a Grade 8 girl (G) said: 'I have learned things I didn't think I would learn [*in mathematics*]', referring to the unit about secret codes. Students valued this as something which helped them to enrich their background, as demonstrated by another Grade 9 girl (B), who asserted that: 'this [*development indexes*] is a topic that makes you have a broader horizon [*background*].' D, a Grade 8 girl, said: 'we

get more information and we have a larger background.' This mechanism was mostly mentioned in connection to other, more relevant mechanisms in order to add to the positive effect of them. Its influence will therefore be discussed below.

### Everyday use

This category includes comments that students made about familiarity with a context, such as: 'I chose sport tournaments first because I like football, but also because I know how they are organised' (L, boy, Grade 8). Everyday use of a context was also directly mentioned by B (girl, Grade 9): 'This is the topic I liked more because we use mobile phones every day and we send SMSs.'

At the same time as the everyday use of a context influenced its choice, distance from it resulted in lack of interest from the students. This was the case, for example, for a boy (L, Grade 8) who expressed his disinterest in learning mathematics used in agricultural matters since 'I don't think I will ever deal with agriculture'.

### Usefulness and relevance

Terms used by students such as 'useful', 'usable', 'valuable', 'needed', 'important', 'relevant' and so on are included in this category, which was mentioned most often during interviews. In most cases it was a good reason for guiding choice of a context:

... because sending SMSs is less *valuable* than indexes, much less valuable. (M, boy, Grade 9)

When I chose indexes before, it was ... it was more ... more *necessary* than this, lotteries. (A, boy, Grade 8)

Because it is *useful* information in general, but also on mathematics part. (D, girl, Grade 8)

The usefulness of the contexts for actual or future life is emphasised and characterised as part of this category:

Yes, I liked it [*indexes*], because they are *useful* things in life. (G, girl, Grade 8)

This topic [*lotteries*] is ... it gives you a ... it *teaches you a lesson*, so in the future one should have in mind that these are to do with fate and it's not that one can win with these. (A, boy, Grade 9)

The same student would be highly interested 'about things that have to do with my future'. Lack of perceived personal relevance of a context is a factor for according it lesser preference. This is supported by a Grade 8 girl (G), who said 'I don't like mathematics used in agriculture because it is not *relevant* for me, since I will not do agriculture in the future'.

### Personal interest in a context

This category showed more interest when students were asked about the topic of sport tournaments. Most of the boys expressed their personal interest in sports as an activity they personally do or follow closely:

... because sport is one of my favourites. (M, Grade 9)

I liked this [*sport tournaments topic*] because I like sports very much and I liked this lesson better. (A, Grade 8)



I chose first sport tournaments because I like football, but also because I know how they work (L, Grade 8).

Another Grade 9 boy (A) chose sport tournaments first and reasoned as follows:

I liked it, for example, because it gave me more knowledge about teams, how the Champions League is organised, how many matches there could be, things I didn't know ... [I liked] the way this topic is organised, since it is also an entertaining topic and sports are something I like, for these reasons ... Yes, [I have] an interest in sports.

A response from a girl, G (Grade 8) points towards a lack of personal interest in sports as a reason for not preferring the topic sport tournaments: 'I am not a sports fan, I don't like them either.'

### Perceived entertainment value

Entertainment was often mentioned during interviews, when lack or presence of entertaining elements was perceived and used to describe lessons:

Entertaining, and the lesson I enjoyed the most. (G, girl, Grade 8)

I would like [to have a topic such as sport tournaments in my mathematics textbook], because it would be an entertaining lesson. (A, boy, Grade 9)

... it's not just mathematics, it is entertaining also. (D, girl, Grade 8)

For some students the degree of entertainment overrides other aspects when choosing a preferred lesson.

### Community matters

Under this category are incorporated mainly aspects from the lesson about development indexes, where relevance of information about one's country and community is at the centre. Students' interest is clearly accompanied by their feelings of responsibility to know about their country 'because it is in everyone's interest to know more about our country and many other countries' (A, boy, Grade 8). As one girl put it, 'since we live in this country, we should know our economic percentages [meaning economic figures and indexes], how developed is our education, to know the development of the country we live in' (B, Grade 9).

However, even with its relevance this topic was not one of the most preferred, because of mathematics aspects which will be discussed further.

### Distance from gambling

Gambling was one of the most discussed topics during the first interviews (Kacerja, 2009) because of its negative effects. In the current realistic interviews students expressed distance from it as an activity that they never take part in. They gave reasons such as:

I wouldn't do it myself, and I would advise my friends not to do it. Because I have learned in this lotteries topic that the probability [to win] is very low if we gamble. (B, girl, Grade 9)

Gambling is seen as an activity that only boys can do, whilst '[girls] during their life they don't have possibilities to deal with lotteries' (A, boy, Grade 9).

### Mathematics

The effect of mathematics has to be considered, since it emerged in the interviews that it was one of the mechanisms often mentioned as influencing students' choice of contexts. The students mostly talked about the degree of difficulty and 'trickiness' of the mathematics:

Secret codes, I liked it, it was not so tiring topic ... I liked it also because mathematics was of a lower level [means easier] than the everyday [school] mathematics. (B, girl, Grade 9)

[Indexes topic] has too many calculations, and one can get lost, it's tricky and it looked to me more like a difficult mathematics lesson than entertaining like others. (A, boy, Grade 9)

I liked it a little bit [indexes] but the problem was that it was tricky [mathematics] and I put it lower than others. (L, boy, Grade 9)

As can be seen, the mathematics is the overriding issue; this relationship is a matter requiring further research.

### Context-mechanism-outcome structure of students' answers

The characteristic of all of the mechanisms presented above is that when combined with each other, their effects change: the same mechanism can produce different outcomes. For example, the everyday use of a context, modern technologies such as sending SMSs, accompanied by new information about it can give rise to disinterest (outcome O1) when it is not perceived as relevant or valuable to the students. However, everyday use of modern technologies for communication (sending SMSs), including security matters (secret codes), accompanied by new information about it when 'it is like a game' (A, girl, Grade 8), highlight its utility value and intrinsic quality. For example: '[secret codes could be used] when I don't want to say something out loud, I can talk with codes with my friends' can result in increased interest (outcome O2), enthusiasm and students' engagement in mathematical activities (outcome O3).

For all these mechanisms, the contexts that make it possible for them to induce the respective outcomes are related to students' age (13–15 years), and their knowledge of and the possibility of them using modern technologies. Even though Albania is one of the poorest countries in Europe, its figures in terms of using mobile phones are higher than averages in the European Union. PIN codes are also used extensively in mobile phones, ATM machines and so on.

When accompanied with the mathematics involved, another important mechanism, community matters, brings about two different outcomes. Community matters bringing new information are perceived as useful in education, occupations and life in general, and can lead to elevated interest (O2) in following and learning the lesson. However, when the unit is identified by students as using difficult mathematics and too many tricky calculations requiring more attention, the same



mechanisms and contexts can end up at a lowered or lost level of interest (O4). This is one of the cases of mathematics overriding context choice, as happened for this girl: '[Indexes] would have been first on my interest, but because it has many calculations I put it third' (B, Grade 9).

The greater context of Albanian reality is also an indicator and predictor of the relevance perceived by students. Issues about community matters, such as health, education, poverty and unemployment, are sensitive and perceived by students as such. Therefore following higher studies that will lead to a good and stable job in order to have a safe future is in itself a desire and objective for Albanian youngsters, as L (boy, Grade 8) states:

[In the future] I wanted to be a lawyer, but there are too many of them now, I should find another field ... If you want to find a job when you grow up, there are many [lawyers] and you don't find it.

The everyday use of sports topics associated with boys' personal interest in sports as a preferred activity in which to participate or watch, conveying new information, makes boys recognise it as a relevant and entertaining topic, which can therefore result in a higher level of interest (O2) in learning mathematics. This is not the case with girls; since sports are not of everyday use to them, their personal interest in sports is also not that developed. In the absence of these two mechanisms, girls' interest in the unit is low (O1).

At the basis of students' answers about lotteries and gambling was their positioning of themselves at a certain distance from it. Albanian students participating in both stages of the ROSME study admitted that they have either used lotteries very seldom or not at all, but that friends around them use them. This has to be understood within the larger reality of Albania, where gambling was considered a negative, illegal behaviour during the communist era (1945–1990). Nowadays lotteries and gambling are a growing industry regulated by law, the phenomenon remaining mainly a male one. Even though it is illegal for people under 21 years to gamble, school children still enter casinos or gambling establishments (Gambling pushes minors toward crime, *Gazeta Shqip*, 30 January 2009).

## Discussion and conclusion

The current study aimed to uncover students' motives for choosing their preferred real-life situations for use when learning mathematics. These motives are presented here under the label of 'mechanisms' as part of a realist paradigm. The same research question (the first one) drove an earlier, qualitative part of this study based on interviews with students in Grades 8–10 (Kacerja, 2009). In the research presented in this article, the difference is that students were interviewed after they had experienced mathematics embedded in some real-life situations that they were then asked about. The purpose of introducing this difference was to ascertain earlier found mechanisms, and to determine whether the teaching units would add further mechanisms.

The second research question was to detect and explain any connection between students' motives for preferences and societal matters in Albania. By formulating the context-mechanism-outcome structure from students' answers, an answer is provided to this question. Albanian societal matters are introduced above as contexts for the realistic theory, and their influence on students is disclosed as part of the realist equation  $outcomes = mechanism + contexts$ . Some of the views that students expressed during realistic interviews reflected some tendencies of Albanian life. This can be seen, for example, in students' distance from gambling as an activity which in the Albanian community is considered problematic and not desirable. Another tendency was expressed in students' need for a good education and work position as desired outcomes for a satisfying life. A study by the World Bank (2005) revealed that most Albanian parents want their children to achieve at school in order to have better possibilities for the future. One can therefore see the parents' ideas reflected in their children's objectives.

Further examples can be connected with students' interest in community matters as important aspects in a developing country. During interviews one student discussed the economic crisis, using the example of remittances from Albanian emigrants for their families in Albania to explain the relevance of being knowledgeable about one's country. These issues are objects of everyday discussion everywhere in Albania.

The realist approach embraced in this study made it possible to consider not only students' motives for their expressed preferences, but also to relate these motives to the context of the students' everyday life in their community. This helps to find the roots of their motives in the influences that society exercises on students. The key matter in the realistic interviews is the flow of information which, as explained earlier, allows the understanding of concepts and conjectures to be assessed by both participants in the interview (Pawson & Tilley, 1997). This openness allowed continuous checking of the meanings obtained from the conversations.

One of the confirmed motives was connected to lotteries and gambling, which, as argued above, is connected to recent developments in the Albanian context. Gambling was considered as a male activity by students, as is the case in the greater Albanian society. It was, however, noticed that during interviews students saw a possible use for the information they received from the lesson, to advise friends who deal with gambling. This result is to some degree different from those of previous questionnaires, where the topic was amongst the least preferred, and from the first interviews where only the negative aspects of gambling were highlighted. A similar finding was presented in South Africa, where the mechanism was defined as 'personal regression via irresponsibility and/or addiction' (Julie, 2009). We can speculate here that putting the teaching unit's emphasis on being able to calculate gambling's negative consequences in order to become aware of its dangers helped in making students' attitudes towards learning the mathematics related



to the topic more positive than in previous results. This issue of least preferred real-life situations, where an appropriate mathematical treatment of the context can contribute to learners engaging with it in a more informed manner, has been discussed previously (Kacerja et al., 2010).

Students' affiliation with modern technologies, a motive revealed by the first interviews, manifested itself in their everyday use of technologies and was related to the topics 'sending and receiving SMSs' and 'secret codes', ordered 6th and 14th respectively in the list of preferences (Kacerja et al., 2010). In the realistic interviews this difference is inverted. The same mechanism in the two topics generates two different results: the first topic is mentioned for its lack of relevance, whilst the second one is perceived as entertaining. This is an indicator of the relevance of integration of mechanisms and the influence of contexts.

Personal interest in an activity and perceived entertainment value are two other motives occurring in most responses during the interviews, seen as desirable qualities for a topic to be preferred. This was the case with the item 'sport tournaments', that was clearly more preferred by the boys; for girls the lack of the two motives made it uninteresting to them. However, no gender differences were found on the item 'recreation, physical exercise, sport activities and competitions', which means that the choice of a topic belonging to the same item can also make a difference. In terms of social life in Albania, for boys (especially those playing football or basketball) following national or international matches, wanting to be football players in the future and discussing sports are very usual, but it is not the same for girls.

The influence of the Albanian reality in students' preferences is also highlighted in connection with the 'community matters' mechanism, and is emphasised in the 'development indexes' topic. The relevance of the topic for their future educational and professional life, as a motive, was closely connected to this as well as to other topics. The two mechanisms find their reflection in the 'need for a safe economic future and upward movement' as a motive disclosed during the first interviews. Findings from the qualitative data are consistent with those from the quantitative data.

One mechanism displayed for the first time during this stage of the research was the issue of the mathematics introduced in the lessons. In some cases this mechanism overrode the choice of the topic, as happened with the 'development indexes'. The difficulty of mathematics, its trickiness, and the amount of calculations steered students' interest away, even with the topic's perceived relevance. However, it is impossible to find a connection between students' characteristics and lowered interest because of difficult mathematics, nor between the kind of mathematics and the degree of interest, from the data obtained. Further research is needed to explain this relationship.

Related to this latter topic, care should be taken to consider the quantity and difficulty level of new concepts (such as life expectancy, gross enrolment ratio, adult literacy index and

gross domestic product [GDP]) when introducing these to students. Apparently these notions require more time to be grasped; thus a unit like this could be extended over two or more lessons to facilitate understanding. Other units could also be extended to two lessons in order to create some space for discussions about each topic, concepts and knowledge used or gained, and generalisations. Some discussion was included in each topic as part of the unit, but it is seen that discussion is crucial to enhance critical thinking which, from personal impressions seems to be missing or at least not so developed in Albanian schools. A study by Sahlberg and Boce (2008) supports this impression, and points toward development of productive learning of the skills needed within a knowledge society. These issues and education in general are especially vital in Albania, for their contribution 'to furthering democracy, to promoting an active citizenry, as well as to creating a vibrant, skilled workforce essential to the country's competitiveness, especially in a context marked by resource scarcity' (Sultana, 2006, p. 10).

Amongst the contexts that influence the level of preference of a teaching unit described in this article, the context of the classroom environment is equally important. Students confirmed that they enjoyed the topic 'secret codes' the most, not only because it was entertaining but also because they could work together and everyone could participate. This suggests that such topics can be even more interesting if there is a classroom climate where participation, discussion and critical thinking are appreciated and fostered. Other factors of influence could be the design of the lesson, the way it is taught and the relationship created between teacher and students, as in every other lesson. It must be emphasised that the focus of this study was the real-life situations and students' perception of these.

Questions of generalisation relate to discussion of results as being time-bound, as mentioned in the section on reliability. Kvale and Brinkmann (2009, p. 265) argue that 'analytical generalisation may be drawn from an interview investigation regardless of sampling and mode of analysis'. It requires detailed descriptions and arguments about the transferability of results to other subjects and situations. In this study the findings can be generalised at a local level, namely in terms of Albanian students. This can be said since, as discussed above, some issues, values and norms in Albanian community are reflected in the students' words when giving their reasons for preferring or not preferring to learn mathematics in specific contexts.

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## Competing interests

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