AN EXPLORATION OF THE EFFECTS OF HIGH-STAKES EXAMINATIONS ON THE TEACHING AND LEARNING OF MATHEMATICS IN POST-PRIMARY EDUCATION IN IRELAND AND TURKEY

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DECLARATION

This thesis is submitted by the undersigned for examination for the degree Doctor of Philosophy at the National University of Ireland, Maynooth. It has not been submitted to any other University or degree-giving institution.

This thesis is entirely my own work.

I, the undersigned, agree that National University of Ireland, Maynooth Library may lend or copy this thesis upon request.

Tugba Aysel

Date: 01/05/2012

To my supportive husband, Ahmet Taner Aysel and

my lovely twin daughters, Ece and Ege

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LIST OF ABBREVIATIONS

ASDQ	Academic Self Description Questionnaire
CAO	Central Applications Office
CBEEE	Curriculum-Based External Exit Examinations
ESRI	Economic and Social Research Institute
FSMAS	Fennema-Sherman Mathematics Attitudes Scale
GPA	Grade Point Average
HD	Higher-level Cognitive Demands (Doing Mathematics)
HL	Higher Level
HP	Higher-level Cognitive Demands (Procedures With Connections to Meaning)
IAEP	International Assessment Educational Progress
ICT	Information and Communications Technology
IP	Intermediate-level Cognitive Demands (Procedures)
LC	Leaving Certificate
LCD	Levels of Cognitive Demands
LM	Lower-level Cognitive Demands (Memorization)
LP	Lower-level Cognitive Demands (Procedures Without Connections to Meaning)
MEB	The Department of Education in Turkey
NCCA	National Council for Curriculum and Assessment
OECD	Organization for Economic Co-operation and Development
OL	Ordinary Level
OSS	University Students Selection And Placement Examination
OSYM	Turkish University Student Selection and Placement Examination Higher Education Council
PISA	Programme for International Students Assessment
SATs	Standard Attainment Tasks and Tests
SMOT	Students' Motivation Scale

ABSTRACT

This thesis explores the effects of the high-stakes examination systems in Ireland and Turkey on the teaching and learning of mathematics in post-primary education. The study comprised of three parts: an exploration of teachers' views on the high-stakes examinations in their countries, a comparison of students' attitudes and study methods, and a classification of examination questions from recent examination papers.

Questionnaires were developed for teachers and students and administered in ten Turkish and thirteen Irish schools; in addition, 48 teachers were interviewed. The qualitative data from the teachers' questionnaire was analyzed using Grounded Theory. The pupils' questionnaire was administered to more than 1200 students and comprised of Likert-type questions organized into several scales. The quantitative data from these questionnaires was analyzed using Rasch analysis as well as other standard statistical techniques. In the third strand of this thesis, the mathematics examination questions from Ireland and Turkey were classified according to the Levels of Cognitive Demand framework (Stein and Smith, 1998).

This study shows that Turkish students have significantly higher levels of confidence in their mathematical ability and are less anxious than their Irish counterparts. Students in both countries reported that when studying they try to understand mathematical ideas, they memorize formulae and procedures, and they practice examination questions. My study shows that practice is very important in Irish classrooms in particular, and Irish teachers seem to feel more pressure to teach to the test than their Turkish colleagues. However, many Turkish teachers felt that their examination system was responsible for a 'grind school' phenomenon. The classification of examination questions showed that most questions in Ireland and Turkey were procedural in nature; however the Turkish examinations had a higher proportion of cognitively demanding questions than the Irish examinations. The fact that the Turkish examination questions are more likely to require conceptual understanding may help to explain why Turkish teachers have a different teaching style to their Irish colleagues.

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CHAPTER 1

INTRODUCTION

1.1. Introduction

This thesis concerns a comparison of the high-stakes examination systems in Ireland and Turkey and the effects of these examinations on the learning and teaching of mathematics at second level in both countries. In this chapter, I will review the literature on high-stakes examinations, their uses in different countries, and I will discuss especially their effects on teachers and students. Then I will introduce two well-known international studies that are concerned with achievement in mathematics at second level: TIMSS and PISA. I will then describe the education systems in Turkey and Ireland. Finally, I will outline the rationale for my own study.

1.1.1.High-Stakes Examinations

Let us begin by asking the question: what are high-stakes examinations? The Economic and Social Research Institute in Ireland described 'high-stakes tests as standardized examinations, the results of which have significant consequences for schools and/or students' (Smyth, Banks and Calvert 2011, p.5). Heubert's (2000) description was very similar to that of Smyth et al. (2011), that is that high-stakes assessments are those used to make significant educational decisions about students, teachers, schools or school districts.

In this thesis, I will consider the high-stakes examinations at the end of secondary education. These examinations are often very important to students because in many countries they determine the students' future career. The examinations that this study considers are specifically the ones that determine entry to third level education. However, there are other different types of high-stakes examinations, for example, in Turkey, there is an assessment system in primary level, which determines entry to different types of second level education (MEB, 2012). In the US, the 'No Child left Behind' policy means that standardized examinations play an important role for schools to get funding and for teachers to get or keep a job (Dee and Jacob, 2011). In England, testing begins at the ages of seven, these tests are called the Standard Attainment Tasks

and Tests (SATs) (Gregory and Clarke, 2003). The purpose of the SATs is to show if students have reached the National Curriculum learning targets. School funding can be affected by the results of SATs. All of these examinations are high-stakes examinations for schools or for students.

1.1.2. Third Level Admission Processes

Bakker and Wolf (2001) noted that in developed countries there are more professional, managerial, and technical jobs than skilled manual jobs and there is often a big gap between the earnings of university-educated people and those of others. People in these countries think that higher education is essential, and therefore, university entrance examinations and tests are considered very important.

In the book entitled "Secondary School External Examination Systems" edited by Vlaardingerbroek and Taylor (2009), the examination systems of nineteen countries are outlined. Ireland and Turkey were not included in this study. In the introduction of this book, Heyneman (2009) explained why end of school examinations are necessary. He asserts that countries need to be able to choose the best students for universities, and he said, "for modern nations to prosper, they must choose, so far as possible, future leaders on the basis of their personal potential for achievement" (p. 2). Examinations are a fair way of choosing students and he added:

On the other hand, fair competition to be a leader may contradict the natural tendency for families to protect and advantage their own children and relatives. In a democracy, the public often takes an active interest in the fairness of the education system. If the public does not believe the education system to be fair, it might be said that current leaders– whether in commerce, science, military, or politics – had acquired their positions of leadership through privilege rather than achievement. If the school system can not be trusted, it may detract from a nation's sense of social cohesion, a principal ingredient of all successful modern societies. (p. 2-3)

Heyneman (2009) also discussed which types of questions are better: oral questions, essay questions or multiple-choice questions. Heyneman (2009) maintained

Essay questions and oral examinations are said to be superior to multiple-choice questions on the grounds that there is more opportunity for creative feedback, more 'data points' for observation, and more subtle means to demonstrate one's competence. When divorced from the context of their application, however, the discussion of the superiority of one testing technique over another is spurious. Both oral examinations and essay questions are more subject to subjective judgment because both are more difficult to standardize. Standardization – the ability of the test designer to create test-taking circumstances that are as nearly identical as possible – is an essential

characteristic of any selection examination considered fair. Oral examinations leave open the possibility of bribery and corruption. Both oral examinations and essay questions are more labour intensive and hence both are considerably more costly-and cost does count: the ideal test design should not come at the expense of what is economically and administratively feasible. (p. 4)

Helms (2008) studied the processes for admission to third level education in twenty-seven countries and grouped them into five categories and further sub-categories. Helms categorised Ireland as type 1, as it has a secondary leaving examination and Irish students need only a national examination score to enter a university. Turkey was categorised as being in the second type of admission system; there is a university entrance examination score and students' secondary school academic performances also taken into account. Table 1.1 is copied from Helms (2008, p.19) and shows the types of admission systems and their sub-categories.

In 2001, an edition of the journal 'Assessment in Education' was devoted to examinations and entry to university. The editors, Bakker and Wolf (2001) identified the types of assessment systems in six countries (France, Italy, Israel, The Netherlands, Slovenia, and USA and three of them have been mentioned in Table 1.1.) which determine entry to third level. They found that an examination administered by State authorities was the most common method of selecting students for university education. They say that such systems seem to be 'objective, fair, and defensible' (Bakker and Wolf, 2001, p.289). However, the editors acknowledge the 'back-wash' effect on second level education. As mentioned earlier, nowadays university diplomas are seen to play a significant role for an individual's life. So there is an increasing demand for tertiary education, and this causes competition between high status universities. Because of this, there can be a backwash effect on teaching and learning at second level education, "shaping both what is taught and how it is taught" and often changing the frame in terms of what counts as worthwhile knowledge (Conway and Sloane, 2005, p. 28).

Type 1: Secondary leaving examinations	
National examination score only	Austria, France, **Ireland**, Egypt
National examination score, plus secondary school academic performance	Tanzania
National examination score, plus application dossier	United Kingdom
Regional/state examination score, plus secondary school academic performance	Australia
Type 2: Entrance examinations	
National examination score only	China, Iran, Georgia
National examination score, plus secondary school academic performance	**Turkey**, Spain
Institutionally administered examination scores only	Argentina, Paraguay
Institutionally administered examination scores, plus secondary school academic performance	Bulgaria, Serbia
Type 3: Standardized aptitude tests	
Standardized aptitude test scores or secondary school academic performance	Sweden
Standardized aptitude test scores, plus application dossier	United States
Type 4: Multiple examinations	
National entrance examination scores, plus institutionally administered entrance examination scores	Japan, Russia, France (*Grandes Ecoles)*
National entrance examination scores, institutionally administered entrance examination scores, and/or secondary school academic performance	Brazil
National secondary leaving examination scores, plus institutionally administered entrance examination score	Finland
National secondary leaving examination scores, plus standardized aptitude test scores	Israel
Multiple examination administered by multiple entities	India
Type 5: No examination	
Secondary school academic performance	Norway, Canada
Application dossier does not require examination scores	Certain U.S. institutions

Table 1.1: The Types of Admission Systems in Different Countries

1.1.3. The Effects of High-Stakes Examinations

A number of studies have been carried out on the effects of high-stakes examinations or other examinations in different countries. In this section, I present some such studies which describe the positive and negative effects of high-stakes examinations on learning and teaching mathematics.

1.1.3.1. The Effects on Achievement

Data from the Trends in International Mathematics and Science Study (TIMSS) have been used in many research studies. (For an explanation of the TIMSS and PISA tests please see section 2 of this chapter.) For example, Phelps (2001) chose six out of the nine top-performing countries on the TIMSS eight-grade mathematics test and compared how these countries controlled their curriculum and instruction systems. In 1997, Phelps (2001) gathered data from these six countries and from The Netherlands. His questionnaire had two parts; the first part was about content standards, textbooks, students' performance standards, and international benchmarking activities. The second part consisted of questions about students' performance standards at decision points. A decision point was described as "an occasion when a student performance standard is actually applied: a judgment is made, for example, that a student achieves or does not achieve a standard and an appropriate consequence results." (Phelps, 2001, p. 397). Decision points mostly consisted of high-stakes tests. He found that most of these high-achieving countries had more than one high-stakes examination. He found that a country's performance on the TIMSS study was positively correlated with the number of decision points in their education system, and this was true even when GDP was controlled for.

Bishop (1997) studied curriculum-based external exit examinations (CBEEE). He defined CBEEE as examinations which have important consequences for students and for which students' achievement is given relative to an external standard not relative to other students' achievement in their school. In addition, CBEEE are organised by discipline, signal multiple levels of achievement in each subject (as opposed to pass-fail only) and are taken by almost all secondary school students. By these standards, the Irish Leaving Certificate (LC) examination is a CBEEE, however, the Turkish

university student selection and placement examination (OSS) is not, since it is taken only by people who wish to enter university (see section 3 and 4 of this chapter for details of the education systems in Ireland and Turkey). Bishop (1997) tried to examine the effects of CBEEE by comparing nations; he did this by looking at the TIMSS and IAEP (International Assessment Educational Progress) data. IAEP surveys the mathematics and science performance of 9- and 13-years-old students. In 1990-91, twenty countries participated in this study. The aim of this assessment was to examine the differences between countries' education systems, their curriculum, and students' achievement. Some questions are also asked about students' home background, classroom activities, and the characteristics of schools that students attended. The TIMSS study will be described in section 2 of this chapter. Bishop classified the countries in the TIMSS 1994-95 study as having CBEEE or not. He found that the countries with CBEEE had test scores significantly higher than the other countries with similar GDP but without CBEEE. Using the data from the 1990-91 IAEP study, he looked at the effects of CBEEE in Canada. At that point in time, some Canadian provinces had CBEEE in English, French, mathematics, biology, chemistry and physics while other provinces did not. Bishop (1997) found that the exit examination had large effects on achievement in mathematics and science with higher attainment levels in provinces with a CBEEE. This study also showed that parents in provinces with CBEEE were more likely to talk with their children about science and mathematics classes and the children were more likely to think that their parents wanted them to well in mathematics. Schools scheduled more science and mathematics classes, assigned more homework, had better laboratories, and used more specialist teachers because of these exit examinations. Bishop (1997) did not find any negative effects of examinations on teaching.

However, Koretz et al. (1991) found that high levels of attainment on a high-stakes test did not necessarily translate into high levels of achievement on other types of test. They studied a large urban school system in a US state with high-stakes accountability. This study showed that in mathematics that 'performance on a conventional high-stakes test does not generalize well to other tests for which students have not been specifically prepared' (Shepard, 2002, p. 54).

1.1.3.2. The Effects on Teaching and Learning

Many studies have been carried out on the effects of high-stakes examinations on the teaching of mathematics, and there is a considerable amount of evidence to suggest that these effects do exist. I will briefly review some of these studies here. Stecher (2002) presents a survey of research that considered the effects of high- stakes testing on classroom practices in the USA. The paper reported both positive and negative potential effects on teaching methods and on students. The positive potential effects on students were that high-stakes testing provides students with better information about their own knowledge and skills, motivates students to work harder in school, sends clearer signals to students about what to study, and rewards students' efforts. The negative potential effects on students were that tests may discourage them from trying, make students more competitive, and influence students not to do higher grades and school assessments (p. 86). Some of the potential effects on teachers mentioned were that tests may motivate teachers to work harder, help them to diagnose student difficulties, encourage teachers to focus more on specific test subjects rather than on curriculum standards, and guide teachers to participate in inappropriate test preparation. Stecher (2002, p. 87-88) mentioned a study (Koretz, McCaffrey and Hamilton, 2001) which identified positive, ambiguous and negative responses of teachers to high-stakes tests. Note that they categorised ambiguous responses as those that could have positive or negative effects on learning depending on the circumstances. The positive responses reported were: providing more instructional time, working harder to cover more material in a certain time, and using more effective teaching methods. The ambiguous responses of teachers to high-stakes tests were: changing the amount of time allocated to topics depending on their importance for the test, aligning instruction with standards, and coaching students to do better by focusing instruction on incidental aspects of the test. The only negative response reported was that of a teacher cheating when preparing or administering a test.

A group of researchers in the USA studied teachers' opinions of statewide testing programs (Abrams, Pedulla, Madaus, 2003). In the USA, all states have their own education systems and testing programs. This study used a survey with eight items in a nationwide study of teachers. Teachers were asked to rate their level of agreement with statements concerning their state testing programs, classroom practices, and student learning. The researchers categorized the states according to: the consequences of test results for districts, teachers and schools; and the consequences of test results for

students. There were three levels of test result implications: high, moderate and low. In this paper, the researchers made a comparison between states that had high stakes consequences for all of districts, teachers, and schools and for students, and states that had low or moderate stakes consequences for districts, schools, and teachers and low stakes consequences for students. The first category will be referred to as 'high-stakes states' here, while the second will be referred to as 'low-stakes states'. One of their results was that 43% of teachers in high-stakes states, compared to 17% of teachers in low-stakes states, indicated that they had increased the time spent on tested material a great deal because of the state examination. This was at the expense of material that was not tested. Teachers in both high-stakes (76%) and low-stakes (63%) states reported that the state tests led them to teach in ways contrary to their ideas of good practice. These teachers were likely to use old examination questions or commercially produced revision materials to prepare students for tests. Teachers in high-stake states reported that they felt under pressure from their employers (and from parents) to raise students' scores on state tests. However, 57% of teachers in high-stake states (as opposed to 37% in low-stake states) felt that these tests should be used to decide if students graduate from high school. Teachers had some bad things to say about tests but they still wanted to use them. Abrams et al. (2003) found that 35% of teachers in high-stakes states and 20% of teachers in low-stakes states strongly agreed that students were very anxious because of the state examination.

In a similar study, Shepard and Dougherty (1991) administered a questionnaire to teachers in 100 primary level schools in districts with high-stakes tests.They found that 52.6% of teachers reported that they felt great pressure from the district administration or board of education to raise test scores. Half of the teachers reported that they gave less emphasis to subjects which were not tested. 51.5% of teachers mentioned that every four or more weeks they gave students worksheets that reviewed the content they expected to be on the test. 60.4% of teachers agreed that standardized test results were helpful in identifying student strengths and weaknesses.

Shepard (2002) discusses the changes associated with high-stakes testing and writes about the testing of children in the US. These tests can have implications for students, teachers, schools, and even districts or states. Shepard (2002) said that

Many teachers would teach to the test. That was a problem if the test was narrowly structured. If the test covered of the full domain of the curriculum, then there was no great harm in teaching to the tests' content. However, there still could be a problem if

students were trained to answer only in multiple-choice format. They needed to be able write and reason using the material. (p.55)

She also mentioned that in many US states, multiple-choice questions were used because of cost issues and the fact that it was easy to administer this format of tests to everybody in every year and in more subjects.

Similarly, in the Harlen and Crick (2003) review it was mentioned that testing in the USA gives a good example of the use of short-answer questions and computational exercises so that tests could be scored quickly and objectively (Schoen et al., 1999). In Slovenia, Gabrscek (2001) studied a recently introduced examination, called the Matura, and the effects of this high-stakes examination on teaching and learning. The Matura has been administered in Slovenia since 1995. Before 1995, there was no high-stakes examination at the end of second level education and Slovenian teachers graded their students using their own examinations. The Matura was developed to use as a school-leaving examination and for entry to higher education. Some negative and positive effects of the Matura were mentioned in this study. This study is interesting since the examination was so new and the effects of introducing it could be seen, such as that it put a lot of pressure on teachers, students, and schools. Gabrscek (2001) said,

The Matura brought great changes to secondary education. Relations between teachers and students changed, they became partners in the process of education. Their common aim is to prepare well for the examination. According to the general perception not only candidates are assessed; the teachers who prepare them and the school itself are indirectly assessed too. (p. 385)

Gabrscek (2001) reports that although teachers still grade their students, they now focus more on the Matura examination. Students had to change their learning habits as they wanted to gain more knowledge in the subjects tested in the Matura. Gabrscek (2001) added that the Matura examination controls everything in schools and leaves less time for more creative work.

Au (2007) carried out some research on the effects of high-stakes examinations on curriculum. He analyzed and compared forty-nine qualitative studies. He found that more than 80% of these studies found evidence of content alignment: almost 70% showed there was a narrowing of the curriculum or curricular reduction to tested subjects while less than 30% showed expansion of subject matter taught. Approximately half of the studies reported fragmentation of knowledge in response to high-stakes testing with teachers teaching in isolated ‘test-sized pieces’ and teaching content directly related to tests rather than subject knowledge. In addition, 65% of the studies

reviewed reported an increase in the use of teacher-centred methods, involving a lecturing style of teaching and direct transmission of the test content.

Similarly, Johnston and McClune (2000) found that because of high-stakes examinations, teachers focused on syllabus content that was tested, they trained their students how to pass tests, and teachers used teaching methods that were not useful for every students' learning. Harlen and Crick (2003) and some other studies (Kohn, 2000; Koretz, 1988; Linn, 2000) found that an increase in test scores may be due to teachers' and students' greater familiarity with the tests rather than an increase in learning.
The review study by Madaus and Clarke (1999) aimed to examine the impacts of high-stakes examinations on teaching and learning of minority students in the US. They found that high-stakes tests did not contribute in a wholely positive way to teaching and learning. They contend that teachers are likely to use past examination papers to train students to pass the tests and that these past examination papers define the curriculum in effect. They also found little evidence that the high-stakes tests motivated students, in particular they report that the tests can lead to an increase in high school drop out rates, especially amongst minorities.

Johnston and McClune (2000) considered the effects of the 11+ examination in Northern Ireland. They found that teachers felt under pressure because of the test to teach in a structured way which emphasized the transmission of knowledge. However, the students surveyed had a preference for more open-ended explorations.

Dochy and McDowell (1997) reviewed some studies and they focused on a view of assessment that was "assessment as a tool for learning". They mentioned that teachers teach to the test because education was assessment driven. They added, 'our view is that assessing high-order skills by means of authentic assessments will lead to the teaching of such high-order knowledge and skills' (p. 290).

The effects of high-stakes tests are also of concern in the teaching and learning of different subjects. Wall (2000) carried out a study about the impacts of high-stakes tests on the language classroom. Wall (1999) used a new test in English language lessons and analysed how these tests influenced teaching in Sri Lanka. The impact of the new test reported in this study was that it affected teachers' selection of content, but did not affect their teaching methods.

High-stakes testing is not always a national standardised phenomenon. Morrison and Tang (2002) presented an overview of an assessment procedure in Macau, which is a Special Administrative Region of China. Macau is in China but uses a different

assessment system. Students in Macau mostly attend private schools. There is no state examination system and the examinations in schools determine entry to third level. Schools are judged on numbers of students entering university and teachers have one-year contracts. This leads to pressure on schools, teachers, and students to pass examinations. The schools set lots of examinations, at least one in each subject every fortnight. Students might have two examinations in one day and testing begins in Macau at age four. Large amounts of class time are spent on testing and teachers spend long hours on grading. Morrison and Tang's (2002) study considered teachers' views of testing. They concluded that

Tests and examinations were demotivating and did not guarantee long-term learning; many teachers did not necessarily resent the amount and kind of testing, indeed most saw tests and examinations as advantageous rather than as disadvantageous; …teachers and students relied on tests and examinations to ensure learning, particularly of book knowledge; the need to pass examinations and tests drove students' learning and teachers' teaching; tests and examinations were strong partners to didactic, textbook-driven methods, drill, rote learning and memorisation, superficial learning, student passivity and spoon-feeding. (p. 312-313)

In their study, Barnes, Clarke and Stephens (2000) examined whether a change in assessment can influence curricular reform. This study was conducted in New South Wales and Victoria in Australia. Eleven schools in Victoria and twelve South Wales schools (grades 7-12) took part. In Victoria, the assessment process takes place in the last two years of school and includes mathematics activities such as problem solving and modelling, skills practice and standard applications and projects. There are three assessments in the 12^{th} year. The first of these assessments takes place in the middle of the year during two weeks, it is a school-based assessment, and it is in the form of an investigation project. The other two assessments are formal tests and take place at the end of the year. The New South Wales syllabus concentrates on content and is not prescriptive about teaching methods. In New South Wales, students' grades are determined from a combination of school assessments and an end of year examination. The results of this study showed that in both states the assessment had a significant influence on instructional practice and school assessments. The study found that the problem solving and investigation skills valued in the Victoria assessment system were encouraged in classrooms there. In contrast, in New South Wales teachers did not spend class time on these activities. Barnes et al. (2000) concluded that the fact that the high-stakes examination in Victoria mandates these activities is the reason why they appear in classrooms there and not in New South Wales.

1.1.3.3. The Effects on Students' Attitudes

Harlen and Crick (2003) reviewed a number of studies on the impact of summative assessment and testing on students' motivation for learning. One of their aims was to examine evidence for claims that testing both raises standards and has a negative effect on motivation in learning. Harlen and Crick (2003) described motivation as 'the will to learn' and for them the term comprises self-esteem, self-efficacy, effort, self-regulation, locus of control, and goal orientation. Harlen and Crick (2003) described two types of motivation in their review study; intrinsic and extrinsic. Intrinsic motivation is when

Learners find interest and satisfaction in what they learn and in the learning process itself. [It] leads to self-motivated and continued learning… learners who are motivated from within recognise their own role in learning and so take responsibility for it. (p. 175)

Extrinsic motivation describes

The behaviour of learners who engage in learning because it is a means to an end that has little to do with the content of what is learned. (p. 175)

In this review, Harlen and Crick discussed the work of Kelleghan, Madaus and Raczek (1996) and in particular the notion that intrinsic motivation is related with conceptual understanding and higher level thinking skills. Kelleghan et al. (1996) said that students motivated by external examinations are likely to have performance goals and not learning goals. Dweck (1986) described learning goals and performance goals as follows:

…learning goals, in which individuals seek to increase their competence, to understand or master something new, and performance goals, in which individualsseek to gain favourable judgments of their competence or avoid negative judgments of their competence. (p.1040)

Similarly, Kelleghan et al. (1996) mentioned that students with performance goals are surface learners and they use rote-learning methods more than students with learning goals. Another study mentioned in the Harlen and Crick (2003) review, carried out by Deci and Ryan (1985) showed one effect of these external assessments was that they take control away from learners and direct them towards 'surface' learning. Some studies in the Harlen and Crick(2003) review (Black, 1993, Crooks, 1988, and Pollard et al., 2000) found that external examinations were not the only assessment system to affect students and they said teachers' assessments were often imitative of external examinations, assuming they were exemplars of good assessment practice. Crooks

(1988) found that students' motivation was related to their performance on classroom assessments and was important for continued learning both within and outside school. In the Leonard and Davey (2001) and Reay and William (1999) studies (also discussed by Harlen and Crick (2003)), students reported that they disliked tests, and did not feel they could give their best performance under test conditions. In these two studies, students' judgements of their own learning was made solely on the basis of a test grade, often even before they had taken a test, because of the use of practice tests. Leonard and Davey (2001) found that parents also put pressure on their children if the test results had important consequences for attendance at the best high school.

Much research has been carried out on the effects of high-stakes examination on students' confidence. Harlen and Crick (2003) reviewed studies by Leonard and Davey (2001), Davies and Brember (1998, 1999), and Paris et al. (1991), these studies showed that low-achieving students (on national tests) generally had low self-esteem. Davies and Brember (1998, 1999) studied children at primary level in England and the effect of the introduction of the National Test to students between grade 2 and grade 6. They concluded that students' self-esteem seemed to decrease in these grades, however, after grade 6, students' self-esteem increased. In this study, most of the students seemed not be comfortable with the learning styles that they had and they thought that they were not good students. In Northern Ireland, Leonard and Davey (2001) reported that the majority of students experienced fear and anxiety because of the national tests at the end of primary level. Benmansour's (1999) study found that assessment was related to extrinsic goal orientation in students, to low self-efficacy, and to limited use of learning strategies.

Alkharusi (2008) examined the effects of classroom assessment practices on students' achievement goals. He administered two questionnaires to 9^{th} grade students and science teachers from Muscat public schools in Oman. He found that classroom assessment that focuses on grades and not on learning encourages students to have performance rather than mastery goals.

Conway and Sloane (2005) said in the book International Trends in Post-Primary Mathematics Education: Perspectives on Learning, Teaching and Assessment that "one of the major ways in which examination and testing traditions determine curriculum is by shaping what is deemed valuable knowledge"(p. 32). They mentioned a newspaper article in which a Leaving Certificate student interviewed said, 'there is no point in

knowing about stuff that is not going to come up in the exams' (p. 32). This shows that high-stakes examination may influence students' attitudes to the subject and its value.

1.1.4. A Summary of the Most Common Effects of High-Stakes Examinations

In our review of the literature on this subject we have found studies which highlight many positive as well as negative aspects of high-stakes examinations. Madaus (1991) wrote a summary of many of these effects. Some of the advantages he mentioned are: high-stakes examinations are objective; they provide national homogeneity in education and they encourage students to focus more on studying. According to him some of disadvantages are: they tend to encourage attention to material covered in examinations and as a consequence of that many worthwhile educational objectives and experiences are not addressed in the teaching and learning of the subject; preparation for the test overemphasizes rote-memorisation by students and drill-and-practice as a teaching method; teaching to the test can encourage students to perform without higher levels of knowledge; they are carried out in a very limited time; they can be stressful and they can negatively affect students' self-concept and self-esteem; students often think that they are not fair.

We have also discussed some other possible effects on teachers: for instance high-stakes examinations can lead to teachers adopting certain teaching methods (sometimes contrary to their own belief on what constitutes good practice) which were not useful for students, and to teachers coaching students to do better in the examinations. High-stakes examinations can also motivate teachers or can lead to teachers feeling under pressure. We have also seen a considerable amount of evidence that high-stakes testing leads to an increase in standards as well as studies that dispute this.

1.2. The TIMSS and PISA Studies

The Trends in International Mathematics and Science Study (TIMSS) gathers data on mathematics and science achievement. This examination evaluates the achievement of US 4^{th}- and 8^{th}-grade students and compares this with students' performance in other

countries. The first TIMSS study was carried out in 1995 and since then it has been repeated every four years. In each country a sample of students are asked to solve mathematics and science problems. In 2003, the mathematics topics in TIMSS were: algebra, statistics (data), geometry, measurement, and number. The cognitive domains in the mathematics assessments were: knowing facts and procedures, reasoning, solving routine problems, and using concepts. In addition, TIMSS asks students, teachers and school principals to complete questionnaires about the context for learning mathematics and science. The students' questionnaire includes questions about students' home resources, which language is spoken at their home, students' learning methods, their self-concept and attitudes towards mathematics and science, what kind of instructional activities and practices they do in their classrooms as well as school safety (TIMSS, 2012). The teachers' questionnaire focuses on the activities and materials they use for mathematics and science instruction and how they assess their students' performance in these subjects (TIMSS, 2012). In 2011, more than sixty countries participated. Ireland participated in the TIMSS study in 1995 and never since then. Turkey has been involved a number of times; 8^{th}-grade only in 1997 and 2007, 4^{th}- and 8^{th}-grades in 2011. There was no statistically significant difference between Ireland's mathematics performance in 8^{th} grade and the international average in TIMSS 1995.

The Programme for International Student Assessment (PISA) evaluates education systems worldwide by assessing 15-year-old students' skills and knowledge in reading, mathematics, and science literacy. The first PISA study began in 2000 and it is carried out every three years. In mathematics, PISA tests for mathematics literacy which it defines as (OECD, 2003, p. 24):

Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.

PISA administers pencil-and-paper tests to students. PISA questions are divided into four subject areas: quantity, space and shape, change and relationship, and uncertainty. The cognitive activities are represented by three competency clusters. Table 1.2 shows these competency clusters (OECD, 2012, p.49).

Students also answer a questionnaire about their home life, their attitudes and emotions such as self-confidence, curiosity, feelings of interest and relevance, and desire to learn (The questionnaire is available athttp://www.pisa.oecd.org). The PISA

test was administered in sixty-five countries in 2009. Ireland began participating in this study in 2000 and Turkey in 2003. In Pisa 2000, 2003, 2006, and 2009, Ireland performed close to the average of OECD countries (OECD, 2000, 2003, 2006, and 2009) in mathematics. Turkish students had a lower level of mathematics performance than the average of OECD countries in PISA 2003, 2006, and 2009.

These studies are explored further in chapters 2, 3 and 4.

Mathematical Literacy		
The reproduction cluster	**The connection cluster**	**The reflection cluster**
Standard representations and definitions	Modelling	Complex problem solving and posing
Routine computations	Standard problem solving translation and interpretation	Reflection and insight
Routine procedures	Multiple well-defined methods	Original mathematical approach
Routine problem solving		Multiple complex methods
		Generalisation

Table 1.2: The Competency Clusters

1.3. Turkish Education System

Primary education is compulsory for children between six and fourteen years of age in Turkey. Secondary education continues for four years after primary level and it is not compulsory. Secondary level includes five different types of education institutions: science, Anatolian, private, ordinary, and vocational high schools. At the end of primary level, there is an assessment system which determines entry to second level education- that is, the assessment system is used to decide which type of secondary school is suitable for each student. The top performing students in this examination can choose to attend science schools and Anatolian high schools. Private schools also select their students with this assessment system, however, admittance mostly depends on parents' economic status. If students cannot enter these three types of schools, then they decide to attend ordinary schools or vocational schools. Vocational schools are preferred by the

students who do not want to go university after second level and want to undertake basic skilled work.

Assessment in secondary schools is based on examinations set by teachers. These examinations are also inspected periodically by government inspectors (MEB, 2012). Students take thirteen subjects in the first year of high school. In order to progress to second year, students must achieve a GPA of 2.5 (out of a maximum 5) over all of these subjects and in addition they must pass Turkish and have failed three or less subjects in total (MEB, 2012). If students pass the first year, they are divided into groups. The information in Table 1.3 is taken from the Department of Education in Turkey (MEB, 2012). This table shows the groups of students and the subjects which are taught to different groups.

Groups	Domain Subjects
Science	Turkish, physics, chemistry, biology, mathematics
Turkish-Mathematics	Turkish, mathematics
Social Science	Turkish, history, geography
Language	Turkish, English

Table 1.3: The Groups of Students in Secondary Education

These groups are very important for university entrance: for example, if a student wants to be a medical doctor, she/he has to graduate from the science group and should take the science, mathematics, and Turkish papers in the university entrance examination. Therefore, in the first year, students have to make a decision about what they want to do in the future.

Students need to sit the national university entrance examination (called the OSS, which stands for the Student Selection Examination), if they want to continue their further education. The Student Selection and Placement Centre (OSYM) administers this examination centrally. The OSS examination is taken by students all over Turkey. Pupils' OSS score is combined with their high school grade point average to create a composite admission score (Helms, 2008), this composite score determines whether they can attend university or not. The secondary school academic performance for each student is calculated as follows. The average of marks for all subjects for each of the four years of post-primary school is calculated and then the average over the four years

is computed (resulting in scores between 1 and 100) and is multiplied by 5. But all pupils for whom this final computation results in a score of less than 50 are awarded a grade point average (GPA) of 50. 12% of this GPA is added to the OSS score to determine entry to third level (OSYM, 2012).

There are two steps in the OSS examination. The first examination is in April and determines entry to the second examination in June. The questions are multiple-choice questions. Up to 2010, the second examination had only one paper, which included all secondary school subjects and students had to answer the questions in three and a half hours in one day. The examination system was changed in 2010. There are now four papers in four days: science, mathematics, Turkish and social science, and language papers. The number of mathematics questions was increased and students now have more time to answer. If necessary, a pupil can re-sit this examination every year. For example, in 2010, 550,000 students graduated from secondary schools, 960,000 people took the second OSS examination, 600,000 people took the mathematics papers, and 530,000 people were offered a place at a university (OSYM, 2012).

1.4. Irish Education System

Attendance at full time education is compulsory from six to fifteen years of age in Ireland. The Irish education system is divided into three levels: Primary (8 years), Secondary (5 or 6 years), and Higher Education. This information is taken from the booklet of the Communications Unit Department of Education and Science in Ireland (2012).

In this thesis, I will concentrate on second level education. Second level is broken into two cycles: junior and senior cycle. Junior cycle is usually comprised of the first three years of second level schooling. At the end of this cycle, students sit the Junior Certificate (JC) examination. Students usually take nine or more subjects in this examination; most of these are offered at Ordinary and Higher Levels, however in English, Irish, and mathematics, there is also a Foundation Level paper. Senior cycle accounts for the last two years of secondary education and students sit the Leaving Certificate (LC) at the end of this second period of post-primary level. Most students take seven subjects. Once again, it is possible to take the mathematics papers at Ordinary, Higher, and Foundation Levels. The questions on all papers are partial credit questions. The LC examination takes place in June. It is centrally administered bythe

State Examinations Commission (SEC) and students sit two 2.5 hours examinations in mathematics. In Ireland, approximately 82% of students continue to the end of secondary school, 96% of those who sit the LC examinations take mathematics, 17% of the latter take higher level, and approximately70% take ordinary level.
The Central Admissions Office (CAO) coordinates admission to third level education in Ireland. Students are awarded points based on their LC scores in six subjects. Based on students' LC scores and their choice of institutions and programs, the CAO matches the institutions and students (Helms, 2008).

The 'Inside Classrooms' study carried out by Lyons, Close, Boland, Lynch, and Sheerin (2003) aimed to gain insight into the teaching of mathematics in post-primary classrooms in Ireland. A triangulated research approach was adopted and the project analysed students', teachers', and parents' data. Lyons et al. (2003) carried out their study in ten Irish post-primary schools. The researchers videotaped ten teachers and their students in their classes and the teachers also filled out a questionnaire. It was found that most of the teachers believed that learning mathematics concerned the memorisation of formulae and procedures, rather than thinking creatively, being able to provide solutions, and being able to make connections between mathematics and real life. From the class observations, a picture of a typical mathematics classes was formed. This usually involved lots of time spent on the giving and correcting of homework, and practicing questions. One of the main activities in mathematics lessons was that students copied examples from the board and practised answering similar questions. All of the teachers in this study were observed using a didactic approach to teaching mathematics. There was little discussion of mathematical topics in the observed classes.

Project Maths

A major reform of the post-primary mathematics curriculum in Ireland is currently underway. This reform is called Project Maths (Project Maths, 2012).It aims to enhance the students' learning experience by placing greater emphasis on conceptual understanding, on problem solving, and on real life applications. After a pilot, the new syllabus is being introduced gradually. The first strands were implemented nationally in 2010. Prior to the introduction of the new syllabus the NCCA commissioned a report "International trends in post-primary mathematics education" by Conway and Sloane (2005). This report outlined developments internationally while the companion discussion paper (NCCA, 2005) described the situation in Ireland.

1.5. Thesis Project

1.5.1. *Aim of the Research*

As we have seen, both Ireland and Turkey have high-stakes examinations at the end of second level schooling that determine entry to third level education. The aim of my research is to explore the effect of such examinations on the teaching and learning of mathematics at second level in both countries. For instance, in terms of teaching, we were interested in what is taught, how it is taught (methodologies, use of textbooks, homework practices, assessment method used), and whether teachers had views on an alternative assessment system. In terms of the effects on students, we were interested in both the possible effects on learning (study methods used, views of students on the nature of mathematics learning), and the possible effects on attitudes and affect (goal orientation, confidence, anxiety, views on the usefulness of mathematics, pressure felt by students). Schoenfeld (2002, p.20) pointed out that 'depending on assessment's nature and the relationship between assessment and the curriculum, assessment can be a positive or a negative force'. Various research reports, for example those by Lyons et al. (2003) and Hourigan and O'Donoghue (2007) have expressed concern in relation to the teaching and learning of mathematics in Irish post-primary schools in terms of an undue focus being placed on the attainment of examination results and a tendency to teach and learn to the examination rather than to the aims of the curriculum. Not only does this result in an increase on the pressure placed on both pupils and teachers but it has also been used to explain the didactic approach to teaching observed in post-primary mathematics classrooms, and the relative emphasis placed on procedural skills and conceptual understanding by pupils. The studies by Lyons et al. (2003), and Hourigan and O'Donoghue (2007) found that teachers emphasized practicing old examination papers and doing homework.

The Economic and Social Research Institute (Smyth et al., 2011) carried out a study which pointed out the effects of the Leaving Certificate examination. They found that Irish students felt very stressed, partly because their teachers mentioned the LC examination constantly, and also because parents put pressure on students to perform well in the examination.

There is also some evidence in Turkey of such a 'backwash' effect from the examinations that mark the end of second-level schooling and entry to the third level system (see p. 4). Noss and Baki (1996) described the Turkish traditional mathematics teaching method as one where teachers followed textbooks, they lectured to their students most of the class time using a blackboard, they emphasized algorithms, rules, definitions, axioms, and formulas that students memorized, and they demonstrated worked examples with simple answers. Noss and Baki (1996) also said that a 'procedural view of mathematics and the transmission model of learning and teaching are dominant at all levels in the education system' (p. 180). They viewed the OSS (university entrance examination) as an obstruction of the learning and teaching of mathematics and they added that the OSS examination measured only procedures and that students did not gain conceptual understanding because of this examination. Another Turkish study (Zembat, 2010) found that Turkish teachers mostly taught by direct transmission of knowledge. The Turkish classrooms involved in this study seemed to be student-centered but the evidence for a student-centered classroom was limited. Tansel and Bircan (2005) mentioned that 'the university examination [OSS] is highly competitive and all high school graduates are qualified to take this examination' (p.2). The OSS examination puts pressure on students to perform well at mathematics (Kahveci and Imamoglu, 2006). Irez (2006) reports that the university entrance examinations in Turkey have required students to memorize large amounts of material. Irez (2006) mentioned a different study (Cimer, 2004) and this study found that teaching had become focused on the transmission of content and effective teachers are perceived to be those whose students perform well on the examination. My study aims to investigate these issues in both countries.

1.5.2. *Methodology*

In order to explore the effects of high-stakes examination on second level education in Ireland and Turkey, I surveyed teachers and students in secondary schools in the Dublin and Istanbul regions. In particular, I chose ten Turkish and thirteen Irish post-primary schools and gathered data both from teachers and students. Both quantitative and qualitative research methods were used to make a more effective comparison of the two countries. I designed a questionnaire for students, which consisted of fifty-five Likert

type and six multiple-choice questions. This was administered to 661 Turkish and 666 Irish pupils. I also designed a questionnaire for these students' teachers and used it as a basis for semi-structured interviews with twenty-one Turkish and twenty-five Irish mathematics teachers. Both questionnaires can be found in the appendix. In addition, in order to be able to compare the examinations, I classified recent examination questions from the Leaving Certificate and OSS examinations.

1.5.3. *Pilot Study*

A pilot study can reveal deficiencies in the design of a proposed procedure and these can then be addressed before time and resources are expended on a large scale study. My pilot study was designed to test the quality of the questions on the teacher and student questionnaires and the questions identified for the teacher interviews. I constructed a small study at a post-primary school in Maynooth and administered the student questionnaire to a group of students and the teacher questionnaire to a mathematics teacher. The teacher was also interviewed. In the pilot version of the pupil questionnaire, an extra response category was included for each Likert scale item asking pupils to indicate if they could not understand the item. No pupils indicated any difficulty in understanding the items and I did not receive any queries or suggestions about the wording or format of the questionnaires. From the point of trialing the audio equipment and time management, this pilot study worked very well.

1.5.4. *Overview of Thesis*

Chapter 2 presents an investigation of teachers' opinions about the examination systems in their respective countries and the influence of these examinations on their teaching and their students' learning, whether they perceived this influence as positive or negative in each country. The data collected from the teachers' questionnaire was analyzed with Grounded Theory. The analysis of the interview data was less structured than that of the questionnaire data. There was a time limitation on the interviews, which meant that I could not ask the same questions to all teachers in the interviews. The results of these analyses (of both questionnaires and interviews) are presented in Chapter 2.

Chapter 3 presents an analysis of students' responses to the questionnaire that was developed for this survey. The pupil questionnaire was comprised of Likert type questions organized into ten scales namely: scales addressing learning goals, performance goals, confidence, anxiety, pressure, usefulness of mathematics, good teaching, mathematics learning, assessment, and study methods. I used Rasch Analysis to investigate the pupil data. This analysis showed students' attitudes to and views of mathematics, their self-confidence, and their learning goals. I have also investigated students' ideas of what constitutes 'good teaching' and the importance of various study methods to them.

Chapter 4 presents a classification of the mathematics examination questions from Turkey and Ireland for the years 2008, 2009, and 2010.I modified the Levels of Cognitive Demand (LCD) framework (Stein and Smith, 1998a, 1998b) to carry out this classification. The reason for using this classification method (LCD) was that almost all questions under inspection involve using mathematical procedures and this system distinguishes different levels of procedural questions.

Chapter 5 is the final part of this thesis. In this chapter, I summarize the effects of the examinations on the teaching and learning of mathematics in Turkey and Ireland, and the result of the classification of examination questions. One of my aims in this whole study was a triangulation between the analysis of the responses to the students' questionnaire, the teachers' questionnaire, and interviews, and the classification of examination questions in Ireland and Turkey. In chapter 5, the results of these analyses are used to corroborate and clarify one another.

CHAPTER 2

AN ANALYSIS OF TEACHERS' QUESTIONNAIRES AND INTERVIEWS

2.1. Introduction

This study explores teachers' opinions on high-stakes examinations in both countries. The focus of this chapter is the analysis of the teachers' questionnaires and interviews. The first section concerns the literature review, followed by a description of the design of this part of the study, research methods and the instruments of these methods (Section 3). In the fourth section, I present the schools from both countries and a description of how we carried out an analysis of the teachers' questionnaire. The results of the questionnaire are represented in Section 5. Section 6 summarizes analysis of the interview transcripts. The last section discusses the findings.

2.2. Literature Review

The effects of high-stakes examinations on teaching have been dealt with in chapter 1. In this section, I will review the literature about teachers' attitudes to mathematics teaching and comparisons between mathematics teaching practices in different countries.

In my study, I compared teachers' views on the effects of high-stakes examinations from Ireland and Turkey. Many studies have been carried out to compare the teaching of mathematics in different countries. A comparison study by Kaiser and Vollstedt (2007) in three European countries focused on teachers' beliefs concerning mathematics and mathematics teaching in general. They used both qualitative and quantitative research methods. Grounded Theory (Strauss and Corbin, 1998) was used to analyze the qualitative data. The researchers began by classifying 41 German teachers' beliefs on

the nature of mathematics according to Grigutsch, Raatz and Torner (1998). This categorization has four aspects: mathematics is an exact, formal and logical science (aspect of formalism); mathematics is a collection of rules and formulae (aspect of scheme); mathematics is a science which mainly consists of problem solving processes (aspect of process); and mathematics is a science which is relevant for society and life (aspect of application). The aspects of formalism and scheme were described as static perspectives and the aspects of process and application were described as dynamic perspectives. Kaiser and Vollstedt's (2007) results clearly show that most of the teachers held a static view about the nature of mathematics and about teaching practices. Teachers described traditional teaching methods where they introduce and explain a mathematical concept. However, some had dynamic views on mathematics learning and saw their own role as a facilitator while the students took responsibility for their own learning. Kaiser and Vollstedt (2007) then describe other studies where they compare German teachers to teachers from both England and France. One of the main differences that they report between the situation in England and France was that teachers in France used concepts, theorems and formulas in their lessons, and theoretical mathematical concepts were very important in their classes. However, teachers in England emphasised the practical nature of the subject. Teachers in Germany focused on the structure of mathematics and on mathematical theory. Nevertheless, there were differences in approach depending on the school type. The Gymnasium (high achieving schools) show a strong emphasis on mathematical theory, while in the lower achieving schools, teachers often rely more on rules and algorithms. The researchers observed that the use of algorithms for solving problems was prevalent in all types of German schools, although in lower achieving schools these algorithms were more likely to be learned by heart without much understanding whereas in the Gymnasium teachers emphasised understanding and fostered the ability of students to develop algorithms themselves. In France, such algorithms were seen to be important as a means to tackle more complex problems, while in England algorithms were not seen to be important and teachers were reluctant to generalise problem-solving techniques.

In another comparison study (Bryan, Wang, Perry, Wong and Cai, 2007), a group of researchers focused on the similarities and differences of teachers' views of effective mathematics teaching and learning from Australia, Hong Kong, Mainland China and the USA. Qualitative methods were used in this research. Thirteen teachers from Australia, eleven teachers from the USA, nine Chinese teachers from Guizhou and twelve Chinese

teachers from Hong Kong were interviewed using semi-structured questions. Teachers' views about mathematics learning were compared according to the three themes of Cai (2007): the nature of understanding, the role of memorisation in understanding, and the role of practice. The teachers from all four countries agreed that understanding is the most important goal of learning mathematics, and that using real life problems can be helpful for developing mathematical understanding. However, teachers in Mainland China seemed to have a strong belief in the importance of helping students understand abstract mathematics, with teachers in the USA holding the opposite view that the focus should be on understanding at a concrete level and teachers in Hong Kong and Australia falling between these extremes. Memorization is deemed important for mathematical understanding in all four countries. However, in the USA and Australia teachers felt that memorisation could only come after understanding and is useful for recalling necessary information which students may apply in the future, whereas, teachers from Mainland China and Hong Kong spoke about memorisation before understanding and felt that this could be a step towards understanding. All teachers thought that the practice of exercises on a particular concept was important. However, in Hong Kong, Australia and the USA, teachers cautioned against the use of repeated practice as it could bore students and they could lose their interest. Teachers had different views on teaching mathematics. The teachers from Hong Kong and Mainland China focused on how well the teachers prepare, present and explain the subjects and their classes were well structured and coherent. The "teacher-led" aspect of the mathematics education was emphasized in their classrooms. However, in Australia and the USA a "students-centred" aspect was emphasized. They provided for students to be actively engaged in their classes in order to keep students' interest. They believed in the importance of flexibility in classes to meet students' needs. It appeared to the researchers that teachers in Australia and the USA focussed on developing students' confidence on problem solving, whereas in Mainland China and Hong Kong, the teachers' aim was that students mastered the necessary skills for proper performance. Bryan et al. (2007) described two different educational cultures: Western and Eastern cultures. The USA could be considered as having a "Western" culture, Mainland China could be considered as having an "Eastern" culture while Hong Kong and Australia could be considered in between these two cultures, with however, Australia having more "Western" culture and Hong Kong having more "Eastern" culture.

Ernest (1989) claims that the key belief components of a mathematics teacher are

- The teacher's view of the nature of mathematics,
- The teacher's view or model of the nature of mathematics teaching,
- The teacher's view or model of the nature of mathematics learning.

He described three models of teaching and these are instructor (intended outcome for students is skills mastery with correct performance), explainer (intended outcome is conceptual understanding with unified knowledge), and facilitator (confident problem posing and solving).There are three patterns of the use of curricular materials in a teaching model. Some teachers follow strictly a textbook or scheme. Some teachers modify a textbook and enrich it with additional problems. The last one is that teachers construct their own curriculum. Ernest (1989) also explained how a teacher's view of the process of learning mathematics is closely related to his teaching model and described possible models of learning mathematics as a compliant behavior and mastery skills model, a reception of knowledge model, an active construction of understanding model, and an exploration and autonomous pursuit of own interests model. Finally, he explained the instrumentalist view of mathematics, the Platonist view of mathematics, and the problem-solving view of mathematics, and how these views are likely to be associated with different models of teaching and learning. The instrumental view of mathematics is that mathematics is a collection of facts, rules, and skills and it is often associated with the instructor model of teaching and with following a text or scheme strictly. The Platonist view of mathematics was explained as an unchanging but unified body of certain knowledge and the teacher is likely to be an explainer, and view learning as the reception of knowledge.

However, in Ireland and Turkey very few studies have been carried out on the same field as my research. Turkey was one of the members of TIMSS in 2007. The Trends in International Mathematics and Science Study (TIMSS) is the largest and most ambitious international study of student achievement (see chapter 1). Students were tested in mathematics and science, and extensive information about the teaching and learning of mathematics and science was collected from students, teachers, and school principals. Some of the teachers' results for Turkey in TIMSS 2007 Mathematics for 8^{th} grade areas follows:

- 35% of teachers emphasised long mathematics homework assignments (more than 30 minutes) whereas the international average was 28%, and 37% of

teachers' emphasised short mathematics homework assignments (30 minutes or less) whereas the international average (int. avg.) was 49%.

- 44% of students had teachers who always monitor whether homework is completed (int. avg. 80%), 38% of students have teachers who always correct homework and then give feedback to students (int. avg. 59%), 25% of students reported that their teachers require them (the students) to correct their own homework in class (int. avg. 32%), 11% of students' teachers use the homework as a basis for class discussion (int. avg. 29%) and 40% of students' teachers use the homework to contribute towards students grades or marks (int. avg. 33%).
- The types of assessment in 8th grades were as follows: 75% of emphasis was on teachers' own professional judgement (int. avg. 45%), 69% of emphasis was on classroom tests (int. avg. 66%) and 45% of emphasis was on national or regional achievement tests (int. avg. 27%)
- In the 8th grade 79% of students had teachers who gave a mathematics test about once a month (int. avg. 39%)
- In the 8th grade 58% of examinations had only or mostly partial credit questions (int. avg. 44%), 27% of examinations had about half partial credit and half multiple choice questions (int. avg. 41%) and 15% of examinations had only multiple choice questions (int. avg. 15%)
- 76% of types of questions on mathematics tests were always based on recall of facts and procedures (int. avg. 52%), 91% of types of questions on mathematics tests were always involving application of mathematical procedures (int. avg. 77%), 62% of types of questions on mathematics tests were sometimes involving searching for patterns and relationships (int. avg. 68%) and 45-46% of types of questions on mathematics tests were sometimes or never requiring explanations or justifications (int. avg. 57% for sometimes and int. avg. 11%for never)

A group of Turkish researchers (Gundogdu, Kiziltas and Cimen, 2010) conducted a survey at the 6th, 7th and 8th grades of elementary schools in Turkey. Their aim was to examine the teachers' and students' views of the SBS assessment system which is used in the last three years of elementary schools in Turkey. The grades from the SBS along with school assessment grades are used to determine entry into the different types of high schools. The researchers administered questionnaires to teachers and students and

they interviewed eight grind school teachers. There were 1143 students and 172 field teachers (25 mathematics teachers). Students were asked if they attended grinds or grind schools. It was found that 84% of students attended grinds. There was not a significant difference between teachers' and students' views on the SBS examination system for example both teachers and students thought that it was pressurized in every year and these examinations make students' study more planned and orderly. However, all of the teachers had a negative impression of grinds believing that the examination system caused grinds.

In another Turkish (Tansel and Bircan, 2005) study, the data of a 2002 survey of the applications to the university entrance examination (OSS) were used. The aim was to investigate how many students had one-to-one grinds and the effects of these grinds on the performance of students in the OSS examination. They found that one-to-one grinds were very popular in the 9^{th}, 10^{th} and 11^{th} years of high school. They observed that the percentage was higher in the 11^{th} grade and 55% of the students who had grinds were placed at a university program.

In 1982, Ireland did not have a tradition of standardized testing program in its primary schools. Kelleghan, Madaus and Airasian (1982) simulated a school testing program from the United States. The aim of this study was to monitor the effects of standardized testing on school organization, on teachers' attitudes, perceptions, and practices, and on students' attitudes, perceptions, and practices. The Educational Research Centre at St. Patrick's College, Dublin, supplied standardized, norm-referenced tests of ability and achievement to schools. In a sample of primary schools, classroom teachers administered the tests to students and posted them to the Research Centre for scoring and processing. 'Norm-referenced' means that the Research Centre did not tell students their actual test scores; but they gave a student's performance relative to the performance of all students. In this study there were three groups of students; one group was called the experimental group (students' ability and achievement information was given to teachers) and the other two were control groups (students' information was not given to teachers). The schools in one of the control groups had high-stakes test experience and the other group did not have high-stakes test experience. This study tried to examine experimentally the consequences of classroom testing procedures on schools, teachers, pupils and parents. Teachers were asked if they felt that these tests have influenced the material they planned to cover in their classes. 5% of teachers indicated that there was a great influence. 40% of them said that the content they

covered was affected to some extent and 30% of them said that their teaching methods were affected to some extent. In addition, teachers who had test experience showed less influence on their teaching compared to the teachers who had no test experience.

A group of Irish researchers conducted a survey with 856 teachers in 130 schools (Cosgrove, Shiel, Oldham & Sofroniou, 2004) as part of the PISA 2003 study. They asked the teachers about their qualifications and teaching experience, the instructional emphasis they placed on aspects of Junior Certificate mathematics and PISA mathematics, teachers' attitudes towards mathematics, and calculator and ICT usage. They found that the percentages of 5^{th} and 6^{th} year mathematics class time spent at various activities were as follows: 18.2% at reviewing homework, 25.7% at presenting new material, 15.3% at explaining mathematical concepts and procedures, and 27.7% at having students practice or solve routine mathematical problems. About 60% of teachers said it is important to understand how mathematics is used in real life in order to succeed in mathematics at school, however, only 4.1% of them have their students practice transfer of mathematical knowledge to solving problems in real-life situations. Almost all of the teachers agreed or strongly agreed that more than one representation (picture, concrete materials, symbol set, etc.) should be used in teaching mathematics and that regular homework assignments help to monitor students' progress. The vast majority of teachers assigned homework after each class, and 99.3% of them agreed that homework is an effective way to consolidate what has been covered in class. When asked if they assigned homework which required students to apply knowledge in novel contexts, only 46.4% agreed. 63.7% of teachers disagreed or strongly disagreed that mathematics is an abstract subject. Over a third of teachers agreed or strongly agreed that computers are important for teaching mathematics, however only 18.4% had used them in their classrooms. The study also found that teachers placed heavy emphasis on using sample questions to prepare for the junior certificate examination.

2.3. Research Design

Both qualitative and quantitative research was employed in this study. In the first section below, I present an overview of these two types of research methods, and my reasons for using them. The construction of the teachers' questionnaire and the semi-

structured interview protocols are discussed in the second section. The final section concerns ethical considerations.

2.3.1. Quantitative and Qualitative Research

The data considered in qualitative research is descriptive rather than numerical. It usually comes from direct observation, interviews, open-ended survey questions, field notes, personal reflections or other written documents.

According to the Open University Research Methods in Education Handbook (2001, p 49), qualitative research has the following features:

- A focus on natural settings (as opposed to artificial experiments).
- An interest in meanings, perspectives and understandings.
- An emphasis on process.
- The use of inductive analysis and grounded theory.

In this type of research, researchers seek to discover the different meanings of real-life situations and they analyze the participants' interpretation of a situation. Researchers often generate a theory from the data, rather than using the data to test a ready-made theory.

The collection of qualitative research data is usually very time-consuming for the researcher and for the participants. If the data comes from audio or video recordings then usually these need to be transcribed and this is also very time intensive. For this reason, along with the inductive nature of the data analysis, small sample sizes are common in qualitative research.

Quantitative research, on the other hand, concerns numerical data, or data that can be coded numerically (for example gender). The Open University Research Methods in Education Handbook (2001, p. 77) defines quantitative research as

- The search for causal relationships conceptualized in terms of the interaction of 'variables', some of which (independent variables) are seen as the cause of other (dependent) variables.
- The design and use of standardized research instruments (tests, attitude scales, questionnaires, observation schedules) to collect numerical data.
- The manipulation of data using statistical techniques.

Sample sizes are usually much larger when dealing with quantitative data as compared to qualitative data. The statistical tests used in the analysis of the data may have a

specific lower bound on the size of the sample, and the use of statistical software makes the analysis of large data sets feasible.

The teachers in this study were asked to complete a questionnaire and to consent to being interviewed. The questionnaire has yes/no, open ended, and multiple-choice questions and it will be discussed fully in the next section. The yes/no and multiple choice questions are quantitative instruments. My reasons for using these kinds of questions on the questionnaire were: to allow easy comparison between the Turkish and Irish teachers' views; to encourage the participants to give a definite answer; and to avoid having to interpret an ambiguous answer. The open-ended questions, both in the questionnaire and in interviews, are qualitative instruments. One of my main reasons for using qualitative methods was that I wanted the teachers to have some flexibility in their answers. I did not want to force them to say something very rigid but wanted to allow them to make comments without any restrictions. In this way, I hoped to discover the reasons behind the teachers' yes/no answers, and maybe discover some unexpected results. These and other positive and negative aspects of using open-ended and closed questions are outlined in the Open University Research Methods in Education Handbook (2001, p. 185).

I decided to combine qualitative and quantitative methods in this study. Many other studies have done this and Bryman (2006) outlines how and why these methods are combined in practice. Greene et al. (1989) devised a scheme with five justifications for the combination of quantitative and qualitative methods. They were: triangulation; complementarity; development; initiation; and expansion. The first three of these justifications are very similar to my reasons for using both methods. The explanations of these three justifications are as follows: (Greene et al., 1989, p. 259)

1. Triangulation: looking for convergence, corroboration, or correspondence of results from different methods. To triangulate, emphasis is placed on seeking corroboration between quantitative and qualitative data.
2. Complementarity: seeking elaboration, enhancement, illustration, clarification of the results from one method with the results from another.
3. Development: seeking to use the results from one method to help develop or inform the other method, where development is broadly construed to include sampling and implementation, as well as measurement decisions.

I used triangulation in this study by matching the results of the teachers' yes/no questions with the results of the coding of the open-ended questions. In this way the

quantitative data was used to corroborate the results of the analysis of the qualitative data. Similarly, the qualitative data was used to elaborate on and illustrate the results of the quantitative analysis. The responses to the yes/no questions gave me an impression of the teachers' views but I gained a deeper understanding from the open-ended questions. With so much qualitative data to work with, I also used the answers to the yes/no questions to direct me to study the questions that might have the most interesting results. Furthermore, triangulation was also used to seek convergence between the findings emerging from the teacher data, the pupil data and the classification of questions appearing on the examination papers in Turkey and Ireland.

2.3.2. Construction of the Questionnaire and Interviews

A questionnaire was used in this part of the study and can be found in Appendix A1. The most important reason for using a questionnaire was that teachers could take their own time to think about the questions before they answered. In general it is easy to administer questionnaires to large groups because of the time factor but this was not relevant here because my samples were only small groups of mathematics teachers. I could ask various questions in the questionnaire about my research topic to get more information from teachers, and all the teachers were asked exactly the same questions. Written data could be kept permanently and it was very useful for analysis. In the Open University Research Methods in Education Handbook (2001), the authors listed the advantages and disadvantages of using questionnaires and interviews. Their list is as follows: (taken from the Open University Research Methods in Education Handbook, 2001, p. 184-185)

Questionnaires

- Questionnaires do not take much time to administer, so are useful for a large sample.
- Everyone is asked the same questions.
- Questionnaires can be designed so that analysis is relatively simple.

Interviews

- Interviews take time to administer.
- Interviews allow the researchers to probe particular issues in depth.
- It is likely that a lot of information is generated in interviews.

This list is very similar to my reasons for using the questionnaire and interviews. As I said above I gave the questionnaires to the teachers and they thought about the

questions and answered in their own time. Therefore, before the interviews the teachers already had an idea of the issues involved in the study and had had a chance to think about their responses. The interviews took a lot of time and I could not ask all the questions from the questionnaire, so the fact that the teachers had already answered most questions was important. I also wanted to get deeper information about the teachers' views and this is another reason for using interviews. The interviews help to explain some of the relationships uncovered through the analysis of the questionnaire data.

2.3.2.1. Format of the Questionnaire

In this study, the design of the questionnaire focused on teachers' feedback about the Irish and Turkish high-stakes mathematics examinations. A review of the literature on this topic showed that high-stakes tests can have serious effects on teaching (Stecher, 2002; Johnston and McClure, 2000; Au, 2007). In an effort to study if these effects exist in Turkey and Ireland, teachers in this study were first asked to describe their own teaching methods and then later were asked questions relating to the effects of the examination systems on their practice. Previous research in Ireland (Lyons et al., 2003; Hourigan and O'Donoghue, 2007) suggested that Irish classrooms were mainly teacher-centered and that teaching focused on the state examination, while in Turkey Noss and Baki (1996) and Irez (2006) reported on the heavy use of memorization and a lecture-style of teaching. Thus the questions on teaching methods were chosen to explore these issues. In addition, many of the studies reported on in Harlen and Crick (2003) described the effects of examinations on students' attitudes and confidence. In my study, I asked teachers about students' study methods and about their perception of the influence of the examination system on students. Teachers were also asked for their views on the syllabus and on alternative examination systems.

The questionnaire consisted of 32 questions, of which there were 18 yes/no questions, 2 further multiple-choice questions and 12 open-ended questions. Twelve of the yes/no questions also had an interpretation part, that is, teachers were asked to explain or comment on their yes/no answers. I administered the questionnaire to the teachers in both countries in the teachers' own language.

2.3.2.2. Format of the Interviews

In Turkey, all of the teachers had completed the questionnaire and returned it prior to the interview. In the interviews, I asked questions from the questionnaire in order to delve deeper into the reasons for the teachers' answers. It was not exactly the same in Ireland because in three schools the teachers wanted to conduct the interviews immediately and filled in the questionnaire later. However, in all cases a selection of the questions from the questionnaire were asked in the interviews. The questions selected for the interviews were about the description of a typical mathematics class; teaching methods; views on the examination system and its influences on teaching, learning, students' attitudes, confidence; and grinds. Because the interviews were semi-structured and because of time constraints, teachers were not all asked exactly the same questions.

The interviews were semi-structured and audio-recorded. Each individual interview took between five and twenty-five minutes and was conducted by me in the teachers' own language.

2.3.2.3. Translation of the Questionnaire

The questionnaire was designed in English. I translated it into Turkish. A researcher at NUI Maynooth, who was also Turkish, checked the translation of the questionnaire and made some small changes. Before administering the questionnaire in Turkey, I had it checked by an official translation service. They also made some modifications. Since the same questions were used in the interviews, there was no need to translate them separately.

2.3.3. Ethical Considerations

Ethical considerations were important in this study since teachers expressed their personal views about their students, their own practices, and the examination system run by their employers in the questionnaire and interviews. The teachers did not want to share their personal thoughts on these sensitive issues publically. So the questionnaire and interviews were anonymous in order to respect the teachers' confidentiality. I also applied for permission to the Ministry of Education in Ankara (Turkey) and to the National University of Ireland Maynooth Ethics Committee. They evaluated my study and I got permission in both countries before I started to conduct my research. Each

participant was given a plain language statement (see Appendix A3) prior to completing the questionnaire. The plain language statement explained that involvement in this research study was voluntary and the participants could withdraw from the study at any point. It also explained that the survey was anonymous and the data would be treated confidentially. In addition, I gave a consent form (see Appendix A4) to all participants to sign at the time of the investigation.

2.4. Methodology

2.4.1. Choosing Schools

Istanbul is separated into two parts: the Asian and the European parts. All the schools were chosen from the Asian part of Istanbul because I had only a short time in Istanbul. The schools were spread out over the whole of the Asian part. I visited the schools and asked the principals if they wanted to participate in this survey. Most of the Turkish schools were chosen randomly. However, I chose one school where I had worked previously as a mathematics teacher and two schools where I knew some teachers. I wanted to have two schools for each type of Turkish post-primary school. The types of the schools were detailed in chapter 1 and listed in table 2.4.2 below. In the Asian part of Istanbul at that time, there was only one science school which had third and fourth year classes. The principal of this science school suggested to me that I should choose a particular Anatolian high school that was very similar to a science school. So I had ten schools in total: one science school, three Anatolian high schools and two schools each from the categories of ordinary secondary schools, vocational schools and private schools.

In Ireland I obtained a list of all post-primary schools in the greater Dublin area. The schools were in counties Kildare, Dublin, Meath, and Wicklow. I divided the list of schools into various different categories of schools and used a random number generator to select two schools in each category (see table 2.4.1 below). These schools were sent a letter that explained my study and asked if the school wanted to participate. From the first selection, four schools replied and said that they wanted to participate. Once again, I randomly chose some more schools and sent a letter to them. This time, three of the schools agreed to participate. After dealing with these seven schools, I still needed schools in a few different categories. I randomly selected more schools and visited them in person and three schools accepted the invitation to participate in my

study. I now had ten schools but I still needed three more schools from different types of post-primary schools. My supervisors then contacted some schools and asked them to participate. Eventually Irish schools representing all categories of schools took part in the research. The types of Irish schools are: secondary, vocational, comprehensive and community schools. Irish schools are also classified as being fee-paying or not, disadvantaged (DEIS) or not, single-sex or co-educational. Four of the Irish schools chosen were disadvantaged schools.

2.4.1.1. Irish and Turkish Schools

The survey was conducted in the 2009-2010 school year in both countries. In total 27 Irish teachers and 21 Turkish teachers took part. Two teachers from each school were invited to participate in this survey. However in one Irish and one Turkish school three teachers were involved in the study. There were two Irish teachers who did not want to complete the questionnaire but who were interviewed and two other Irish teachers who did fill in the questionnaire but were not interviewed; the reason they gave was that they did not have enough time to take part in the interview. All Irish teachers were teaching fifth and sixth years (these are the two final years of post-primary school in Ireland); 8 of them were teaching Higher Level Leaving Certificate classes and 16 of them were teaching Ordinary Level Leaving Certificate classes. The Turkish teachers were teaching mostly 4th year groups. (4th year is the final year of secondary school in Turkey).

Tables 2.4.1a-b-2 detail the characteristics of the schools chosen.

Irish school codes	School type	DEIS	Fee-paying	Gender	Syllabus levels of participating class teachers
A1	Secondary	No	Fee-paying	Girls	2 Ordinary
A2	Secondary	No	Fee-paying	Girls	1 Higher & 1 Ordinary
A3	Secondary	No	Non-fee-paying	Girls	2 Ordinary
A4	Secondary	No	Non-fee-paying	Girls	1 Higher & 1 Ordinary

Table 2.4.1a: Different Types of Irish Schools

B1	Secondary	No	Non-fee-paying	Boys	1 Higher & 1 Ordinary & 1 Foundation
C1	Secondary	No	Fee-paying	Both	1 Higher & 1 Ordinary
B2	Secondary	Yes	Non-fee-paying	Boys	1 Higher & 1 Ordinary
C2	Secondary	No	Non-fee-paying	Both	1 Ordinary & 1 Foundation
V1	Vocational/community	No	Non-fee-paying	Both	1 Ordinary & 1 Foundation
V2	Vocational/community	Yes	Non-fee-paying	Both	1 Higher & 1 Ordinary
V3	Vocational/community	Yes	Non-fee-paying	Both	2 Ordinary
C3	Comprehensive/community	No	Non-fee-paying	Both	1 Higher & 1 Ordinary
C4	Comprehensive/community	Yes	Non-fee-paying	Both	1 Higher & 1 Ordinary

Table 2.4.1b: Different Types of Irish Schools

Turkish school codes	School type	Fee-paying	Gender
AS	Science	Non-fee-paying	Both
KA	Anatolian	Non-fee-paying	Both
BB	Anatolian	Non-fee-paying	Both
KH	Anatolian	Non-fee-paying	Both
KP	Private	Fee-paying	Both
SS	Private	Fee-paying	Both
GZO	Ordinary	Non-fee-paying	Both
AO	Ordinary	Non-fee-paying	Both
KV	Vocational	Non-fee-paying	Both
MSV	Vocational	Non-fee-paying	Both

Table 2.4.2: List of Turkish Schools

2.4.2. Grounded Theory

There are various different ways of analyzing qualitative data, for example: grounded theory, ethnography, the phenomenological approach, life histories and conversational analysis. I used grounded theory in this study to analyze the responses to open ended questions on the questionnaires. I used grounded theory in my study with the aim of discovering what lies behind the teachers' thoughts about the effects of high-stakes examinations which I did not yet know. The reason I chose grounded theory as opposed to other forms of analysis was that I wanted to allow the theory to emerge from the data instead of analyzing the data with a preconceived theory in mind.

Two sociologists called Barney Glaser and Anselm Strauss developed grounded theory in the 1960's. I followed the methods outlined in the book of Strauss & Corbin (1990) for grounded theory. Strauss & Corbin (1990) explained that grounded theory is a way of developing a theory about a phenomenon. They also mentioned that analysis in grounded theory does not begin with a theory, but the theory develops during the analysis. The analysis is done with a coding process. Coding means breaking down the data and then conceptualizing and putting them back together in new ways. The aim of these processes is to build a theory from the data. Open coding was used in this study: it is the part of the analysis where phenomena are named and categorized. There are two procedures that should be used during the open coding process: asking questions and making comparisons. The data are broken down and conceptualized by asking questions about a sentence or paragraph in the data. The basic questions are what, how, and why. The reason for asking questions is to open up the data. These conceptualized data should be grouped so the phenomena can be identified. This is called categorizing the data. An abstract name should be given to each category because it is useful to remember the categories' referent. The process is not only about the discovery of categories but also the discovery of properties and dimensions of the categories. The properties are the characteristic of the phenomena (category) and these properties can be dimensionalized.

Now I want to explain how I used grounded theory in this study through a process of open coding. I read the teachers' questionnaires one by one and I underlined any sentences, paragraphs, phrases, or words which I found important. Then I went back and did the same thing several times. I coded repeatedly because I did not want to miss any

data that were useful for my analysis. I labeled the data by giving name to the ideas emerging. Then I did a deeper analysis by making connections between these names and grouped them to categorize the data. I compared the two countries with these categories and their concepts. For example, one category name was called “lecturing style” and the concepts it encompasses were using chalk and talk, using black or white-board, didactic method and introduction method. One of my supervisors and I did all the coding independently. We discussed our coding and agreed concepts and categories. Grounded theory was not used for analyzing the interviews. The reason for using a different method was that teachers could not all be asked the same questions and teachers did not answer the same questions in the same way because of the time limitation. For this reason, the analysis here is less structured than for the questionnaire. One of my advisors and I each read the transcripts and compiled a list of themes that occurred. We compared our lists and agreed on the most important themes that arose.

2.5. Results

In this section, I present the frequencies of responses to yes/no and multiple choice questions and the results of open-ended questions. The first sub-section 2.5.1 presents the responses of yes/no questions (1, 2, 3, 4, 5, 8, 10, 11,12,13, 15, 18, 19, 22, 28, 29, 30, 31) and discusses responses to questions 14 and 25. The responses to these questions are analysed quantitatively in this section, while in the following subsections of 2.5 responses to the open ended are analysed qualitatively. Questions 9-13 concerned teachers’ views on the examination systems in their country and the responses to these open-ended questions are discussed in section 2.5.2. Questions 7, 8, 16, 19, 32, 20 related to teachers’ descriptions of their own practice; the responses are represented in section 2.5.3, and question 3 is also revisited here. Responses to questions 17,18, 21 are shown in section 2.5.4, these questions relate to teachers’ recommendations for a new examination system.The text of each question is included in the paragraph introducing each subsection. Questions 6, 23, 24, 26-31 and the open part of questions 4, 5, and 22 are not discussed at all because in some cases the number of responses was not sufficient to allow us to meaningfully code the data and to interpret it clearly, while in other cases we found that the data were not directly relevant to the aims of my research.

2.5.1. Summary of responses to yes/no and multiple choice questions

Table 2.5.1a-b details the frequencies and percentages of responses to yes/no questions.

QUESTIONS	IRISH		TURKISH	
	YES	NO	YES	NO
Q1- Do you usually ask questions of your students in your class?	25(100%)		21 (100%)	
Q2- Do you encourage them to ask you questions?	25(100%)		21(100%)	
Q3- Do you use any textbooks?	25(100%)		13 (62%)	8 (38%)
Q4- Do you usually give homework and correct them?	24 (96%)		18 (86%)	3 (14%)
Q5- Do you discuss your teaching with the other mathematics teachers?	24 (96%)	1 (4%)	20 (95%)	
Q8- Do you have complete freedom in your choice of teaching methods?	23 (92%)	1 (4%)	16 (76%)	5 (24%)
Q10- Do you think the examination system influences the way that you teach?	22 (88%)	3 (12%)	16(76%)	5(24%)
Q11- Do you think that the examination system influences the way your students learn or study?	23 (92%)	1 (4%)	19 (90%)	2 (9.5%)
Q12- Do you think that the examination system influences your students' attitudes to mathematics?	18 (72%)	7 (28%)	19(90%)	2 (9.5%)
Q13- Do you think that the examination system influences your students' confidence in mathematics?	18 (72%)	5 (20%)	16(76%)	5(24%)
Q15- Do you try to help your students with anxiety problems, confidence, study style before the examination?	24 (96%)		21(100%)	
Q18- If there was a different national assessment system, would you change the way that you teach?	15 (60%)	6 (24%)	11 (52%)	9 (43%)
Q19- Do you ever discuss topics in class that will not be examined?	10 (40%)	14 (56%)	15 (71%)	6 (29%)

Table 2.5.1a: Frequencies of Responses to Yes/No Questions

Q22- Do you cover every topics in the syllabus?	11 (44%)	13 (52%)	11 (52%)	8 (38%)
*Q28- Do you think that your students will choose the right vocation?			9 (86%)	8 (9.5%)
*Q29- Do you believe the curriculum of mathematics in university entrance examination is covered by the curriculum at schools?			18 (86%)	2 (9.5%)
*Q30- Do you think the mathematics that you teach in your class is enough for university entrance examination?			14 (67%)	7 (33%)
*Q31- Do you do old university entrance examination questions in your class?			21 (100%)	

Table 2.5.1b: Frequencies of Responses to Yes/No Questions

The main differences were in questions 3, 8, 12 and 19, although none of these differences were statistically significant. The responses to these questions will be discussed later. The questions marked with * (questions 28, 29, 30, 31) were designed for Turkish teachers because of the examination system in Turkey.

Questions 14 and 25 were multiple-choice questions. Question 14 asked "how often do you refer to the examination in class?" Table 2.5.2 outlines the responses to this question.

	Every class	Every week	Every month	Every term	Only before the examination	Others	missing
Irish	4 (16%)	13 (52%)	5 (20%)	1 (4%)	0	0	2(8%)
Turkish	6 (28%)	10 (48%)	1 (5%)	1 (5%)	0	0	3 (14%)

Table 2.5.2: Frequencies of Responses to Question 14

Table 2.5.2 shows the results for this question to be very similar, with approximately 70% of teachers in both countries mentioning the examination at least every week.

Question 25 was "what study methods do you think that your students use?" and Table 2.5.3 details the frequencies of responses here.

From Table 2.5.3 Irish teachers said that their students' study methods involved practicing questions from textbooks and old examination questions considerably more often than Turkish teachers. More Irish teachers than Turkish teachers thought that their

students practiced textbook questions. Practicing old examination questions seemed to be more important for Irish teachers than Turkish teachers. However, Turkish teachers were more likely to believe both that their students used memorization when learning mathematics and that they try to understand the underlying mathematical concepts. Two Turkish teachers also said their students' study methods involved studying with a tutor.

	Reading texts/notes	Practicing questions from textbooks	Practicing old examination questions	Memorizing	Understanding underlying concepts	Others
Irish	14 (56%)	19 (76%)	25 (100%)	10 (40%)	3 (12%)	-
Turkish	13 (62%)	10 (48%)	3 (14%)	14 (67%)	7 (33%)	4 (19%)

Table 2.5.3: Frequencies of Responses to Question 25

2.5.2. Teachers' Opinions of the Leaving Certificate (LC) and the University Selection and Placement Examination (OSS) and Their Impacts on Teaching and Learning

We also asked the teachers a variety of open questions. Here we will report on the ones dealing directly with the impact of the examinations on teaching and learning and on those questions for which we observed the greatest differences between Irish and Turkish responses. Responses given by the Turkish teachers in Turkish have been translated into English by the author. The categories below were arrived at through the grounded theory coding. It should be noted that occasionally teachers gave answers that were not related to the topic of the question and these answers have not been included in the tables below.

2.5.2.1. Question 9: Positive and Negative Aspects of the Examination System

The teachers were asked an open-ended question about the examination system: What do you think of the examination system? What are its positive aspects? What are its negative aspects? Twenty-four Irish and twenty-one Turkish teachers responded to this question and there was a great variety of responses. We classified the responses into

positive and negative comments and then broke these subdivisions down further into categories (in italics in the table below). Some categories were further subdivided into concepts. If a category contains just one concept then the data is reported for the category title, otherwise the data is reported for each concept. The main difference observed in the negative comments was that Irish teachers were more likely to say that the examination negatively affects learning. However, Irish teachers were also more positive about the characteristics of the examination itself and its effects on the students' attitudes.

Table 2.5.4 gives a summary of the negative responses of Irish and Turkish teachers.

Negative comments	# of Irish teachers	# of Turkish teachers
Performance condensed into one examination in one day	8 (32%)	8 (38%)
Characteristics of the examination		
Not creative/not challenging/ does not allow for research and fun	3 (12%)	-
Pressurized	5 (20%)	3 (14%)
Has no open-ended questions/only has multiple choice questions	-	6 (29%)
Negative effects on interest		
Students have no interest because of the examination	3 (12%)	
Does not assess their interests/capabilities	-	1 (5%)
Negative effects on learning		
No understanding/encouraging memorization	6 (24%)	4 (19%)
Students have difficulties with school examinations because of OSS	-	1 (5%)
System problems		
Frequently changes	-	3 (14%)
Administration system is wrong	-	1 (5%)
Difficulty		
Does not encourage students to do higher level mathematics	1 (4%)	
Big difference in difficulty between syllabus levels	2 (8%)	-
Unsuitability for weaker students(e.g. students with poor memory)	4 (16%)	
Differences between school types		
Unfair due to different types of schools	-	2 (9.5%)
No alternative system because of the population	-	10 (48%)
Causes grinds	-	4 (19%)

Table 2.5.4: Frequencies of Irish and Turkish Negative Responses to Question 9

Furthermore, other negative comments made by individual Irish teachers were that they had to stick to a strict time schedule and the examination questions try to trick students

rather than assess them. The most common negative comments relate to performance condensed into one examination in one day (8) and effects on learning (6). For instance, an Irish teacher stated that the examination was "based too much on learning things off by heart as opposed to actually understanding" (V12). Another negative comment made by a Turkish teacher was that the examination is stressful and unfair because of the conditions of studying for the examination. The most common negative comments made by Turkish teachers were that there is no alternative system because of the population (10), the students' performance is condensed into one examination in one day (8) and the examination has no open-ended questions but all multiple-choice questions (6).Moreover, a Turkish teacher stated that "time limitation can be considered as a negative aspect. Some students may perform better if they are given more time" (KP1).

Table 2.5.5 summarizes the positive responses of Irish and Turkish teachers to question 9.

Positive comments	# of Irish teachers	# of Turkish teachers
Effects on students' attitudes		
Gives a clear direction/goals	6 (24%)	1 (5%)
Keeps students away from bad habits	-	1 (5%)
Fair/rewarding		
Rewards students' efforts	7 (28%)	-
The system is fair	8 (32%)	7 (33%)
Characteristics of the examination		
Tests knowledge/understanding	4 (16%)	-
Covers a broad range of topics	2 (8%)	-
Questions are chosen in detail from all topics	-	3 (14%)
Predictable	3 (12%)	-

Table 2.5.5: Frequencies of Irish and Turkish Positive Responses to Question 9

Moreover, individual Irish teachers also commented that all the topics are covered because of the examination, assessment is necessary, the questions are graduated from easiest to difficult ones, there is a choice on the examination and it is very good preparation for third level. The most common positive comments were that the examination system is fair (8), it rewards students (7) and it provides clear direction (6). For instance, an Irish teacher said "an exam does help to keep students focused and to help students set goals" (C41). Turkish teachers were also in favor of the system because students developed good habits. The most popular positive comment was that

the examination system is fair (7). For example, a Turkish teacher said, “it is fair, everybody has same conditions” (AO1).

2.5.2.2. Question 10: Influence of Examination System on Teaching

When the teachers were asked if the examination system influences the way they teach, twenty-two (88%) Irish teachers agreed and three (12%) disagreed. When the teachers were asked if this influence was positive or negative, six made positive comments, namely, that the examination system ensures all topics are covered (2), ensures the students are prepared for the examination (1) and it gives a clear direction or structure to their teaching (3). For instance, one teacher stated, “I like the structure of having to cover a set amount in a given time” (B22). Fourteen Irish teachers made negative comments and these comments addressed two main issues: how the examination controlled what topics were taught and how it controlled how these topics were taught. Comments relating to the first issue were that teachers teach to the test or examination (5), they have no time to look beyond examination questions or syllabus (3) and the students are not interested in topics or aspects of these that are not on the examination (1). For example, one teacher wrote that “I teach the examination, not the subject” (B21). Comments relating to the second issue were that the examination does not allow for discovery or investigation (2), the examination restricts methods of teaching (2) and teaching is not for understanding because of the examination (1). When talking about this issue, one teacher stated that “the teaching of mathematics can become very rigid and the examination becomes the only important thing” (C41). There was a different comment from a teacher who disagreed that the examination system influences the way he/she teaches. This teacher stated that “I teach everything with full explanations-never mechanically just to get results” (A22).

When Turkish teachers were asked if the examination system influences the way they teach, sixteen (76%) of them agreed and five (24%) of them disagreed. When the teachers were asked if this influence was positive or negative, a number of Turkish teachers made comments about students’ learning rather than their own teaching. There were no relevant positive comments about the influence of the examination system on teaching. Seven teachers indicated that the examination had negative aspects and these comments addressed two main issues: how the examination controlled what and how topics were taught. Comments were that teachers cannot teach the main ideas of mathematics (1), teachers have to teach according to the examination (3) and they have

to teach superficially (2). One teacher stated “of course it is not positive, in each year we have to teach the subjects parallel to the examination system” (GZO1). There was a different comment from a teacher who disagreed that the examination system influences the way he/she teaches. This teacher said “I do my job as Department of Ministry of Education indicates” (AO1).

Table 2.5.6 outlines the categories of responses from sixteen Irish and fifteen Turkish teachers who indicated that the examination influences teaching. Note that only seven of the Turkish responses related to this topic and these are the ones detailed here.

Positive comments	# of Irish teachers	# of Turkish teachers
Controlling teaching		
Ensures topics covered	2 (8%)	-
Ensures students are prepared for examination	1 (4%)	-
Gives a clear direction/structure	3 (12%)	-
Negative comments		
Controlling what topics are taught		
Teaching according to the test/examination	5 (20%)	3 (14%)
No time to look beyond examination questions/syllabus	3 (12%)	-
Students not interested in topics/aspects not on examination	1 (4%)	-
Controlling how topics are taught		
Doesn’t allow discovery/investigation	2 (8%)	-
Restricts methods of teaching	2 (8%)	-
Not teaching for understanding	1 (4%)	2 (9.5%)
Have to teach superficially	-	2 (9.5%)
Other comments		
Without examination some teachers wouldn’t push students	1 (4%)	
Mathematics department mission at school is preparing students for 3rd level instead of teaching towards the examination	-	1 (5%)

Table 2.5.6: Frequencies of Irish and Turkish Positive and Negative Responses to Question 10

2.5.2.3. Question 11: Influence of Examination System on Learning

In answer to this question (Do you think the examination system influences the way your students learn or study?) twenty-three (92%) Irish teachers agreed, whereas one (4%) disagreed. Four of the Irish teachers explicitly said that the influence was positive

and their comments were that the examination focuses the mind and provides motivation for students (2), it encourages task completion (1) and repeated questions become familiar to students and this builds students' confidence (1). For example, a teacher stated that "many weaker students are extremely demotivated and the examination helps to focus the mind" (B12). Fourteen Irish teachers explicitly said that the examination system negatively influences the way their students learn or study. The negative comments centred on two main topics: the examination system's influence on learning or studying methods and the examination system's influence on students' interest in or view of mathematics. Comments addressing the first of these were that students learn by rote (3), students do not try to understand material (2), the examination system does not encourage students to think independently (1), students study by practicing examination questions (1) and students feel they need grinds (1). For instance, one teacher stated that "often the students fail to realise the reason for learning at times and get bored learning things by rota [sic], which are immediately forgotten after examination" (B22). The comments relating to the second topic were that students are not interested in topics or aspects of topics not on the examination (3), students take a narrow view of mathematics and learning mathematics (1), students focus on achieving points (1) and students learn only for the examination (1). One illustration here is the statement by a teacher that the students "always want to know if this is on the examination. They feel it is a waste of time if it is not on examination" (A12). The Irish teacher who stated the examination system did not influence the way his/her students learn or study did not comment any further.

When we asked the teachers if the examination system influences the way their students learn or study, nineteen (90%) Turkish teachers agreed and two (9.5%) of them disagreed. When the teachers were asked if this influence was positive or negative, three Turkish teachers made positive comments, namely, that students have to learn all the topics in detail (1), in the process of preparation they are learning (1), the examination makes students study to retain the information longer (1). For example, one teacher stated that "it makes students study more consistently" (GZO1). There were far more negative comments from these teachers. These addressed two main issues: effects on learning/study methods and effects on interest in or view of mathematics. Comments relating to the first issue were that the examination causes memorization (7), there is no understanding of the ideas or no analysis (6), the examination pushes students to develop only test habits (2). For instance, a teacher said "it makes students to do always

tests, nothing else, moves them away from research. It causes only result oriented learning" (KA3). Comments relating to the second issue were that students use rote learning (1) and students have no interest because of the examination (1). For example, a teacher said that "we educate rote individuals, people who memorize everything" (KH1). One Turkish teacher, who disagreed that the examination system influences the way their students learn or study, said "if the students study hard then they go on studying hard, if the students do not study hard then they go on not studying" (AO1). The coded responses from sixteen Irish and nineteen Turkish teachers who said examination influences learning are outlined in Table 2.5.7.

Positive	# of Irish teachers	# of Turkish teachers
Examination focuses the mind, provides motivation	2 (8%)	-
Students must complete tasks	1 (4%)	-
Repeated questions become familiar to students & build confidence	1 (4%)	-
Students have to learn all the topics in detail	-	1 (5%)
In process of preparation they are learning	-	1 (5%)
Makes students study consistently	-	1 (5%)
Negative		
Influence on learning/study methods		
Students learn by rote/memorization	3 (12%)	8 (38%)
Students do not try to understand material	2 (8%)	6 (29%)
System does not encourage students to think independently	1 (4%)	-
Students study by practicing examination questions	1 (4%)	-
Students feel they need grinds	1 (4%)	-
It pushes them to learn only test techniques	-	2 (9.5%)
Influence on interest in/view of mathematics		
Students not interested in topics/aspects not on examination	3 (12%)	1 (5%)
Students take narrow view of mathematics/learning	1 (4%)	-
Negative – Other		
Students focus on achieving points	1 (4%)	-
Students learn only for the examination	1 (4%)	2 (9.5%)
Difference between examination questions and school examination questions affects students negatively	-	1 (5%)
Difficult to learn the main idea in a short time period	-	1 (5%)
Chance factor with multiple choice questions	-	1 (5%)
Comments for both		
Students have to change study habits in 12^{th} year	-	1 (5%)

Table 2.5.7: Frequencies of Irish and Turkish Positive and Negative Responses to Question 11

2.5.2.4. Question 12: Influence of Examination System on Students' Attitudes to Mathematics

Teachers were also asked whether the examination system influences students' attitudes to mathematics. Their responses to these questions are outlined in Tables 2.5.8-10 below. However, the responses were sufficiently different to afford their display in separate tables.

Irish responses				Turkish responses		
Yes	No	Missing	Do not know	Yes	No	Missing
18 (72%)	5 (20%)	1 (4%)	1 (4%)	19 (90.5%)	2 (9.5%)	-

Table 2.5.8: Frequencies of Irish and Turkish Yes/No Responses to Question 12

Table2.5.9 outlines the categories of explanations from Irish teachers who said the examination influences their students' attitudes to mathematics. Fourteen Irish teachers responded to this question.

Positive	# of teachers
Mathematics is seen as subject in which it is important to do well/not to fail	2 (8%)
Better students get great satisfaction from course	1 (4%)
Negative	
Effects on interest	
Examination reduces interest	2 (8%)
Students forced to study mathematics regardless of interest or understanding	1 (4%)
Students fail to appreciate beauty and wonder of mathematics	1 (4%)
Some students are not interested in explanations, just the methods	2 (8%)
Relevance	
Students feel mathematics is irrelevant after they leave school	2 (8%)
Lack of sufficient practical applications of mathematics	1 (4%)
Negative – Others	
Many students try HL (for points) despite ability	1 (4%)
Not sure if the influence is positive or negative	
Students always examination-focussed	1 (4%)

Table 2.5.9: Frequencies of Irish Positive and Negative Responses to Question 12

There were four Irish teachers who indicated that the examination system positively influences students' attitudes. For instance, one stated, "mathematics is seen as a subject where it is important to do well" (B12). Ten Irish teachers made negative comments. For example, a teacher said that "if they did not have to do any examination, they might have more of an interest" (V21). Furthermore, one Irish teacher disagreed that the examination system influences students' attitudes and said that "they either like or dislike mathematics-depending on ability" (A41).

Table 2.5.10 outlines the categories from Turkish teachers who said the examination system influences their students' attitudes to mathematics. Twenty Turkish teachers responded to this question but only seventeen responses were relevant to this topic.

Positive	# of teachers
They have to learn mathematics	1 (5%)
Focuses them	1 (5%)
Lots of mathematics questions in the examination so they study hard	2 (9.5%)
They like mathematics if they understand the main idea	1 (5%)
Negative	
Effects on learning	
Memorization	6 (29%)
Put away from mathematics/research/reasoning	3 (14%)
Negative – Others	
Limited time	1 (5%)
Examination makes students stressed	1 (5%)
Comments for both positive and negative	
Who wants to enter a university studies harder and harder	1 (5%)

Table 2.5.10: Frequencies of Turkish Positive and Negative Responses to Question 12

There were five Turkish teachers who explicitly said that the examination system positively influences students' attitudes. For example, one teacher stated that "the number of questions are very high so that students pay attention to learn maths" (BB2). Eleven Turkish teachers stated that the influence was negative. For instance, a teacher said that "the students think that mathematics is consisting of lots of formula that they have to memorize" (KP1).

Moreover, two Turkish teachers disagreed that the examination system influences students' attitudes and one of them stated "this is a vocational school so the students do not have any aim to enter a university" (KV1).

Some comments in Table 2.5.10 are related more to students' study habits rather than their attitudes. The main negative influence mentioned by Turkish teachers was that students memorized the subjects because of the examination and the main positive influence was there were lots of mathematics questions in the examination so students study hard, whereas Irish teachers did not say anything similar to this. However, Irish teachers had different negative codes: those students felt mathematics was irrelevant after they left school; there was a lack of sufficient practical applications of mathematics; and many students tried HL (for points) despite ability.

2.5.2.5. Question 13: Influence of Examination System on Students' Confidence in Mathematics

Table 2.5.11 presents the frequencies of Irish and Turkish teachers' responses to the question 'Do you feel the examination system influences your students' confidence in mathematics?'

Irish responses				Turkish responses		
Yes	No	Missing	Do not know	Yes	No	Missing
18 (72%)	5 (20%)	1 (4%)	1 (4%)	16 (76%)	5 (24%)	-

Table 2.5.11: Frequencies of Irish and Turkish Yes/No Responses to Question 13

Table2.5.12 outlines the categories of responses from Irish teachers who said the examination influences their students' confidence in mathematics. Thirteen Irish teachers responded to this question.

Positive	# of teachers
Good/high grades/performance increase confidence	6 (24%)
Good students can prepare well & know what to expect	1 (4%)
Students who work consistently can build confidence	1 (4%)
Negative	
Poor/low grades/performance decrease confidence (may demotivate and scar students)	8 (32%)
Fear of failure means some students don't try	1 (4%)
Lack of relevance for weaker pupils	1 (4%)

Table 2.5.12: Frequencies of Irish Positive and Negative Responses to Question 13

Turkish and Irish teachers' responses for this question were very different. Eight Irish teachers made explicitly positive comments that the examination system influences their students' confidence. For example, one said that the examination's influence may be positive "if [the student was] achieving success else can demotivated if [the student was] experiencing failure" (A42). Ten Irish teachers made explicitly negative comments and one of them said "a student who performs poorly in exams can become very disillusioned but a student who does well can gain confidence to maintain a good overall performance" (C41). Moreover, one Irish teacher, who disagreed that the examination system influences his/her students' confidence, said "there has to be some way of testing students' understanding" (B13).

Table 2.5.13 outlines the categories from Turkish teachers who said examination influences their students' confidence in mathematics. Fourteen Turkish teachers responded to this question but only seven responses directly related to students' confidence.

Positive	# of teachers
Strong students have high confidence	1 (5%)
Negative	
Makes them stressed	1 (5%)
Makes students feel under pressure	1 (5%)
Weak students feel panic	1 (5%)
They feel unconfident although they are good at school	1 (5%)
Students do not believe in themselves	2 (9.5%)

Table 2.5.13: Frequencies of Turkish Positive and Negative Responses to Question 13

Sixteen Turkish teachers believed that the examination system influenced students' confidence but only one elaborated on this in a positive way. This teacher taught at one of the Anatolian high schools; he/she said "most of our students have a high understanding of numerical subjects" (BB2). Six Turkish teachers made explicitly negative comments and one of them said "students get under pressure. While learning mathematics they do not feel comfortable" (KP2). On the other hand, a teacher who disagreed that the examination system influences his/her students' confidence said "implications for maths in post-primary level continue the same as in primary level" (AO1).

2.5.2.6. Summary of Teachers' Opinions of the Leaving Certificate (LC) and the University Selection and Placement Examination (OSS) and Their Impacts on Teaching and Learning

In this section, I will summarize the findings of Section 2.5.2. The most common negative aspects of the examination system for both Irish and Turkish teachers were that measurement of their students' performance was condensed into one examination in one day, and that the examination encouraged memorization. Turkish teachers seemed not to be happy with the format of the examination (multiple choice questions) but they thought that there was no alternative system because of the size of the population. The common positive aspect of the examination systems was that Irish and Turkish teachers believed the respective examinations were fair.

The teachers mentioned more negative effects than positive effects of the examination system on teaching. Some Irish and Turkish teachers felt that the examination system controlled their teaching for example, that they had to teach according to the examination. Irish and Turkish teachers gave different positive responses about the effects of the examination system on their students' learning. More Turkish teachers than Irish teachers believed that their students learned by rote or they memorized and they did not understand material.

Most of the Irish and Turkish teachers agreed that the examination system influenced their students' attitudes and confidence. Irish teachers believed that high grades or performance increased confidence, and low grades or performance decreased confidence.

2.5.3. Teachers' Description of Current Practices

In this section, I present teachers' descriptions of their current practices in their classrooms. The practices discussed are the teaching methods and the assessment methods that teachers use. There is also a summary of topics that were taught by teachers but were not examined, and a summary of teachers' thoughts about grinds.

Teachers were asked if they used any textbooks and which books they used: Table 2.5.14 shows the frequencies of Irish and Turkish teachers' responses to this question. The distribution of responses was statistically significantly different (chi-squared test, p-values<.05).

	Yes	**No**	**Missing**
Irish	25 (100%)	0	0
Turkish	13 (62%)	8 (38%)	0

Table 2.5.14: Frequencies of Irish and Turkish Yes/No Responses to Question 3

In Ireland the Department of Education does not approve any text or exercise books and the Irish teachers indicated that they used books published by commercial companies. Turkish teachers said that they used the books published by the Ministry of Education. They also mentioned exercise books and particular text books published by commercial companies, as well as other books they used as resources.

Question 7 (part 1) asked “what teaching methods do you use?” Responses were coded and the results are shown in table 2.5.15.

	# of Irish teachers	# of Turkish teachers
Use of ICT/technology	12 (48%)	3 (14%)
Lecturing style	16 (64%)	15 (71%)
Student practice	15 (60%)	21 (100%)
Dialogue	6 (24%)	3 (14%)
Active learning	5 (20%)	2 (9.5%)
Others	4 (16%)	1 (5%)

Table 2.5.15: Frequencies of Irish and Turkish Responses to Question 7

Twenty-one Irish and twenty-one Turkish teachers responded to this question. There are six categories of teachers’ teaching methods and these categories had some sub-categories. The sub-categories for 'use of ICT or technology' were using ICT (5 Irish and 3 Turkish), using overhead projector (5 Irish) and using data projector (2 Irish). The sub-categories for 'lecturing style' were using chalk and talk (7 Irish), using black or whiteboard (7 Irish), didactic method (2 Irish) and introduction method (15 Turkish). By the introduction method teachers meant that they taught the topic on the board while students listened to them. 'Student practice' had sub-categories of demonstration and examples (8 Irish and 3 Turkish), practicing examination questions (1 Irish), group work (3 Irish) and asking students to complete questions (3 Irish and 18 Turkish). By asking students to complete questions, the teachers meant that they ask questions to students after they introduced the subject. The sub-categories for 'dialogue' were discussion (4 Irish and 2 Turkish), questions from students (1 Irish), group discussion (1 Irish) and brainstorming (1 Turkish). The code 'active learning' was made up of the sub-

categories of discovery learning (1 Irish and 1 Turkish), active teaching (1 Turkish), learning by doing (1 Irish), projects (2 Irish) and games (1 Irish). Other teaching methods mentioned by the teachers included assigning homework (2 Irish), considering practical applications (1 Irish), using problem solving quizzes (1 Irish) and bringing students to the board (1 Turkish).

Moreover, question 7 (part 2) requested that teachers would describe a typical class. Twenty-three Irish and twenty-one Turkish teachers responded to this question. When we looked at the interviews, all the codes were similar to those described in the questionnaires and outlined in Table 2.5.16 below except that three Irish teachers had team teaching in their classes. One of these teachers (B13) explained team teaching as "there are two teachers in the room. ……one teacher is teaching the topic and the other teacher would be walking around. You might do an example on the board or there might be an activity you would get them to do and the other teacher would walk around and help them on their own. So there are two of us really helping students and students are getting down to the work themselves. And we swap over every chapter, every topic. The students get used to it and it works really well."

Table 2.5.16 attempts to portray a typical class in each country for the teachers concerned.

	# of Irish teachers	# of Turkish teachers
Settle class	2 (8%)	1 (5%)
Take roll	5 (20%)	
Check homework was attempted	3 (12%)	2 (9.5%)
Correct homework	18 (72%)	2 (9.5%)
Deal with problems with homework	3 (12%)	
Recap on previous lesson/remind the related topic	3 (12%)	4 (19%)
Introduce new theory	16 (64%)	7 (33%)
Teacher demonstrates/shows new examples	13 (52%)	3 (14%)
Student practice	16 (64%)	8 (38%)
Monitoring student progress	4 (16%)	2 (9.5%)
Summarizing	2 (8%)	
Oral examinations		1 (5%)
Students always take notes		2 (9.5%)
Students discover		2 (9.5%)
Using technology		1 (5%)
Assigning homework	11 (44%)	1 (5%)
Team teaching	3 (12%)	

Table 2.5.16: Frequencies of Irish and Turkish Responses to Question 7

We can see in Table 2.5.16 that the majority of Irish teachers began their classes with correcting the homework. Then, after introducing the new topic the lesson continued with students practice. However, Turkish teachers did not check homework regularly. They began the class by introducing the new topic and then practicing with students.

In the interviews, most Turkish teachers (19 of them) described their classes in a very similar way. They say that they usually began their classes by reminding students of the previous lesson. Then they checked homework if any had been assigned (this was not done everyday). The teacher then introduced the next topic and did a few examples. At the end of the class, teachers gave students questions to work on. For example, one of these nineteen teachers said,

first of all, I remind them of what we did in the previous class. If I gave homework, I would check it generally. …then I start teaching. But I ask quick questions of the students or let them ask questions while I am on the board…. At the end of the class, I ask questions of the students and let them solve them on the board. (AO2).

However, one Anatolian high school teacher and one private school teacher said that sometimes they taught the material, and sometimes the students taught the class depending on the subject. However, these two teachers did not mention exactly how this happened in their classes.

In the interviews with Irish teachers, sixteen of them made very similar comments when asked about their typical classes. They said that they usually began their classes by checking the homework, then they introduced the new topic, did a few examples, asked the students questions, and monitored their progress. For instance, one of the Irish teachers said,

go in, call the roll, correct the homework early on the board for where it has difficulty, then teach something new, two or three examples on the board. [Students] do two, three examples in the copy and set homework. See you tomorrow. (A11).

Furthermore, one of the Irish teachers, who did not fill in the questionnaire, mentioned a different type of class in the interview. He/she said

…in my classroom I have a poster and it has complex numbers and there is ten things you need to do for complex numbers. And as we complete each one, someone comes and ticks it off…(C32).

Another Irish teacher talked about the revision of old examination questions during class in the examination year. The teacher solved old examination questions in the class. She/he said

…so the emphasis is on exam papers. So at the moment we are revising the mock exams that they did two or three weeks ago. We are going through those papers. We go through each individual question on them. And once they are done, again it is the emphasis will be back on to previous mock exam papers… (B21).

One of the Irish teachers explained how they spent class time on reading examination questions and on familiarising students with the mathematical language used on the examination papers. He/she said that

[students] do not know how to dismantle [the examination papers]. I think a lot of [the] problem is that. I feel [students] do not know how to take it apart: they do not know what to concentrate on. I think mathematical language is an issue as well as I do not think that…they do not know the words, they do not know the difference…you know, expression, equation, they do not know what the differences are (C31).

Question 8 was one of the yes/no questions and asked if teachers have complete freedom in their choice of teaching methods. This question also has an open-ended part that invited teachers to make further comments. Tables 2.5.17-19 detail the responses to this question.

Irish responses			Turkish responses		
Yes	No	Both	Yes	No	Missing
23 (92%)	1 (4%)	1 (4%)	16 (76%)	5 (24%)	-

Table 2.5.17: Frequencies of Irish and Turkish Yes/No Responses to Question 8

Table 2.5.18 below shows the Irish teachers' comments on whether they felt free or if there was a restriction in choosing teaching methods. While 92% of Irish and 76% of Turkish teachers responded that they have complete freedom, this difference between the countries was not statistically significant (chi-squared test, p-value=.053). There were fifteen Irish and nineteen Turkish teachers who responded to this question.

Both Turkish and Irish teachers' made comments suggesting that there were a number of restrictions limiting their choice of teaching methods. However, there were some differences in the restrictions perceived. The restrictions mentioned by Irish teachers' concerned lack of funding for ICT, the problems of mixed ability classes, time constraints, and the fact that some school policies influenced how they teach. For example, one Irish teacher said "no, because I would like to use computer software more to teach mathematics but I do not have a PC/laptop or data projector in my classroom" (C42). The Turkish teachers mentioned that the education system, the

examination system and school mathematics department determined the methods, they also reported restrictions arising from the abilities of different groups or weak students. For instance, a Turkish teacher said “our students are very weak in mathematics so my method depends on their ability” (KV1). Irish teachers did not mention that the examination restricted their choice of teaching methods.

Restrictions	# of teachers
Access to computers/computer facilities are limited	5 (20%)
School policy or tendency to teach same techniques for some topics	2 (8%)
Time constraints restrict teaching methods	2 (8%)
Variety of ability in classes restricts teaching methods	1 (4%)
No budget for active methodologies	1 (4%)
Freedom	
Each teacher uses own methods	2 (8%)
All teaching methods supported by management	1 (4%)
School well-resourced and requests for new resources generally approved	1 (4%)
Trying out new or alternative methodologies	2 (8%)
No restriction as long as topics are covered	1 (4%)

Table 2.5.18: Frequencies of Irish Responses to Question 8

Table 2.5.19 below shows the Turkish teachers’ comments on whether they felt free or if there was a restriction on choosing teaching methods.

Restrictions	# of teachers
Education system chooses the method	3 (14%)
Depends on the groups	3 (14%)
Not free because of the examination	1 (5%)
Not free because of the weak students	1 (5%)
Methods are determined by school mathematics department	1 (5%)
Freedom	
Mathematics teachers choose at school	1 (5%)

Table 2.5.19: Frequencies of Turkish Responses to Question 8

Table 2.5.20 represents the Irish and Turkish responses to question 16 which asked “what kind of assessment methods do you use in your classes?”

	# of Irish teachers	# of Turkish teachers
Regular written examinations/tests	22 (88%)	13 (62%)
End of term examinations	4 (16%)	-
Examinations based on LC/OSS questions	1 (4%)	-
Asking past examination questions	1 (4%)	-
Asking questions/Oral examinations	14 (56%)	9 (43%)
Quiz	3 (12%)	3 (14%)
Checking homework	11 (44%)	3 (14%)
Bringing students to board	1 (4%)	4 (19%)
Observing them in the class	-	7 (33%)
Investigating written work	-	1 (5%)
Asking questions to explain solutions to a friend	-	1 (5%)

Table 2.5.20: Frequencies of Irish and Turkish Responses to Question 16

Twenty-five Irish and twenty Turkish teachers responded to this question. Both Irish teachers and Turkish teachers used written examinations/tests regularly and they assessed their students by asking questions or by having oral examinations. Irish teachers were more likely to say that they assessed their students by checking homework. Turkish teachers commented that they observed their students in their classes to see if they were participating.

We asked teachers if they ever discussed topics in class that would not be examined. Table 2.5.21 details the yes/no responses to question 19. The proportions were here statistically significantly different (chi-squared test, p-value<.05).

	Yes	No	Missing
Irish	10 (40%)	14 (56%)	1 (4%)
Turkish	15 (71%)	6 (29%)	0

Table 2.5.21: Frequencies of Irish and Turkish Yes/No Responses to Question 19

Table 2.5.22 summarizes the comments to question 19.

There were ten Irish and fifteen Turkish teachers who responded to this question. A number of Turkish teachers commented that they discussed daily issues in their classes, whereas some Irish teachers (not included in Table 2.5.22) mentioned covering extra materials on specific topics such as large matrices, some aspects of probability (gambling, Fibonacci series), permutations, combinations, certain algebraic techniques or skills, Fibonacci sequences.

Teachers who discuss other topics at present	# of Irish teachers	# of Turkish teachers
History of mathematics	1 (4%)	1 (5%)
Lateral thinking	2 (8%)	-
Applied mathematics in transition year	1 (4%)	-
Logical thinking puzzles-board games/brain teasers	2 (8%)	-
Daily issues (not mathematics)	-	6 (29%)
Applications	-	3 (14%)
Proofs	-	1 (5%)
Revision	-	1 (5%)
Teachers who do not discuss current topics at present		
Refer from time to time to where mathematics is used but not on a regular basics	1 (4%)	-

Table 2.5.22: Frequencies of Irish and Turkish Responses to Question 19

Question 32 asked "what do you think about grinds?" Table 2.5.23 below shows the comments to this question. Twenty-five Irish teachers and twenty-one Turkish teachers responded to this question.

Positive Comments	# of Irish teachers	# of Turkish teachers
Helpful if student is struggling/needs one-to-one attention	6 (24%)	2 (9.5%)
Sometimes necessary	4 (16%)	6 (29%)
Sometimes helpful	11 (44%)	-
Grinds can give students confidence/make them feel better	5 (20%)	-
Necessary to deal with the difference between school types	-	2 (9.5%)
Teacher approves of grinds	2 (8%)	-
Negative comments		
Encourage rote learning not understanding/ topics covered mechanically	3 (12%)	2 (9.5%)
Some students taking grinds feel they don't need to work in school	2 (8%)	2 (9.5%)
Different techniques used in grinds may confuse students	1 (4%)	-
Some teachers use them to make money	1 (4%)	-
Teacher doesn't approve of weekly/regular grinds	2 (8%)	-
Unnecessary for lazy students	2 (8%)	-
Not fair	-	1 (5%)
Everybody gets grinds even if they do not need them	-	1 (5%)
Grind schools make students tired	-	2 (9.5%)
Other comments		
Teacher more important than grind tutor	1 (4%)	-
Examination system causes grinds	-	8 (38%)
If students listen carefully and study at home then not needed	-	1 (5%)

Table 2.5.23: Frequencies of Irish and Turkish Negative and Positive Responses to Question 32

To continue with Question 32, we also specifically asked teachers if grinds were necessary. Table 2.5.24 details Irish and Turkish responses. Teachers responded ‘sometimes’ although the options given in this question were "yes" and "no".

	Yes	Sometimes	No	Missing
Irish	1 (4%)	17 (68%)	6 (24%)	1 (4%)
Turkish	7 (33%)	8 (38%)	5 (24%)	1 (5%)

Table 2.5.24: Frequencies of Irish and Turkish Responses to Question 32

The most common comment was that grinds could be helpful: eleven Irish teachers said that grinds were useful or helpful in certain situations including if the teacher failed to deliver or if the student was under pressure to achieve high grades.

Many negative comments are related to the negative effects of grinds on students' learning. Eight Turkish teachers said that the examination system caused students to get grinds. For example, one Turkish teacher said “grind schools are necessary for solving lots of different questions [for the examination] but not for learning the subjects” (GZO2). The OSS examination depends only on students’ performances on one examination in one day. For this reason, in Turkey, grind schools are used widely when preparing for the examination. The aim of these schools is to teach students test techniques and to cover the many different types of multiple-choice questions that are likely to appear on the examination. Another reason for the popularity of grind schools is the difference between the OSS examination system and the school education system.

We asked teachers if they try to help their students with anxiety problems, confidence, and/or study style before the examination (Q15). Twenty-one Turkish and twenty-four Irish teachers said that they tried to help their students in this way. For instance, a Turkish teacher stated that he/she is “encouraging students by reminding them of their mistakes in previous exams and telling them if they need more practice on a specific topic” (KP1). An Irish teacher said that he/she helps students through “encouraging comments on frequent returned tests and building up confidence doing questions from past papers” (B22).

We asked teachers in question 20 what they thought of the syllabus and its positive and negative aspects. Twenty-two Irish teachers commented on positive aspects of the syllabus. Some of these comments were that the syllabus is wide-ranging or broad (9), it is good or very good (6), it stretches or challenges students (4) and gives a good

overview of mathematics or covers the main ideas (3). For instance, an Irish teacher said "I like the fact that there is a wide variety on the course" (B21). Eight Irish teachers made an explicitly negative comment regarding the lack of relevance, real world links or applications on the course. For example, one of these eight Irish teachers said that "students do not get to use mathematics method properly e.g. statistics should be related to real life" (A41). Seven of them also said the syllabus was too long. Ten Turkish teachers made explicitly negative comments that the topics were not distributed evenly. For example, a Turkish teacher said "there are a lot of topics in 10^{th} year but few in 11^{th} year. So it is impossible to teach all of them and we teach quickly, we can not give the details" (AS1).

2.5.3.1. Summary of Teachers' Description of Current Practices

Both Irish and Turkish teachers mentioned similar teaching methods: lecturing style and student practice. Irish teachers also used ICT or technology in their classes. The Irish mathematics classes seemed to begin with correcting homework, followed by the introduction of anew topic, student practice, and the assignment of homework for the next class. The Turkish flow of mathematical activities in classes was introducing a new topic and then student practice. More Irish teachers than Turkish teachers felt free in choosing their teaching methods. Both Irish and Turkish teachers assessed their students by regular written examinations and oral examinations (asking questions). Some of the Turkish teachers mentioned that they observed students in class and some Irish teachers assessed students by checking homework. Irish teachers seemed to think that grinds were sometimes helpful and Turkish teachers believed that the examination system caused grinds (grind schools).

2.5.4. Teachers' Recommendations for New System

This section presents how teachers would design a new national assessment system and how they would change the way that they taught under a new assessment system.

Question 17: if you were designing a new national assessment system, what it would be?

Generally speaking, the Irish teachers would change the assessment system, whereas the Turkish teachers would change the types of questions asked. However, a Turkish teacher said, "I would do continuous assessment and I would evaluate students'

performance at school with the continuous assessment system" (KH1). An Irish teacher made a similar comment, namely that his preference would be for "ideally continued assessment, oral examinations, projects and presentations" (C11).
Table 2.5.25 details the responses to question 17.

Advocating change	# of Irish teachers	# of Turkish teachers
Continuous assessment	13 (52%)	2 (9.5%)
Modularized examinations	4 (16%)	2 (9.5%)
Questions more relevant to everyday life (i.e. changing content)	4 (16%)	-
Project work	3 (12%)	-
Oral examinations	2 (8%)	-
Presentations	1 (4%)	-
Like Project mathematics	2 (8%)	-
More hands-on	1 (4%)	-
Extra examination at primary level	1 (4%)	-
More interpretation	-	1 (5%)
Partial credit, open-ended and practical questions	-	3 (14%)
Number of questions should be increased	-	1 (5%)
Each university should select their students	-	2 (9.5%)
Assessment must be done in class/schools	-	4 (19%)
Separate examination for vocational schools	-	1 (5%)
Students scores at schools would be weighted more	-	2 (9.5%)
Let students use calculator and log table	-	1 (5%)
Happy with the new system in 2010	-	1 (5%)
Reluctant to change		
Keep examination system as it is	1 (4%)	
Reluctance to move to continuous assessment	2 (8%)	
Keeping some element of formal examination	4 (16%)	

Table 2.5.25: Frequencies of Irish and Turkish Responses to Question 17

Question 18: if there were a different national assessment system, would you change the way that you teach? Table 2.5.26 details the responses to question eighteen.

	Yes	No	Missing	Perhaps
Irish	15 (60%)	6 (24%)	3 (12%)	1 (4%)
Turkish	11 (52%)	9 (43%)	1 (5%)	

Table 2.5.26: Frequencies of Irish and Turkish Yes/No Responses to Question 18

Table 2.5.26 shows between 50% and 60% of Irish and Turkish teachers said they would change the way that they taught it there was a different national assessment

system. To continue teachers were asked “if so, how?” Table 2.5.27 details the responses to this question.

Most Turkish teachers did not elaborate on how they would change the way that they taught.

Change in content	# of Irish teachers	# of Turkish teachers
More relevant/real life/practical applications	3 (12%)	-
Change in resources used		
More use of/access to computers/technology	3 (12%)	-
More props	1 (4%)	-
Change in general approach/strategy		
In order to maximize results/help students fulfill potential	2 (8%)	-
Less pressure/more relaxed	2 (8%)	-
Not so examination focused	2 (8%)	-
Change in teaching methodologies		
Discovery learning	1 (4%)	2 (9.5%)
More proofs	-	1 (5%)
More theory	-	1 (5%)
More time for investigations	1 (4%)	-
Get students to explain answers	1 (4%)	-
Depends on new system	3 (12%)	1 (5%)

Table 2.5.27: Frequencies of Irish and Turkish Responses to Question 18

In question 21, we asked teachers if they were writing a new syllabus, what they would include or omit.

Seven of the Irish teachers would put more emphasis on real life applications. Only one Turkish teacher made a comment about real life applications. This is maybe because the books approved by Turkish Ministry of Education include many contextualized mathematics questions. Irish and Turkish teachers would include and omit some specific topics. Individual Irish teachers would include differential equations, trigonometry, and algebra and two Turkish teachers would include statistics. The topics that individual Irish and Turkish teachers would omit are complex numbers, matrices, vectors, linear transformations, linear programming, induction, difference equations, convergence and divergence, geometry at Leaving Certificate, sequences at Ordinary Level, calculus at Ordinary Level Leaving Certificate, trigonometry, number and group theory.

Include	# of Irish teachers	# of Turkish teachers
Real life applications (esp. ones relevant to teenagers)/practical mathematics	7 (28%)	1 (5%)
Mathematical modeling	1 (4%)	-
Historical background	2 (8%)	-
More hands-on/ Project mathematics	1 (4%)	-
Problem solving	1 (4%)	1 (5%)
Puzzles	1 (4%)	-
Computer programming	1 (4%)	1 (5%)
Specific topics	3 (12%)	3 (14%)
More arithmetic	1 (4%)	-
Proofs	-	1 (5%)
Omit		
Theorems	2 (8%)	-
Specific topics	7 (28%)	3 (14%)
Omit some topics, do others in more detail	1 (4%)	-
All third and fourth year topics from vocational schools	-	2 (9.5%)
Final year topics	-	2 (9.5%)

Table 2.5.28: Frequencies of Irish and Turkish Responses to Question 21

Although the Project Maths review was not explicitly referred to in the questions on the questionnaire or in the interviews, one Irish teacher mentioned Project Maths in the questionnaire and two of them referred to it in their interviews. For instance, when asked his/her thoughts about the syllabus, C32 said "I think it is starting to be dated. Whether Project Maths is right or not. I do not know, I have not thought it yet. But something had to be done, it needed to be brought into the 21st century…". V22 said, "…Project Maths which is trying to make mathematics more problem solving centered. That is a very good idea. Because what is happening is most teachers, I am being teaching long time, I can predict what is coming up more in the LC…If there was much more problem solving involved, the youngsters themselves would have to think of the nature of problems and how to go on solving and so on…" Also, some of the suggestions teachers made on Table 2.5.28 are in line with the aims of Project Maths (e.g. problem solving, real life applications)

2.5.4.1. Summary of Teachers' Recommendations for New System

Irish teachers seemed to think that a continuous assessment system would be better than the existing system. Turkish teachers would change the format of the examination questions. More Irish teachers than Turkish teachers thought they would change the way

that they taught if there was a different examination system. More Irish teachers than Turkish teachers would include more real life applications, practical mathematics, and they would omit specific topics from the syllabus.

2.6. Summary of Interviews

In this section, I will outline some of the similarities and differences that emerged from the interviews with Irish and Turkish teachers. Twenty-one Turkish (all) and twenty-three Irish (out of twenty-five) teachers were interviewed. The interviews took between three and thirty minutes. The data from interviews was analyzed as described on section 2.4.2. In this section, I explore the themes that arose from these interviews. The sub-sections mostly follow the order of questions asked in interview and each theme is preceded by a sentence which says whether the teachers were explicitly asked a question or not. The sub-section 2.6.2 does not follow the same order, it was not explicitly asked to the teachers.

2.6.1. Teaching Methods

Twenty-one Irish and twenty-one Turkish teachers were asked to describe a typical mathematics class. All of the teachers talked about their teaching methods. Most of the Irish teachers (20 out of 21) described very similar class situations and this has already been described in section 5.3. For example, an Irish teacher stated that

A typical class would be for me to make sure that they have all their books and copies, to ask them if they have any difficulties with the homework that they would be assigned for the previous night, to sort out these difficulties, to go on to the next example, to do the example usually on the board, discuss it, explain it…. (V22)

From the Irish teachers' responses in the interviews the emphasis in their classes seemed to be on doing questions, for example, doing homework questions or textbook examples. V12 was a foundation level teacher and said that she/he had a very weak class. She/he spent most of the class time working on homework questions.

It all depends on the class I find…. Well, my 5th year class is very weak, very weak. So I spend about five minutes trying to get them to get everything out and get ready for the class…. I have to go through the homework all the time, like literally step by step by step. And then more than likely you are staying on the same topics again because they are very weak. And then it might just literally be like that, trying to get them to understand the homework, sticking on the same topic, trying the comprehension of that. And then probably, maybe three or four days after each new topic that I do, maybe give them a small test on it to see if they understand, and it is just like that and that is if they

are all in. You could have four or five people in the class a day and you cannot move on. (V12)

This was a typical weaker class, however, some Higher level teachers used similar methods:

It is very difficult to say what a typical class is because it depends on the level I teach.……In the higher class, basically the way I do it is recap the previous class, go over any problems that they had, if they brought up anything they did not understand. Correct the homework, which is also to help them and make sure that they understood the previous class. I would introduce the topic for the class at the start and show them some example, try to get them understanding, get them to work on it. And then I would probably set homework… (C41)

A31 said that checking the homework at the beginning of the class was time consuming so she/he changed the method. Even though this teacher changed his/her method, still the emphasis was on practicing questions. She/he asked students to reflect on what they had learned.

I would go in and …I actually changed my method. I actually start a new topic at the start. I used to always correct homework. But what I found with that was: I ended up spending a disproportionate time correcting homework. So I start a new topic, they have lots of practice and while they are practicing their questions, I am going around checking their homework. And I find that has reduced the amount of mistakes that they make, because they have more time in the class to practice, I can look a copy and ultimate [sic] something small, so it saves me doing a full question at. So I would start the topic and then at the end I might for the five minutes, get them to reflect –what did they learn- for new things and write it down, bullet points, like summarize. (A31)

In section 5.3, I explained the typical Turkish class as described by BB1:

Generally, I use teacher-centered method. I am on the board, the students are listening to me, while I am teaching on the board, students can ask what they do not understand or have a question. Also I always ask them quick questions. (BB1)

Four of the Turkish teachers said that if they gave homework, they would do homework questions in the class. One of them said,

…if I have given homework previously, I would start lesson by checking them. And I solve the problems that [students] could not do… (SS2)

Four of the Turkish teachers mentioned learning by discovery. One of them said,

I usually give a question prior to the lesson for preparation. I start a lesson by discussing that question. Usually this question also pushes students to research and think. I think it is useful. (KA1)

This teacher was from an Anatolian high school. Another teacher from this school spoke about discovery, and the other two teachers who talked about discovery were

from ordinary and private schools. Five of the Turkish teachers pointed out that they wanted their students to listen to them carefully. One of them said,

I think the most important thing is the students' participation in the class. Absolutely, I want them listen to me very carefully while I am teaching a new topic. (AS1)

Four Anatolian high school teachers and one vocational school teacher wanted their students to be active in the class. One of them said,

Definitely, a lesson would be where all students are active and are enjoying [the lesson]. Even if one student would not enjoy the lesson that would cause me to lose my attention. I mean I would like to my students to be actively join lesson, I want them to put their effort into the lesson. I teach them the subject and they usually are more active when they solve problems. (KA2)

Six Turkish teachers explicitly said that they asked questions of their students to see if they understood the topic or not. One of them said,

I always want my students to listen to me very carefully. I am always on the board, teacher-centred lessons. I always have to understand whether the students understand the ideas or not. So that, I try to ask them quick questions while I am teaching. (AS2)

2.6.2. Student Background

Teachers were not asked specifically about their students' backgrounds however, when answering other questions, some teachers mentioned that students' backgrounds affect their teaching. Four Anatolian and two Science school teachers said that they did not have to make too much of an effort with teaching because their students were the most intelligent and hardworking students in all of Turkey and they were selected with a continuous assessment system during the last three years of primary education. For example, a Turkish teacher said "Since we have selected the students they do not have any problem with mathematics……." (KH1).

One Irish teacher mentioned this also and said that,

We really have wonderful girls to work with here. Their parents expect them to work. So they work. I think background is of huge importance. Sometimes we have some who won't do it as well as they should, but in general, they are fantastic. So there is great job satisfaction. You can see the children developing and understanding what you are doing. It is absolutely lovely to teach here… (A22)

2.6.3. Homework

Twenty Irish and thirteen Turkish teachers were asked if they gave and checked homework. All the Irish teachers gave daily homework and checked it. For example, an Irish teacher said,

Yes, every night. The way I do it is, I give them the homework then check that they have it attempted. I correct the questions on the board if they have difficulty with it. If not we just talk about them. (B12)

Six Turkish teachers gave homework after each topic mostly in 9^{th} and 10^{th} years and they did not check it regularly. Two Anatolian high school teachers said that it was the students' responsibility to do homework in the given time. For instance, a Turkish teacher said,

Yes, at the end of the subject. I prepare a few questions and give them. And I solve the questions that they could not answer. We have high caliber chosen students. They know their responsibilities. They do their homework on their own and that is why I do not check them constantly. (KH1)

2.6.4. Teachers' Co-operation

We asked about the teachers' co-operation at schools. Eighteen Irish teachers were asked about co-operation with their colleagues. Ten Irish teachers said that they had very little co-operation or they had formal meetings once a month or term. For example, one of them said,

I would say very little except that we decide on the same topic to be done each year (C22)

One of the other Irish teachers said,

No, from time to time but not much. From time to time at meetings, but other than that, not really(B12)

Six Irish teachers said that they had informal chats with their colleagues and one of them said, "…and [we all] sit at lunch time, just generally chatting…" (A11)

In addition, they described team teaching, which had not come up with the Turkish teachers. Team teaching was explained in section 5.3.

Nineteen Turkish teachers were asked if they co-operated with their colleagues. Fourteen (out of nineteen) teachers said that they co-operated. This was mainly a consequence of the fact that they had to set common examinations at schools. Common examinations were compulsory and made teachers get in touch very often. Often

teachers had to spend the same time as their colleagues on teaching the same topics and they also shared their notes and examples. One of the teachers said,

Yes absolutely. We have common exams. So we have to co-operate with each other. We have to start and finish the same topics at the same time. We co-operate very often. We always have some dialogues. (AO2)

2.6.5. Syllabus

One of the other questions asked in the interviews was on teachers' thoughts about the syllabus. Twenty-one Irish teachers were asked this question. Five Irish teachers focused on the examination when asked about the syllabus. They seemed to think that the syllabus and the examination were identical, what they did in the syllabus was just for the examination. One of them said,

…. So you have to make sure by the end of fifth year you have a certain amount done so when you come back in sixth year. So really you are looking at the examination the whole time. (A12)

Moreover, V21 said

…you would have to cover the questions on the examination paper

Nine Irish teachers added that syllabus was too long to cover or to go into as deeply as they would like to do. They could not discuss all the topics with their weak classes. An Irish teacher stated,

…for the L.C., I think it is very broad. It would cover many different aspects. …. (B13)

Another Irish teacher said,

I think it is very long. For two years and possibly a bit of fourth year, it is very hard to finish the course. I know, like for example myself, and I know other teachers do not do all the course. We can not get it fitted in, plus revision. So what we are doing is we are really aiming, at the end of the day our goal is, to get through the LC examination. So all we are trying to do is get enough of the course covered so we can actually get six questions per paper. So we are trying to cover seven topics to get it done. And that is leaving stuff out as well. The course in my opinion is very long. (C41)

In addition, A42 said that because the syllabus is too long, it prevented teachers from teaching in a more student-centered manner.

…what I have found in the past when I have tried to use more active method, or tried to make it that the students are more active or different methods, then I ended up behind in the year to get the same amount of work covered.

Ten Turkish teachers were asked about the syllabus. All Turkish teachers thought the syllabus was exactly the same as what they did in the class and did not focus on the OSS examination. One of them said,

I think it is better with recent changes. It is now more related to daily life. It is positive. But subjects are not distributed evenly through years (4 years). And too many subjects. It is much too detailed. (KH2)

Four Turkish teachers explicitly said that they were happy with the syllabus, most of the remainder also seemed to be happy. However, eight of them were not happy with the distribution of topics into four years. They said the topics were not distributed evenly, there were more topics in 9^{th} and 10^{th} years than 11^{th} and 12^{th} years. A Turkish teacher said,

… in the 9^{th} and 10^{th} years, there are lots of topics to finish in a year. But in 11^{th} and 12^{th} years the number of the topics is very low. I think they have to change it (AO1)

2.6.6. Grinds

There were different thoughts in the interviews about grinds. Twenty-three of the Irish and twenty Turkish teachers were asked about grinds. Fifteen Irish teachers mentioned grinds as studying with a tutor individually. Thirteen (out of fifteen) of them thought that certain students who struggled on a specific topic needed grinds but this should not be done on a weekly basis. For instance, an Irish teacher stated,

…I think they [students] should have it if they are stuck on different topics, maybe get a little help with particular topics. But I do not really agree with weekly grinds as such because I do not think you need a grind one a week… (V21)

Fourteen of the Turkish teachers felt grind schools were necessary for the examination. One of them said,

I think they are necessary. OSS is a kind of a race. I mean, the students do not only want to enter a university, they also want to enter the best universities. So that they study very seriously. (GZO1)

Eight of them said that the examination system caused grind schools. There is quite a difference between the university selection examination system and the assessment system at schools in Turkey. The OSS examination has multiple-choice questions and it is done in one day, while the school examinations have partial credit questions and students have six school examinations in a year. As a result students attend these grind

schools to learn how to solve multiple-choice questions quickly. One of the teachers said,

In these conditions, they are necessary. Because of the conditions of the exam system: multiple choice questions, limited time and the growing population of students. But I think, it is too much demanding on the grinds and it is not good. Because it assumes that what we teach at schools is not enough and that is not true. (AS2)

Six of the Turkish teachers were not happy that attending grind schools were more important than attending schools and students thought that they did not need to listen to their teachers at schools because they could learn everything in grind schools. Turkish teachers thought their students had a very negative attitude believing that they could only learn the idea of mathematics in grind schools. For instance, a teacher said,

Grinds are now more important than schools. We prepare our students for real life and also provide them to mathematical research and give explanation of the idea of mathematics. But grinds are only working toward the OSS exam. Students have to get a result within the test system in the most efficient way. So I think this is why grind schools are not necessary for OSS. (KA3)

In vocational schools, the number of mathematics classes was less than the other schools had. Because of this reason, vocational school students could not get a chance to learn all the topics in detail. In 2010, the Minister of Education increased the number of the mathematics classes in vocational schools. However, two vocational school teachers thought their students needed grinds to close the gap between vocational schools and the other types of schools. One of them said,

It is needed. They need grinds to improve test skills and close the gap. We have half the maths hours of other schools. To close this gap grinds are needed. (KV1)

2.6.7. The Examination System

Twenty-five Irish teachers and nineteen Turkish teachers were asked about their thoughts on the examination system. Five Irish teachers and six Turkish teachers thought these examination systems were fair because everybody had the same conditions in every part of the country. Even though the countries are different, both sets of teachers held similar views on this issue. An Irish teacher said,

…[the examination system] is so fair, I really think. You could be down in West Cork, and you are doing the same examination as somebody in this school here, and nobody knows your name and – for a country like this where who you know often is very important – I think that is wonderful, you could be a professor's son or minister's son, and you are treated in exactly the same way. I think that is fantastic. (B22)

A Turkish teacher said,

*…it is a very fair system. Everybody has the same questions at the same time. It is a fair way of selecting students. Because the students' population is huge… (*KP2)

In Turkey, twelve teachers thought that the OSS examination had to be run in the way that it is because of the huge population. One of the Turkish teachers said,

I think it is necessary in Turkey. The student population is growing who graduate from post-primary schools…there should be an examination. (BB1)

Four Turkish teachers said there were frequent changes to the examination system in the past and they were not happy with these changes. However, they seemed to be happy with the last change in 2010. One of them said,

…in our country, they make some changes about the examination system very often. Every two or three years, there are some changes. We try to settle for these changes, I mean as a teacher. But I think the last change is the best, I hope so. The numbers of the questions were increased so they can ask more detailed questions. And also we can teach more detail… (GZO2)

In addition an Anatolian high school teacher stated that he/she was not happy with the multiple-choice questions in the examination and said

…we can discuss whether this examination system is fair or not. Because the questions are multiple-choice and they are very quick questions. I think it makes students memorize mathematics…(AS2)

2.6.8. The Effects of the Examination on Teaching

Although usually not explicitly asked about in the interviews, nineteen Irish teachers said something about the effects of the examination on their teaching. Eight of them mentioned using examination questions in class and covering the course in terms of the examination questions. One of them said,

…so what we are doing is we are really aiming, at the end of the day our goal is, to get through the LC exam. So all we are trying to do is get enough of the course covered so we can actually get 6 questions plus one safety question per paper. So we are trying to cover 7 topics to get it done. And that is leaving stuff out as… (C41)

Another example,

Yes, it influences [students] because it influences me. I have to work to the prescribed syllabus. I have no choice. If I want my students to do well, I cannot be elaborating on L'Hôspital's Rule or Eratosthenes' sieve and things like that, if it is not on the course. Of course it does affect them. (A21)

Another Irish teacher mentioned that,

…I mean you are looking at the examination papers, obviously work from the syllabus you know, try make sure all the stuff's done… (A12)

Some Irish teachers seem to feel it is their responsibility to ensure that students achieve a certain grade and A32 said,

… after the mocks in sixth year for the last three months, I will in revision of everything, I will have spoken myself to the two or three of [students], who are really just going to pass and say to them "which are your six topics?" and actually we might only do A and B. You do not mind part C. "do not be getting stressed about part C. Cause you need twenty marks at each questions not fifty." So I teach everything and I revise everything but there will be certain students who I will have spoken to say "this is not your topic."

A41 said,

… your aim is to show them ways to get the best result as possible. To pass them, to get them the honor, and the high honor. Your teaching is focused on the end, the L.C.

Teachers are very aware of how to obtain marks in the examination and V11 said,

… [the examination] totally influences how I teach, especially for ordinary level group. I would constantly be telling them how to get the attempt marks. I would say things like "look at this stuff. I know you are telling me you cannot do it" because they are all saying " it is too hard, it is too hard, I can not do it" and I am going "how about we just get the attempt marks." So I am not asking them to do any comprehension or understanding. I would say "look how the question is phrased: how will we get attempt marks for doing that?" and hopefully then they get on and get more than attempt marks but that is how I would be teaching them. Especially at LC, they are coming to an absolutely massive jump at LC. I have no time to try re-teach them, you know what I mean, or give them an appreciation or understanding of what they are doing because for one they do not want to know…or they are maybe so demoralized from JC that they do not want to, they just want to know how to get the answer. When you try and do fun things at all, they are "just tell us", they are not interested. So I do not try to do anything extra or different, because they just want to know how to get the marks in the end.

Moreover, A42 said that they decided as a mathematics department in September, what they would teach in fifth and sixth years and added that

You tend to teach the topics that they get most marks on, that they find easiest in the examination. Everything would be asked on the examination but they would not have to answer it, because they have choice we do not have to cover all the topics if we do not have time.

Eleven Irish teachers spoke about teaching to the test: for example, choosing topics to teach based on how easy it is to get marks on L.C., constantly telling students how to get attempt marks, aiming to get students certain grades, concentrating on parts (a) and (b) of the questions, training students to read examination questions, giving students

skills to get points on L.C. rather than giving them an understanding of mathematics, etc.). For instance, one Irish teacher said,

… this is very academic school and so points are very definitely the requirement at the end of the day. And you just sit there the whole time, teaching, you give your student the skills to get the most points. Not necessarily a lot of mathematics or understanding of mathematics, just to get the points, points, points all the time (A11).

Four Irish teachers explicitly mentioned the fact that the examination is predictable, one seemed to think this was good but the others made comments like you could teach someone to do the examination without having any understanding, or the examination is predictable so that a teacher can gear his/her students towards questions. B22 said,

…we will then take the examination papers out, we will have a look at what was in the examination paper, the questions that are asked. I will explain the questions they are asking, what the question is looking for and what particular area in geometry we are looking at. I am talking the questions…

Eight Turkish teachers made comments on the effects of the examination on their teaching. Four (out of eight) were asked about the influences on teaching. Each of the teachers said different things. KH2 said,

Of course it does. We have to teach more theoretically instead of relating to practical life situations. We have to teach towards the test system by teaching in a short time period and short answers. And that's why I can't teach lessons detailed enough.

GZO1 teacher said,

Absolutely yes. If there is not an exam, I do not think that we would teach all the topics from the syllabus or more details from all the topics. The exam pushes the teachers to go deeply in to teaching maths and also we do lots of examples or questions for each topic. I think if there were no exam, the maths that we teach in secondary schools would be more superficial. I mean the quality of teaching would be less.

Moreover, BB1 stated,

…we try to teach the ideas at maths. We try to help the student understand the maths idea…

Two Turkish teachers who were not asked about the influences of the examination on teaching mentioned the OSS examination very often in their classes and one of them said, "…I talk about the exam almost every class in the 12th year…." (AS2)

In addition, GZO2 mentioned,

Nobody knows what maths is useful for or teachers do not know how/where/when the students use maths. We teach maths only for the exam and the students learn maths only for the exam. I think we can change it with the changes of the exam system. They can ask exam questions more related to real life. I think the teachers have to be educated like this.

2.6.9. The Effects of the Examination on Learning

Eighteen Irish teachers were asked about the effects of the examination on students' attitudes and two of them were asked how the students felt about the L.C. examination. Six teachers mentioned stress or pressure. One of them said, "for L.C., it is always on their mind, definitely, the examination…..*"* (A41)

Five teachers spoke about the examination as a positive motivating force for example saying that it makes students work, or rewards work etc. One of them said,

I would be happy with the system, because it gives them focus. They know what they have to do. It rewards those who work basically. (B12)

C42 said,

…if you do not have any examinations, it is more difficult to get students motivated to study….

Four teachers saw the examination as a negative motivating force in some students that thought they would not do well and stopped working. Negative attitudes arose from the fact that mathematics was compulsory, and two teachers felt that it made students 'hate' mathematics because of the focus on the examination in the teaching of the subject. One of them said,

I think [the examination] makes the students, a lot of students especially weak ones, hate mathematics and they get really negative about it and they have no motivation because constantly we are telling them it is all about the exam, you have to do the exam, you have to pass the exam, and they just get a very negative impression of mathematics. Whereas if they were able to achieve some success on mathematics as they went along and get praise from us and realize that it is good, that I achieved this and then they might not have such a negative aspects of mathematics…[the examination system] makes [students] just worry about the examination and worry if they are going to pass or worry if they are going to fail rather than think about the different topics of mathematics just as 'this is the topic in mathematics that I am learning – it is the topic: can I pass it? Will I fail it? how will I do in the examination?' (A42)

Six Irish teachers talk about students being focused only on the examination and wanting methods rather than understanding. One of them said, "….[because of the examination, students] want solutions, they want methods, they want steps…." (A31) One of the other Irish teachers said,

…[students] are maybe so demoralized from JC that they do not want to, they just want to know how to get the answer. When you try and do fun things at all, they are "just tell us", they are not interested. So I do not try to do anything extra or different, because they just want to know how to get the marks in the end. (V11)

For instance, A31 stated, "…[the examination] influences [students'] study…they want solutions, they want methods and they want steps…"

Only four Turkish teachers were asked about the influences of the examination on their students, however some of them spoke about these influences when they were asked about their thoughts on the examination system. Four of them said that the examination causes memorization and one of them stated,

…the questions are multiple choice questions and they are very quick questions. I think it makes the students memorize the maths… (AS2)

Five Turkish teachers said that students want to learn only for the examination. One of them said,

Yes, absolutely. At the last grade, the students do not come to school regularly. Their excuse for not coming to school everyday is to study for the exam. While I am teaching in the class, they don't try to understand the idea of maths. They only think, this topic is necessary for the exam or not. They only think exam, exam and exam. They are not interested in the course. (KP1)

AS1 teacher made a positive comment that the examination made students study regularly and stated that

I have positive aspects about OSS. The variety of questions is very much. I think, because of this, the students study very regularly.

Four of the Turkish teachers were asked about their students' attitudes to mathematics. There were different responses such as if students understand the idea of mathematics, they love it (GZO1); students like mathematics and so they are good at mathematics (KA1 & KA2); students were weak and had no confidence in mathematics (MSV)

2.6.10. Time Pressure

Teachers were not explicitly asked about the time pressure, however, fourteen Irish and three Turkish teachers said something on this topic over the course of their interview. Four Irish teachers said they left out some topics for weak students because of time pressure. For example, one of them said

…if I have a good student who maybe particularly weak I feel there is no point overloading them with all this information. They are the kinds of students who just need the twelve topics that they are going to have answer in the examination. (A11)

Ten of the Irish teachers mentioned that syllabus was too long to teach in two years and they did not have time to do anything off course or re-teach or teach deeply. For instance, one Irish teacher said,

…you are looking at the examination papers, obviously work from the syllabus you know, try make sure all the stuff's done. But here is a time thing that you have to make sure that you have everything covered for the examination. So you have to make sure by the end of 5th year you have a certain amount done so when you come back in 6th year. So really you are looking at the examination whole time. (A12)

Moreover, C31 stated that

…do the kids understand everything in-depth that comes up on it? No. but the reality is the teachers would not have time to get into every single thing, the nitty-gritty of every little thing, every time. Because [teachers] just do not have time…

A21 commented that the examinations were time-consuming for the students and said,

…[students] are not prepared to spend the time. It is very time absorbing. Look, it is a fact of life, like George Orwell, "all pigs are equal but some are more equal than other". That is the reality and we have to accept that. And I do not think it is much good if you spend two years, and a lot of time and you end up with a D, for example, on the honors paper. That has not achieved anything.

Three Turkish teachers stated that after the post-primary level was extended to four years, they were able to spend more time to teach the syllabus and relaxed. For example, one of them said,

we feel very relaxed after the post-primary schools were for four years. Our syllabus is very long for three years. I mean we had many difficulties while we were teaching in three years. Now we have more time. And from this point of view it is good… (AO2)

2.7. Discussion

We saw in the literature review that different authors have reported both positive and negative effects of high-stakes examinations on teaching and learning (Stecher, 2002). In this chapter, I have presented my findings on the similarities and differences of the effects of high-stakes examinations on teaching and learning in Ireland and Turkey.

2.7.1 Teaching to the Test

In section 2.5.2.2, I considered the responses of teachers to the question on how the examination system had influenced the way they taught. Six Irish teachers and no

Turkish teachers expressed positive comments. Three of the Irish teachers said the examination gives a clear direction to their teaching. There were fourteen negative comments from Irish teachers and seven negative comments from Turkish teachers, with five Irish teachers and three Turkish teachers saying that they had to teach to the test. In the interviews, they explained that they left out topics that were not examined and they taught their students how to make strategic choices to get easy points in the examination.Lyons et al. (2003), Elwood and Carlisle (2003), Hourigan and O'Donoghue (2006), Dochy and McDowell (1997), Au (2007), Shepard (2002), and Stecher (2002) all mentioned this effect of examinations, that is, that teachers taught according to the examinations. The NCCA discussion paper (2005), Stecher (2002), Kelleghan et al. (1982), Au (2007), Wall (2000), Reay and William (1999), and Johnston and McClune (2000) also mentioned that teachers focused more on specific test subjects rather than on curriculum standards. Three of the Irish teachers in my study expressed views similar to those mentioned by teachers in the USA in studies conducted by Abrams, Pedulla and Madaus (2003), Koretz et al. (2001) and Shepard and Dougherty (1991). These teachers had increased the time spent on tested materials because of the state examinations. In addition, three Irish teachers felt that they had no time to work on topics that were not examined. Abrams et al. (2010) found that the state tests led teachers to teach in ways contrary to their notions of good practice. When I studied the interviews, more information on this subject came up. Even though, most Irish teachers were not asked explicitly in the interviews about their thoughts on the effects of high-stakes examinations on their teaching, nineteen of them said something about the effects of the examination on their teaching. Irish teachers made similar comments to those made on the questionnaire concerning teaching to the test. For example, teachers described advising students to choose topics based on the perception of how easy it is to get marks on LC, how to gain attempt marks, and teaching test techniques in the class. There was a similar discussion in NCCA (2005) that the emphasis in teaching in Ireland was on 'what would get marks' rather than 'what may improve students' learning' or 'what might be good for mathematics education'. A similar influence was identified by Koretz et al. (2001), and Johnston and McClune (2000) that they found teachers in the US coached their students to do better by focusing instruction on aspects of the test. The examination in my study also seems to have an effect on teachers' choice of topics, for example, they left out some topics, which were not examined or were considered too difficult. Elwood and Carlisle (2003) mentioned

that the LC examination was predictable and rewarded students who were well prepared. Because the examination is predictable, some Irish teachers in my study said that it was possible to train students to do well on the examination without developing an understanding of the mathematics involved. Some of them used examination questions in class as a teaching resource. In the other USA studies (Abrams et al., 2010, and Madaus and Clarke, 1999), teachers also used old examination questions or commercially produced revision materials to prepare students for tests. When I asked Irish teachers for their thoughts on the syllabus, they often responded by speaking about the examination and not the syllabus itself. Madaus and Clarke (1999) remarked that teachers may use past examination papers to define the curriculum and this seems to be what I observed. We have seen that Irish mathematics education at post-primary level seems to focus on the L.C. examination system. The examination system seems to control the teachers' practice and also how or what they teach in their classes (Table 2.5.6).

However, Turkish mathematics education was not just focused on the examination. There is one explicit response in this vein in Table 2.5.6 that is 'preparing students for 3rd level instead of for the examination' and seven teachers maintained in the interviews that they taught the idea of mathematics, and did not teach towards the OSS examination. Noss and Baki (1996) described Turkish traditional mathematics teaching and said that teachers followed the textbooks, emphasized algorithms, rules, definitions, axioms, and formulas that students memorized, and showed examples with simple answers and spent most of their class time lecturing to their students using the blackboard. The teachers in my study did not describe their teaching methods in this way but seemed to value understanding over memorization.

2.7.2 Memorization and Understanding

From Table 2.5.4, six Irish and four Turkish teachers (and six Turkish teachers in the interviews) expressed the view that the examinations encourage memorization. We can see the similar responses in Table 2.5.7 (five Irish and fourteen Turkish teachers) and from the interviews six Irish and five Turkish teachers felt that students learned by rote or memorized, that they did not want to understand the idea of mathematics, and that they just wanted to learn for the examination. One of the Irish teachers mentioned in the

interview that "because of the examinations, students want solutions, they want methods, they want steps...” A similar view was described in the book International Trends in Post-Primary Mathematics Education (Conway and Sloane, 2005).There an Irish Leaving Certificate student said that there was no need to know materials which were not on the examination. The NCCA discussion paper (2005), indicated that memorizing was highly emphasized in Ireland in teaching and learning. The Irish teachers in Inside Classrooms (Lyons et al., 2003) also believed that learning was associated with memorisation of formulas and procedures in mathematics.The chief examiner’s report (2005) mentioned that Irish students had insufficient understanding of mathematical concepts and underdeveloped problem solving and decision making skills. In addition, Hourigan and O’Donoghue (2006), and Morrison and Tang (2002) found that teachers sometimes provided ‘ready-made’ mechanisms for their students and this caused memorization. Irez (2006) reported that because of the university entrance examination, Turkish students memorize large amounts of material. In contrast to Irez's (2006) result, one Turkish teacher in my study said that the examination made students understand deeply.

As I mentioned in the first chapter, memorization can sometimes be a positive aspect of understanding mathematics as the teachers from Australia, the USA, Hong Kong and Mainland China felt (Bryan et al., 2007). Teachers from Mainland China and Hong Kong teachers thought that memorisation could lead understanding or come after understanding. However, Australian and American teachers believed that memorization is useful only after understanding to make recall of necessary information. I did not receive any positive responses in my study that memorization could come after or before understanding like the teachers’ beliefs in Bryan et al. (2007) study. In Ireland and Turkey, teachers seem to have a negative belief about memorization that their students wanted to memorize instead of understanding the content.

2.7.3 Teaching Styles and Use of Resources

There are many differences between teachers’ descriptions of their current practices at schools in both countries (section 2.5.3). Using textbooks was more heavily emphasized in Ireland (Table 2.5.14 and Table 2.5.3). The Lyons et al. (2003) and Hourigan & O’Donoghue (2007) studies found that Irish teachers emphasized practicing old

examination papers and doing homework. In the Smyth et al. (2011) report, Irish students' perspective of teaching was teacher-led instruction, for example, teachers spent a lot of time practicing old examination papers and doing homework. In both countries, sixteen Irish and fifteen Turkish teachers used a lecturing style of teaching method such as chalk and talk, using the board, didactic method or introduction method. Similarly, Au (2007) reported that because of the high-stakes examinations, there was an increase on using lecturing style of teaching and direct transmission of the test content. Studies in both Ireland and Turkey (Noss and Baki,1996; Lyons et al., 2003; Hourigan and O'Donoghue, 2007) have spoken of teachers using a didactic approach to teaching which emphases procedural skills. Moreover, in Kaiser and Vollstedt's (2007) study, teachers used teaching methods in which they introduced and explained the mathematical concepts similar to Turkish teachers in my study.

Twelve (48%) Irish teachers mentioned that they emphasized technology in their classes whereas three (14%) Turkish teachers used it. In the Cosgrove et al. (2004) study, 18.4% of the Irish teachers mentioned using computers in their classes. Between 50-70% of the Irish teachers used ICT and between 45-55% of them used audio/video in the Smyth et al. (2011) study.

Fifteen Irish and twenty-one Turkish teachers used student practice, and eighteen (out of twenty-one) Turkish teachers and three (out of fifteen) Irish teachers (Table 2.5.15) mentioned that they asked their students to complete questions in front of the whole class. In addition, four Turkish teachers said in the interviews that they want their students to be more active in their classes so they asked questions and let their students solve a problem on the board or made comments while somebody was doing the questions. Irish lessons seem to be teacher-led classes where practice is important. I do not have information on Irish teachers' views of mathematics (i.e. whether they are instrumentalist or Platonist, etc.) except some teachers want more applications of mathematics in their classes. According to the information given in Bryan et al. (2007), Irish teachers seem to be located on the "Eastern" side of the spectrum. The Irish lessons seem to be very structured, with the teacher in control and with a very heavy emphasis on practice and homework. It should be noted that some Irish teachers taught (or wanted to teach) in a different manner and some expressed the view that time pressure stopped them from using other teaching methods or from exploring complex ideas. In Turkish classes, the teacher-led aspect of the mathematics education is also emphasized and practice is important as in the Irish classes. However, practice in both

countries means something slightly different. Turkish teachers asked questions because they want to make sure if their students understand a concept. If the students do not understand, teachers explain more about the questions. Turkish teachers also emphasize active student engagement in their classes as mentioned above. So, Turkish teachers seemed to act as with "Eastern" and "Western" cultures, they use mostly teacher-centered methods as in the "Eastern" culture, and they also have beliefs similar to teachers' beliefs in the "Western" culture that active student participation is important in classes.

From Table 2.5.16, the structure of a typical Irish mathematics class seemed to be: begin with checking homework, introduce a new topic, then some student practice with the teacher going around helping the students, and at the end of the class the teacher assigns the next day's homework. This supports the findings of Lyons et al. (2003) and Hourigan and O'Donoghue (2006) that Irish teachers gave homework and corrected it every lesson. Also from Table 2.5.16, teachers in Turkey started their classes with reminding students of the previous lesson, and then introducing a topic followed by students practice. By the student practice, the teachers meant that students came to board or were active while doing examples. Moreover, twenty Irish teachers and all Turkish teachers described a typical mathematics class in the interviews and only one Irish teacher (out of twenty) and two Turkish teachers (out of twenty-one) had a very different approach as I mentioned in section 2.5.3. Otherwise, most of the descriptions in the interviews were very similar as in Table 2.5.16.

As discussed in section 2.2, Ernest (1989) described three models of teaching and these are instructor (intended outcome for students is skills mastery with correct performance), explainer (intended outcome is conceptual understanding with unified knowledge), and facilitator (confident problem posing and solving). From the Irish teachers' interviews, the emphasis in their classes seemed to be on doing questions; for example, doing homework questions or textbook examples (section 2.6.8) and they got their students to practise, and they seem to show students how to do questions instead of explaining the concepts required in the questions. Irish teachers also trained their students how to attempt the examination questions and how to get marks. Irish teachers also make heavy use of textbooks. Thus, Irish teachers are more likely to be described as instructors (Ernest, 1989). Irish teachers seem to have instrumental view of mathematics in that they strictly follow a textbook as mentioned earlier. From the Turkish interviews, we see that in the beginning of the class, teachers taught a subject

and then they asked questions. They spent most of their class time on explaining, to help students understand the content (section 2.6.8). Therefore, Turkish teachers are more likely to be described as explainers (Ernest. 1989). Turkish teachers often did not stick to one text but used their own notes. They construct their own curriculum and they seem to have a “Platonist” view of mathematics in which teachers are the explainers.

2.7.4 Homework

From Table 2.5.1, we can see that almost all of the Irish teachers and the majority of Turkish teachers responded that they usually gave homework and corrected it. Twenty Irish and thirteen Turkish teachers were asked in the interview about homework and all of the Irish teachers said that they gave homework daily. About half of the Turkish teachers mentioned that they gave homework mostly in the first and second years for high school.

2.7.5 Grinds

Turkish teachers say that they tend to focus on teaching the ideas in mathematics and that they were not really aiming to teach to the OSS examination. They did not use any multiple-choice questions like in the OSS examination, instead they use partial-credit questions. So, there is quite a difference between the OSS system and the education system at schools in Turkey. One Turkish teacher (KA3) said that

We prepare our students for real life and also encourage them to mathematical research and give explanation of the idea of mathematics. But grinds are only working toward the OSS exam. Students have to get a result within the test system in the most efficient way. So I think this is why grind schools are not necessary for OSS.

Because of this difference between the examination and education system at schools, in Table 2.5.23, 38% of Turkish teachers involved in the research for this thesis responded that the examination system led to the grind school phenomenon. A group of Turkish researchers (Gundogdu, Kiziltas and Cimen, 2010) mentioned that teachers thought the primary assessment (SBS) system caused grinds. Another Turkish study (Tansel and Bircan, 2005) showed that the proportion of students who had one-to-one grinds increased in the examination year. The Turkish teachers in my study said that their students needed to attend grind schools to learn how to solve multiple-choice questions and that is why grind schools are very popular or, even compulsory, for the preparation of the examination whereas some of the Irish teachers felt that their students did not

need any grinds for the examination. However, Table 2.5.23 shows that Irish teachers thought that one-to-one grinds were sometimes helpful if students were struggling with particular topics.

2.7.6 Examination Systems

Section 2.5.2.1 refers to teachers' thoughts about the examination system. From Tables 2.5.4 and 2.5.5, we can see that there are more negative responses in both countries than positive responses. In Table 2.5.5, eight Irish and seven Turkish teachers mentioned that the L.C. and OSS examinations were a fair way of selecting students for third level of education. In the interviews, seven Irish and seven Turkish teachers made similar comments. Teachers felt that it was important that all students had the same conditions in the examinations in every part of the two countries.

Heyneman (2009) spoke about the importance of the trust of a country's population in the examination system and it appears that this trust is strong in both Ireland and Turkey. Stecher (2002) mentioned that an effect of high-stakes examinations on students was that such examinations provided students with better information about their own knowledge and skills, motivated them to work harder in school, sent clearer signals to students about what to study, and rewarded students' efforts. In my study, six Irish and one Turkish teacher (Table 2.5.5) (and five Irish teachers from the interviews) said that the examination system rewarded students' efforts and gave them a clear direction.

2.7.7 Alternative Systems

In Table 2.5.6, we can see that Turkish teachers did not make too many comments on the examination system, but they were not happy with the format of the existing examination system, and said that for example, partial credit, open-ended or practical questions must be added or the number of questions must be increased (Table 2.5.25). Similar to Turkish teachers' belief, Shephard (2002) discussed the problem that students were trained to answer only multiple-choice questions and added that they needed to be able to write and reason using material. Heyneman (2009) maintained that essay questions and oral examinations are superior to multiple-choice questions because there

is more opportunity for creative feedback, however, he said that using essay questions and oral examinations cost more than multiple-choice questions. Schoen et al. (1999) also mentioned in their study that multiple-choice questions may be used because of a lower costs and that the quality of assessment may be sacrificed for economic reasons. Irish teachers made more negative comments (fifteen Irish teachers and whereas four Turkish teachers) on the examination (Table 2.5.6) and they would be happy if there would be a new assessment system (Table 2.5.25) such as continuous assessment system or modularized examinations. Barnes et al. (2000) compared two different assessment systems to see whether they can influence curricular reform or not. In Victoria, the assessment had mathematical activities such as application, practice, and projects. The NSW assessment system depended on the syllabus content. They found significant influence, however this influence appeared in different ways. The teachers in Victoria felt that they had to change their instructional practices according to a new assessment system. In NSW, teachers stressed examinations' importance to students. They felt that they had to complete the syllabus before the examinations and showed students similar examination questions, so there was no time to do investigation practices.

2.7.8 Class-based Assessment

In the questionnaire, teachers were asked what kind of assessment methods they used in their classes, however, this question was not asked in the interviews. Twenty-two Irish teachers and thirteen Turkish teachers used regular written examinations or tests. Fourteen Irish teachers and nine Turkish teachers used oral examinations or they assessed their students by asking questions. A different method mentioned by seven Turkish teachers was that they assessed their students by observing them in the class. In the TIMSS study (2007), most of the Turkish teachers assessed students with classroom examinations and their own professional judgments. We did not have any response from Irish teachers that they observed their students in their classes.

2.7.9 Pressure on Students

Eight teachers from Ireland and Turkey had a common response (Table 2.5.4) that the fact the examination was condensed into one day put a lot of pressure on students and also four Turkish teachers mentioned this comment in the interviews. However, there is another comment in Table 2.5.4 explicitly mentioned by ten Turkish teachers in the questionnaire and twelve teachers in the interviews that this examination had to be done in this way because of the huge population.

2.7.10 External Pressure

Abrams et al. (2003) and Shepard and Dougherty (1991) found that in the USA teachers felt under pressure from their employers, parents of their students, or their state board of education (which is the policy making body of the state's public education system). We did not receive any responses from teachers in my study related to this.

2.7.11 Time Pressure

In the questionnaire, Irish teachers mentioned time pressure and felt that they could not be behind with the syllabus and they had limited time for applying different teaching methods. In the interviews, Irish teachers said that they could notdo anything off the course or re-teach or teach deeply because of the time pressure. Turkish teachers seemed to be more relaxed about time pressure because they have four years before the examination whereas Irish teachers have two years. Barnes et al. (2000) reported that New South Wales teachers did not do problem solving or investigation activities because of time pressure.

2.7.12 Real-life Examples

Eight Irish teachers explicitly discussed the lack of relevance the syllabus had to real life whereas no Turkish teachers mentioned this in the questionnaire (section 2.5.3). In addition, nine Irish teachers and two Turkish teachers said in the interviews that the mathematics taught in the classroom was not put in a real life context. A similar result

was mentioned by the teachers from Australia, Hong Kong, Mainland China and the USA that understanding was the most important goal of learning mathematics, and the USA teachers concentrated on the relationship between mathematics and daily life (Bryan et al., 2007). In the Cosgrove et al. (2004) study, most of the Irish teachers said that it was important to understand how mathematics was used in real life, however, very few teachers used mathematical knowledge to solve problems related with the real life situations. In the book Inside Classrooms (Lyons et al., 2003), it was found that most of the Irish teachers observed believed that learning was equated with the memorization of formulae and procedures instead of thinking creatively and that students did not understand how to use mathematics in real life.

2.7.13 Summary

This study showed that the LC and OSS examinations have influenced teaching and learning mathematics, however, the effects of the examination systems appear to change between Ireland and Turkey. Irish teachers seem to focus on the examination more than the Turkish teachers. This may be because Turkish teachers prepare their own examinations at schools to evaluate the students and there is a high-stakes examination (OSS) to determine entry to third level whereas the Leaving Certificate is the only examination which is taken into account for entrance to third level in Ireland. In both countries, the mathematics lessons are teacher-led classes and practice is important. However, from my study, practice is slightly different in both countries. Turkish teachers used practice questions to decide whether students understand and explain anything that they did not understand. Irish teachers seem to use practice questions to show students how to use formulas and procedures. As we have seen, Irish teachers used practice questions and old examination questions to prepare for the Leaving Certificate examination. I have also found evidence of Irish teachers teaching to the test in that they concentrate on some topics which would be tested, and leave out others. Another reason for leaving out some topics was time pressure. They felt this time pressure because they need to prepare students for the examination. Turkish teachers aimed to cover the syllabus and they did not see their job as the preparation of students for the OSS examination. They thought that this was the role of grind schools. In Turkey, one of the effects of the OSS examination was that teachers thought that the

OSS examination created the grind schools. In both countries, teachers thought that the examination was fair but placed a lot of pressure on students.

In the next chapter, I will look at the effects of the examinations on students' learning.

CHAPTER 3

STUDENTS' PERSPECTIVES ON HIGH-STAKES EXAMINATIONS

3.1. Introduction

In this chapter, I will report on students' attitudes, confidence, and motivation as well as their study habits. I designed a questionnaire which focused on these areas and administered it in schools in Turkey and Ireland. The reason I studied these affective variables was to examine the influences of high-stakes examinations on learning, for example, through confidence, and anxiety. These effects of high-stakes examinations on learning were mentioned in some studies described in chapter 1. For example, Madaus (1991, p. 229) clarified the disadvantages of high-stakes examinations and one of these disadvantages was '[high-stakes examinations] can negatively affect such personality characteristics as self-esteem and self-concept.' Similarly, Harlen and Crick in their review study (2003), reported that Davies and Brember (1998, 1999) found that high-stakes testing affects students' self-esteem. Leonard and Davey (2001), and Reay and William (1999) showed that students did not like tests and they were anxious whether they performed at their best under test conditions. Moreover, Benmansour (1999) mentioned that assessment was related to low self-efficacy and to limited use of learning strategies. The literature suggests then that high-stakes tests can have negative impacts on motivation, anxiety, and self-confidence. For this reason, I gathered data on these variables and I will present the results of my survey in this chapter.

The first section of this chapter concerns the literature review, this is followed by the research design of this part of the study. Then I present the analysis of the students' questionnaire with a description of the results. The last section is concerned with the conclusions reached in this part of the study.

3.2. Literature Review

I have already summarized the results of studies, which concern the effects of high-stakes tests on students' attitudes. In this section, I will review the literature on affect and motivation. I will also consider the findings of the PISA studies relating to students' attitudes.

Affective variables such as confidence and anxiety have been studied for many years. Reyes (1984) published a paper to provide an overview of knowledge about affective variables and mathematics education. Four variables were discussed: confidence in learning mathematics, mathematics anxiety, attributions of success and failure in mathematics, and perceived usefulness of mathematics. Confidence in learning mathematics, or self-concept specific to mathematics, has to do with how sure a person is of being able to learn new topics in mathematics, perform well in mathematics class, and do well on mathematics tests (Reyes, 1984, p. 560). Reyes reported on many studies which examine confidence (Dowling, 1978; Armstrong, 1980; Fennema and Sherman, 1977, 1978; Crosswhite, 1972; Hirsch, 1979). The findings from these studies show that people who have more confidence in their ability in mathematics will usually study mathematics more often and for longer than those who do not have this confidence. Mathematics anxiety was described by Richardson and Suinn (1972, p. 551) as involving feelings of tension and anxiety that interfere with the manipulation of numbers in a wide variety of ordinary life and academic situations. Furthermore, Reyes (1984) described the relationship between mathematics anxiety and test anxiety as explored in some studies (Spielberger et al., 1978;Richardson and Suinn, 1972; Hendel, 1980; Betz, 1978): these found that on the whole students who have high levels of mathematics anxiety, also have high levels of test anxiety as well. Reyes (1984) reported that students in high school often drop mathematics classes because they do not know whether mathematics is useful for their future life. Some studies (Fennema and Sherman, 1977, 1978; Armstrong, 1980; Perl, 1979) concluded that, in general, students who achieved more in mathematics knew more about the usefulness of mathematics, whereas lower achieving students did not.

Ten years after Reyes's (1984) report on affective variables in mathematics education, McLeod (1994) discussed some studies about similar topics that were published in the Journal for Research in Mathematics Education and noted that qualitative research methods were becoming more prevalent. McLeod (1994) reported on a study conducted

by Schoenfeld (1989) on how students' beliefs about mathematics influenced their performance in the subject of plane geometry. Schoenfeld (1989) pointed out that students' problem-solving performance was often undermined by students' beliefs about mathematics. These beliefs were mostly negative such as: in mathematics it is important to memorize rules and procedures. He found that students expected that mathematical problems could be solved in just a few minutes or they could not be solved at all. Students felt that a good teacher was one that made sure students knew the rules but also one that shows students many ways to solve a problem.

In the 1970's, a lot of work was done on the study of affective variables by Fennema and Sherman. They developed the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman, 1976). These scales were: attitude toward success in mathematics, mathematics as a male domain, perceived attitude of mother, father, and teacher towards one as a learner of mathematics, effectance motivation in mathematics, confidence in learning mathematics, mathematics anxiety scale, and usefulness of mathematics. Using these scales, Fennema and Sherman carried out many studies of high-school students' attitudes. In one such study, (Fennema and Sherman, 1977), they looked at the influence of affective variables on students' decisions to study more mathematics. They found that more males than females intended to study more mathematics and this difference persisted even when achievement levels were controlled. They found that there were differences between the students who intended to carry on studying mathematics and those who did not on all eight of the attitudinal scales. Few gender differences were found in this study and the authors point out that in some of their previous work (Fennema and Sherman, 1976) these differences were found to exist when achievement levels were not controlled for. Some important differences that emerged (Fennema and Sherman, 1977) were that male students were more confident in their ability to learn mathematics than female students and female students did not score as highly on the usefulness of mathematics scale as their male counterparts. The scales developed by Fennema and Sherman have been used by many researchers since the 1970's.

In Ireland, Mulhern and Rae (1998) tried to provide the reliability of each scale of FSMAS from data provided by a sample of Irish school children. They also aimed to determine whether a shortened form of FSMAS could be used reliably. They were also interested in whether the scales would be valid if used with different age groups and in different countries. Each scale had twelve Likert-type items with five responses. They

did not change the number of items (108 items) in the FSMAS and they distributed them randomly, putting all the items from the nine scales together. They made minor changes in the wording of some items in FSMAS so that Irish students could understand them more easily. They administered their survey to 198 secondary school students. They calculated a Cronbach`s alpha for each scale and found that the scales had as high a reliability as in Fennema and Sherman's study. They carried out a factor analysis to investigate the factorial validity of the FSMAS. They ended their study with a shortened (51 items) form of the FSMAS, this was of interest because the shortened form should take approximately half of the time to administer and score. Moreover, they showed that FSMAS could be reliably used for the different groups of children in different countries.

As mentioned in Chapter 1, Inside Classrooms (Lyons et al., 2003) was a very important publication in Ireland that identified students' and teachers' perspectives on learning mathematics. They conducted their survey in ten different second-level schools. The students were given a short mathematics test, which was similar to the TIMSS study and they completed a questionnaire about learning mathematics. Twenty mathematics lessons were videotaped and a number of students also were interviewed. Almost all of the students in the single-sex girls, single-sex boys and co-educational schools thought that having a good teacher was required for success in school mathematics. At four out of ten of the schools, over half of the students said that learning the textbook off by heart was important. There was no difference between the response rates of the different school types in that the majority of students at all of the schools found that lots of hard work studying at home was useful for them. Girls had more positive attitudes to mathematics, had higher expectations of themselves, and had more positive views of their classroom experience of learning the subject than boys. However, boys had a slightly higher mathematics self-image than girls (but this was not statistically significant). There was no obvious pattern between the school types (single sex-boys or girls, coeducational schools, disadvantaged or non-disadvantaged schools) in terms of the students' confidence levels and students' attitudes to mathematics levels. In addition, most of the Irish students felt that they needed to do well at mathematics because it was useful for third level and everyday life.

The Economic and Social Research Institute in Ireland studied the effects of the Leaving Certificate on students, their performance, their decisions about their future life and the skills that they developed in the secondary schools (Smyth et al., 2011). Over

900 sixth-year students from twelve case-study schools participated: these schools having been drawn from an earlier national survey of second-level principals conducted by Irish researchers (Smyth et al., 2011).The students participating in the case-study survey took the Leaving Certificate examination in 2007 or 2008. In-depth interviews with students and school personnel were used to complement the survey.

Approximately half of the students found mathematics interesting and difficult. The majority (75-80%) thought mathematics was a useful subject. There were big differences between the percentages of students studying different syllabus levels in Mathematics. The highest percentage (65-75%) were taking Ordinary Level, about 20% of students surveyed were taking Higher Level and a small proportion(less than 10%) were in Foundation Level. The students were asked about the use of different kinds of teaching methods used in every or most lessons and reported practicing previous examination papers (70-80%), getting homework (85-95%), project work (10-20%), expressing opinions in class (45-60%), teachers doing most talking (nearly 85%), teachers explaining well (55-65%), group work (15-25%), and copying notes from board (60-65%). Moreover, most of the students stated that they never used ICT in the sixth class. 44% of the students were having grinds when this survey was conducted (in January of sixth year). In addition, they stated a student perception of teachers that good teachers prepare themselves very well before the class, explain more, and recognise the importance of treating students with respect and care.

Two Turkish researchers (Kahveci and Imamoglu, 2006) aimed to examine students' motivational attitudes toward mathematics and investigate whether these attitudes were affected by gender, age, and mathematics grade. Seventy-nine students from two private schools in Istanbul participated in this study. Three different scales were used in this survey. They used a modified version of the Fennema-Sherman scale (Deopken et al., 1993) and the categories were usefulness of mathematics content, mathematics perceived as a male domain, perceived mathematics success, teacher support, perceived mathematics ability, perceived mathematics performance, and teachers' belief of competency in mathematics. The second scale was for measuring mathematics self-concept and it was a combination of the original form of the Academic Self Description Survey 2 (ASDQ 2) scale (Marsh, 1990) and a modification of it (Githua and Mwangi, 2003). This scale concerned: perceived performance and success; feelings towards mathematics; and perceived mathematical ability. The third instrument was called students' motivation scale (SMOT) (Githua and Mwangi, 2003) and the topics in this

scale were: usefulness of mathematics, intrinsic motivation, and perceived probability of success. The researchers concluded that students in two private schools had a positive attitude toward mathematics and they were highly motivated in mathematics. In addition, students did not see mathematics as a male domain.

Berberoglu (2004) reported on Turkey's results in the PISA 2003 study. There were 4855 students who participated in this study. According to this report, students in ordinary schools and vocational schools had low-levels of performance in mathematics. Science schools, Anatolian schools and Private schools had high levels of performance in mathematics. The students in these three types of schools also had low anxiety of mathematics and high self-concept.

Stipek and Gralinski (1996) studied children's beliefs about intelligence and school performance. There were 319 students participating in this study. They designed a questionnaire to explore students' views on how intelligence affected their performance and learning goal strategies, and administered the questionnaire to the students in the autumn and again in the following spring. There were six topics in this questionnaire: entity-related beliefs, effort, mastery goal orientation, performance goal orientation, active cognitive engagement, and superficial cognitive engagement. (Some of the items used in my survey came from Stipek and Gralinski's (1996) performance goal orientation and mastery goal orientation questions.) The researchers computed the mean scores of the participants on the individual items on the scales. The correlations among motivation variables was carried out twice – once for the data collected in the autumn and a second time for the data collected in the spring. The correlation between the learning goal scale and performance goal scale was .26 at first and then .35, which were not high. Students believed that intelligence affected performance, and intelligence and performance were important in their achievement outcome. In addition, students who had high mean scores on the performance scale indicated that they used more learning goal strategies for completing classroom tasks.

PISA 2003

The report of the 2003 cycle of the Programme for International Student Assessment (PISA) was published in order to identify teaching and learning strategies related with mathematics achievement (OECD, 2003). The first PISA study was carried out in 1997 and it is now repeated every three years. There are three focuses in PISA assessment: mathematics, reading, and science. In 2003, the PISA assessment had mathematics as its

major focus with minor assessments in science and reading. A selection of 15-year-old students and school principals in forty-one countries completed the questionnaires. The PISA study tests mathematical literacy by asking students to answer mathematics questions related to real life situations. In addition, students also complete a questionnaire on their attitudes to mathematics and their study habits. PISA 2003 especially focused on the learning of mathematics (e.g. mathematics homework time, tutoring, out-of-class lessons, memorisation/rehearsal strategies, competitive learning preference, and teacher support). The PISA study uses the Rasch model to analyse these results and to create measures of each trait for each student. This model will be explained in section 3.

The PISA study assesses student perceptions of their capabilities in mathematics using three indices: the index of anxiety in mathematics, the index of self-efficacy in mathematics, and the index of self-concept in mathematics. Self-efficacy was described as students' confidence in their ability to solve particular mathematics problems and self-concept was defined as students' perceptions of how good they are at mathematics in general (p. 85). In 2003, it was found that there was a positive correlation between self-concept in mathematics and self-efficacy in mathematics and strong negative correlations between both of these and anxiety in mathematics.

These three indices were compared with students' performance. Most countries including Ireland and Turkey had a statistically significant negative association between anxiety in mathematics and performance on the PISA test. There was a strong positive association between self-efficacy and performance in mathematics for all countries. Moreover, the association between self-concept and performance in mathematics was similar in all countries including Ireland and Turkey.

Students' mathematics performance and how much time that they spent on mathematics homework were measured separately. The number of hours spent each week on mathematics homework was positively associated with mathematics performance for most of the OECD countries including Ireland and Turkey. The effects of tutoring and other forms of out-school learning were similar to homework measurement in that they had negative effects on students' mathematics performance on the PISA test. However, Turkey had a small positive association between out-of-school learning and performance in mathematics on PISA. 43% of Turkish students and 16% of Irish students were being tutored and 59% of Turkish students and 8% of Irish

students were having out-of-schools classes when the PISA 2003 survey was administered to students.

PISA asserted that students with effective learning strategies would learn more quickly than other students. Memorisation/rehearsal was one of the learning strategies measured in this study. It was found that memorisation did not have a positive effect on learning mathematics in most of the countries, including Ireland and Turkey.

One of the scales was about competitive learning situations; that is, if students wanted to be the best or do better than others. The mean scores of OECD countries were spread widely and most of them had positive correlations between the mean scores on the competitive learning strategies scale and mathematics performance. Turkish students had a high mean score and Irish students had a low mean score on this scale. Both Ireland and Turkey had a positive relationship between competitive learning situations and students' performance in mathematics.

One of the indices in student perceptions of the learning strategies was 'teacher support', this category included items on teacher interest in students, whether teachers helped students with learning, and allowed students to express opinions. Turkey's mean score was very high whereas Ireland had a low mean score on this scale.

3.3. Research Design

Quantitative research was employed in this study. The first section presents the development of the pupils' questionnaire: the format and translation of the questionnaire. The ethical issues considered are described in section two.

3.3.1. Construction of the Questionnaire

A questionnaire was used in this study and can be found in Appendix A2. This section presents the design of the pupil questionnaire, its format, and the translation of the questionnaire.

There are some advantages to using a questionnaire with a large group. There is a huge saving in time and probably also in cost. Information obtained from large groups is more representative than smaller groups and so this information is likely to be more reliable. In addition, a questionnaire allows all participants to be asked the same questions.

3.3.1.1. Format of the Questionnaire

In this study, the design of the questionnaire focused on students' thoughts about learning and teaching mathematics and also on their thoughts about the assessment system. I did not ask students open-ended questions because there were more than one thousand students and it would not have been easy to analyze the data. I also could use different scales which had Likert-type items and these scales were used before reliably. There were a few differences between the questions in the Irish and Turkish questionnaires. We designed two questions for the Irish students regarding the motivation for their choices of Leaving Certificate subjects and choices of syllabus level of mathematics taken for LC, and one question which asked which level of mathematics they were studying. The Irish questionnaire consisted of sixty-one questions, of which there were 55 Likert-type items and four multiple choice questions. There was one different question in the Turkish questionnaire regarding whether the Turkish students had attended grinds previously.

There were 55 Likert-type questions and four multiple choice questions in the Turkish questionnaire. The Likert-type scale is named for its inventor Likert (1932) and it is one of the most popular methods of measuring attitude. A Likert scale consists of statements with which participants are asked to record their level of agreement. The responses are often of the form: strongly agree, agree, neutral, disagree and strongly disagree.
Most of my questions were designed as Likert type items with five responses. Using a greater number of response scale points increases the variability in responses and it gives more detail about the variables under study, compared with giving the option of a smaller number of responses. Also, using an odd-number of response choices allows students a "neutral" option. The Likert-type items were made up of questions on: learning goals (five questions), performance goals (five questions), confidence (six questions), anxiety (seven questions), pressure (four questions), usefulness of mathematics (six questions), good teaching (five questions), mathematics learning (five questions), assessment (three questions) and study methods (ten questions). Most of these questions were taken from other studies, some were adapted, and some were constructed specially for this project. These other studies focused on different constructs in the field of mathematics education and used Likert scale items successfully. Therefore, we copied or adapted some items that were related to my study. Items were adapted (or reworded) because we wanted to make them more comprehensible for

students and to relate them more closely to the focus of my study. In addition, we designed some questions focusing on students' thoughts about the examination. For example, in the performance scale, items 3-5 concerned three different reasons for performing well generally in mathematics and we constructed two extra items that related to performing well specifically on mathematics examinations. All the learning goal items were adapted from Stipek and Gralinski (1996). In the performance goals scale, questions 1-2 were designed for this study and questions 3-5 were adapted from Stipek and Gralinski (1996). We copied the first three confidence items from Mulhern and Rae's (1998) shortened form of the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman, 1976), adapted item four from the PISA (OECD 2003) students' questionnaire, copied item five from the PISA (OECD 2003) students' questionnaire and the last question was designed for this study. Three of the items (1-3) in the anxiety scale were copied from Mulhern and Rae's (1998) shortened form of the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman, 1977) and the other four items were copied from Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman, 1977). In the pressure scale, questions 1 and 3 were designed for this study and question 2 was copied from the Fennema-Sherman Mathematics father/mother scale (FSMAS) (Fennema and Sherman, 1977). We copied all of the usefulness items from Mulhern and Rae's (1998) shortened form of the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman, 1976). In the good teaching scale, questions 1-2 were copied from Schoenfeld (1989) and questions 3-5 were designed for this study. The first three mathematics learning items were copied from Schoenfeld (1989) and the fourth and fifth items were designed for this study. All questions in the assessment scale were designed for this study. We also designed all of the multiple-choice questions in the pupils' survey for this study.

We included some reverse-worded items when we were constructing the questionnaire. The reason for using reverse-worded items was that some students would tend to agree with statements and so if all the items were worded positively, a bias might develop. A few reverse worded items ensured that each student stopped to think about what the item was actually asking.

In the questionnaire in the Appendix, the questions are ordered according to topics, however, in the version given to students a random number generator was used to randomize the questions. This was because we thought the order of the items could

affect a student's response and we thought that if the items from a scale were distributed through the questionnaire then we would get a clearer picture of the students' views on this scale.

3.3.1.2. Translation of the Questionnaire

The questionnaire was designed in English. I translated it into Turkish and a Turkish researcher at NUI Maynooth checked the translation of the questionnaire. Before administering the questionnaire in Turkey, an official translation service had a final check on the translation.

3.3.2.Ethical Considerations

Ethical considerations were important in this study since students expressed how they think and feel about learning mathematics, their thoughts on their teachers and the examination system. The students may not want to share their thoughts on these issues publically. Therefore, the questionnaire was anonymous. As I mentioned in chapter 2, I applied for permission to the Ministry of Education in Ankara (Turkey) and to the National University of Ireland Maynooth Ethics Committee. I got permission in both countries before I started to conduct my research. Each participant was given a plain language statement prior to completing the questionnaire and a consent form to sign.

3.4. Methodology

The method of choosing schools and the details of the schools were summarized in section 2.4.1 (chapter 2). The survey was conducted in the 2009-2010 school year in both countries. In total 666 Irish students and 661 Turkish students took part. The Irish students and the Turkish students were in the final year of post-primary school, and all were taught by teachers participating in this study. Irish students taking Mathematics at each of higher, ordinary and foundation levels participated. The Turkish participants were in the science or Turkish-mathematics groups because these groups in their schools had mathematics, geometry, and analytic geometry classes. The teachers who took part in this survey administered the students' questionnaire.

Table 3.4 details the total number of Irish and Turkish students; the number of female and male students; the number of the Irish students at each syllabus level; the number of the Turkish students in different school types.

# of students	Gender	Age	# of students in different levels at Irish schools/types of Turkish schools
Irish: 666 Total	Male: 478 (71.8%) Female: 188 (28.2%)	Age 15: 67 (10.1%) Age 16: 299 (44.9%) Age 17: 257 (38.6%) Age 18: 29 (4.4%) Age 19: 3 (0.5%) Missing: 11 (1.7%)	Higher Level: 126 Male (19%) 155 Female (23.3%) Ordinary level: 173 Male (26.1%) 180 Female (27.1%) Foundation level: 19 Male (2.9%) 11 Female (1.6%) Missing: 2 (0.3%)
Turkish: 661 Total	Gender was not recorded	Age 15:1 (0.2%) Age 16: 5 (0.8%) Age 17: 368 (55.8%) Age 18: 245 (37.1%) Age 19: 24 (3.6%) Age 20: 6 (0.9%) Missing: 10 (1.6%)	Science school: 58 (8.8%) Anatolian High school: 211 (31.9%) Private school: 102 (15.4%) Ordinary school: 155 (23.4%) Vocational school: 135 (20.4%)

Table 3.4: Number of Irish and Turkish Students

3.4.1. Rasch Model

Researchers commonly use questionnaires for collecting quantitative data. My questionnaire with mostly Likert-type items was constructed to examine students' attitudes towards mathematics, their motivation, and their views on learning mathematics. Rasch analysis is a commonly used statistical technique, which can be used to analyze Likert survey data. The aim of the Rasch model is to produce genuine interval measures and with these measures, this model allows researchers to test relationships between traits and to test levels of a trait in different groups of people.

Rasch analysis takes the ordinal data (from the responses to Likert type items) and converts this data to interval level scores. The interval scores allow the persons to be ordered in terms of ability. Also the difference between scores is consistent with a single unit difference between scores assigned to two pupils at any point on the scale representing the same difference in their abilities. This is important in order to be able make meaningful comparisons between participants.

For each trait that we considered here (for example confidence about mathematics), we asked three to seven Likert-type questions. We did this in an effort to improve the reliability of our findings. It allowed us to ask about the trait in various different ways and in this way, we hoped to capture more information about the students' attitudes than if we had asked just one question. We used the Rasch model to convert students' answers to the group of questions on each scale into an interval measure of their 'ability' on this scale. This idea of a number of items on a scale measuring the same trait is referred as unidimensionality.

The Rasch model computes *difficulty levels of items* and *ability or trait levels of people* and measures these on the same scale. We will consider the simplest version of the Rasch model first before moving on to the Partial Credit Model that we used to analyze the Likert-type scale questions. The basic Rasch model is for analyzing dichotomous data, which have two values, usually coded as 0 and 1. For example, we could assign a code of 0 for each person who does not answer an item correctly and 1 for each person who answers an item correctly. The dichotomous Rasch model makes the assumption that the probability of a person answering a particular item correctly is a function of the person's ability and the item's difficulty. The Rasch model assumes that people will have a higher probability of answering easy questions than difficult ones. Suppose p_{ij} is the probability of a person with ability level A_i correctly answering a question with difficulty level D_j, that is

p_{ij} = P (correct answer | ability level = A_i and difficulty level = D_j).

In the Rasch model, this probability is assumed to depend only on the difference between ability and difficulty and is assumed to be given by

$p_{ij} = \frac{e^{A_i - D_j}}{1 + e^{A_i - D_j}}$ and if $A_i = D_j$ then p_{ij} = ½ that is, if a person is faced with a question whose difficulty level is the same as that person's ability there is a 50/50 chance that the person will answer correctly. Rasch analysis then proceeds by determining statistical

estimates for the values of Ai and Dj from the data that provide the best-fit to the formula for p_{ij}.

Most of my items were Likert-type questions and each item had five responses such as strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). The dichotomous Rasch model is obviously not applicable in this situation. I needed to use the Partial Credit Model (PCM), which I will explain now. A student with trait level A_i could choose category k=1,2,3,4,5 on Item j. Therefore, each item had four thresholds (i.e. between 1 and 2, 2 and 3, etc), and instead of finding a difficulty level D_j, D_{jk} can be computed which is a parameter concerning the probability of scoring k rather than k-1 on item j. The partial credit Rasch model is based on the assumption that p_{ijk} is as in this formula,

$p_{ijk} = \dfrac{\exp\sum_{l=2}^{k}(A_i - D_{jl})}{1+\sum_{h=2}^{5}\exp\sum_{l=2}^{h}(A_i - D_{jl})}$. Here p_{ijk} is the probability of person i choosing category k instead of k-1on item j (for k greater than or equal to 2).

In order to calculate the parameters (person ability and item difficulty) in my model I used Winsteps. It uses maximum likelihood methods to measure these parameters. The method of maximum likelihood selects the values of parameters that gives the observed data the greatest probability. It does this iteratively until convergence criteria are met.

Using the Rasch model, I was able to construct measures for each person for each trait. These measures are interval data. I also used the Winsteps software to test the validity of my questionnaire to see if all the items were useful, if they had enough information to construct a good scale, or if they were measuring the same trait.
The Rasch measurement model provides indices that help the investigator to determine whether there are items spread along the continuum, as opposed to clumps of them, and if there is enough spread of ability among persons (Bond and Fox, 2007. p. 39). The *person reliability* index indicates the replicability of person ordering we could expect if this sample of persons were given another parallel set of items measuring the same construct (Bond and Fox, 2007. p. 40). The *item reliability* index indicates the replicability of item placements along the pathway if these same items were given to another sample of the same size that behaved the same way (Bond and Fox, 2007. p.

41). Person reliability is very similar to Cronbach`s alpha which determines the internal trait or average correlation of items in a survey to measure reliability.

The Winsteps software estimated the items' difficulty levels and error estimate in logits. A 'logit' is a log odds unit. Raw percentage scores (for a person on an item) are first converted to success-to-failure ratio or odds and then this is transformed from an ordinal to an interval score using a log odds scale, avoiding compression at the ends of the scale. The software estimates both unweighted and weighted mean-squared residuals for each item. The residuals represent the differences between the model's theoretical expectation of item performance and the performance actually encountered. Each raw residual is standardized using its variance. In the weighted mean square, each standardized residual is weighted using the variance of the observed performance. The unweighted mean square is more sensitive to outliers. The response x_{ij} of a person with ability A_i to item j can take values between 1 and 5. Under the model, the probability of person i scoring h on item j is p_{ijh}. The expected value and variance of x_{ij} are $E_{ij} = \sum_{k=1}^{5} kp_{ijk}$ and $V_{ij} = \sum_{k=1}^{5} (k - E_{ij})^2 p_{ijk}$. The standardized difference between person i's observed and expected response to item j is $z_{ij} = \frac{(x_{ij} - E_{ij})}{\sqrt{V_{ij}}}$. For each item j an unweighted mean square (or outfit) is $u_j = \sum_{i=1}^{n} \frac{Z_{ij}}{n}$, and the weighted mean square (or infit) is $v_j = \frac{\sum_{i=1}^{n} V_{ij} Z_{ij}^2}{\sum_{i=1}^{n} V_{ij}}$. Here n is the number of people in the sample and Mean Squares (MSQ) of around 1 are good. Fit statistics can be reported in unstandardized and standardized form. The unstandardized form is a mean square as described above while the standardized form is reported as a t-statistic (following the t distribution) and with values between -2 and +2 being acceptable. The reasonable range of MSQ for infit and outfit for Likert items is 0.6 to 1.4 according to Bond and Fox (2007. p. 243, table 12.6).

The Cronbach`s alpha is a measure to determine how closely related a set of items are as a group. Values greater than 0.7 are acceptable and the statistic is defined to be

$$\alpha = \frac{N}{N-1}(1 - \frac{\sum_{i=1}^{N} \sigma_{y_i}^2}{\sigma_x^2})$$

Here, N is the number of items, σ_x^2 is the variance of the observed total test scores, and $\sigma_{y_i}^2$ is the variance of the observed item i scores.

3.5. Results

3.5.1. Summary of Rasch Analysis

Before analyzing the nine scales, negative worded questions were reversed. I have distinguished these items with "N" below.

3.5.1.1. Learning Goal Scale

There were five items in this scale. The questions concerned students' reasons for studying mathematics.

ITEM	Estimate	Error	Infit	Outfit
Item_1: I work at mathematics because I want to learn as much as possible	-.34	.04	1.19	1.20
Item_2: I work at mathematics because it is important for me that I understood the ideas	-.51	.04	1.21	1.22
Item_3: I work at mathematics because I like figuring things out.	.26	.04	1.00	1.01
Item_4: I work at mathematics because I like learning new things.	.31	.04	.75	.74
Item_5: I work at mathematics because I like finding new ways of doing things.	.28	.04	.82	.82

Table 3.5.1: Item Fit for Learning Goal Scale

Table 3.5.1 shows the measure, infit and outfit statistics for the Learning goal scale. It is clear that all the items were behaving well in this scale because the infit and outfit measures were between 0.6-1.4. Person reliability was 0.78, item reliability was 0.99 so we can say that the items in this scale measure the same trait and my person measures would be reliable. The Cronbach`s alpha was 0.822. The first column represents estimates of item difficulties as computed by Winsteps and so gives the order of the items. Item 2 is the easiest item to agree with and item 4 is the most difficult one with which to agree. The second column gives error estimates for each item which indicate the stability and replicability of the item estimate.

3.5.1.2. Performance Goal Scale

There were five items in this scale. The first two questions concerned students' thoughts on the examination, the third and fifth questions concerned what other people thought about them, and the fourth question was about competition with the other students.

Table 3.5.2 shows the measure, infit and outfit statistics for the Performance goal scale. The items seemed to be behaving well in this scale because the infit and outfit measures are between 0.6-1.4. However, the person reliability was only 0.51 and Cronbach`s alpha is 0.555. The person reliability was quite small which means that my person measures are not reliable. I carried out Rasch analysis; for the pressure scale, the good teaching scale, the mathematics-learning scale, and the assessment scale as well. However, the person reliabilities and Cronbach`s alpha measures were quite small for all these scales so we decided not to use the measures generated by this Rasch analysis. One reason for this may be that the numbers of the items on the scales were not sufficient for Rasch analysis, for example, in the pressure and assessment scales where four and three items (respectively) were included. Or perhaps this may have happened because items one and two on the performance goal scale were about the examination as a motivating factor whereas the other three items concerned the effect of the opinions of other people on performing concerning the examination. I will consider the items on these scales individually in Section 3.5.4.

ITEM	Estimate	Error	Infit	Outfit
Item_1: I work at mathematics because it is important to me that I do well on the Leaving Cert mathematics exam.	-1.10	.04	.96	.95
Item_2: I work at mathematics because it is important for me to get as many CAO points as I can.	-.91	.04	.93	.95
Item_3: I work at mathematics because it is important for me that the teacher thinks I do a good job.	.39	.03	1.03	1.05
Item_4: I work at mathematics because it is important to me to do better than the other students.	.40	.03	.95	.96
Item_5: I work at mathematics because I do not want people to think that I am stupid.	1.07	.03	1.09	1.16

Table 3.5.2: Item Fit for the Performance Goal Scale

3.5.1.3. Confidence Scale

There were six items in this scale. The questions were about how confident students felt in mathematics.

ITEM	Estimate	Error	Infit	Outfit
Item_1: Generally, I have felt confident about approaching mathematics.	-.04	.04	.73	.70
Item_2: I am no good at mathematics. (N)	-.37	.04	.70	.71
Item_3: For some reason even though I study, mathematics seems unusually hard for me. (N)	-.03	.04	1.18	1.25
Item_4: Mathematics is one of the best subjects.	.19	.04	1.00	1.04
Item_5: I learn mathematics quickly.	.18	.04	.75	.75
Item_6: I have trouble understanding anything with mathematics in it. (N)	.07	.04	1.61	1.70

Table 3.5.3: Item Fit for the Confidence Scale

Table 3.5.3 shows the measure, infit and outfit statistics for the Confidence scale. The person reliability was0.82, item reliability was0.96 and Cronbach`s alpha was .880. We can see that item six did not perform well since its measure was not between 0.6-1.4. As

a result, I decided to delete it. When I considered the modified scale all remaining items had infit and outfit values in the allowable range and the person reliability was .83 and the item reliability was0.97. Cronbach`s alpha increased to 0.889 when item six was deleted. In the analysis that follows. I will use the measures from the modified scale.

3.5.1.4. Anxiety Scale

There were seven items in this scale. The questions concerned whether students were anxious in mathematics classes or in mathematics tests. In this analysis, high scores indicate low levels of anxiety.

ITEM	Estimate	Error	Infit	Outfit
Item_1: I usually have been at ease during mathematics classes.	-.60	.04	1.02	1.00
Item_2: Mathematics makes me feel uncomfortable and nervous. (N)	-.57	.03	.78	.78
Item_3: I get a sinking feeling when I think of trying mathematics problems. (N)	-.36	.03	1.16	1.21
Item_4: I almost never have got nervous during a mathematics test.	.73	.03	1.13	1.22
Item_5: I usually have been at ease during mathematics tests.	.56	.03	.82	.82
Item_6: A mathematics test would worry me more than a test in another subject. (N)	.26	.03	1.11	1.19
Item_7: My mind goes blank and I am unable to think clearly during a mathematics test. (N)	-.03	.03	.94	.98

Table 3.5.4: Item Fit for the Anxiety Scale

We can see from Table 3.5.4 that all the items were behaving well in this scale because the infit and outfit measures were between 0.6-1.4.Person reliability was0.80, item reliability was 1.00 and Cronbach`s alpha was0.851.

3.5.1.5. Usefulness of Mathematics Scale

There were six items in this scale. The questions concerned whether students felt mathematics was useful for them.

We can see from Table 3.5.5 that all the items were behaving well in this scale and infit and outfit measures were between 0.6-1.4. Person reliability was 0.79, item reliability was 0.99 and Cronbach`s alpha was 0.843.

ITEM	Estimate	Error	Infit	Outfit
Item_1: I study Mathematics because I know how useful it is.	.12	.04	1.19	1.23
Item_2: Mathematics is a worthwhile and necessary subject.	-.81	.04	.88	.87
Item_3: I will need mathematics for my work in the future.	.11	.04	1.12	1.13
Item_4: I will use mathematics in many ways as an adult.	-.09	.04	.78	.79
Item_5: Mathematics is of no relevance to my life. (N)	.09	.04	.99	.98
Item_6: I see mathematics as a subject I will rarely use in daily life as an adult. (N)	.58	.03	1.04	1.05

Table 3.5.5: Item Fit for the Usefulness of Mathematics Scale

3.5.1.6. Other Measures of Reliability

I constructed person-item maps for each scale and found that the spread of students was normal, and the spread of the thresholds covered the full range of measures. I did this for the learning goal, the confidence, the anxiety, and the usefulness of mathematics scales and the person-item maps can be found in Appendix A5. The person-item map is a representation of abilities for persons and difficulties of items shown together in graphical form. Persons are located on the left and items are located on the right of the vertical line. The spread of both shows how items on a scale are distributed. For example, in Figure 1 (Appendix 5) the pupil abilities are spread from bottom to top while the item difficulties are concentrated around 0. Figure 2 shows all of the thresholds for the items for the learning goal scale. The kth threshold indicates the difficulty of choosing k+1 and not k in answer to the item. The spread of the thresholds in this map covers the range of the person abilities and so indicates that the items are able to distinguish between respondents with different levels of the trait in question. From the analysis so far, we can see the learning goal, confidence, anxiety, and

usefulness of mathematics scales behave well. The items seem to measure one construct per scale and the difficulty level of the items on each scale is spread out. So we can be confident that the person measures generated are reliable.

3.5.2. Summary of Comparisons

In this section, I will consider the measures generated by Rasch Analysis for the learning goals, the confidence, the anxiety, and the usefulness scales. I will use these measures to compare the students' attitudes. The comparisons are based on independent sample t-tests.

3.5.2.1. Difference Between Irish and Turkish Students

I found no difference between the mean scores of students in the two countries on the learning goals scale (p-value = .211). However, there was a difference between the countries on the confidence scale (p-value<.001) with the Turkish students being more confident than their Irish counterparts and similarly Turkish students displayed significantly higher measures on the anxiety scale (p-value<.001) (indicating lower anxiety) and on the usefulness of mathematics scale (p-value = .001) indicating a greater appreciation of the usefulness of mathematics.

So in general, Turkish students seem to be more confident in their mathematical ability, less anxious about the subject and appreciate the usefulness of mathematics.

3.5.2.2. Difference Between Groups of Students in Irish Schools

Here I will look at Irish students only and test for differences between school types, between higher, ordinary and foundation level groups, and between genders.

Comparison of Levels

Students studying Higher level mathematics displayed higher mean measures on the learning goals scale and p-values were less than 0.05 for both comparison of higher level and ordinary level, and higher level and foundation level. The difference between

ordinary level and foundation level was not statistically significant on the learning goal scale (p-value = .371).

Similar results were found in the confidence scale and on average, the Higher level students displayed more confidence than the ordinary level students (p-value< 0.001) and foundation level students (p-value< 0.001). I found no statistically significant difference between the mean scores of the ordinary level students and foundation level students (p-value = .265).

On the anxiety scale, the only difference was between the mean scores of the Higher level students and the ordinary level students (p-value = .013) with Higher level students being less anxious. The differences between the mean scores of the higher level and foundation level students, and ordinary level and foundation level students were not statistically significant (p-value >.05).

I found similar results for the usefulness of mathematics scale and once again, the Higher level students displayed a higher mean measure than the ordinary level students (p-value = .000). There was no statistically significant difference between higher level and foundation level and ordinary level and foundation level (p-value >.05).

Comparison of Genders

I compared the scores of students in single sex (girls) schools to single sex boys schools and to co-ed schools, single sex boys schools to co-ed schools. I found no significant difference between the mean scores of students in these types of schools on the learning goal, the confidence, the anxiety, and the usefulness of mathematics scales (p-value >.05).

Similarly, when I grouped all the female and male students together regardless of school types, I found no gender differences on any of the scale.

Comparison of Deis and Non-Deis Schools

The title 'Deis schools' refers to designated disadvantaged schools. I found no statistically significant difference between the mean scores of students in deis and non-Deis schools on the learning goals, the confidence, the anxiety, and usefulness of mathematics scales (p-value > .05).

3.5.2.3. Difference Between Turkish School Types

In this section, I will compare the mean scores of students in different Turkish school types. For this analysis, I amalgamated the Science school and the Anatolian schools together into the same school type. My reason for doing this was that these school types both select the highest achieving students from primary level. Thus, there were four types of schools in this comparison: Science and Anatolian schools; private schools; ordinary schools; and vocational schools.

There was no statistically significant difference between the means of the measures of students on the learning goals scale, except for the difference between Science and Anatolian school students and students in private schools (p-value = .021). Here the Science and Anatolian school students displayed a higher mean measure. There was no statistically significant difference between the other types of the schools on this scale (p-value > .05).

The difference between the mean scores of private schools and ordinary schools on the confidence scale was not statistically significant (p-value = .603).However, there were statistically significant differences between the Science and Anatolian schools and the other schools types (p-values <.05) with the students at the Science and Anatolian schools being more confident than the students at the other schools were. In addition, I found a significant difference between the mean scores of students at private schools and at vocational schools (p-value = .006), and students at ordinary schools and vocational schools (p-value = .005). The students at private schools and at ordinary schools displayed higher mean measures than the students at vocational schools did.

I found that there was a statistically significant difference between the Science and Anatolian schools and the other school types on the anxiety scale (p-values < .001). The students at the Science and Anatolian schools were less anxious than the other students were. The other difference was between the mean scores of private schools and ordinary schools (p-value = .010) with private schools being less anxious. The differences between the other school types were not statistically significant (p-value > .05).

In the usefulness scale, the differences between the Science and Anatolian schools and private schools were statistically significant (p-value = .000) and the Science and Anatolian schools displayed higher mean measure than private schools. Similarly, there were statistically significant differences between private schools and ordinary schools (p-value = .006) and private schools and vocational schools (p-value = .034). The

ordinary schools and vocational schools displayed higher measure than the private schools. There was no statistically significant difference between the other schools on this scale (p-value > .05).

3.5.3. Correlation Between Some Scales

I carried out a correlation analysis, and drew scatter plot graphs to examine the correlations between the learning goal, the confidence, the anxiety, and usefulness scales.

		Learning measure	Confidence measure	Anxiety measure	Usefulness measure
Learning measure	Pearson Correlation	1	.577**	.355**	.627**
Confidence measure	Pearson Correlation	.577**	1	.620**	.509**
Anxiety measure	Pearson Correlation	.355**	.620**	1	.345**
Usefulness measure	Pearson Correlation	.627**	.509**	.345**	1

Table 3.5.6: Correlation Values

**. Correlation is significant at the 0.01 level (2-tailed).

The correlations were all statistically significant, however, the correlations between the learning goal scale and the anxiety scale, and the anxiety scale and the usefulness scale were quite low. The highest correlations were between the learning scale and usefulness scale, and between the confidence scale and the anxiety scale. The confidence scale was highly correlated with all of the other variables.

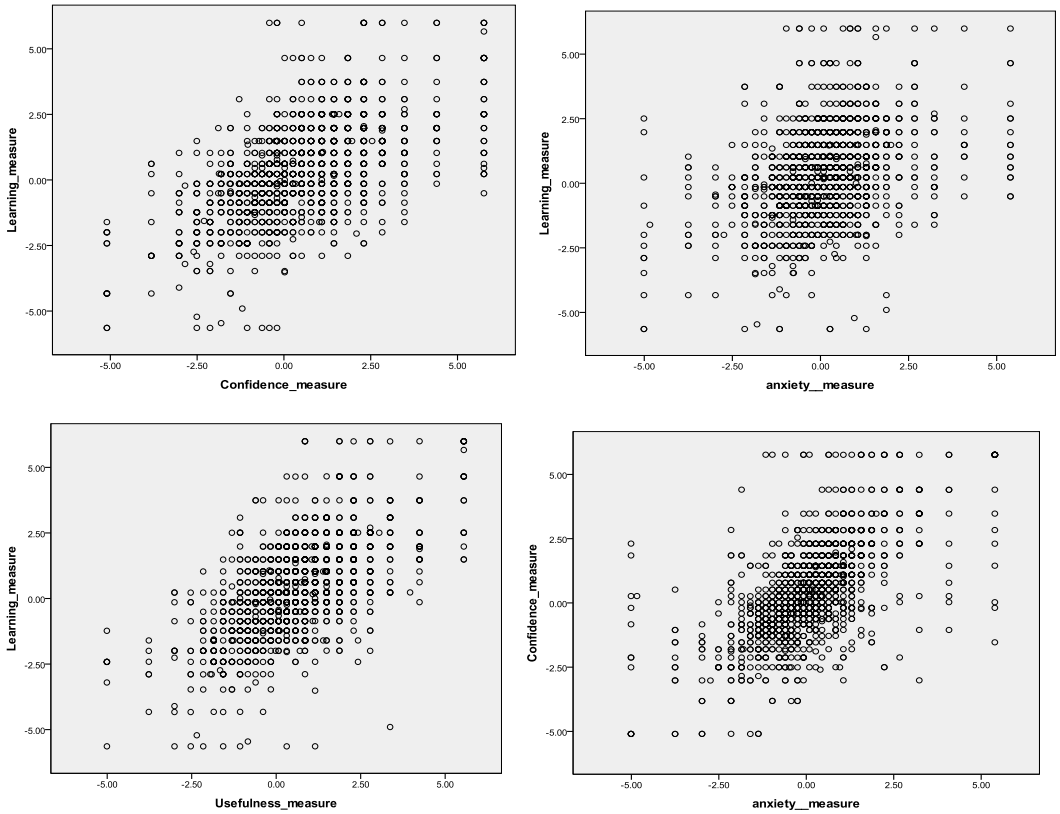


Table 3.5.7: Scatter Plots

Moreover, I carried out a regression analysis; learning goal measure was chosen as dependent variable, and the independent variables were confidence, anxiety, and usefulness of mathematics measures. The confidence and the usefulness of mathematics measures were statistically significant predictors for the learning goal measure ($p < .05$). However, the anxiety measure was not statistically significant ($p > .05$). When I used the stepwise method in the regression analysis the anxiety measure was dropped from the model. The final model was: Learning-goal-measure = -.112 +.515 × Usefulness-measure +.341 × Confidence-measure + ε. The R^2 (= .483) value tells us that almost half of the variation in the Learning Goal measure can be explained by the other variables in the regression model.

3.5.4.Summary of Responses to Likert-type Items

In this section, I will present a summary of the students' responses to the items regarding learning goals, performance goals, pressure, good teaching, mathematics

learning, and assessment. The tables show the percentages of students for the disagree/neutral/agree categories, missing values and p-values. I merged strongly agree and agree, and strongly disagree and disagree responses to compute the percentages. In addition, I constructed Chi squared tests to see if there was a significant difference between the two countries on each item and the p-values in the tables refer to these tests.

Learning goals		Disagree	Neutral	Agree	Missing	p-value
Item-1: I work at mathematics because I want to learn as much as possible	Irish	23.3%	35%	41.5%	0.3% (2)	< .001
	Turkish	18.1%	24.2%	57.3%	0.3% (2)	
Item-2: I work at mathematics because it is important for me that I understand the ideas	Irish	12%	26.3%	60.2%	1.5% (10)	< .001
	Turkish	20.4%	34.8%	42.8%	2.0% (13)	
Item-3: I work at mathematics because I like figuring things out	Irish	36.2%	27.9%	35.8%	0.2% (1)	.099
	Turkish	31.2%	27.7%	40.7%	0.5% (3)	
Item-4: I work at mathematics because I like learning new things	Irish	34.2%	32.4%	33.2%	0.2% (1)	.471
	Turkish	31.9%	31.3%	36.1%	0.6% (4)	
Item-5: I work at mathematics because I like finding new ways of doing things	Irish	32.3%	33%	33.3%	1.4% (9)	.173
	Turkish	27.7%	35.9%	35.4%	1.1% (7)	

Table 3.5.8: Percentages of Irish and Turkish Pupil Responses to Learning Goal Items

In Table 3.5.8, 41.5% of the Irish and 57.3% of the Turkish students agreed that they worked at mathematics in order to learn as much as possible and 60.2% of the Irish and 42.8% of the Turkish students agreed that they worked at mathematics because it was important for them to understand the ideas of mathematics. There is a significant difference between Ireland and Turkey on items 1 and 2 (p-value<.05). Turkey had a higher proportion than Ireland of responses agreeing with on item 1 and Ireland had higher proportion than Turkey of students agreeing with item 2. For learning goal items 3-5, the responses for both countries of students were split quite evenly between the disagree/neutral/agree categories.

From Table 3.5.9, the majority of the Irish students and Turkish students responded that they worked at mathematics because it was very important to do well on LC/OSS mathematics examinations and said that they worked at mathematics because it was important for them to get as many as CAO/OSS examination points as they could. They seemed to be focused on the examination as they wanted to do well on the examination and they wanted to get as many points as possible. For items 1 and 2, the missing values are relatively high for the Turkish students. One of the private schools wanted to use the English form of the pupils' questionnaire but the meaning of LC and CAO points was not explained to the students so they could not respond to these items.

Some students indicated that it was important to them that their teachers thought they did a good job (36.5% of Irish and 20.9% of Turkish) while only a minority of the students also pointed out that they felt they were in competition with the other students (22.7% of Irish and 34.2% of Turkish). There is a significant difference between the countries in the students' responses to these items (3 and 4). The majority of the Irish students (53%) and the Turkish students (72.6%) also disagreed with item 5, and there is a significant difference between Ireland and Turkey on this item (p-value<.05)with Ireland having higher proportion of people who agreed. It seems from the answers to items 3, 4, and 5 here that students are not overly motivated by the opinions of others concerning their ability.

Performance goals		Disagree	Neutral	Agree	Missing	p-value
Item_1: I work at mathematics because it is important to me that I do well on the LC/OSS mathematics exam.	Irish	5.3%	11%	83.6%	0.2% (1)	.095
	Turkish	7.9%	11.2%	77.3%	3.6% (24)	
Item_2: I work at mathematics because it is important for me to get as many CAO/OSS points as I can.	Irish	7.4%	16.4%	75.5%	0.8% (5)	.222
	Turkish	8.2%	12.6%	73.9%	5.3% (35)	
Item_3: I work at mathematics because it is important for me that the teacher thinks I do a good job.	Irish	33.3%	30%	36.5%	0.2% (1)	< .001
	Turkish	45.2%	33.1%	20.9%	0.8% (5)	
Item_4: I work at mathematics because it is important to me to do better than the other students.	Irish	51.1%	26%	22.7%	0.3% (2)	< .001
	Turkish	37.6%	28%	34.2%	0.3% (2)	
Item_5: I work at mathematics because I do not want people to think that I am stupid.	Irish	53%	19.1%	27.3%	0.6% (4)	< .001
	Turkish	72.6%	17.2%	9.4%	0.8% (5)	

Table 3.5.9: Percentages of the Irish and Turkish Pupil Responses to Performance Goal Items

Anxiety		Disagree	Neutral	Agree	Missing	p-value
Item-1: I usually have been at ease during mathematics classes.	Irish	19.5%	25.2%	54.7%	0.6% (4)	.025
	Turkish	17.5%	21.8%	60.1%	0.6% (4)	
Item-2: Mathematics makes me feel uncomfortable and nervous.	Irish	55.9%	24.2%	19.7%	0.3% (2)	.015
	Turkish	59.6%	18.9%	20.9%	0.6% (4)	
Item-3: I get a sinking feeling when I think of trying mathematics problems.	Irish	52.3%	22.2%	25.2%	% (2)	.600
	Turkish	50.2%	21.3%	28.3%	0.2% (1)	
Item-4: I almost never have got nervous during a mathematics test.	Irish	67.7%	15.6%	16.4%	0.3% (2)	< .001
	Turkish	43.4%	21.2%	35.2%	0.2% (1)	
Item-5: I usually have been at ease during mathematics tests.	Irish	46.1%	27%	26.6%	0.3% (2)	.071
	Turkish	43.1%	21.3%	35.4%	0.2% (1)	
Item-6: A mathematics test would worry me more than a test in another subject.	Irish	33.5%	17.9%	47.9%	0.8% (5)	.001
	Turkish	42.1%	17.1%	39.5%	1.4% (9)	
Item-7: My mind goes blank and I am unable to think clearly during a mathematics test.	Irish	39.6%	25.2%	34.5%	0.6% (4)	.002
	Turkish	48.1%	23%	28.6%	0.3% (2)	

Table 3.5.10: Percentages of the Irish and Turkish Pupil Responses to Anxiety Items

On the anxiety scale, (Table 3.5.10) students responded to statements concerning whether they were anxious in mathematics classes or in mathematics tests. There was a significant difference between the two countries (p-value = .015) on items 1 and 2, here Turkish students were less anxious about mathematics than Irish students were. From the answers to items 4, 6, and 7, it seems that Irish students are more anxious on the whole about mathematics tests than their counterparts in Turkey (as higher scores indicate lower levels of the trait on this scale). The differences between the proportions on these items were statistically significant (p-value < .05).

From Table 3.5.11, we can see in both Ireland and Turkey, according to the students, the majority of parents seem to want their children to do well in mathematics and think it is an important subject. The overwhelming majority of parents in both countries want their children to do well in school.

Pressure		Disagree	Neutral	Agree	Missing	p-value
Item_1: It is not important to my parents that I do well at mathematics.	Irish	65.4%	15.6%	18.6%	0.3% (2)	< .001
	Turkish	72%	17.1%	10.5%	0.5% (3)	
Item_2: My parents think that mathematics is one of the most important subjects I have studied.	Irish	17.9%	22.2%	59.3%	0.6% (4)	.004
	Turkish	11.5%	22.1%	65.5%	0.9% (6)	
Item_3: It is important to my parents that I do well in school.	Irish	3.8%	12%	83.9%	0.3% (2)	.005
	Turkish	7.7%	10%	81.5%	0.8% (5)	

Table 3.5.11: Percentages of the Irish and Turkish Pupil Responses to Pressure Items

Good-teaching		Disagree	Neutral	Agree	Missing	p-value
Item_1: Good mathematics teachers show students lot of different ways to look at the same question.	Irish	10.7%	16.7%	72.2%	0.5% (3)	< .001
	Turkish	3.4%	8.9%	86.8%	0.9% (6)	
Item_2: Good mathematics teachers show you the exact way to answer the mathematics questions you will be tested on.	Irish	9.2%	18.8%	71.9%	0.2% (1)	.024
	Turkish	13.9%	17.1%	68.8%	0.2% (1)	
Item_3: Good mathematics teachers help students to understand mathematical ideas.	Irish	1.7%	4.2%	94.1%	-	.034
	Turkish	2.2%	7.4%	90.5%	-	
Item_4: Good mathematics teachers show students how mathematics is used in the real world.	Irish	15.5%	23.4%	60.5%	0.6% (4)	< .001
	Turkish	9.4%	19.7%	69.7%	1.2% (8)	
Item_5: Good mathematics teachers do not spend class time talking about topics that will not be on the examinations.	Irish	20.6%	18.9%	59.9%	0.6% (4)	< .001
	Turkish	40.4%	18.9%	40.1%	0.6%	

Table 3.5.12: Percentages of the Irish and Turkish Pupil Responses to Good-Teaching Items

In Table 3.5.12, almost all of the Irish (94.1%) and Turkish (90.5%) students wanted their teachers to help them understand mathematical ideas and most of them (72.2% of

Irish and 86.8% of Turkish) thought that good teachers should show them different ways to look at the same questions. However, the majority of the students (71.9% of Irish and 68.8% of Turkish) also agreed that good mathematics teachers should show them the exact way to answer the mathematics questions they would be tested on. There is a significant difference between Irish students' and Turkish students' thoughts on item 3 (p-value <.05) with Turkish students being slightly less likely to agree that good teachers helped them to understand mathematical ideas. 59.9% of the Irish students agreed that good mathematics teachers did not spend class time talking about topics that will not be on the examination, however, 40.1% of the Turkish students agreed with the same statement whereas 40.4% of them disagreed. While Table 3.5.12 shows that some of the Turkish students naturally wanted to learn content that would be on the examination, many also wanted to hear about real life topics as well (items 4 and 5). In Ireland, there was a higher proportion of ordinary level students compared to Higher level students who agreed on item 5 (p-value < .001), and more high achieving Turkish students (Science, Anatolian, and private schools) than lower achieving students disagreed on the same item (p-value < .001). On items 3 and 4, Turkish students in Science and Anatolian were more likely to agree than the students in private, ordinary and vocational schools (p-values < .05). More Irish female students than males agreed that good mathematics teachers did not spend class time talking about topics that would not be on the examination (p-value < .05).

Approximately equal numbers of the Irish students agreed (35.9%) and disagreed (35.8%) that the mathematics they learned at school was mostly facts and procedures that had to be memorized (Table 3.5.13).There is no significant difference between Irish ordinary and higher level students on this item (p-value = .479).30.6% of Turkish students agreed with this item while 43.4% disagreed. Some Irish (44.9%) and Turkish (30.9%) students agreed with 4, however, Ireland had a significantly higher proportion of students than Turkey who agreed that the mathematics that they learned at school was mostly about understanding ideas (p-value<.05). 37.1 % of the Irish and 40.2% of the Turkish students agreed that the mathematics at school was not relevant to real life. On item 5, 38.9% of the Irish students were neutral and 39.8% of them disagreed that the mathematics at school was about identifying patterns and relationship, whereas, 43% of the Turkish students were neutral and 40.2% of them agreed. There was a statistically significant difference between the two countries on item 5 with a higher proportion of

Turkish students believing that the mathematics they learned at school was about identifying patterns (p-value<.05).

Mathematics learning		Disagree	Neutral	Agree	Missing	p-value
Item_1: The mathematics I learn at school is mostly facts and procedures that have to be memorized.	Irish	35.8%	27.8%	35.9%	0.6% (4)	.016
	Turkish	43.4%	25.9%	30.6%	0.2% (1)	
Item_2: The mathematics I learn at school encourages me to think for myself.	Irish	30.5%	28.8%	40.4%	0.3% (2)	.072
	Turkish	24.8%	31%	43.7%	0.5% (3)	
Item_3: The mathematics I learn at school is not relevant to real life.	Irish	36.6%	25.8%	37.1%	0.5% (3)	.047
	Turkish	30.1%	28.7%	40.2%	0.9% (6)	
Item_4: The mathematics I learn at school is mostly about understanding ideas.	Irish	17.4%	37.5%	44.9%	0.2% (1)	<.001
	Turkish	24.1%	44.2%	30.9%	0.9% (6)	
Item_5: The mathematics I learn at school is about identifying patterns and relationships.	Irish	39.8%	38.9%	20.3%	1.1% (7)	< .001
	Turkish	15%	43%	40.2%	1.8% (12)	

Table 3.5.13: Percentages of the Irish and Turkish Pupil Responses to Mathematics Learning Items

Moreover, there is a significant difference between the countries on items 1 and 3 concerning students' beliefs about the mathematics they learn at school (p-value<.05): on item 1, Turkey displayed a higher proportion who disagreed than Ireland and Turkish students were less likely to agree that mathematics at school was mostly memorizing facts and procedures. On item 3, Irish students were more likely to disagree that

mathematics at school was not relevant to real life by the fact that Ireland had a higher proportion who disagreed than Turkey. More higher achieving students than low achieving students in both countries disagreed with item 2 and were neutral on item 5. High achieving Irish students had a higher proportion than lower achieving students who were neutral on item 4 and in Turkey, high achieving students were more likely than low achieving students to agree. In addition, in Ireland more ordinary level students than Higher level students disagreed with items 1 and 3. There was no statistically significant difference between the proportions of Irish female and male students on this scale.

Assessment		Disagree	Neutral	Agree	Missing	p-value
Item_1: I think the Leaving Certification examination is a fair way of assessing mathematical ability.	Irish	27.1%	29.1%	43.3%	0.6% (4)	<.001
	Turkish	39.3%	27.5%	27.8%	5.3% (35)	
Item_2: I think project work would be fair way of assessing mathematical ability.	Irish	44%	27.2%	28.5%	0.3% (2)	< .001
	Turkish	33.9%	42.2%	23.4%	0.5% (3)	
Item_3: I think a number of short examinations over number of years would be fair way of assessing mathematical ability.	Irish	13.1%	20.3%	66.5%	0.3% (1)	< .001
	Turkish	30%	40.8%	28.9%	0.3% (2)	

Table 3.5.14: Percentages of the Irish and Turkish Pupil Responses to Assessment Items

Irish and Turkish students' thoughts are significantly different in Table 3.5.14 on whether the L.C./OSS examination was a fair way of assessing mathematical ability. Fewer Turkish students than Irish students agreed that the examination system was fair and this difference was statistically significant. Turkish students seemed not to have strong thoughts on the different assessment systems suggested with approximately 40% remaining neutral to and less than 30% agreeing with the suggestions made in items 2

and 3. There is a significant difference between Irish and Turkish students on assessment item 3 (p-value<.05) and Turkish students were less likely to agree that the examination system should be changed to a continuous assessment system involving a number of examinations over a number of years.

Study Methods

Students were asked to rank nine study methods from 'not at all important' to 'very important'. The results for both countries are given in Table 3.5.15 I have also tabulated the results by level in Ireland (Table 3.5.15- Table 3.5.16) and by school type in Turkey (Table 3.5.15- Table 3.5.17)

From Table 3.5.15, it can be seen that there were statistically significant differences between the two countries on all questions. Reading the textbook was very important or quite important for 68.4% of Irish students while only 35.4% of Turkish students felt the same. The majority of students in both Ireland and Turkey said that reading class notes was important. The majority of the Irish (91.2%) and Turkish students (83.4%) said understanding mathematical ideas was important. Irish students felt that practicing questions from the textbook (91%) and old examination papers (93.2%) was important and this was significantly different from the responses of the Turkish students to these questions (61.7% and 73.3% respectively). Turkish students had mixed feelings on discussing mathematical ideas with classmates whereas 59.6% of Irish students found that it was not important. The majority of the Irish students (77.8%) and Turkish students (53.9%) felt that using the internet was not important. Irish students (74%) said that it was important to use examination revision guides and Turkish students again had mixed feelings on this subject.

Study methods		Very important	Quite important	Not very important	Not at all important	Missing	p-value
Reading the textbook	Irish	21.8%	47.6%	24.3%	3.8%	2.6% ()	< .001
	Turkish	12.4%	23%	39%	23%	2.6% ()	
Reading the notes from class	Irish	53.2%	38.6%	4.7%	1.4%	2.3% ()	< .001
	Turkish	39.3%	44%	9.8%	4.2%	2.6% ()	
Trying to understand the mathematical ideas	Irish	65.8%	25.4%	4.8%	1.2 %	2.9%	< .001
	Turkish	48%	35.4%	10.1%	3.8%	2.7%	
Memorizing formulae and procedures	Irish	49.2%	35.1%	11.1%	1.5%	3% ()	< .001
	Turkish	31.8%	43.9%	18%	4.1%	2.3% ()	
Practising questions from the textbook	Irish	60.8%	30.2%	5.4%	0.9%	2.7%	< .001
	Turkish	25.4%	36.3%	23.4%	12.1%	2.7%	
Practising questions from past examination papers	Irish	76.1%	17.1%	3.2%	1.1%	2.6% ()	< .001
	Turkish	38.4%	34.9%	18.8%	5.7%	2.1%	
Discussing mathematical ideas with classmates	Irish	11.1%	26.7%	44.7%	14.9%	2.6% ()	< .001
	Turkish	26.8%	31%	27.8%	12%	2.4%	
Using the internet	Irish	6%	13.8%	51.1%	26.7%	2.4% ()	< .001
	Turkish	21.3%	22.4%	33.9%	20%	2.4%	
Using examination revision guide	Irish	27%	47.3%	17.7%	5.1%	2.9% ()	< .001
	Turkish	19.1%	29.3%	30.7%	17.4%	3.5%	

Table 3.5.15: Percentages of the Irish and Turkish Pupil Responses to Study Methods Items

There were statistically significant differences between Higher level and Ordinary level students in Ireland on some of the study methods items (Table 3.5.16). More Higher level students than Ordinary level students said that it was important to try to understand the mathematical ideas, practise questions from the textbook, practise

questions from past examination papers, and discuss mathematical ideas with classmates. However, 80.8% of Ordinary level students felt that using an examination revision guide was important whereas 69.5% of Higher level students felt it was important. There was no statistically significant difference between Higher level and Ordinary level students on ‘memorizing formulae and procedures’.

Study methods	Levels	Very important	Quite important	Not very important	Not at all important	p-value
Reading the textbook	Higher	18%	53.2%	24.8%	0.4%	.042
	Ordinary	24.3%	47.2%	24.6%	3.8%	
Reading the notes from class	Higher	51.6%	41.6%	5%	1.8%	.758
	Ordinary	57.3%	37.1%	4.4%	1.2%	
Trying to understand the mathematical ideas	Higher	75.5%	21.2%	2.9%	0.4%	< .001
	Ordinary	63.4%	28.3%	6.2%	2.1%	
Memorizing formulae and procedures	Higher	49.6%	38.8%	10.4%	1.1%	.788
	Ordinary	51.3%	34.5%	12.1%	2.1%	
Practicing questions from the textbook	Higher	66.4%	30.7%	1.8%	1.1%	.028
	Ordinary	59.5%	31.4%	8.2%	0.9%	
Practicing questions from past examination papers	Higher	83.9%	13.3%	2.5%	0.4%	.017
	Ordinary	75.1%	19.4%	3.8%	1.8%	
Discussing mathematical ideas with classmates	Higher	12.3%	31.4%	44.8%	11.6%	.159
	Ordinary	10.2%	24.9%	46.5%	18.4%	
Using the internet	Higher	2.9%	8.6%	56.6%	31.9%	< .001
	Ordinary	7.9%	17%	49.6%	25.5%	
Using examination revision guide	Higher	20.9%	48.6%	25.2%	5.4%	< .001
	Ordinary	32.9%	47.9%	13.5%	5.6%	

Table 3.5.16: Percentages of the Irish Pupil Responses to Study Methods Items

From Table 3.5.17a-b, it can be seen that there were statistically significant differences on all the study methods between Turkish students in different types of schools. More lower achieving students than higher achieving students felt that it was important to read the textbook and notes from class, try to understand the mathematical ideas, memorize formulae and procedures, practice questions from the textbook, use the internet, and use examination revision guide. The proportion of higher achieving students who said that it was important to practice questions from past examination papers and discuss mathematical ideas was more than the proportion of lower achieving students.

Study methods	Schools	Very important	Quite important	Not very important	Not at all important	p-value
Reading the textbook	Science, Anatolian, Private	10.1%	17.4%	40.1%	32.4%	< .001
	Ordinary, Vocational	10.7%	20.8%	44.3%	24.2%	
Reading the notes from class	Science, Anatolian, Private	31.9%	47.2%	13.2%	7.6%	< .001
	Ordinary, Vocational	52.7%	42%	3.3%	2%	
Trying to understand the mathematical ideas	Science, Anatolian, Private	53%	32.3%	10.2%	4.6%	.228
	Ordinary, Vocational	48%	41.3%	6.7%	4%	
Memorizing formulae and procedures	Science, Anatolian, Private	19.4%	50.7%	23.6%	6.3%	< .001
	Ordinary, Vocational	38.7%	46.7%	12%	2.7%	
Practicing questions from the textbook	Science, Anatolian, Private	22.2%	31.6%	27.1%	19.1%	< .001
	Ordinary, Vocational	30.9%	32.2%	26.2%	10.7%	

Table 3.5.17a: Percentages of the Turkish Pupil Responses to Study Methods Items

Practicing questions from past examination papers	Science, Anatolian, Private	41.7%	38.2%	13.5%	6.6%	< .001
	Ordinary, Vocational	40.9%	29.5%	27.5%	2%	
Discussing mathematical ideas with classmates	Science, Anatolian, Private	27%	36.5%	23.2%	13.3%	.110
	Ordinary, Vocational	32%	26.7%	32%	9.3%	
Using the internet	Science, Anatolian, Private	14.3%	19.2%	41.1%	25.4%	< .001
	Ordinary, Vocational	26.8%	24.8%	32.2%	16.1%	
Using examination revision guide	Science, Anatolian, Private	12.8%	26.7%	36.3%	24.2%	< .001
	Ordinary, Vocational	20.9%	39.2%	29.1%	10.8%	

Table 3.5.17b: Percentages of the Turkish Pupil Responses to Study Methods Items

The students were also asked to specify other study methods and 31 Irish and 28 Turkish students mentioned other study methods. The Irish students' responses were: having grinds (7), doing homework (3), revision (3), making notes in class (3), listening carefully and trying to understand in class (2), studying more and more, and doing lots of examples/tests (8), asking a teachers for help (1), asking older sister for help (1), good quiet place to study (1), sitting down and trying to relate mathematics and all its areas to the real world (1), and attempting complex problems and challenging yourself (1). The Turkish students' responses were: grinds (4), try to understand in class (6), memorizing (1), study more and more, and solving lots of different questions (14), using internet (1), revision (1), and studying on proofs (1).

Students were asked if they attended grinds or grind schools. The majority of Turkish students (80.2%) said they attended grind schools whereas 88.9% of Irish students did not attend any grinds.

80.2% of Turkish students indicated that they attended grind schools in the 2009-2010 school year, while 16.9% of them said they did not. 83.7% of Turkish students said they

did and 13.3% of them said they did not attend grind schools before this. In contrast, 12.2% of Irish students answered yes and 86.8% of them answered no when asked if they attended grinds before 2009-2010.

Choice of Subjects

In the Irish students' questionnaire, there were two questions which asked the students for their reasons for choosing Leaving Certificate subjects. In the first question, 54.7% of students responded that they were interested in the subject and 41.1% of them said they wanted to maximize CAO points. The second question asked them if their reason for choosing the level of mathematics that they studied for Leaving Certificate was interest in mathematics or maximizing CAO points. 32.3% of them responded that they were interested in mathematics, however, 62.3% of them stated they wanted to maximize CAO points.

3.6. Discussion

As seen in the literature review in chapter 1, research has shown that high-stakes examination can have an effect on students' motivation, confidence, and learning strategies. In this chapter, I have presented the results of the questionnaire administered to secondary level students in Ireland and Turkey.

3.6.1. Learning Goal and Performance Goal

There is no statistically significant difference between Irish and Turkish students on the Learning Goal scale. Even though Science and Anatolian school students seemed to have more learning goals than those in private schools, there is no strong evidence to make a comparison between the other Turkish school types on this scale. Irish Higher level students seemed to have more learning goals than Ordinary level students. Kelleghan et al. (1996) mentioned that one effect of examinations on students was that because of the examination students have performance goals and not learning goals. However, there is no evidence to say that students in my study had performance goals because I could not construct a measure on the performance scale using the Rasch Model.

Kelleghan et al. (1996) suggest that students with performance goals are surface learners and that they use rote-learning methods more than students who have learning goals. Stipek and Gralinski (1996) found that students who had a high score on the performance goal scale were more likely to engage superficially rather than actively with classroom tasks. In my study, we can see from Table 3.5.9 that both Irish and Turkish students were motivated by achieving good examination results and to a far lesser extent by the opinions of others. Since the performance goal scale in this study did not produce a reliable interval measure using Rasch Analysis, I was not able to test whether students with high scores on the performance goal scale employed superficial study methods. However, more Irish students than Turkish students believed that it was important that they understood ideas (Table 3.5.8, item 2).The majority of students from both countries reported that trying to understand the mathematical ideas is an important study habit but they also think that memorizing formulae and procedures is important (Table 3.5.18).

Turkish students seemed to be more competitive with other students than the students in Ireland were, as we can see from the responses to item 4 on the Performance Goal scale. PISA 2003 found the same result that is that Turkish students had a high mean score, Irish students had a low mean score on the competitive learning scale, and both Ireland and Turkey had a positive relationship between competitive learning situations and students' performance in mathematics.

3.6.2.Affective Variables

3.6.2.1.Confidence and Anxiety

In my study, I asked students questions on the confidence scale and anxiety scale. Using Rasch analysis, I constructed a measure for each student for each of these variables. Turkish students were found to be more confident at mathematics than Irish students in my study. In addition, a comparison of mean scores on the anxiety scale showed that Irish students were more anxious than their Turkish counterparts. A similar result was found when I looked at the proportions who agreed with the anxiety items in both countries. In PISA 2003, Turkey was more anxious and less confident than Ireland and Turkey had a lower mathematics performance than Ireland. There were some

differences between the Turkish school types. In my study, the students in science and Anatolian schools were more confident and less anxious at mathematics than the students in the other schools. Two Turkish studies (Kahveci and Imamoglu, 2006, and Berberoglu, 2004) found that students in private schools had high level of confidence. I found that private schools and ordinary schools had no statistically significant difference on the confidence scale. Irish students studying Higher level were more confident and less anxious than the students studying Ordinary level Mathematics. Some studies (Dowling, 1978, Armstrong, 1980, Fennema and Sherman, 1977,1978, Crosswhite, 1972, and Hirsch, 1979) found that students who have more confidence in their ability in mathematics will usually study mathematics more often and for longer than those who do not have this confidence. This might be associated with the result that Irish students who had more confidence studied Higher level, and students who had less confidence studied Ordinary level.

The regression and correlation analyses undertaken (Table 3.5.6- Table 3.5.7) showed that the highest correlation was between the confidence scale and the anxiety scale. In PISA 2003, a similar correlation between confidence and anxiety was found for all countries including Ireland and Turkey. There is no significant difference between Irish Deis and non-Deis schools, and single sex (girls) schools, single sex (boys) schools, and co-ed schools, and gender on the confidence scale. Inside Classrooms (Lyons et al., 2003) found similar results for different Irish school types.

Some studies (Spielberg et al., 1978, Richardson and Suinn, 1972, Hendel, 1980, Betz, 1978) found that students who had a high level of mathematics anxiety, also have high levels of test anxiety. However, I found a slightly different result from theirs. I carried out Rasch analysis for the anxiety scale and I also found frequencies for each item of this scale. There are two items that asked students whether they were comfortable in mathematics classes and in mathematics tests. The frequencies of items 1 and 5 (Table 3.5.10) showed that students were usually comfortable in mathematics classes and they were not comfortable in mathematics tests.

3.6.2.2.Usefulness

Mulhern and Rae (1998) used the FSMAS scale in their study and they aimed to determine whether a shortened form of FSMAS could be used reliably. They also showed that the FSMAS could be used with a different group of students (that is Irish students instead of students from the USA). At the end of their study, they concluded

that the shortened form of this scale would be appropriate to administer. In my study, all of the usefulness items were copied from Mulhern and Rae's (1998) shortened form of the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema and Sherman,1976). I did not use exactly the same confidence scale and anxiety scales as in Mulhern and Rae's (1998) shortened form of the Fennema-Sherman Mathematics Attitudes Scales or in the original form of FSMAS (Fennema and Sherman,1976) and I developed new confidence and anxiety scales. Once again, using the Rasch model I showed, as in the Mulhern and Rae (1998) study, the FSMAS scale could be administered in different countries.

Higher achieving Irish students in my study seemed to know more about the usefulness of mathematics than lower achieving students. Similarly, some studies (Fennema and Sherman,1977, 1978; Armstrong, 1980; Perl, 1979) concluded that students who achieved more in mathematics knew more about the usefulness of mathematics, whereas lower achieving students did not. In Turkey, there is no strong evidence between different school types on the usefulness of mathematics, however, private schools seemed to have less understanding of the usefulness of mathematics than the other types of schools. Inside Classrooms (2003) found that Irish students felt that they needed to do well at mathematics because it was useful for the third level. I did not ask a question like this in my study. Turkish students seemed to believe that mathematics was more useful than Irish students did. In 2011, The Economic and Social Research Institute found that the majority of Irish students thought that mathematics was one of the most useful subjects.

3.6.3. Gender

Two different groups of Irish researchers (Lyons et al., 2003; Smyth et al., 2011) found that males were more confident than females. There were no gender differences for Irish students on the confidence and the usefulness scales found in this study. However, Irish students studying Higher level mathematics were more confident and scored higher on the usefulness of mathematics scale than the students studying Ordinary-Level. Similarly, higher achieving Turkish students in Science and Anatolian schools were more confident than students in other schools and the students in private schools had, on average, lower scores than the other schools on the usefulness scale. In addition, in the Irish study by Lyons et al. (2003), the school types such as single sex-

boys or girls, coeducation schools, disadvantaged or advantaged schools did not make a statistically significant difference to the students' confidence levels (measured by their MATHIMG scale) and most of the Irish students felt that they needed to do well at mathematics because it was useful for the third level and everyday life.

Fennema and Sherman (1977) found that more males than females intended to study more mathematics and this difference persisted even when achievement levels were controlled. I surveyed only a small number of schools, it was not a representative sample of Irish students, and found that the proportion of males studying Higher level mathematics was less than the proportion of females studying Higher level but the difference was not statistically significant. The number of Irish schools in my study was nevertheless greater than the number of schools studied by Lyons et al. (2003) in Inside Classrooms. In this study, most of the Irish students were studying Ordinary Level mathematics as in the report of ESRI (2011).

In Turkey, a gender variable was not recorded and more than half of the Turkish students who participated in this survey attended Science, Anatolian, and private schools. Berberoglu (2004) reported Turkey's results in the PISA 2003 study and outlined that students in Science schools, Anatolian schools, and private schools performed better in mathematics than students in ordinary schools and vocational schools.

3.6.4. Teaching

In the Schoenfeld study (1989), students believed that good teaching practice in mathematics consists of making sure that students know how to use the rules and students thought that good mathematics teachers show students lot of different ways to look at the same question. The majority of Irish and Turkish students here had similar thoughts on good teaching. On the other hand, almost all of the Irish and Turkish students believed that good teachers help students to understand mathematical ideas. In the PISA 2003 study, it was found that Turkish students felt that teachers helped students with learning, and allowed them to express opinions and Irish students had a lower score on this scale. Smyth et al. (2011) reported a student perception of teachers that good teachers prepare themselves very well before the class, explain more, and recognise the importance of treating students with respect and care.

In Inside Classrooms, almost all of the students in the single-sex girls, single-sex boys and coeducational schools thought that having a good teacher was required for success in school mathematics (Lyons et al., 2003). In my study, most of the Irish and Turkish students thought that good mathematics teachers show students how mathematics is used in the real world. However, students responded slightly differently when they were asked if the mathematics they learned at school was relevant to real life. Irish students seemed to have mixed feelings and some of the Turkish students agreed that there was no relation between the mathematics they learn at school and real life. It could be that this was because they wanted to hear about mathematics problems related with real life from their teachers, but they thought they did not at present.

3.6.5.Learning

Another belief expressed by students in the Schoenfeld study (1989) was that in mathematics it was important to memorize rules and procedures. About 30% of the Turkish students in my study agreed that the mathematics they learned at school was mostly facts and procedures that had to be memorized while 43% disagreed and Irish students also had mixed feelings about this.It was found that memorisation did not have a positive effect on learning mathematics in most of countries, including Ireland and Turkey, in the PISA 2003 study.

Kelleghan et al. (1996) mentioned that students motivated by external examinations are likely to have performance goals and not learning goals. Alkharusi (2008) studied classroom assessment that was focused on grades, and not on learning, and stated that these examinations encouraged students to have performance rather than learning goals.Most of the students from both countries in my study seemed to be focused on doing well on the examinations (Table 3.5.9). At the same time, many of them wanted to understand the ideas of mathematics (Table 3.5.8) and they believed that they would learn the main idea of mathematics at school if their teachers were good (Table 3.5.12). However, a statistically higher proportion of Irish students wanted to understand the idea of mathematics (Table 3.5.8).

3.6.6.Study Methods

Students were asked which study methods were important for them. Smyth et al. (2011) asked Irish sixth year students (in Leaving Certificate) what kind of teaching

methods were used in their classes, for example, practicing previous examination papers and most of the students claimed this method was used in every or most of their mathematics classes. Lyons et al. (2003) reported that at four out of ten of the schools in their study, over half of the students said that learning the textbook off by heart was important. Similarly, a large majority of the Irish students and most of the Turkish students involved in my study believed that it was very or quite important to practice questions from the textbook and from past examination papers. Irish students' thoughts on practicing old examination questions are very similar to their teachers. However, Turkish students did not have similar beliefs about this study method with their teachers. Over two-thirds of LC students stated that ICT was never used in the sixth year in the study by Smyth et al. (2011). In my study, Irish and Turkish students were asked if they used the internet as a study method and most of the students in both countries (with Ireland having a higher proportion of such responses than Turkey) thought that it was not very or not at all important.

There is no significant difference between Higher and Ordinary level students in Ireland on the students' belief that memorizing formulae and procedures is important, however, more Higher level students than Ordinary level students tried to understand the mathematical ideas (Table 3.5.16). In Turkey, lower achieving students seemed to believe more than higher achieving students that memorizing formulae and procedures is important. The majority of higher and lower achieving students seem to try to understand mathematical ideas (Table 3.5.17).

I was curious about the use of grinds as a study method. Irish and Turkish students' responses were very different and most of the Irish students stated that they did not have any grinds whereas most of the Turkish students stated that they had grinds. Smyth et al. (2011) said that just less than half of the sixth year Irish students they surveyed had grinds. The 2003 PISA study found that 43% of Turkish students and 16% of Irish students were being tutored and 59% of Turkish students and 8% of Irish students were having out-of-schools classes. However, the PISA 2003 study found that there was a negative association between tutoring and students' PISA mathematics performance in Ireland, and Turkey had a small positive association between out-of-school learning and PISA performance.

3.6.7.Pressure

I found that students in both countries reported that their parents thought that mathematics was one of the most important subjects and put pressure on their children to do well at mathematics and also at school. Schoenfeld (1989) found that being good at mathematics did not correlate strongly enough with students' belief about their parents' thoughts that it was important to do well in mathematics.

3.6.8.Examination Systems

Some of the Irish students (27.1%) agreed and some of the Turkish (39.3%) students disagreed that the Leaving Certificate or OSS examination was a fair way of assessing mathematical ability. Turkish students seemed not to have strong thoughts on different assessment systems, however, two-thirds of the Irish students thought a number of short examinations over a number of years would be a fair way of assessing mathematical ability.

3.6.9. Summary

I found that Irish students seem to be more anxious and less confident about mathematics than Turkish students. Turkish students were also more likely to have higher scores on the usefulness of mathematics scale. More higher achieving students than lower achieving students in both countries had learning goals in mathematics. I found no significant gender differences in my study. The majority of students in Ireland and Turkey believed that good mathematics teachers help students to understand mathematical ideas. Most of the students in both countries seem to focus on the examination in that they work at mathematics in order to do well in the LC or OSS examinations. More Irish students than Turkish students wanted to understand the idea of mathematics and they also reported that they tried to understand mathematical ideas. Most students in both countries also seem to memorize formulae and procedures when studying. Irish students seem to practice questions from textbook and from old examination papers more than Turkish students. Turkish students stated that they had grinds whereas most Irish students stated that they did not have.

The next chapter presents the classification of the mathematics examination questions in Ireland and Turkey.

CHAPTER 4

A CLASSIFICATION OF QUESTIONS FROM IRISH AND TURKISH HIGH-STAKES EXAMINATIONS

4.1. Introduction

In order to compare the examination systems in Turkey and Ireland, the focus of this chapter will be on the classification of mathematics questions on Irish and Turkish high-stakes examinations. First a literature review of various classification systems is presented, then the methodology that I used to classify the 2008, 2009 and 2010 Irish and Turkish mathematics examinations questions according to three different classification systems is described, followed by a number of examples and the results of the classifications of examination questions. Finally there is a comparison of the Irish and Turkish examination papers and a discussion of the relationship between these results and the results of other classification studies.

4.2. Literature Review

There are two main sections in this literature review. The first section deals with question classification systems: there is a summary of different classification systems and a description of each of the categories used in these classification systems. The second section presents some classification studies from Turkey, Ireland and other countries.

4.2.1. Question Classification Systems

In the first chapter, the effects of high-stakes examinations on teaching mathematics were mentioned. One of the most common effects was 'teaching to the test'. Because of this effect, I considered it to be important to classify mathematics examination questions in order to examine what teachers teach in their classrooms from another perspective. Dochy and McDowell (1997) explained that assessing higher-order skills meant that

assessments would then lead to the teaching of such high-order knowledge and skills. Masters and Mislevy (1993) looked at different kinds of learning and assessment (on traditional achievement tests) and the kind of learning needed to succeed on them. They observed,

Most items on standard achievement tests assess students' ability to recall and apply facts and routines presented during instruction. Some require only the memorization of detail; they seek evidence that students have observed factual details presented in class and are able to reproduce these on command. Other achievement test items, although supposed to assess Higher level outcomes like "comprehension" and "application", often require little more than the ability to recall a formula and make appropriate substitutions to arrive at a correct answer.(p. 219-220)

Thus the kinds of questions asked in high-stakes examinations can affect the emphasis on higher and lower order skills in both the teaching and learning of the subject. In this chapter, I will consider several different methods of classifying mathematics examination questions. Several studies have been carried out on the classification of examination questions in order to give guidance to people who construct mathematics examinations. In some cases researchers developed new classification methods, while in others they modified old ones into new forms to achieve their aims. In this section, we will consider the classification systems of Bloom et al. (1956), Smith et al. (1996), Schoenfeld (1992), and Stein and Smith (1998).

4.2.1.1. Bloom's Taxonomy

In 1956, a group of educational psychologists in the USA (including Benjamin Bloom) produced a classification system which aimed to categorize learning domains. Their taxonomy (Bloom et al., 1956, p. 18) has six major classes: *knowledge, comprehension, application, analysis, synthesis* and *evaluation*. They defined *knowledg*e as recalling previously learned methods or ideas; students store certain information and materials while learning and later they remember this factual information in an assessment. *Comprehension* is the ability to understand what is communicated in a task and to be able to use some of the material or ideas. *Application* is the ability to transfer previously learned information to new or practical situations to solve problems. *Analysis* is the ability to distinguish and justify conclusions, material or models. *Synthesis* is the ability to reconstruct previous experiences into new forms and the ability to understand and put together unclear elements of many sources into a

whole. *Evaluation* is the ability to make judgments and comparisons about the values of procedures for some purpose based on definite criteria.

4.2.1.2. Taxonomy of Smith et al.

Bloom's Taxonomy is one of the most common methods used to classify mathematics examination questions at different levels of education. A group of researchers in Australia (Smith, G., Wood, L., Coupland, M., Stephenson, B., Crawford, K., Ball, G., 1996) modified Bloom's Taxonomy, as shown in Table 4.1, in order to make it more relevant to mathematics education. They then used their modification to classify undergraduate mathematics examination questions to show how an examination could be constructed in order to assess a broad knowledge in mathematics.

Group A	Group B	Group C
Factual Knowledge	Information Transfer	Justifying and Interpreting
Comprehension	Application in New Situations	Implications, Conjectures and Comparisons
Routine Use of Procedures		Evaluation

Table 4.1: Smith's Taxonomy (Smith et al., 1996)

The group A categories are: *Factual Knowledge; Comprehension;* and *Routine Use of Procedures*. The *Factual Knowledge* category concerns the recall of a formula, a definition or a proof. Questions in the *Comprehension* category require students to show some understanding of the factual knowledge they use, for example to understand the symbols in a formula or to check the conditions in a definition. In the *Routine Use of Procedures* category students use algorithms or procedures that they have learned previously.

The group B categories are *Information Transfer* and *Application in New Situations*. In the first of these categories students need to transfer information from one representation to another, for example, information from a graph to algebraic form. In the same category, questions demand students to be able to decide on an appropriate method or to explain or summarize information. In the second category, the tasks focus on the choice and application of methods in new situations, for example, modeling or proving an unseen theorem using previously seen methods.

Group C concerns higher order skills such as: *Justification and Interpreting*, *Implications, Conjectures and Comparisons* and *Evaluation*. To answer questions in the *Justifying and Interpreting* category, students should be able to justify their reasoning and choices. They should also be able to interpret their outcomes. Problems in the *Implications, Conjectures and Comparisons* category require students to be able to see the implications of a result and make further conjectures, and to be able to compare methods. In the last category, *Evaluation*, students should be able to make judgments based on definite criteria and be able to use their knowledge in creative ways.

4.2.1.3. Schoenfeld's Framework

Alan Schoenfeld devised another framework to look at examination questions. He was involved in the Balanced Assessment Project (Schoenfeld, 1992) which was sponsored by the NSF in 1992. The aim of this project was to describe the various components of mathematical understanding and performance, and to advise people who are responsible for constructing mathematics assessments at different levels of education, and also to guide students' and teachers' teaching and learning. As part of the project a classification framework was created to examine how to evaluate students' mathematics performance with an assessment system. There are 7 dimensions in this framework: *Content; Thinking Processes; Student Products; Mathematical Point of View; Diversity; Circumstances of Performance*; and *Pedagogic-Aesthetics*. Each dimension has itself a number of components: these are described in detail below. Questions would be classified under each of the seven dimensions.

The *Content* dimension has five components: Concepts; Mathematical Sense; Procedures and Techniques; Representation; and Connections. The Concept component refers to the mathematical concepts that students need to understand in order to tackle the question. Sense represents the mathematical concept knowledge and strategies that students use in solving problems. The types of senses are: quantitative, spatial, symbol, relational, chance, logic and common sense. The Procedures and Techniques component concerns the ability to execute techniques or the ability to select and employ appropriate techniques when producing a response. Representation is the ability to select an appropriate representation for the information in question and make connections across the procedures. The types of representation are: picture, diagram, sketch, table, chart, spreadsheet, coordinate graph, equation, formula, prose, oral discussion, model, map,

manipulatives, network, tree and matrix. In Connections students need to connect ideas from different areas of mathematics or ideas from outside of mathematics.

In the *Thinking Process* dimension there are ten types of thinking process which students may employ when preparing a solution: explore, experiment, investigate; formulate, conjecture, hypothesize; analyze, interpret; evaluate, relate, compare; choose, decide; plan, organize; design, make; argue, justify, prove; generalize, predict, pattern; reflect, explain, summarize.

The *Student Products* dimension concerns the work that students produce. The types of mathematical products are: mathematical model, plan, pure investigation, design, decision and justification, applied research report, explanation of concepts, problem solution and exhibition of technique.

Schoenfeld explained that the *Mathematical Point of View* dimension represents the role of mathematics in the students' work. It has three components: realistic use, pure and illustrative. In realistic use mathematics is used to consider a realistic situation, pure refers to the development of mathematical structures, the illustrative point of view concerns tasks that use context to explain a mathematical idea.

The *Diversity* dimension comprises: Access to the Task; Language and Culture; and Context. In the Access to the Task category a task should be set up to be accessible for all students. In the Language and Culture category a task should be prepared so that students' linguistic and cultural background will not be a disadvantage for them. Context should also be unbiased with respect to students' linguistic and cultural background.

In the *Circumstances of Performance* dimension a task should give students fair opportunities, for instance students should be given enough time and enough resources to complete the task.

In the *Pedagogics and Aesthetics* dimension a task should be designed to provide students with opportunity for engagement and the mathematical ideas in a task should be believable or important.

4.2.1.4. The Levels of Cognitive Demands Framework

The Level of Cognitive Demand framework is a classification system developed by QUASAR (Stein and Smith, 1998a, 1998b). The QUASAR project (Quantitative Understanding: Amplifying Student Achievement and Reasoning) was a reform project aimed at fostering and studying the development and implementation of enhanced

mathematics instructional programs in six middle schools in the US. Stein and Smith (1998) asserted that their framework could be used as a reflection tool, if it is used in the right way, to analyze what students do and think in mathematics lessons. They also mentioned that high level tasks should require students to think and reason.

Four Levels of Cognitive Demand were used in the QUASAR Project and can be described as follows**:**

1. Memorization
2. Procedures without connections to concepts or meaning
3. Procedures with connections to concepts and meaning
4. Doing mathematics

Questions can be classified into these levels. Criteria for each of these are explained further below.

Levels of Cognitive Demands (taken directly from Stein and Smith (1998b), p. 344-350)

Lower-level demands (memorization) (LM)

- Involve either reproducing previously learned facts, rules, formulas, or definitions or committing facts, rules, formulas or definitions to memory.
- Cannot be solved using procedures because a procedure does not exist or because the time frame in which the task is being completed is too short to use a procedure.
- Are not ambiguous. Such tasks involve the exact reproduction of previously seen material, and what is to be reproduced is clearly and directly stated.
- Have no connection to the concepts or meaning that underlies the facts, rules, formulas, or definitions being learned or reproduced.

Lower-level demands (procedures without connections to meaning)(LP)

- Are algorithmic. Use of the procedure either is specifically called for or is evident from prior instruction, experience, or placement of the task.
- Require limited cognitive demand for successful completion. Little ambiguity exists about what needs to be done and how to do it.
- Have no connection to the concepts or meaning that underlies the procedure being used.
- Are focused on producing correct answers instead of on developing mathematical understanding.

- Require no explanations or explanations that focus solely on describing the procedure that was used.

Higher-level demands (procedures with connections to meaning) (HP)

- Focus students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas.
- Suggest explicitly or implicitly pathways to follow that are broad general procedures that have close connections to underlying conceptual ideas as opposed to narrow algorithms that are opaque with respect to underlying concepts.
- Usually are represented in multiple ways, such as visual diagrams, manipulatives, symbols, and problem situations. Making connections among multiple representations helps develop meaning.
- Require some degree of cognitive effort. Although general procedures may be followed, they cannot be followed mindlessly. Students need to engage with conceptual ideas that underlie the procedures to complete the task successfully and that develop understanding.

Higher-level demands (doing mathematics) (HD)

- Require complex and non-algorithmic thinking – a predictable, well-rehearsed approach or pathway is not explicitly suggested by the task, task instructions, or a worked-out example.
- Require students to explore and understand the nature of mathematical concepts, processes, or relationships.
- Demand self-monitoring or self-regulation of one's own cognitive processes.
- Require students to access relevant knowledge and experiences and make appropriate use of them in working through the task.
- Require students to analyze the task and actively examine task constraints that may limit possible solution strategies and solutions.
- Require considerable cognitive effort and may involve some level of anxiety for the student because of the unpredictable nature of the solution process required.

4.2.1.5. Advantages and Disadvantages of These Four Classification Methods

Bloom's Taxonomy is a general classification; it is used for all subjects and was originally developed to categorize learning domains. Smith's Taxonomy is a modification of Bloom's taxonomy for mathematics education and has been applied to undergraduate examination questions. Schoenfeld's Framework was devised to help describe and construct balanced assessment instruments. It specifically considers mathematics and it is not useful for distinguishing between different procedural questions. The Level of Cognitive Demand framework (Stein and Smith, 1998a, 1998ba,b) is much more focused on levels of procedural questions and that is why it is particularly useful for my study.

4.2.2. Classification Studies

This section presents a number of classification studies from Turkey, Ireland and other countries. These studies used various classification methods to classify mathematical tasks in second and third level education.

Using Bloom's Taxonomy, Azar (2005) compared the Turkish university entrance (OSS) physics examination questions with physics examination questions asked at Turkish high schools. His aim was to find if there were differences between high school physics examination questions and OSS physics questions, and how good these questions were at assessing students' scientific thinking. He analyzed seventy-six physics questions from the 2000-2003 OSS examinations and 600 high school physics 9^{th}-10^{th} grade examination questions. He collected high school questions from twelve physics teachers at three types of high schools in Zonguldak. These three types of schools were Anatolian High Schools, Ordinary Schools and Vocational Schools. According to his analysis, OSS physics questions are good for assessing application, analysis, synthesis and evaluation skills. He also found that teachers used questions at the application and comprehension levels to determine students' achievements in school assessments. He added that these results would guide teachers when preparing physics examination questions at schools which aim to develop students' scientific thinking.

Sangwin (2003) classified 489 undergraduate mathematics course examples and examination questions. His aim was to describe higher level mathematical skills, which higher level skills were assessed and how often students were asked to use these higher level skills in practice. He identified eight mathematical question types to classify the

course questions. These eight mathematical question types are 1) factual recall, 2) carry out routine calculation or algorithm, 3) classify some mathematical object, 4) interpret situation or answer, 5) prove, show, justify-(general argument), 6) extend a concept, 7) construct example/instance and 8) criticize a fallacy (Sangwin, 2003, p. 814). His classification results and analysis of students' solutions showed that 84.5% of course examples and 71.2% of examination questions were classified as either carrying out routine procedures or proofs (with many of these proofs simply requiring memorization or simple modifications of similar results) and 3.4% of the questions required students to use higher level skills.

In a study of first year undergraduate Calculus courses in four universities in Sweden, Bergqvist (2007) analyzed the types of reasoning required to succeed on examinations. Bergqvist used Lithner's framework (Lithner, 2008) to categorize types of mathematical reasoning. In this framework, reasoning is broken into two main categories: imitative and creative mathematically founded reasoning. Creative mathematically founded reasoning is characterized by "new and reasonably well-founded task solutions" (Bergqvist, 2007, pg 350). This means that students have to justify their answers and they have to use mathematical processes in the correct way. Imitative reasoning (Lithner, 2008) can be further broken into two categories: memorized reasoning and algorithmic reasoning. Memorized reasoning refers to recalling a complete answer from memory. Algorithmic reasoning involves remembering a method or a set of rules and carrying out well-rehearsed procedures. In order to classify types of reasoning, Bergqvist checked 16 exams consisting of 212 tasks, textbooks and course materials. Based on how familiar the students were with these tasks, she decided whether the reasoning required was creative or imitative reasoning. She found that 69% of all tasks needed only imitative reasoning and it was possible to pass all but one exam using only imitative reasoning. In fact, it was possible to pass one quarter of the exams with distinction without using any creative reasoning.

Close and Oldham (2005) mapped mathematics questions from the 2003 Junior Certificate examination onto the three dimensional PISA Mathematics Framework. They were prompted to undertake this because the mean mathematics performance of Irish 15-years-old students on PISA 2003 placed Ireland 21st out of the 39 countries involved. This was of concern because mathematics is an important factor in moving towards a knowledge-based society. The items were analyzed by studying sample answers expected from students in response to the examination questions, in

conjunction with the State Examinations Commission marking scheme. From the model answers, they identified the skills involved and compared them to the three competency classes of PISA. Recall that the three competency classes are *reproduction*(performing calculations, solving equations, reproducing memorized facts or "solving" well-known routine problems), *connections*(integrating information, making connections within and across mathematical domains, or solving problems using familiar procedures in contexts) and *reflection*(recognizing and extracting the mathematics in problem situations, using that mathematics to solve problems, analyzing and developing models and strategies, or making mathematical arguments and generalizations) (Close and Oldham, 2005, p. 187). Their results showed that 30.6% of the PISA 2003 Mathematics test, 83.1% of the 2003 JC Higher Level Mathematics examination and 95.1% of the 2003 JC Ordinary Level Mathematics examination involved the reproduction category; while 47.1% of the PISA 2003 Mathematics test, 16.9% of the 2003 JC Higher Level Mathematics examination and 5.0% of the 2003 JC Ordinary Level Mathematics examination involved the connections category.22.4% of the PISA 2003 Mathematics test involved reflection, none of the questions from the 2003 JC Higher Level Mathematics or 2003 JC Ordinary Level Mathematics papers involved processes from the reflection category. Close and Oldham (2005) also noted that PISA and the Junior Certificate examination have different aims; PISA does not aim to assess the Irish Curriculum while the Junior Certificate examination does.

Elwood and Carlisle (2003) aimed to examine differential performance by gender and achievement in the Junior and Leaving Certificate examinations. They looked at gender patterns in differential achievement in the 2000 and 2001 examinations. They also reviewed the examination syllabus and papers in English, mathematics, and physics/science. The structure of the mathematics questions (especially at Ordinary Level) seemed to focus on the recollection of formulae and procedures. This study looked at only two years of examination papers: however, Elwood and Carlisle (2003) mentioned that the type of the questions on the certificate examinations was predictable, and this influenced how students were prepared for the examination, that is, they were trained to answer particular questions from particular areas of the syllabus. They also added that there were very few pictures or diagrams and there were no questions related to real-life situations in the LC mathematics examination.

The Levels of Cognitive Demand Framework (Stein and Smith, 1998a, 1998b), described in section 2.1, was used by Ozgeldi and Esen (2010) to classify the

mathematics tasks found in the new Turkish elementary school mathematics textbooks. Their aim was to investigate the connections between the levels of cognitive demands of the Turkish elementary school mathematics curriculum and those of the textbooks. They collected their data from 6^{th}, 7^{th} and 8^{th} grade mathematics textbooks in Turkey. In this study, forty-two teachers used 2785 mathematics tasks in their classes in six weeks. Then the teachers classified these tasks according to the levels of cognitive skills the tasks required (Stein and Smith, 1998a, 1998b) in the following eight weeks. The new Turkish elementary mathematics curriculum aspired to the development of higher level cognitive skills. The results of the forty-two teachers' classification showed that almost all of the textbook tasks were at the lower levels of cognitive demand, and this did not match with the aim of the Turkish elementary mathematics curriculum.

4.3. Methodology

I collected my data from the 2008, 2009 and 2010 Irish and Turkish high-stakes examinations mathematics questions. The Irish examination (Leaving Certificate) has three levels called Higher, Ordinary, and Foundation. We will not consider Foundation Level questions in this analysis. Each level has two mathematics examination papers. Initially my two supervisors and I separately classified some questions on the mathematics papers from 2007 and 2008 according to Smith et al. (1996) and Schoenfeld's Framework for Balanced Assessment (1992). We did not use the Diversity, and Pedagogic and Aesthetics dimensions from Schoenfeld's Framework for Balanced Assessment (1992) because we were primarily interested in the mathematical contexts and products involved in the tasks and the cognitive skills needed to succeed on the examinations. We also did not concentrate the Circumstances of Performance category since we worked with the state examination in which all candidates had the same circumstances of performance. After finishing the classification of the questions, we discussed our analysis. However, in each of the dimensions the questions usually fell into just one or two categories according to our conclusions.

When using Smith's taxonomy, we found that almost all questions were classified as belonging to one of three categories: routine use of procedures; information transfer; application in new situation. The most popular categories in each of the dimensions (of Schoenfeld's framework) were: *symbol* in the Mathematical Sense component dimension, *equation* in the Representation component, *within mathematics* in the Connection component, *usage* in context in the Procedures and Techniques dimension

(Content dimension),*evaluate* in the Thinking Process dimension, *problem solution* or *exhibition of technique* in the Student Product dimension, *pure* in the Mathematical Point of View dimension, *access to task* in the Diversity dimension. Thus, this classification system failed to discriminate between mathematics questions within the Irish and Turkish mathematics examinations for each of 2008, 2009 and 2010, and also between the two countries' examinations. So we decided to use a different classification method - the Levels of Cognitive Demands (LCD) framework described in section 4.2.1.4. The reason for using this classification method (LCD) was that almost all questions under inspection involve using procedures. The LCD system distinguishes between different levels of procedural questions. We classified all the questions on the 2008-2010 Irish Leaving Certificate Higher and Ordinary Level Mathematics papers and the Turkish OSS Mathematics examination papers. My supervisors and I classified the questions independently. Then we had several meetings to discuss our own classifications and we resolved any disagreements through negotiation.

4.3.1.*Creation of an Intermediate Level*

Initially we classified the 2008-2010 Irish and Turkish mathematics examination questions according to the four levels of cognitive demands described by Stein and Smith (1998). While the three of us were attempting to resolve the disagreements in our classifications, we felt that some questions involved a level of cognitive demand above the lower level but below the higher level of cognitive demand outlined. Such questions may require students to use algorithms with multiple steps. Students may have to make some connections from different areas of mathematics to the underlying concepts. We felt these questions fell between Lower Level Demands (Procedures without connections to meaning) and Higher Level Demand (Procedures with connections to meaning). So we decided to create a new category called Intermediate Level Demands (Procedures). The description of this category follows:

Intermediate-level demands (procedures)(IP)

- The questions are *algorithmic*. Use of more than one procedure may be evident from previously learned information.
- Algorithms with *multiple steps*may need to be used.

- Although there is a well-defined procedure to be used, students may need to make an educated choice of starting point.
- Also students may have to make *some connections from different areas* of mathematics to the underlying concepts.
- The questions require *moderate cognitive effort*. A complicated but routine calculation is involved in the questions.

4.3.2. *Examples*

Here we give some examples of questions in each of the five categories of cognitive demand. We also show how these questions were classified according to the taxonomy of Smith et al. (1996) and Schoenfeld's Assessment Framework (using the Thinking Process and Student Products dimensions only). In what follows, OL represents the Irish Leaving Certificate Ordinary Level examination, HL represents the Irish Certificate Higher Level examination, OSS represents the Turkish university selection and placement examination. There are two steps in the OSS examination. The first examination determines entry to the second examination. The number following the abbreviation refers to whether the question appeared on the first or second paper of the examination in question. The questions labelled 'Project Maths' (appearing on the 2010) Higher or Ordinary Level papers refer to questions on an alternative version of the second paper in the Irish examinations (HL and OL) taken by students whose schools were involved in piloting a revised curriculum.

Example1:

Prove that the measure of one of the angles between two lines with slopes m_1 and m_2 is given by $\tan\phi = \frac{m_1 - m_2}{1 + m_1 m_2}$. (2009 HL2).

Expected student response

This is one of a very small number of proofs that students are required to reproduce as described in the syllabus.

Smith's Taxonomy: factual knowledge and fact systems.

Schoenfeld's framework: Schoenfeld's seven dimensions do not take account of the fact that students might learn by heart.
Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Lower level demands (memorization) (LM)

Example2:

Let $f(x) = x^3 + x^2 - 4x - 4$. Verify that f (-2) = 0. (2009 OL1).
Expected student response
To substitute -2 into function f(x) and carry out a basic calculation

Smith's Taxonomy: routine use of procedures
Schoenfeld's framework: evaluate (thinking process), problem solution and exhibition of techniques (students product)
Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Lower level demands (procedures
without connection to meaning) (LP)

Example3:

Three points A, B and C have co-ordinates: A (2, 9), B (6,-6) and C (11, 6). The line ℓ passes through B and has equation 12x-5y-102=0. Verify that C lies on ℓ. (2010 HL2-Project Maths)
Expected student response
To substitute the point C into the given equation and carry out a simple calculation.

Smith's Taxonomy: routine use of procedures
Schoenfeld's framework: evaluate (thinking process), problem solution and exhibition of techniques (students product)
Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Lower level demands (procedures without connection to meaning) (LP)

Example4:

Below is a steam-and-leaf plot of the heights of a group of students in centimetres.

13	3
13	5 6
14	0 0 1
14	6 6 7 8
15	0 1 2 2 3 3
15	5 5 6 7

Key: 13|3 means 133 cm.

How many students are in the group? (2010 OL2-Project Maths)

Expected student response

Students need to understand the information presented in the stem-and-leaf plot and calculate the number of people in the group using the information to the right side of the vertical line in the plot.

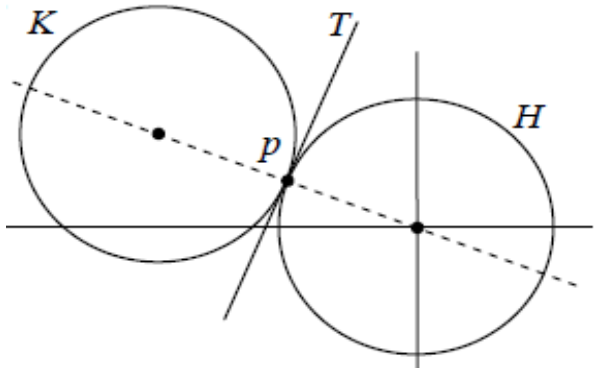
Smith's Taxonomy: information transfer

Schoenfeld's framework: evaluate (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Lower level demands (procedures
without connection to meaning) (LP)

Example5:

The diagram shows two circles H and K, of equal radius. The circles touch at the point p (-2, 1). The circle H has centre (0, 0). T is a tangent to the circles at P. Find the equation of H. (2008 OL2)



Expected student response

Students should be able to calculate the radius of circle H and be able to write the formula of a circle.

Smith's Taxonomy: information transfer

Schoenfeld's framework: evaluate (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Lower level demands (procedures without connection to meaning) (LP)

Example6:

The same diagram as in previous question. Find the equation of T.

Expected student response

Students should be able to calculate the slope of line OP and the slope of the tangent T and then they should be able to find the equation of tangent line T.

Smith's Taxonomy: information transfer

Schoenfeld's framework: interpret (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Intermediate level demands (procedures) (IP)

Example7:

Suppose m and n are the roots of $x^2 - 2x - 4 = 0$. Which of the following equations has 1/m and 1/n as roots? (2009 OSS2)

A) $2x^2 - x + 4 = 0$ B) $2x^2 + x + 1 = 0$ C) $4x^2 + 2x - 1 = 0$ D) $4x^2 + 3x - 4 = 0$ E) $8x^2 - 3x + 4 = 0$

Expected student response

Students are expected to link $x^2 + \left(\frac{1}{m} + \frac{1}{n}\right)x + \left(\frac{1}{m} \times \frac{1}{n}\right) = 0$ to $x^2 - 2x - 4 = 0$ and find the correct coefficients.

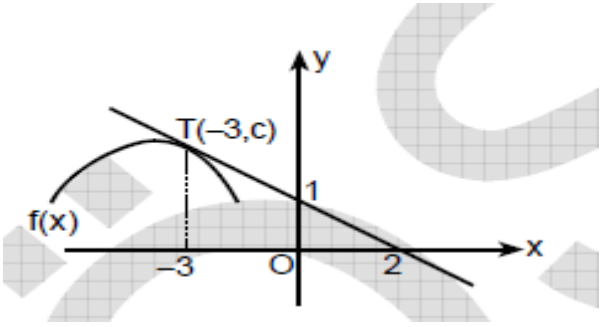
Smith's Taxonomy: routine use of procedures

Schoenfeld's framework: evaluate (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Intermediate level demands (procedures) (IP)

Example8:

Shown below is part of the function f(x) and its tangent at the point T (-3, c). Let k(x) = ln (f(x)). Find $k'(-3)$.(2009 OSS2)



Expected student response

First students need to interpret the graph to identify two points on the tangent line and to be able to write down the equation of tangent line. Then students should be able to find the derivative of the logarithmic function k(x) ($k'(x) = \frac{f'(x)}{f(x)}$) and evaluate it at x=-3. To do the latter, they must use the equation of the tangent line.

Smith's Taxonomy: application in new situation

Schoenfeld's framework: analyse or interpret (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Higher level demands (procedures with connection to meaning) (HP)

Example9:

Let $y^2 = -4x$ be a parabola and x=2 be a line. What is the equation of the reflection of the curve $y^2 = -4x$ through the line x=2? (2010 OSS2)

A) $y^2 = 4x$ B) $y^2 = -4(x-2)$ C) $y^2 = -4(x+4)$ D) $y^2 = 2(x-4)$ E) $y^2 = 4(x-4)$

Expected student response

Students should be able to recognise the graph of the parabola, use the definition of reflection.

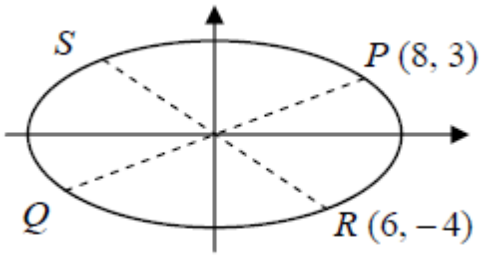
Smith's Taxonomy: application in new situation

Schoenfeld's framework: interpret (thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Higher level demands (procedures with connection to meaning) (HP)

Example10:

An ellipse e has equation $\frac{x^2}{100}+\frac{y^2}{25}=1$. $[PQ]$ and $[RS]$ are diameters of the ellipse, where P is (8,3) and R is (6,-4). Using a transformation to or from the unit circle or otherwise show that the diameters $[PQ]$ and $[RS]$ are conjugate. (2010 HL2)



Expected student response

This question requires students to be able to apply the definition of conjugate diameters.

Smith's Taxonomy: application in new situations

Schoenfeld's framework: interpret(thinking process), problem solution and exhibition of techniques (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Higher level demands (procedures with connection to meaning) (HP)

Example11:

Let f be an affine transformation. The point M is the mid-point of the line segment $[AB]$. Show that f (M) is the mid-point of the line segment $[f(A)\,f(B)]$.(2010 HL2)

Expected student response

This is an unseen proof for which students should be able to apply previously learned information in a new situation.

Smith's Taxonomy: justification and interpreting.

Schoenfeld's framework: evaluate, prove and justify (thinking process), problem solution, exhibition of techniques and decision and justification (students product)

Levels of cognitive demands (Stein and Smith, 1998a, 1998b): Higher level demands (doing mathematics) (HD)

In this section, we presented some examples of Irish and Turkish mathematics examination questions and the classifications of these examples according to Smith's Taxonomy (Smith et al. 2007), Schoenfeld's Framework (Schoenfeld, 1992) and the Levels of Cognitive Demands Framework (Stein and Smith, 1998a, 1998b). In doing so, we studied the syllabus in each country in order to ensure we were aware of the importance placed on particular aspects of the content in the relevant syllabus. Smith's Taxonomy and Schoenfeld's Framework often did not place the questions into different categories. For instance, example 2 and example 7 are in the same categories of Smith's Taxonomy and Schoenfeld's Framework. However, these two examples are at different levels of cognitive demand in the LCD Framework. The LCD Framework discriminates between the questions, placing them into different categories according to the procedures involved in their solution. For that reason we found the LCD system to be the most suitable method for our classification of mathematics examination questions from the OSS and LC examinations.

4.4. Results

This section presents tables showing the percentages of questions at each of the five levels of cognitive demand for each Irish and Turkish Mathematics examination from 2008 to 2010. The OSS examination system was updated in 2010. The first OSS examination was not changed. However, in the second examination, there are now two papers as a separate paper has been introduced for geometry.

Table 4.2 shows the number of questions on the 2008-2010 Irish terminal/end-of school and Turkish university selection mathematics examinations.

Year	OSS1	OSS2	OSS2-Geometry	HL1	HL2	OL1	OL2	HL2-Project Maths	OL2-Project Maths
2008	30	30	-	32	59	47	72	-	-
2009	30	30	-	39	55	48	81	-	-
2010	29	50	30	40	57	40	74	35	46

Table 4.2: Numbers of Irish and Turkish Mathematics Examination Questions 2008-2010

Tables 4.3-4.5 below show the percentages of exam questions that were classified as belonging to each of the five categories in our scheme.

	LM	LP	IP	HP	HD
OSS1	-	40%	26.67%	33.33%	-
OSS2	-	13.33%	46.67%	40%	-
HL1	3.12%	31.25%	46.88%	12.5%	6.25%
HL2	4%	33.90%	37.29%	15.25%	6.78%
OL1	-	70.21%	25.53%	4.26%	-
OL2	2.78%	70.83%	22.22%	4.17%	-

Table 4.3: Classification of 2008 Irish and Turkish Examination Questions

	LM	LP	IP	HP	HD
OSS1	-	40%	20%	40%	-
OSS2	-	23.33%	26.67%	46.67%	3.33%
HL1	2.56%	48.72%	28.20%	20.52%	-
HL2	10.91%	32.73%	21.82%	25.45%	9.09%
OL1	-	81.25%	14.58%	4.17%	-
OL2	2.47%	77.78%	6.17%	13.58%	-

Table 4.4: Classification of 2009 Irish and Turkish Examination Questions

	LM	LP	IP	HP	HD
OSS1	-	61.54%	20.51%	10.26%	7.69%
OSS2	-	38%	24%	36%	2%
OSS2 Geometry	6.67%	23.33%	33.33%	23.33%	13.33%
HL1	-	45%	40%	15%	-
HL2	-	54.39%	17.54%	22.81%	5.26%
HL2(Project Maths)	2.86%	31.43%	45.71%	14.29%	5.71%
OL1	-	87.5%	7.5%	5%	-
OL2	2.7%	82.43%	4.06%	10.81%	-
OL2(Project Maths)	-	60.87%	30.43%	8.70%	-

Table 4.5: Classification of 2010 Irish and Turkish Examination Questions

2008-2010	LM	LP	IP	HP	HD
OSS1	-	48.5%	22.2%	26.3%	3%
OSS2	1.4%	26.4%	31.4%	36.5%	4.3%
HL	4%	41%	31%	19%	5%
OL	1.6%	78%	12.7%	7.7%	-

Table 4.6: Percentages of Average of Classifications of Irish and Turkish Examination Questions 2008-2010

All questions in the OSS examination carry equal marks but this is not true in the Irish examination. Also for 2010, some students sat an alternative version of the second paper in the Irish examinations (HL and OL), labeled 'Project Maths' as some schools were involved in piloting a revised curriculum.

	LM	LP	IP	HP	HD
2008 HL	6.32%	26.32%	40%	17.89%	9.47%
2009 HL	8%	34%	27%	26%	5%
2010 HL	-	42%	28%	27%	3%
2008 OL	4.21%	66.32%	23.68%	5.79%	-
2009 OL	4%	74%	10%	12%	-
2010 OL	4%	80%	8%	8%	-
2010 HL-Project Maths	5.71%	25.72%	42.86%	20%	5.71%
2010 OL-Project Maths	-	62.22%	26.09%	8.69%	-

Table 4.7: Percentages of Total Marks for Each Level of Irish Terminal/End-of school Examination Questions

Table 4.7 gives the percentages of marks awarded to questions in each category on a particular examination each year, with a separate entry for the Project Maths papers.

4.5. Discussion

There are a few differences between the Irish and Turkish examination systems. The main difference is that the Turkish examination has multiple choice questions and the Irish examination has partial credit questions. This section discusses the differences between these two examination systems according to the Levels of Cognitive Demand Framework (Stein and Smith, 1998a, 1998b).

The OSS1 examination acts as a filter for entry into the OSS2 examination and does not otherwise influence the placement of students in university. However, it is interesting to consider the kinds of questions used in this examination. In 2008 and 2009 there was quite a high percentage of HP questions on the OSS1 examination (33.33% and 40% respectively). The remaining questions were at the LP (40% in both years) and IP levels. The profile changed in 2010: the proportion of LP questions increased while the number of HP questions decreased dramatically. However 7.69% of the OSS1

questions in 2010 were at the HD level, whereas there had been no HD questions previously.

If we consider the OSS2 examination, we immediately see some differences from the OSS1 papers. The percentage of LP questions is generally quite low (except for OSS2 in 2010) and often more IP questions appear than on the OSS1 examination. There are usually about 40% of higher level cognitive demand questions (HP and HD). The new geometry paper in 2010 had the highest percentage of HD questions of any of the examinations that I studied (at 13.33%). This is in contrast to the findings of Noss and Baki (1996). They reported that the OSS examination measured only procedures and because of this students did not gain conceptual understanding. However, I have found that a significant proportion of the OSS examination questions from 2008 to 2010 do require higher order thinking skills and students need to be able to make connections to meaning to succeed. It could be that the pattern in examination questions has changed since 1996. Azar's (2005) findings have similarities with my analysis of the OSS papers: he found that high level questions were asked in OSS physics exams. He concluded that the OSS questions assessed comprehension, application, analysis, synthesis, and evaluation (according to Bloom's Taxonomy). This taxonomy might be compared to the LCD classification (Stein and Smith, 1998a, 1998b); depending on the questions, comprehension might be associated to IP questions, application might be similar to IP or HP levels, and synthesis and evaluation questions might be at the HP or HD levels of cognitive demand.

Azar (2005) found that in school assessments physics teachers used questions in the lower classes of Bloom's taxonomy. The TIMSS (2007) study similarly found that in Turkey most of the types of questions on mathematics tests given by teachers at schools were based on the recall of facts and procedures, and the majority of them involved applications of mathematical procedures. Ozgeldi and Esen (2010) classified elementary textbook mathematics questions in Turkey and they used the Levels of Cognitive Demand Framework by Stein and Smith (1998). Their study showed that almost all of the elementary mathematics questions required lower levels of cognitive demand only. My study considered the OSS assessment of secondary school material and identified a more balanced distribution of questions over the levels of cognitive demand. But I did not classify questions from examinations set locally in schools or from school textbooks.

In the Irish examinations, we can see a clear difference between the OL and HL papers. At OL, the majority of questions are in the LM and LP categories and usually between 70% and 85% of marks are awarded for questions at the lower end of the LCD scale. There are very few HP questions on the OL papers and no HD questions at all. These results indicate that the OL questions are algorithmic and students do not need to make connections to underlying meanings in these examinations. Similar to my classification results of Leaving Certificate OL examination, Close and Oldham (2005) reported that Junior Certificate examination questions did not require higher order thinking skills.

At HL, we see some differences from year to year. In particular, the 2008examination seems to be more challenging than the 2009 or 2010 papers. However, the general trend seems to be for about 30% of marks to be awarded for higher levels of cognitive demand questions, about 30% are awarded for IP questions and the remainder for LM or LP questions.

Sangwin (2003) classified a large number of undergraduate mathematics questions and showed that the majority of the questions posed required students to use lower level skills. Bergqvist (2007) concluded that it was possible for students to pass one quarter of all mathematics papers in first year University Calculus courses with distinction without using any creative reasoning. A similar conclusion can be drawn for the Irish examination results in terms of levels of cognitive demands. From Table 4.7 it looks like it was possible to pass both the 2009 and 2010 HL examinations using only skills at the LP level and it is possible to get a B grade on any of the OL examinations inspected using the same skills. More worryingly, it was possible to get 70% (an A2) on the 2009 and 2010 HL papers without using any HP or HD skills. The NCCA (2005) review of mathematics education at second level mentioned that Irish examination questions emphasized recall and the application of routine procedures. Another study carried out by Elwood and Carlisle (2003) found that the Leaving Certificate mathematics questions seemed to focus on lower level skills. From the perspective of the grades that can be achieved on the Leaving Certificate examinations by invoking only lower level skills, my classification of the LC papers supports these findings.

Only one set of Project Maths examinations was analyzed in this study and even then only one paper (in HL and OL) was available. From the classification, it appears that at OL the number of marks for lower level category questions is less on the Project Maths examination than on the standard papers. This also seems to be true at HL, however,

there also seem to be slightly less HP questions than previously and slightly more IP questions on the Project Maths papers. The aim of Project Maths is to enhance the students learning experience by placing greater emphasis on conceptual understanding, on problem solving, and on real life applications. My classification study showed that the Project Maths examination in 2010 had more lower level cognitive demand questions than higher level cognitive demand questions and this does not match the aim of this project. However, in 2010 there was only one Project Maths paper: more analysis on other Project Maths examinations will be required to make conclusions about the success of the new syllabus and assessment system.

This analysis has shown that the examinations in Ireland and Turkey are quite different. Firstly the OL examinations have a very high percentage of lower level demand questions. The OSS2 examination in Turkey seems to consistently contain more higher cognitive demand questions than the Irish HL examination and more marks are awarded to LP questions in the HL examination than are available in the OSS2 examination. We can say then that the OSS2 examination seems to be more cognitively demanding, and asks students to make more connections to meaning than the Leaving Certificate examinations. This is in spite of the fact that the OSS2 examination is entirely made up of multiple-choice questions. Shepard (2002) mentioned that using multiple-choice questions could be a problem if students were only trained to answer these type of questions and advocated that students needed to be able to write and reason using material (p.55). Similarly, Heyneman (2009) maintained that oral and essay questions were superior to multiple-choice questions because there was more opportunity for creative feedback and more 'data points' for observation. However, from the comparison of the OSS2 and HL examinations, we can see that it is possible to assess higher level thinking skills with multiple-choice questions. Shepard (2002) also said that many US states mostly used multiple-choice questions because these types of tests were easy to administer; while Heyneman explained that the cost of oral and essay questions was more than cost of multiple-choice questions. Turkey has a large population so it is easy to administer multiple-choice questions with lower cost.

Using the LCD framework, I was able to give a picture of the type of skills needed to succeed on the LC and OSS examinations. The classification shows the differences between the OL and HL papers in Ireland and between the Irish and Turkish examinations.

CHAPTER 5

CONCLUSION

As we have seen from the Introduction chapter, high-stakes examinations are important in society because they are often the mechanism used to select university students and therefore future leaders (Heyneman, 2009). For this reason, I was interested the university selection examinations in Ireland and Turkey.

A summary of effects of high-stakes examinations reported in the literature was given in section 1.1.4. These included that high-stakes examinations are objective and provide homogeneity, and they focus students on studying. However, high-stakes examinations encourage attention to material covered by the examinations and because of that worthwhile aims of the curriculum may not be addressed in teaching and learning and teachers may be encouraged to adopt certain teaching methods. For instance, drill-and-practice may be used as a teaching method with students using memorisation as a learning style and not focussing on conceptual understanding. High-stakes examinations can be stressful and can negatively influence students' confidence and anxiety.

The focus of my thesis was to investigate the effects of high-stakes examinations in Ireland and Turkey. I administered a questionnaire to teachers and students, I also interviewed teachers, and analysed the data that arose. In addition, I classified the Leaving Certificate and OSS mathematics examination questions for the years 2008-2010. My analysis showed that the L.C. and the OSS examinations had some similar and some different effects on teaching and learning from the perspective of teachers and students in both countries. In this chapter, I discuss these effects of the examinations and the results of the classification of examination questions.

In Ireland and Turkey, some studies mentioned the effects of the high-stakes examinations. However, these studies did not set out to specifically identify and examine the effects of these examinations on the teaching and learning of mathematics. This study is the first of its kind that specifically explores teachers' thoughts on the examinations and the first to compare the two countries in order to explore how these examinations have an influence on mathematics education locally.

This study is also the first one that used the LCD framework to classify Irish and Turkish mathematics examination questions at post-primary level and to compare the

high-stakes examination papers from two countries. I want to mention here that a Turkish study (Ozgeldi and Esen, 2010) used the LCD framework for elementary school mathematics textbook questions. In this part of my study, I also modified the LCD framework to incorporate an intermediate level of cognitive demand.

From a broader perspective, this project compared mathematics education in the two countries. While both countries have participated in international studies on mathematics education (e.g. TIMSS, PISA), the study described here set out to directly compare post-primary mathematics education in Ireland and Turkey. Thus, instruments were specifically designed for these countries and were appropriate for Irish and Turkish teachers and students.

5.1. Limitations of This Study

In the classification part of the study, only three years of past examination papers were used. In order to be more confident of the results, more years of examinations could be looked at. This classification study was carried out while Project Maths was being piloted and some of my findings may no longer be relevant once Project Maths has been fully implemented. (There were no pilot Project Maths schools included in this study.)

While efforts were made to include all types of schools in both countries, the shortage of time and resources meant that a small number of schools participated in this study and thus there may be questions as to whether the findings can be considered to be generalisable.

It should be noted that I did not carry out any classroom observations in this study. All inferences about teaching methods are based on the responses of teachers on the questionnaire or in the interviews.

As this was an exploratory study, it was broad but not deep. No study of this type had been carried out previously in Ireland or Turkey and so we aimed to build a broad picture or obtain an overview of the effects of the examinations on all aspects of post-primary mathematics classrooms: examining the structure of the examination papers themselves and their effects on both teaching and learning by surveying both teachers and pupils. Lyons et al. (2003), Hourigan and O'Donoghue (2007), and Smyth et al. (2011) carried out their research only in Ireland and they focused on gender differences in the learning and teaching of mathematics in post-primary classes, on examinations of students' mathematics experience in post-primary level, on the effects of the Leaving

Certificate in terms of students' performance, their decisions about their future life and which skills they gained in second level education. In each of these three studies, fewer schools took part in the research than was the case in my work: Lyons et al. (2003) studied ten schools, Hourigan and O'Donoghue (2007) studied two schools and Smyth et al. (2011) studied twelve schools.

Furthermore, I did not conduct student interviews in this study and so I could not delve more deeply into students' opinions on the effects of high-stakes examinations, beyond the responses they provided to the questionnaire.

5.2. The Findings Relating to The Effects of the Examination

In this section, I will summarize and compare the results from the different strands of my research.

5.2.1. Study Methods

The students were asked how they studied mathematics (Section 3.5.4). The majority of students in both countries indicated that they tried to understand the mathematical ideas and also that they memorized formulae and procedures. In addition, 37% of Irish and 57.8% of Turkish students mentioned that discussing mathematical ideas with their classmates was very or quite important for them. I also asked the teachers about their students' study methods (Section 2.5.1). Some Irish (40%) and two thirds of the Turkish (67%) teachers thought that their students used 'memorizing'. The majority of the teachers did not believe that their students tried to understand underlying mathematical concepts. The teachers' belief is in contrast to their students' responses; the vast majority of students in both countries said that they tried to understand the mathematical ideas. The teachers mentioned memorization in a negative way. However, not everybody believes using memorization is always negative. Kirschner et al. (2006) mentioned that expert problem solvers store their experiences along with a huge amount of information in long-term memory, and these people are able to retrieve this information quickly and use it to apply the most appropriate procedures for problem-solving. They claimed that if nothing has changed in long term memory, it means that nothing has been learned. Bryan et al. (2007) also reported on the importance that teachers in both eastern and western countries placed on memorization.

Students in Ireland and Turkey also placed heavy emphasis on practicing old examination questions and for the Irish students, practicing questions from the textbook was also important. The Irish teachers were in agreement with their students here, however the Turkish teachers did not think that students spent time on practicing examination questions. Most of the Irish students felt the use of an examination revision guide was 'quite' or 'very important'. From the evidence gathered here, we see that the examinations do seem to influence study methods to some extent, in that students practice past examination questions and memorize formulas and procedures. It is not clear that the students are focused on studying mathematics only for the examination from their responses to the questions on study methods.

Teachers were explicitly asked about their thoughts on the effects of the examination on students' learning. Almost all of them said that the examinations did affect learning and most of them seemed to believe that the examination system had negative effects on students' learning. They mentioned in the questionnaire that students learned by rote or memorized, and that students did not want to understand the underlying ideas because of the pressure of the examination and that their object was to achieve high scores (Table 2.5.7). In the interviews, the teachers expressed similar thoughts; for example that students were disheartened because of the examination, or that they did not want to understand ideas and they just wanted to learn the material that was on the examination. From the teachers' point of view, students seemed to focus on the examination. Moreover, from Table 3.5.8, more Irish students than Turkish students responded that they worked at mathematics because it was important for them that they understood the ideas. Similarly, the majority of students in both countries believed that it was important to try to understand the mathematical ideas with a higher proportion of Irish students than Turkish students believing this to be quite or very important (Table 3.5.15). The responses on these two items showed that more Irish students than Turkish students seemed to try to understand the mathematical ideas and this difference was statistically significant. This is in contrast with Irish and Turkish teachers' responses (Table 2.5.4, and Section 2.6.9), recall that they said that the examination system caused memorization and students did not want to understand the idea of mathematics.

From the teachers' and students' responses, we can see that practicing is important in the Irish classes (Sections 2.5.1 and 3.5.4). Irish teachers also mentioned practice as a teaching method (Table 2.5.15) and they reported that they spent most of their class time practicing homework, questions from the textbook, and questions from old

examination papers. In addition, Irish teachers were more likely than their Turkish counterparts to assign and to correct homework (Tables 2.5.1 and 2.5.16 and Section 2.6.3). This could be because the LC examination questions were mostly concerned with procedures (for example, in Chapter 4, I showed how almost 80% of questions on the Irish OL examination papers from 2008 to 2010 could be classified as Lower-level demands (procedure without connections to meaning) or lower, see Table 4.7) so teachers emphasized the practice of procedures and students also believe that memorizing formulae and procedures is important. Similarly, the Chief Examiner's Report (2005) stated that students performed strongly on procedural questions in the LC examination; however, they showed insufficient understanding of concepts.

5.2.2. The Effect of the Examination on Subject Choice

The majority of Irish and Turkish students indicated that they wanted to do well on the examination and they wanted to get as many points as they could (Table 3.5.9). Irish students were asked whether their interest in the subject or maximizing CAO points was most important in their choice of LC subjects. More than half said that interest was the most important factor while 40% of them said that they wanted to maximize CAO points. When asked whether their interest in the subject or maximizing CAO points was most important in their choice of the level of mathematics they studied for LC, nearly two thirds said that maximizing CAO points was the most important element. It seems that in Ireland, the points system has an influence on the choice of subject; as well as the choice of level in mathematics. There could also have been other reasons influencing students' choice of subjects and level of mathematics.

5.2.3. The Effects of the Examination on Teaching

My study also examined the effects of the examination on teaching mathematics. The vast majority of teachers in both countries agreed that the examination influenced their teaching and teachers mentioned more negative effects than positive effects (Section 2.5.2). More Irish teachers than Turkish teachers indicated that they had to teach to the examination and cover only examination material. Some Irish teachers (12%) felt that the examination gave their teaching structure and ensured that all topics are covered (Table 2.5.6). In the interviews, the teachers spoke more about this effect (Section 2.6.8). Some (44%) said that the Irish teachers emphasized content directly related to

the examination instead of subject knowledge and emphasized mostly the content that was tested. In addition, some described how they trained their students for the examination and that they thought that the LC examination was predictable. Few Turkish teachers explicitly mentioned in the interviews that they taught the idea of mathematics and they did not teach according to the OSS examination.

In the Introduction chapter, the processes used in Ireland and Turkey to decide admission to third level education were classified in different categories (Helms, 2008): Irish students need only a national examination score to enter a university while Turkish students require a national examination score and also a secondary school performance score. This could possibly be one reason why Irish teachers seem to place so much emphasis on the Leaving Certificate examination, and why the Turkish teachers do not seem to focus so much on the OSS examination. Some studies (mostly carried out in Ireland) found similar results to those in my study. Lyons et al. (2003) and Hourigan and O'Donoghue (2006) mentioned that the culture in Irish mathematics classes was 'teaching to the examination'. NCCA (2005), Kelleghan et al. (1989), and Au (2007) mentioned that one effect of a high-stakes examination system is that emphasis may be placed on teaching content directly related to the examination instead of on general subject knowledge.

In Turkey, to graduate from post-primary level, students need a certain GPA from school but they only take the OSS examination when applying to universities (MEB, 2012). The school and OSS examinations have different types of questions in Turkey; teachers prepare their own school examinations and ask partial-credit questions, while the OSS examinations contain only multiple choice problems. To prepare for OSS multiple choice questions, Turkish students practice similar OSS-style questions. Often this practice takes place outside school in private grind schools (Tansel and Bircan, 2005). Therefore, some teachers in my study mentioned that they tried to teach the ideas of mathematics and that the grind schools taught to the (OSS) test. They also maintained that because of the OSS examination system, grind schools became very popular. In 2010, 550,000 students graduated from post-primary level and 960,000 students sat on the OSS examination. This indicates that many people are applying to university some time after they have left school and that a lot of people prepare for the OSS outside of the school system. This might help account for the seemingly smaller effect of the OSS examination on the teaching and learning of mathematics at high-school in Turkey when compared to the effect of the LC on the Irish Education system.

Elwood and Carlisle (2003) found that the LC examination was predictable, and this may influence teaching with students being trained to answer particular questions from particular areas of the syllabus. They also showed that the LC examination mathematics questions required lower level skills. I have found similar results from my classification study; I found that most of the LC examination questions (2008-2010) are procedural and mostly require only intermediate and lower levels of cognitive demand.The style and predictability of the LC mathematics examination papers may be encouraging teachers to teach to the test.

My classification study showed that the 2008-2010 OSS questions require more higher-level skills than is the case in LC examination papers, and this could be related to teachers' stated aim that they wanted to teach mathematical ideas. Dochy and McClune (1997) expressed the view that assessing higher-order skills will lead to the teaching of such higher-order skills.

5.2.4. The Effect of the Examination in Turkey-Grind Schools

The teachers' and students' responses in both countries show that the examinations influenced mathematics education, however, Turkish teachers seemed to be less worried about the OSS than Irish teachers were about the LC. This might be because in Turkey assessing students is done in two different ways: the school assessment and the OSS examination. The teachers in Turkey did not seem to view the preparation of students for the OSS examination as their responsibility in the same way as Irish teachers did. Turkish teachers seemed to think that teaching to the examination is the purpose of grind schools. Some of the Turkish teachers responded that grind schools were very popular in Turkey because of the OSS examination and the majority of students said that they attended grinds (Section 2.6.6, Tables 2.5.4 and 2.5.23). In Ireland, teachers thought that students did not need any grinds for the examination and the majority of students said they did not attend any grinds. Some of the Turkish teachers mentioned that grind schools had a negative impact on the school system with students either not attending school in favor of attending grinds or not valuing the education they received in school.

5.2.5. Syllabus

When I asked for the teachers' opinions on the syllabus, many Irish teachers thought that the syllabus and the examination were identical and they explained the syllabus as the material that needs to be covered for the examination. We saw that teachers decided on which topics to teach depending on the distribution of examination questions (see page 71). So here once again we see that Irish teachers are focused on the examination. The Turkish teachers' responses to this question were slightly different. They thought that the syllabus was the material that they covered in their classes. Some Irish teachers and a few Turkish teachers also mentioned the syllabus' lack of relevance with real life (Section 2.5.3, p. 72). Similarly, some Irish and Turkish students responded that the mathematics they learned at school was not relevant to real life (Table 3.5.13).

5.2.6.Fairness of the Examination

The vast majority of Irish and Turkish teachers responded that the examination system was fair (Table 2.5.5) and that everybody had the same conditions in every part of country. Some Irish and fewer Turkish students agreed that it was fair (Table 3.5.14). It might be that Turkish students did not think the examination is fair because they thought the fairness was to do with the conditions for studying for the OSS examination, for example the economic status of the students determines if they attend grinds. The students could also be referring to the pressure of basing their future career on the result of one examination taken in one day.

5.2.7.Format of the Examination and Alternative System

I considered if teachers were happy with the existing examination systems and if they wanted to change the system (Tables 2.5.26 and 2.5.27). The format of the Irish and Turkish examination systems is different in that the Turkish examination has multiple-choice questions and the Irish examination has partial credit questions. Turkish teachers seemed not to be happy with this type of question. The concern of the Irish teachers was not about the type of questions; they wanted to change the existing examination system to a continuous assessment system or to a modularized system. I saw a very similar belief emerging from the Irish students' responses about changing the examination system, as they also favor a continuous assessment system. However, Turkish students did not express any ideas about alternative examination systems.

5.2.8. Good Teaching

The majority of the students in both countries described good mathematics teachers as the teachers who help students to understand mathematical ideas (Table 3.5.12). In addition, they also believed that good mathematics teachers show them the exact way to answer the mathematics questions they would be tested on.

Students were also asked their thoughts on the mathematics that they learned at school (Table 3.5.13). Most students in both countries did not agree that the mathematics they learned at school was mostly about facts and procedures that have to be memorized. More Irish than Turkish students believed that the mathematics they learned at school was mostly about understanding ideas. In the interviews, Turkish teachers explicitly mentioned that they taught the idea of mathematics (Section 2.6.6). However, the responses of the Turkish students did not really reflect this.

5.2.9. Affect

Some of the Science and Anatolian school teachers said that they did not have to make too much of an effort with teaching because their students were the most intelligent and hardworking students in all of Turkey since they were the top students selected using an assessment system during the last three years of primary level education (Section 2.6.2). Similarly, students' responses show that higher achieving Turkish students in Science and Anatolian schools were more confident than the students in private, ordinary, and vocational schools (Section 3.5.2.3). This is in contrast with the Kahveci and Imamoglu (2006) and Berberoglu (2004) studies where it was found that students in private schools were highly motivated. An Irish teacher in a girls school said that they had huge job satisfaction because their students were very good at mathematics but other teachers in different types of schools did not mention similar thoughts (Section 2.6.2). I did not find any statistical difference between students' scores in different Irish school types on the confidence, anxiety, usefulness of mathematics, and learning goal scales (Section 3.5.2). However, there was a difference between Irish students who were studying Higher level mathematics and ordinary level mathematics: Higher level students were more confident, less anxious, and had higher scores on the learning goal scale and the usefulness scale than the students studying ordinary level mathematics.

5.2.10. Summary

In summary, we can see that the examination systems in both countries affected students' study methods but there is not much evidence to say that Irish and Turkish students just focused on the examinations. However, the majority of students agreed that it was important to them to do well on the LC/OSS examinations and to get as many points as they could. Irish and Turkish teachers believed that their students focused on the examinations. Irish teachers were more likely to say that they taught to the examination and that they covered the material that was tested.

The syllabus was described differently in two countries. Some Irish teachers saw the syllabus as being exactly the same as what they did for the LC examination while Turkish teachers thought that it was what they did in their classes. From the teachers' point of view, both LC and OSS examinations were fair. However, Turkish students had slightly different beliefs. Approximately 28% agreed but 40% disagreed that the OSS examination was a fair way of assessing mathematical ability. I think the reason for this could be because of the conditions for studying for the examination in Turkey.

In the first chapter, the positive and negative effects of high-stakes examinations are summarised. Research has found that high-stakes examinations

- are objective (Madaus, 1991);
- encourage students to focus more (Madaus, 1991);
- provide national homogeneity in education (Madaus, 1991);
- encourage attention to material covered in examinations (and as a consequence many worthwhile educational objectives and experiences may not be addressed in the teaching and learning of the subject) (Madaus, 1991); (Stecher, 2002; Koretz et al., 2001; Abrams et al., 2010; Shepard and Dougherty, 1991; Au, 2007);
- are often carried out in a very limited time (Madaus, 1991) ;
- are stressful and they negatively affect students' self-concept and self-esteem; are often perceived to be unfair by students (Madaus, 1991; Abrams et al., 2010; Leonard and Davey, 2001, Reay and William, 1999; Benmansour, 1999;
- may lead to teaching to the test (Madaus, 1991; Shepard, 2002; Au, 2007; Dochy and McDowell, 1997);

- may encourage students to perform without higher levels of knowledge due to teaching to the test ((Madaus, 1991; Kohn, 2000, Koretz, 1988; Linn, 2000);
- may lead to teachers adopting certain teaching methods (sometimes contrary to their own belief on what constitutes good practice) which are not useful for students (Au, 2007; Johnston and McClune, 2000).

My findings provide evidence to support many of these. Both Irish and Turkish teachers gave more negative responses than positive responses to questions related to the influences of the examination. I found that teachers in both countries felt that the examinations were fair and objective, while the Turkish students seemed to disagree. I found evidence in Ireland of teachers training students for the test and moreover of the examination shaping the implemented curriculum. The influence of the examination on the teachers' choice of teaching methods did not seem to be so prevalent in Turkey: Turkish teachers did not seem to feel the same level of pressure from the OSS examination as Irish teachers did from the LC examination. In both countries, I found that higher achieving students were more confident and less anxious than lower achieving students. In my study, only a few Irish teachers mentioned that the LC examination focuses students. Moreover, Turkish teachers thought that the OSS examination encourages grind schools and they seemed unhappy that grind schools affect students' attitudes towards mathematics at schools. This effect of high stakes examinations does not appear to be discussed in the literature.

Concern with the effects of high-stakes examinations on individuals and social institutions is not new: thirty years ago Kelleghan et al. (1982) stated 'in recent years controversy about examinations and testing has reached a high level of intensity'. They quoted Cooper and Leiter (1980) as saying

Misapplication and misinterpretation of test results can injure individual students and erode curriculum and instruction…create social and intellectual segregation, foster elitism, fashion a punishment/reward syndrome, reduce learning to rote and regurgitative modes, deprecate, stigmatize, exclude.

Thus, it would seem important that time is taken when designing or redesigning an assessment or examination system to consider its potential effects and that research is undertaken to monitor the effects of existing systems on teaching, learning and related beliefs and attitudes.

5.3. Implications for Future Research

It was mentioned earlier in this chapter that only three years of examination papers were used so a more comprehensive review of examination papers or classification of mathematics questions could be carried out in either Ireland or Turkey in the future.

It would be useful to repeat the classification study once Project Maths has been fully implemented and it could then be seen if there have been changes due to the Project Maths on Irish practices and experiences.

This was an exploratory study to explore all aspects of the effects of the high-stakes examinations and so the interviews conducted were semi-structured. It would be interesting in the future to conduct further, more structured, interviews with teachers focussing specifically on certain aspects of the findings from the original study (for instance, the effects of the examination on encouraging memorisation). It would be also interesting to ask students more directly about the effects they feel that the examination has on teaching and learning. In this study, the students' questionnaire aimed to address this indirectly. However, there were often discrepancies between the students' views of teaching and learning and those of their teachers. It would be valuable to explore these issues further.

Many Turkish teachers spoke about the impact of attendance at grind schools on students' learning and attitudes. It would be interesting to research this further by collecting data from students who do and do not attend grind schools for comparison. In the first chapter, I mentioned a study of Dochy and McDowell (1997) which expressed the view that assessing higher-order skills would encourage the teaching of higher-order skills. From the responses of the teachers in my study, (Table 2.5.6 and 2.5.16, and section 2.6.1 and 2.6.8) it seems that Irish teaching practices are mostly didactic, they emphasise student practice, and the Irish teachers seem to teach to the test. The results of the classification part of this thesis indicate that most LC examination questions involved carrying out procedures and only a few of them required higher level skills. In the future, it would be interesting to further investigate the effects of procedural questions on the teaching and learning of mathematics.

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APPENDICES

Appendix A1: Irish and Turkish Teachers' Questionnaire

1- Do you usually ask questions of your students in your class? Yes ☐ No ☐

2- Do you encourage them to ask you questions? Yes ☐ No ☐

3- Do you use any textbooks? Yes ☐ No ☐

Which ones?

4- Do you usually give homework and correct them? Yes ☐ No ☐

If so, how often?

5- Do you discuss your teaching with the other Maths teachers? Yes ☐ No ☐

How often?

6- How much time on average do you spend preparing classes/correcting/etc for each lesson?

7- What teaching methods do you use?

Describe a typical class?

8- Do you have complete freedom in your choice of teaching methods? Yes ☐ No ☐

Please comment

9- What do you think of the exam system?

What are its positive aspects?

What are its negative aspects?

10- Do you think the exam system influences the way that you teach? Yes ☐ No ☐

Is the influence positive or negative?

11- Do you think that the exam system influences the way your students learn or study?

Yes ☐ No ☐

Is the influence positive or negative?

12- Do you think that the exam system influences your students` attitudes to Mathematics?

☐

Yes ☐ No

Is the influence positive or negative?

13- Do you think that the exam system influences your students` confidence in Mathematics?

Yes ☐ No ☐

Is the influence positive or negative?

14- How often do you refer to the exam in class?

Every class ☐ Every week ☐ Every month ☐ Every term ☐

Only before the exam ☐ etc

15-Do you try to help your students with anxiety problems, confidence, study style before the exam?

Yes N☐ ☐

If so, how?

16- What kind of assessment methods do you use in your classes?

17- If you were designing a new national assessment system, what would it be?

18- If there was a different national assessment system, would you change the way that you teach?

Yes ☐ No ☐

If so, how?

.

19- Do you ever discuss topics in class that will not be examined? Yes ☐ No ☐

If yes, what topics?

If not, would you like to? Yes ☐ No ☐

If yes, what topics?

20- What do you think of the syllabus?

What are its positive aspects?

What are its negative aspects?

21- If you were writing a new syllabus, what would you include/omit?

22- Do you cover every topic in the syllabus? Yes ☐ No ☐

If not, which topics do you leave out? Why?

23- For the exam-year classes, when do you finish teaching the course?

24- How much time do you spend on revision for exam-year classes?

25- What study methods do you think that your students use?

Reading texts/notes ☐ Practicing questions from textbook ☐ Practicing old exam questions ☐ Memorizing ☐ Understanding underlying concepts ☐ Other ☐

26- How much time do you think that your students spend studying Maths outside of class?

27- How many exams do you do in a year?

28- Do you think that your students will choose the right vocation? Yes ☐ No ☐

29- Do you believe that the curriculum of Maths in university exam is covered by the curriculum in schools? Yes ☐ No ☐

30- Do you think the Maths that you teach in your class is enough for university exam? Yes ☐ No ☐

31- Do you do old university exam questions in your class? Yes ☐ No ☐

32- What do you think about grinds?

Are they necessary?

Appendix A2: Irish and Turkish Students' Questionnaire[1]

Which of the following was **most** important in your choice of Leaving Cert subjects?

Interest in the subject ☐ Maximising CAO points ☐

Which of the following was **most** important in your choice of the level of maths to study for Leaving Cert?

Interest in maths ☐ Maximising CAO points ☐

For each of the following please rate on a scale of 1-5 how strongly you agree with the statement, where 1 means *disagree strongly*, 2 means *disagree*, 3 means *neutral*, 4 means *agree*, and 5 means *agree strongly*.

If there are any statements you don't understand, please indicate this by putting a mark in the box on the left-hand side.

	Learning Goals	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
1	I work at Maths because I want to learn as much as possible					
2	I work at Maths because it is important for me that I understand the ideas.					
3	I work at Maths because I like figuring things out					
4	I work at Maths because I like learning new things.					
5	I work at Maths because I like finding new ways of doing things.					

[1] In this questionnaire, the items were randomly reordered before they were administered to students.

	Performance Goals	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
6	I work at Maths because it is important to me that I do well on the LC/OSSMaths exam.					
7	I work at Maths because it is important for me to get as many CAO/OSS points as I can.					
8	I work at Maths because it is important to me that the teacher thinks I do a good job.					
9	I work at Maths because it is important to me to do better than the other students.					
10	I work at Maths because I don't want people to think that I'm stupid.					

	Confidence	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
11	Generally I have felt confident about approaching Maths.					
12	I'm no good at Maths.					
13	For some reason even though I study, Maths seems unusually hard for me.					

	Confidence	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
14	Mathematics is one of my best subjects.					
15	I learn mathematics quickly.					

16	I have trouble understanding anything with mathematics in it.					

	Anxiety	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
17	I usually have been at ease during Maths classes					
18	Mathematics makes me feel uncomfortable and nervous.					
19	I get a sinking feeling when I think of trying Maths problems					

	Anxiety	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
20	I almost never have got nervous during a Maths test.					
21	I usually have been at ease during Maths tests.					
22	A Maths test would worry me more than a test in another subject.					
23	My mind goes blank and I am unable to think clearly during a Maths test.					

	Pressure	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
24	It is not important to my parents that I do well at Maths.					
25	My parents think that mathematics is one of the most important subjects I have studied. (F-S Mother/Father scales)					

26	It is important to my parents that I do well in school.					
27	I work at Maths because I don't want to worse than the other students in the class. (S&G above repeated)					

	Usefulness	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
28	I study Mathematics because I know how useful it is.					
29	Mathematics is a worthwhile and necessary subject.					
30	I'll need mathematics for my work in the future.					
31	I will use mathematics in many ways as an adult.					
32	Mathematics is of no relevance to my life.					
33	I see mathematics as a subject I will rarely use in daily life as an adult.					

	Good Teaching	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
34	Good Maths teachers show students lots of different ways to look at the same question.					
35	Good Maths teachers show you the exact way to answer the Maths questions you'll be tested on.					
36	Good Maths teachers help students to understand					

	mathematical ideas.					
37	Good Maths teachers show students how Maths is used in the real world.					
38	Good Maths teachers do not spend class time talking about topics that will not be on the exam.					

	Maths Learning	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
39	The Maths I learn at school is mostly facts and procedures that have to be memorized.					
40	The Maths I learn at school encourages me to think for myself.					
41	The Maths I learn at school is not relevant to real life.					
42	The Maths I learn at school is mostly about understanding ideas.					
43	The Maths I learn at school is about identifying patterns and relationships.					

	Assessment	1 Disagree Strongly	2 Disagree	3 Neutral	4 Agree	5 Agree Strongly
44	I think the LC/OSS exam is a fair way of assessing mathematical ability.					
45	I think project work would be a fair way of assessing mathematical ability.					

	I think a number of short exams over a number of years would be a fair way of assessing mathematical ability.					

(The following four questions were designed for Irish students)

How often is the Leaving Cert exam mentioned in class?

Every class ☐ Every week ☐ Every month ☐ Every term ☐ Only before the exam ☐

Do you attend maths grinds?

Yes ☐ No ☐

At what level are you studying Maths?

Higher ☐ Ordinary ☐ Foundation ☐

What age are you? ☐

Gender M ☐ F ☐

(The following three questions were designed for Turkish students)

How often is the OSS exam mentioned in class?

Every class ☐ Every week ☐ Every month ☐ Every term ☐ Only before the exam ☐

Do you attend maths grinds?

Yes ☐ No ☐

What age are you? ☐

For each of the following please rate on a scale of 1-4 how important the following methods of study are for you, where 1 means *very important*, 2 means *quite important*, 3 means *not very important*, 4 means *not at all important.*

If there are any statements you don't understand, please indicate this by putting a mark in the box on the left-hand side.

	Study Methods	1 Very Important	2 Quite Important	3 Not very important	4 Not at all important
	Reading the textbook				
	Reading the notes from class				
	Trying to understand the mathematical ideas				
	Memorizing formulae and procedures				
	Practicing questions from the textbook				
	Practicing questions from past exam papers				
	Discussing mathematical ideas with classmates				
	Using the internet				
	Using exam revision guides				
	Other (please specify)				

Appendix A3: Plain Language Statements for Teachers and Pupils

Plain Language Statement for Teachers and Pupils

I. **Introduction to the Research Study**

Both Ireland and Turkey have high-stakes examinations at the end of second level schooling that determine entry to third level education. This project aims to explore the effect of such examinations on the teaching & learning of mathematics at second level in both countries, including the impact on students' attitudes to and beliefs about mathematics. (The study is funded by a student scholarship awarded by the National University of Ireland, Maynooth for research towards a PhD.)

II. **Details of what involvement in the Research Study will require**

Participation in the study will involve the teacher and the pupils in his/her class completing questionnaires. Pupil questionnaires will take approximately 30 minutes to complete, while questionnaires for teachers will take approximately 45 minutes. Following completion of the questionnaire, a small number of teachers and possibly pupils will also be invited to take part in audio-taped semi-structured interviews of 30 minutes duration.

III. **Benefits (direct/ indirect) to participants from involvement in the Re search Study**

It is hoped that participation in this study will benefit both teachers and pupils by encouraging them to reflect on the impact a high-stakes examination system is having on their teaching and learning respectively and will enable them to identify ways in which negative impacts may be diminished.

IV. **Advice as to arrangements to be made to protect confidentiality of data,**

Pupils will be asked to complete questionnaires anonymously. All identifying information for participating teachers and schools will be removed from all reports of the findings of the study. Also, every effort will be made not to report results using small subgroups of participants which might lead to the identities of those concerned being inadvertently revealed

V. **Statement that involvement in the Research Study is voluntary**

Involvement in this research study is voluntary. Participants may withdraw from the study at any point. There will be no penalty for withdrawing before all stages of the study are completed.

If participants have concerns about this study and wish to contact an independent person, please contact:

The Administrator,
Office of the Dean of Research and Humanities,
St Patrick's College,
Drumcondra,
Dublin 9.
Tel 01-884 2149

Plain Language Statement for Pupils

I. Introduction to the Research Study

This project aims to compare the teaching and learning of mathematics at post-primary schools in Ireland and Turkey. Both countries have important examinations at the end of school and in this project we are especially interested in the connections these exams have with your experience of mathematics and your attitudes to the subject. (The study is funded by the National University of Ireland, Maynooth.)

II. Details of what you will be required to do

Participation in the study will involve you and your classmates completing a questionnaire. This will take approximately 30 minutes. (Your teacher will also be completing a similar questionnaire.) A small number of pupils may also be invited to take part in an audio-taped interviews. These interviews will also take approximately 30 minutes. If you are chosen to be interviewed, you will be allowed to bring an adult you trust to the interview with you.

III. Possible benefits to you

It is hoped that taking part in this study will help you to think about how the exams are having an effect on your leaning of mathematics and will help you to find ways to make the experience as positive as possible.

IV. Confidentiality of information you give

You will not need to give your name on the questionnaire. When we are writing a report on what the questionnaires have told us, we will remove all information that could be used in any way to identify you from your responses.

V. Voluntary Involvement

Completing the questionnaire and being interviewed (if invited) are voluntary. You can decide at any point that you do not want to be involved.

If you are concerned about this study and wish to contact an independent person, please contact:

The Administrator,
Office of the Dean of Research and Humanities,
St Patrick's College,
Drumcondra,
Dublin 9.
Tel 01-884 2149

Appendix A4: Informed Consent Form for Teachers and Pupils

ST PATRICK'S COLLEGE DRUMCONDRA

Informed Consent Form - Teachers and Pupils

I. Research Study Title

An Exploration of the Effects of High-Stakes Examinations on the Teaching and Learning of Mathematics in Post-Primary Schools in Ireland and Turkey

II. Purpose of the Research

Both Ireland and Turkey have high-stakes examinations at the end of second level schooling that determine entry to third level education. This project aims to explore the effect of such examinations on the teaching & learning of mathematics at second level in both countries, including the impact on students' attitudes to and beliefs about mathematics.

III. Requirements of Participation in Research Study

Participation in the study will involve the teacher and the pupils in his/her class completing questionnaires. Pupil questionnaires will take approximately 30 minutes to complete, while questionnaires for teachers will take approximately 45 minutes. Following completion of the questionnaire, a small number of teachers and possibly pupils will also be invited to take part in audio-taped semi-structured interviews of 30 minutes duration

IV. Arrangements to protect confidentiality of data

Pupils will be asked to complete questionnaires anonymously. All identifying information for participating teachers and schools will be removed from all reports of the findings of the study. Also, every effort will be made not to report results using small subgroups of participants which might lead to the identities of those concerned being inadvertently revealed

V. Participant – Please complete the following

(Circle Yes or No for each question).

Have you read or had read to you the Plain Language Statement? Yes/No

Do you understand the information provided?

Yes/No

Have you had an opportunity to ask questions and discuss this study?

Yes/No

Have you received satisfactory answers to all your questions?

Yes/No

VI. Confirmation that involvement in the Research Study is voluntary

I am aware that if I agree to take part in this study, I can withdraw from participation at any stage. There will be no penalty for withdrawing before all stages of the Research Study have been completed.

VII. Signature:

I have read and understood the information in this form. The researchers have answered my questions and concerns, and I have a copy of this consent form. Therefore, I consent to take part in this research project

Participant's Signature:

Name in Block Capitals:

Witness:

Appendix A5:

Figure 1(**PERSON-ITEM MAP FOR THE LEARNING GOAL SCALE)**

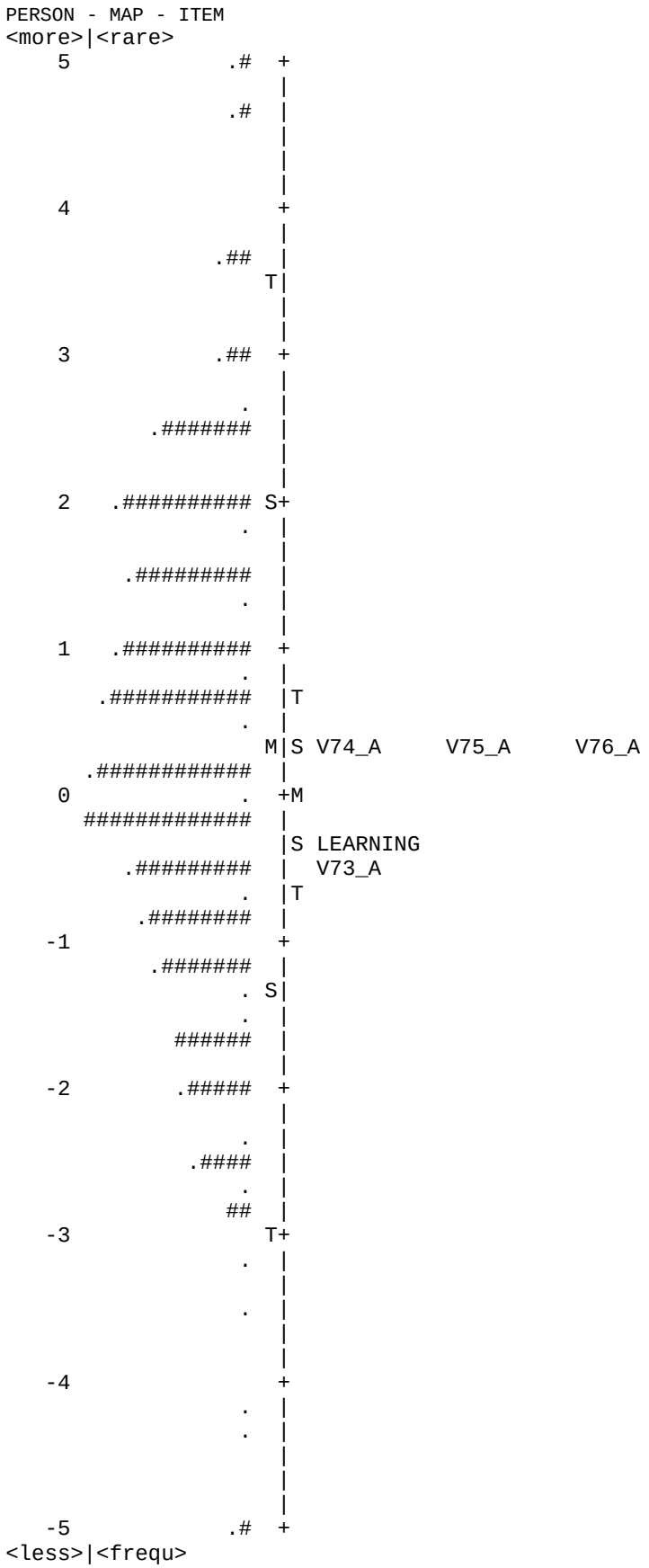

Figure 2(PERSON ITEM MAP WITH THRESHOLDS FOR LEARNING GOAL SCALE)

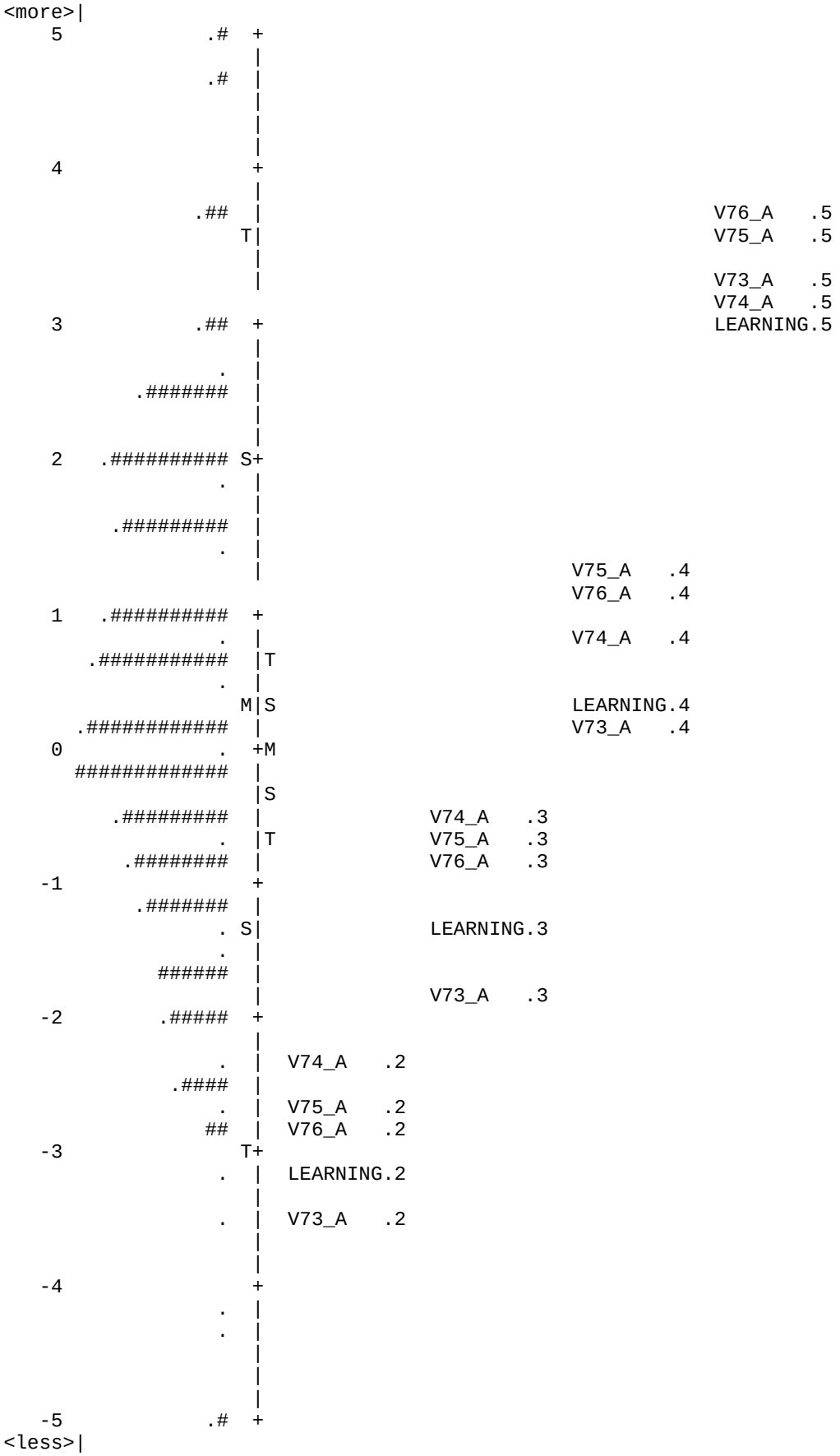

Figure 3 (**PERSON-ITEM MAP FOR THE CONFIDENCE SCALE)**

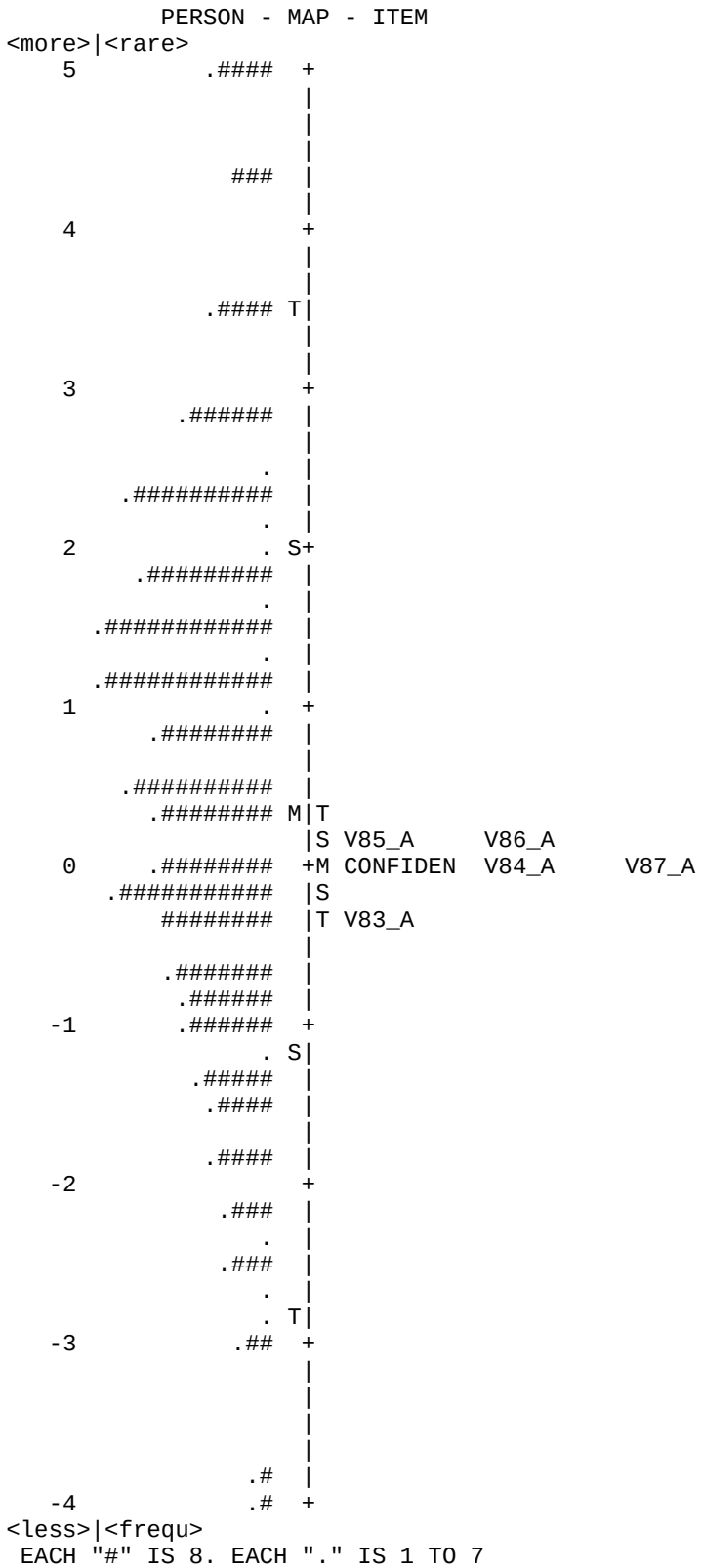

Figure 4(PERSON ITEM MAP WITH THRESHOLDS FOR CONFIDENCE SCALE)

```
          PERSON - MAP - ITEM
<more>|
    5         .####  +
                     |
                     |
                     |
                     |
                ###  |
                     |
    4                +
                     |
                     |
                     |
              .#### T|                                        V86_A   .5
                     |                                        CONFIDEN.5
                     |
    3                +
            .######  |
                     |                                        V87_A   .5
                  .  |                                        V84_A   .5
         .##########  |                                        V85_A   .5
                  .  |
    2             . S+
          .#########  |
                  .  |                                        V83_A   .5
       .############  |
                  .  |
       .############  |
    1             .  +
           .########  |                          V85_A   .4
                     |                          V86_A   .4
         .##########  |
           .######## M|T                         V87_A   .4
                     |S                         CONFIDEN.4
                                                V84_A   .4
    0     .########  +M
       .############  |S                         V83_A   .4
           ########  |T
                     |              V85_A   .3
                                    V87_A   .3
           .#######  |              V84_A   .3
            .######  |              V86_A   .3
   -1       .######  +              CONFIDEN.3
                  . S|              V83_A   .3
              .#####  |
               .####  |
                     |
              .####  |  V85_A   .2
   -2                +  V83_A   .2
                .###  |  V84_A   .2
                   .  |  V87_A   .2
                .###  |
                   .  |  V86_A   .2
                   . T|  CONFIDEN.2
   -3            .##  +
                     |
                     |
                     |
                     |
                 .#  |
   -4            .#  +
<less>|
 EACH "#" IS 8. EACH "." IS 1 TO 7
```

Figure 5 (**PERSON-ITEM MAP FOR THE ANXIETY SCALE)**

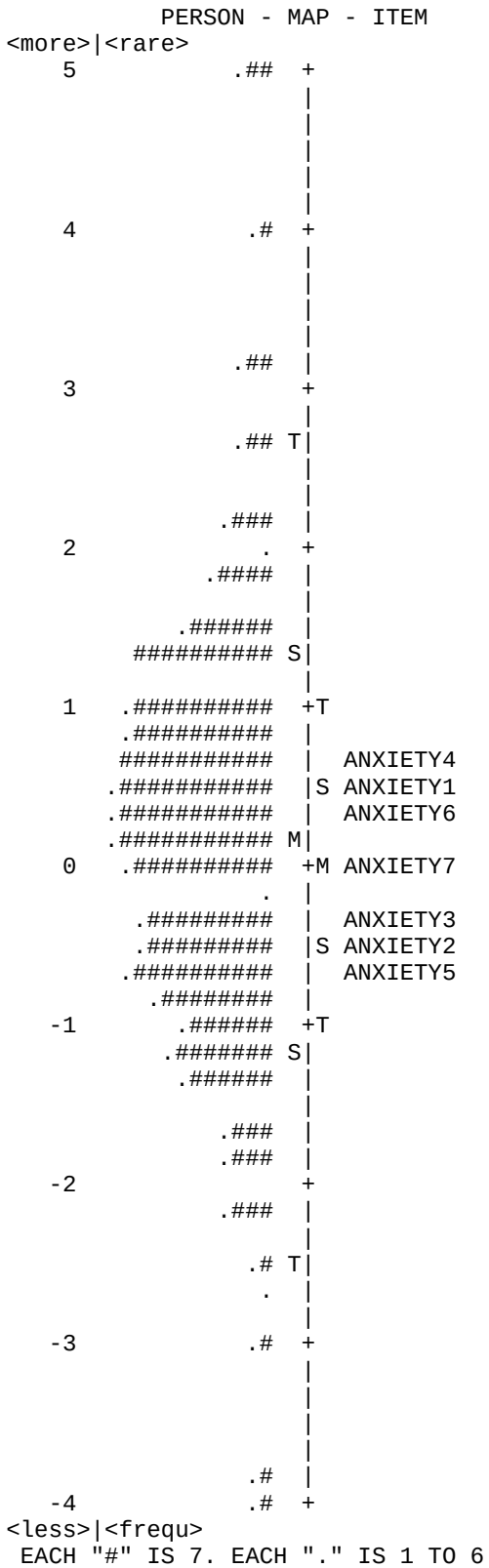

Figure 6(PERSON ITEM MAP WITH THRESHOLDS FOR ANXIETY SCALE)

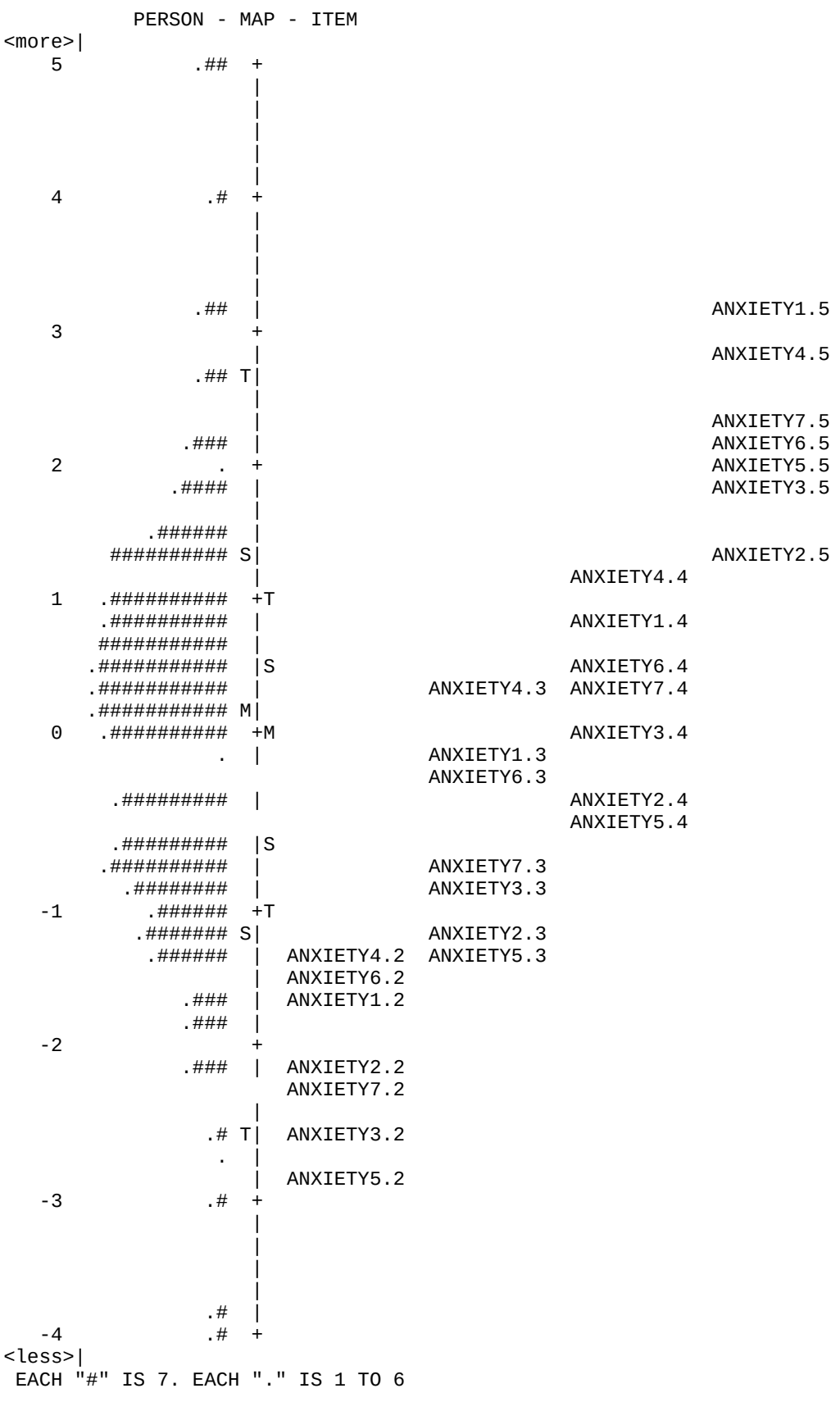

Figure 7 (**PERSON-ITEM MAP FOR THE USEFULNESS SCALE)**

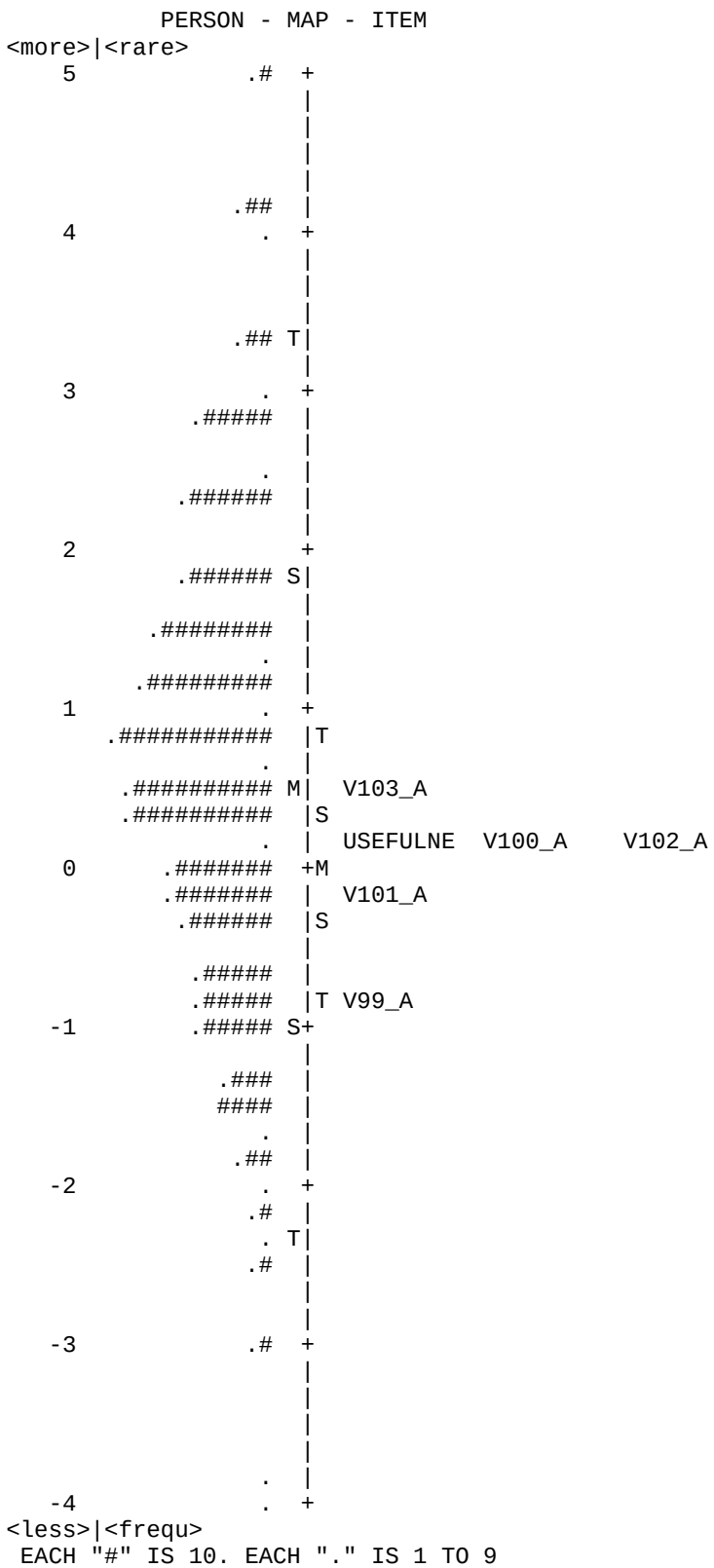

Figure 8(PERSON ITEM MAP WITH THRESHOLDS FOR USEFULNESS SCALE)