MATHEMATICS IN MALTA

THE NATIONAL MATHEMATICS SURVEY OF YEAR 1 PUPILS

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Typeset at Media Centre Publications
Printed at Media Centre, Blata l-Bajda

Published in 2005

Cover photos: Ms Sharon Richard
Pupils from Carmela Sammut Primary School A, Mosta.

CATALOGUING-IN-PUBLICATION DATA

Mathematics in Malta : the National Mathematics Survey of Year I pupils / authors, Charles Mifsud … [et al.]. – Floriana, Malta : Education Division, 2005

p. : ill., charts ; cm.

Includes bibliography

ISBN 99909-74-19-5

1. Mathematics – Study and teaching
2. Education – Primary - Malta
3. Education – Malta

I. Malta. Ministry of Education, Youth and Employment. Education Division
II. University of Malta. Faculty of Education. Literacy Unit
III. National Foundation for Educational Research (United Kingdom)
IV. Mifsud, Charles

DDC: 510.0704585 LC: QA14.M3M3

Melitensia Classification: MZV5

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Acknowledgements

The Project Team of this study gratefully acknowledges the good work and involvement of:

- all the schools and pupils that took part in the study;
- all the test administrators and survey assistants including complementary teachers, literacy tutors and university students;
- Ms Michela Gnaldi, of the National Foundation for Educational Research, UK;
- Ms Emma Borg, Mr Laurence Azzopardi and Ms Sandra Gouder, Research Unit, Department of Planning and Development, Education Division;
- Ms Marjes Zammit, Ms Maria G. Sammut and Ms Elaine Mifsud Scicluna, Literacy Unit, University of Malta and Education Division, Malta;
- Ms Irene Vella for managing the survey in Gozo;
- Mr Robert Grixti and Ms Denise Hollier for data inputting;
- Ms Catherine Vella for compiling the index for this publication;
- Ms L. Deguara, Head of Carmela Sammut Primary School A, Mosta for allowing us to photograph the pupils and the school.

Executive Summary

Scope

- The first ever National Mathematics Study in Malta and Gozo was carried out in April 2004.
- This was a baseline test of all Year 1 pupils in Malta and Gozo.
- Attainment in Mathematics was measured using the Mathematics 5 test (nferNelson) in the first language of every pupil, which was either Maltese or English.
- All the 101 schools in Malta and Gozo with Year 1 pupils participated in the study. Information was supplied for a total of 4,662 pupils. After excluding those without key variables, such as a test score or home background information, full information was available on 4,384 pupils (94%).

Main Findings

- Girls performed better than boys.
- Older pupils performed significantly better than younger pupils.
- Pupils who spoke Maltese as their first language performed less well in the test than those who spoke English. When other background factors were accounted for, the difference was not statistically significant.
- Special Educational Needs on average had the strongest effect on pupils' raw score of any of the background variables considered. This significant difference in achievement was largely unaffected when all other factors were taken into consideration.
- The preponderance of pupils (nearly 90 per cent) had attended two years of pre-schooling. The greater the amount of pre-schooling, the better children appeared to perform.
- The differences between types of school, in favour of private church and private independent schools, were not statistically significant either in isolation or after allowing for other factors.

- The differences in performance between the districts were not statistically significant.
- Effects of class size were not statistically significant.
- The stability of the home relationship seems to be an important factor in school attainment. In this study, there was a highly significant relationship between this factor and attainment. However, when allowing for other background factors these effects were no longer statistically significant.
- Fathers' current occupation had a statistically significant impact on their children's raw score and followed the ordering of the classification itself. The higher the father's occupation, the higher the score the child obtained in the test.
- There was a statistically significant difference in performance of pupils between categories of mother's occupation. This difference showed a comparable pattern to that of father's occupation. As with father's occupation, the differences were reduced after allowing for other background factors. However, they remained statistically significant, albeit at a lower level. Children of mothers in skilled or white-collar jobs do better than those whose mother stays at home.
- The level of the fathers' education had a statistically significant impact on their children's performance. The higher the father's educational level, the higher the score the child obtained in the test. This pattern was reduced and not statistically significant after adjusting for other factors.
- The level of the mothers' education had a statistically significant impact on their children's performance. The higher the mother's educational level, the higher the score the child obtained in the test. This pattern was reduced but, in contrast with that for father's education, was still statistically significant after adjusting for other factors.
- When making international comparisons it was found that Maltese pupils performed relatively better than their UK counterparts on some of the more practical items. They performed better in practical areas such as: reading the clock, a telephone number pad and shopping. However, UK children performed better in addition, subtraction, ordering a series of events, and comparing and counting shapes.

Implications

- The Malta National Mathematics Study provides the first ever baseline study of Mathematics attainment in Malta.
- Children who attended pre-school do better in Year 1 as they seem to be more ready for the demands of formal education.
- Generally Maltese pupils perform well. They perform better on more practical items and perform less well on more formal items when compared to their counterparts in the UK. This may be due to incompatibility between home and teaching language, and the amount of teaching pupils have received. However these are early stages, and one should not read too much into such comparisons. This does not mean that the formal teaching of Mathematics should start earlier.
- Maltese children do relatively better than their counterparts on more practical test items. These items are more related to 'everyday' situations.

Recommendations

- The results of the study and of the individual schools results are to be fed back to schools, as had been done in the case of the Literacy studies. This should help to raise awareness in schools and among parents about the importance of mathematical skills.
- It would be valuable to conduct such an assessment on a regular basis as happens in other countries like England, Australia and the U.S. Follow-up studies could be conducted with the same pupils in later years.
- Further measures are to be taken to ensure that language does not act as a barrier to the attainment of mathematical skills. In this regard the continued use of appropriate materials and resources, together with the use of Information and Communication Technologies (ICT) and multimedia may help to facilitate better acquisition of mathematical skills.
- This study has shown that pre-school attendance boosts attainment. The provision of quality programmes at this stage should be strengthened.
- The strength of Maltese children in practical aspects of Mathematics

is positive and should be promoted and extended further. This could also serve as a good basis for the introduction of more abstract notions at a later stage.

Introduction

In 1999, the first ever Malta National Literacy Survey collected information from all schools in Malta. This survey was aimed at all Year 2 pupils, born in 1992 (Mifsud *et al*., 2000). A wealth of information was collected on pupils' attainment in literacy and their home background, enabling insightful comparisons on both a national and an international basis. In 2002, a comparable study was also carried out on the same cohort of pupils, then in Year 5. The results are reported in Mifsud *et al.* (2004a). Practically the same cohort of pupils was involved in both surveys and thanks to the excellent record-keeping and co-operation of schools, it was possible to merge the data for the same pupils for the two year groups, and use the results as the basis for a Malta value added study. These value added findings are reported in Mifsud *et al.* (2004a). A team from the Education Division, the University of Malta and the National Foundation for Educational Research, UK was able to produce individual reports for each school, and to conduct a one-to-one discussion with the Head of that school. This afforded schools the opportunity to be able to engage in school development planning based on recent attainment data.

In view of the success of these studies, it was decided to embark on a comparable exercise focusing on Mathematics education at baseline level. A pilot study involving twelve schools was carried out by the Education Division and the Literacy in May 2003. The data were analysed and the results are reported in Mifsud *et al.* (2004b). This report showed that the administration of the test went smoothly and that the test was well received by schools and appropriate for the age group. In particular, no serious problems were reported by administrators concerning the language of test administration.

Chapter 1

Background

The Maltese Islands in the Mediterranean Sea have two official languages. Maltese, a Semitic language, is the native tongue. English is used widely and is taught early on at school. For Malta it is the Language of Wider Communication (LWC).

Recognising the importance of Mathematics, the Education Division decided in 2003 to carry out a national survey of mathematical attainment, to take place in 2004. It was decided that this, the first national survey of Mathematics undertaken in Malta, should focus on the attainment of Year 1 pupils.

1.1 Mathematics in Maltese Primary Schools

In Maltese Primary schools, basic skills are introduced in kindergarten and then reinforced and further developed as the pupils proceed through the primary and secondary school years.

Up to scholastic year 2002-2003, the formal teaching of Mathematics started in Year 1 when the pupils were five and going on to six years of age. As from scholastic year 2003-2004, the Abacus Scheme was introduced in Kindergarten. Currently, Abacus F1 is used with pupils who are in their second year of kindergarten, that is at the age of four. Pupils carry out tasks requiring the sorting of objects and the use of shapes, as well as activities involving recognition and value of number through an amalgamation of verbal and concrete activities.

The Abacus 'R' (Reception) Scheme has been used in Maltese Year 1 classes since 2002. This scheme is based on three principles as laid out in the 'Teacher's book' (Merttens & Kirkby, 2001). It promotes:

a) Direct and interactive teaching of Mathematics;

b) Clear teaching and regular rehearsing of a range of mathematical skills and strategies, particularly those which help children become fluent in mental Mathematics;

c) Use of mathematical resources to support teaching and to promote active and meaningful learning.

This scheme was introduced in state and non-state schools in the scholastic year 2002-2003 after being piloted with Year 2 classes during the previous year.

Following the introduction of the Abacus Scheme an updated Mathematics syllabus was published by the Curriculum Department, Education Division in 2005. The main topics covered in the syllabus at Year 1 level are:

a) Number and Algebra;

b) Measure, Shape and Space;

c) Data Handling;

d) Problem Solving.

1.2 The Language Issue

The bilingual situation in Malta, which in the National Minimum Curriculum is considered "as the basis of the educational system" (NMC, 1999:37) was the reason why language was one of the main issues considered while planning the National Mathematics Survey. It was necessary to make a decision on the language that was to be used during the test administration.

> There is no doubt that unless the students taking the tests are proficient in the language of the test, their performance will only represent a modest sample of their true knowledge. (del Rosario Basterra, 1998-9:2)

Lack of, or limited proficiency in the use of English has been and still is a very important issue when considering the assessment of pupils. In a study carried out by Caruana Anastasi (2003), statistical analysis showed that there was a high correlation between Year 6 pupils' Mathematics and English Exams results, thus suggesting that 'performance in Mathematics is dependent on language competence' (p.54).

Del Rosario Basterra (1998-9), while claiming that assessing non-English-language learners is quite challenging and complex, insists that schools should find ways to assess them. She argues that when using large scale standardised tests, 'efforts should be made to assess students in their primary language; and to make appropriate accommodations in the administration of tests' (1998-9:3).

Ascher (1990) claims that 'the reliability and validity of tests may be undermined by language differences' (p.1.). Various assessments carried out abroad tried to minimise this validity and equity problem through what Shephard et al. (1998) call 'accommodation', i.e.

> …adaptations or changes in how an assessment is administered or in the mode of response. The intention of accommodations is to remove irrelevant sources of difficulty, to get a fairer or a more accurate picture of what the test-taker actually knows. (p.3)

Del Rosario Basterra (1998-9) claims that 'The current practices of making accommodations to include a large number of English-language learners does not necessarily solve the problem' (p.2). Accommodation can be used in the preparation of the test itself as well as in the method of administration. The Mathematics Performance Assessment carried out on Rhode Island in 1997 made various assessment accommodations based on Butler and Steven's (1997) model of accommodation. These included the preparation of glossaries and giving oral instructions in the native language of the pupils. One has to be cautious in the amount of accommodation made, and in the identification of the group targeted for accomodation. This in view of the fact that 'improved performance might not be evidence of improved validity.' (Shephard et al. 1998:11)

Ascher (1990) claims that apart from the fact that bilingual pupils process information more slowly in their less familiar language, 'in any given moment or circumstance, any bilingual will have a temporarily stronger language' (p.1). In order to find out about pupils' stronger language, teachers of classes participating in the Malta National Mathematics Survey were asked to point out the language each child was most fluent in since, as Ascher (1990) argues, 'a bilingual student may have relatively greater fluency with the formal or informal style in either language.' (p.1).

In the case of the Malta National Mathematics Survey, one of the teachers, who acted as the project researcher in the Pilot testing, carried out observations in 5 schools in order to identify the language used:

a) by teachers and pupils throughout the day;

b) by the teacher to deliver lessons;

c) by the teacher to give instructions during the lessons;

d) by the pupils among themselves.

In the initial phase of the study, observation sessions were carried out in a number of Year 1 classes in 5 state schools (2 schools in Gozo; 3 schools in Malta). Classes were chosen randomly and the project researcher spent between two and three mornings in each class observing different lessons and taking notes about the language used during lessons including instructions given to the pupils.

These observations showed that while some teachers delivered lessons and gave instructions mainly in English or Maltese, others tended to code-switch. These sessions also helped to identify specific language related to the marking of answers during tasks, e.g. 'Tick'; 'Draw a ring around…'; 'Mark it'.

While ensuring that the highest level of consistency was maintained in the administration of the test, it was decided that the prevailing circumstances in each situation were to dictate the language/s to be set for its administration. Very clear and specific instructions were provided for those situations where the predominant language was either Maltese or English.

1.3 Aims of the Study

The aims of this study were:

- to conduct a national survey of the Mathematics attainment of all Maltese Year 1 pupils in state, private church and private independent primary schools;
- to produce a national standardisation of the Mathematics 5 test (Hagues et al., 2001a), suitable for future use in Malta to assess

attainment of Year 1 pupils. A rationale and indication of the procedure is given in Annex 3;

- to obtain raw and standardised scores on the test for Maltese Year 1 pupils;
- to provide feedback to all schools regarding the pupils' levels of attainment in Mathematics;
- to investigate the relationship between the pupils' attainment in Mathematics and background variables at pupil and school levels;
- to provide information on the levels of attainment in Mathematics of Maltese Year 1 pupils for the benefit of all stakeholders in Maltese education: the pupils themselves, their parents and teachers, administrators and policy makers;
- to encourage public debate on the implications of the test results for education and social policy in Malta;
- to make international comparisons, especially since the test used was a standardised UK test;
- to determine whether the language of test administration has differential effects on performance outcomes;
- to investigate the relationship between pupil attainment and home background. This has been thoroughly investigated in a UK context (Strand, 1997; Tymms et al., 1997; Strand, 1999; Thrupp, 2001; Strand, 2002; Hutchison, 2003). It was considered to be of interest to see whether these findings were replicated in the Malta situation.

Chapter 2

Survey Administration

2.1 Tests

As with the literacy studies carried out previously, there are no Mathematics tests that have been standardised for the Maltese context. The home language of the vast majority of pupils is Maltese (Mifsud *et al.,* 2003), and much of the teaching of Mathematics at primary level in Maltese Primary schools is conducted in both languages. Caruana Anastasi (2003) claims that out of the twenty-eight Year 6 Maths lessons observed, none of these were delivered completely in one language (i.e. Maltese or English). There was frequent code-switching in all the lessons.

Particularly at this very early stage in education (Year 1), pupils could experience difficulties in understanding some of these tests as these could contain a high proportion of word problems and are heavily dependent on English literacy. Therefore an important feature of the pilot study was to check the suitability of the test in a Maltese context.

After inspection of and consultation on the range of available Mathematics tests set in English, a standardised British test was chosen for assessing the pupils' level of attainment in Mathematics. The test selected was the *Mathematics 5* test from the *Mathematics 5-14 series* (Hagues *et al.,* 2001a). This test is the first of a series of ten standardised tests developed by the National Foundation for Educational Research for nferNelson. The series was designed to indicate the extent to which a pupil is making progress in Mathematics from one year to the next. The *Mathematics 5-14* series as a whole assesses attainment in the three key content areas of Number: Shape, Space and Measures; and Handling Data. Each test item in the series has been designed and categorised to demonstrate the ability to use different mathematical concepts or processes, resulting in possible diagnostic information.

The *Mathematics 5-14* series draws from both the requirements of the National Curricula in England, Wales and Northern Ireland, and the National Guidelines 5-14 for Scotland, implying that it would not be too closely tied to a single curriculum. It was considered that the education system in Malta is sufficiently similar to that of the UK. Hence, there were no problems due to cultural transfer. Visual inspection by Maltese curriculum experts confirmed the face validity of the test in a Maltese situation. All items in the test are covered by the Year 1 syllabus of the Curriculum Department, (2005), Education Division of Malta.

The Instruction Booklet of the selected test comments that 'The entire test is administered orally so that limitations in pupils' reading ability do not mask the assessment of their mathematical attainment' (Hagues *et al.*, 2001b:1). This made it particularly suitable for a bilingual society such as Malta, where knowledge of English is likely to be an important factor in the apparent performance on a test administered in English. The findings of the pilot study (see Section 2.2) showed that the combination of the particular test and the careful instructions for testers meant that there were no apparent language problems.

2.1.1 A Brief Outline of the *Mathematics 5 Test*

The *Mathematics 5* test is a recently published test (2001) designed to contribute a baseline score to the 'progress scale scores' which are available for the *Mathematics 5-14* Series. The test was designed to cover both process and content. Table 2.1 presents the four process categories of *Mathematics 5* and the relevant test items.

As for the series as a whole, the content has been drawn from the various curricula of England, Scotland and Northern Ireland. It is intended for use with groups of rising five-year-old pupils, but it is equally suitable for use as an on-entry test for rising six-year-olds. It is important to point out that the *Mathematics 5* test has been designed to be administered orally. The test is part of a series which includes *Mathematics 6, 7, 8* and *9* tests. This makes it possible to follow up the sample, using the series, in later years.

Furthermore, the *Mathematics 5* test has recently been standardised on a UK national sample (2001), so that the results for Maltese children could be used as the basis for wider comparison. The *Mathematics 5* test contains 24 items in all, and is standardised for the age range 4 years 0 months to 6 years 3 months (4:00-6:03). Prima facie, the test seemed well suited to the age group to be tested.

Table 2.1: Process Categories and Test Items in Mathematics 5 (nfer Nelson)

Process Category	Item Number	Item Title
Understanding Number – These questions require pupils to demonstrate an understanding of basic numerical concepts and processes. The challenge in these questions lies in the understanding of the process rather than in the performance of a numerical operation (if any).	1	Counting fingers and thumbs
	4	Number pad
	6	Matching dots
	8	Domino
	13	Money
	16	Counting
	18	Comparing numbers – buttons
	23	Counting shapes 1
Non-numerical Process – These questions require an understanding of non-numerical mathematical concepts and process in order to be answered correctly. The questions do not have any significant numerical content that needs to be considered by the pupils.	7	Reasoning – T-shirts
	12	Comparing shapes
	19	Repeating patterns
	20	Copying pattern
	22	Describing shapes
Computation and Knowledge – Computation questions are those in which the operation is stated or ir relatively unambiguous. The other questions in this category can be answered directly upon recall of one or more mathematical facts or terms. All these questions largely involve either memory or well-rehearsed procedures.	2	Clocks
	10	Triangles
	17	Weighing
Mathematical Application – Pupils have to use mathematics in a problem-solving situation. The first involves determining from the context the required operation before performing the calculation (if any).	3	Addition – balloons
	5	Comparing heights
	9	Half full
	11	Ordering – mouse
	14	Shopping
	15	Subtraction – apples
	21	Sorting shapes
	24	Counting shapes 2

2.1.2 Instruction Booklets

For the administration of the test in Malta the original 'At a Glance Guide' and 'Teacher's Guide' (Hagues *et al.,* 2001) were used. However, test administrators were asked to use Maltese when the situation warranted this and specific instructions were duly provided. A group of Maltese educators, who are specialists in the Maltese language and have extensive teaching experience, prepared a Maltese version of the Guidelines. Subsequently, the Guidelines in Maltese were also field-tested in a number of classes.

2.2 Pilot Study

The pilot study of the National Mathematics Survey was carried out in May 2003.

2.2.1 Aims of the Pilot Study

The aims of the pilot study were:

- to identify an appropriate Mathematics test for use in a Maltese context;
- to conduct a pilot survey of the Mathematics attainment of a sample of Maltese Year 1 pupils in State Primary Schools;
- to carry out practice statistical investigations of the relationships between the pupils' levels of Mathematics and background variables at pupil and school levels;
- to draw lessons for the conduct of the main survey.

2.2.2 Method

The pilot study was carried out in twelve Year 1 classes in twelve Primary State schools, two in each geographical region of the Maltese Islands. The number of pupils tested in both languages was 204. The participants who took the test were those born in 1997.

Background data on the pupils and schools involved was collected successfully with the help of the Heads of Schools. The tests were administered and scored by three teachers who were also working as researchers for the study. The ratings of the test administrators showed a high level of approval of the tests.

The technical reliability of the test was satisfactory, and the test level matched the ability of the pupils. Analysis of the items in the test showed that they all had good characteristics. The pilot study found no evidence of any differentiated item functioning between the performance of boys and girls. The benefits of using an intact test outweigh those of attempting to remove this item. Unfortunately there were very few pupils who spoke English as a first language in the pilot, so it was not possible to consider whether there was any differential item functioning based on the language spoken or the language of test administration.

2.2.3 Main Findings

The main findings of the pilot study were as follows:

- Girls' average score was higher than the boys', and the difference in average scores was statistically significant.
- Both parents' occupation and education did not have a statistically significant impact on the pupils' scores.
- The number of pupils in each region was too small to allow statistical analyses to be conducted at this stage.

2.3 Other Research Instruments

The other research instruments used in this study were intended to gather information about the schools, the Year 1 classes and the pupils involved, and to obtain the test administrators' opinion of the test after it was administered.

2.3.1 School Questionnaires

A School Questionnaire (see Annex 1a) was designed to request the following data at school level: the geographical region, type of school and the number of male and female pupils in Year 1. The Head or Assistant Head of school was requested to provide this information. A Geographical Classification of all Districts was also provided. (See Annex 1b).

2.3.2 Pupil Data Form

A Pupil Data Form, one in Maltese (see Annex 2a) and one in English (see Annex 2b), was designed. This requested information about a variety of pupil- and home-level background variables: age, gender, first language, special educational needs, pre-school education, father's occupation, mother's occupation, father's level of education and mother's level of education. These were tested in the pilot study, and shown to function successfully. This information was obtained through the class teacher or the pupil's parents or primary carer(s). The teachers were requested to identify the language of test administration for each pupil.

The School Questionnaire and Pupil Data Form were field-tested by six teachers, one in each of the schools. The School Questionnaire was considered to be straightforward and easy to complete. The Pupil Data Form, which had to be completed for all the pupils in the class, was considered time-consuming as the background details required were not always readily available. As expected, the items concerning mother's occupation and father's and mother's level of education proved to be problematic since this information was not included in the Cumulative Record Card (CRC). On the other hand, the father's occupation was usually listed in the CRC.

2.3.3 Test Administrator's Questionnaire

A Questionnaire (see Annex 3) was designed for test administrators. They were asked whether they felt that the tests were suitable and matched the pupils' levels of Mathematics, and whether the tests were easy or difficult to administer. The Questionnaire also asked the test administrators to provide other comments about the tests.

This instrument was reviewed by the project team. It was considered to be very clear and easy to complete.

Chapter 3

Methodology

A decision was taken to proceed with the main study, not only due to the success of the pilot study but also because of the worthwhile information that the study would provide. It would enable schools to check their knowledge of their pupils and their progress against an objective measure, and to set the attainment of their Year 1 pupils in the national context.

The National Mathematics Survey was carried out on the same lines as the pilot study, subject only to differences entailed by the difference in scale; such as the number of test administrators required and the involvement of all schools, that is, state schools, private church schools and private independent schools. The tests could be used as screening devices so that pupils having weak mathematical skills, and therefore being at risk of mathematical failure, could be given extra help in order to boost their educational prospects during the coming school years. All this was possible since items in the test are classified by process, therefore making it possible to use this information to locate areas of strength and weakness in pupils' performance.

3.1 Method

It was decided that every Year 1 pupil on the Maltese Islands was to take the test of Mathematics. All the schools in Malta with Year 1 pupils participated. The survey could not take place too early in the scholastic year since primary school teachers would not have covered most of the Mathematics Syllabus. At the same time, carrying out the survey towards the end of the scholastic year would have come at a time of year when children would be on a half-day timetable. Besides, the hot weather may have affected the pupils' performance on the test. Therefore it was decided to carry out the survey at the end of April.

Pupils in Gozitan state schools and Maltese non-state schools sat for the test on the 27^{th} April, 2004, while pupils in Maltese state schools took the test on the 28^{th} April, 2004. Schools with a high pupil population carried out the test over the two days. Pupils who were absent on their scheduled day of testing were allowed to sit for the test the day after.

Information was supplied for a total of 4,662 pupils. After excluding those without key variables, such as a test score or home background information, full information was available on 4,384 pupils (94%).

A meeting for all Heads of Schools was held in February 2004. The main purpose of these meetings was to acquaint the Heads of Schools with the aims of the test, procedures etc. Apart from these, they were given:

a) Data forms to be completed by parents of all Year 1 students;

b) An information pack which included the date and time of testing; the number of rooms and furniture required; a plan of the actual setting of this furniture; a School Information Sheet and an Annex to the School Information sheet.

Arrangements were made to recruit the survey assistants and test administrators required for the survey to run smoothly. Pupils were to sit for the test in groups of 5 or less. The test took around 30-45 minutes to complete. Each test administrator had to carry out approximately 5 sessions in one day. While the test administrator was responsible for administering the tests, the survey assistant was responsible for organising the pupils to take the test and was required to complete a number of information sheets. If a test administrator did not manage to complete any of the scheduled sessions in one day, these were administered the following day. Meetings for survey assistants and test administrators were held separately. These brief meetings were held on the eve of the survey in order to minimize possibility of disclosure. Survey assistants were given packs with tests and other materials (coins, containers and shapes) necessary for the administration of the tests. These were sealed and were to be opened on the day of the test.

To ensure that the highest level of consistency was maintained, the specially trained test administrators conducted the test by following instructions in the original 'Teacher's Guide' (Hagues *et al.,* 2001b). As in the pilot study, very clear and specific instructions for the test administration were provided. These included situations where the predominant language of testing was either Maltese or English. The test administrators were asked to feel free to explain in English / Maltese as well, if they felt that the pupils did not understand the instructions in the main language used for test administration.

3.2 Scoring the Tests

The project researcher trained four fully qualified teachers how to score the test according to the instructions in the original 'Teacher's Guide' (Hagues *et al.,* 2001). Each correct answer was to be awarded one mark. Prior to data entry, all test booklets were double-checked by the five markers on the team, to ensure that the scoring was accurate.

Chapter 4

Findings

This chapter presents the results of the Test Administrator's Questionnaire and the main raw score results of the *Mathematics 5* test.

4.1 Test Administrator's Questionnaire

The test administrators completed a questionnaire (see Annex 3) about the suitability and manageability of the test

Table 4.1: Test Administrator's Questionnaire

Suitability	Suitability of test	Suitability of test materials	Manageability	Manageability of test
Very suitable	80	137	Very manageable	103
Fairly suitable	112	55	Fairly manageable	98
Borderline	11	12	Borderline	3
Unsuitable	1	0	Unsuitable	0
Total	204	204	Total	204

The test was described as being enjoyable and suitable for the age group in question, as it covered most of the skills children are expected to acquire at this particular stage of learning. The test administrators felt that the handling of materials (shapes and coins) made the test pleasant for the pupils, as it resembled a play situation. Carrying out the test with groups of not more than five children was considered to be positive. However, some administrators considered the test to be somewhat long for pupils of this age.

4.2 Reliability

Using Cronbach's alpha the reliability of the tests was estimated at 0.75. This is slightly lower than that quoted for the UK standardisation (0.81), but indicated clearly that the test had reasonably satisfactory internal reliability.

4.3 Raw Scores

The maximum possible score on the test was 24. Raw scores achieved by pupils ranged from 0 to 24. Figure 4.1 below shows the distribution of their scores.

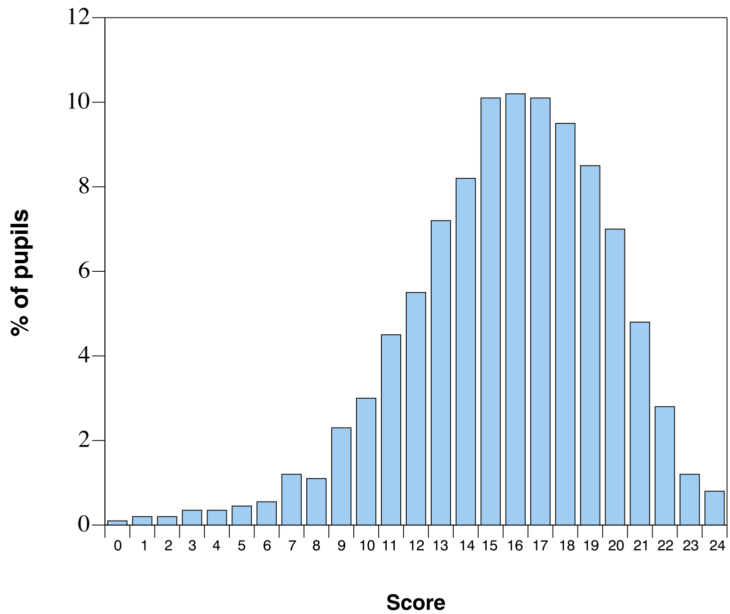

Figure 4.1: Frequency distribution of raw scores on the Mathematics test.

The graph shows the distribution is slightly skewed towards higher scores. The mean score on the test was 15.6 (with a standard deviation of 3.9) and the median score was 16.0. The mean and the median raw scores are similar, though the mean is slightly lower because of the skewness of the distribution. The latter were both about two-thirds of the maximum marks available.

Table 4.2 presents the average raw scores of boys and girls on the test.

Table 4.2: Boys' and Girls' Raw Scores on the Mathematics Test

	No. of Pupils	Mean Raw Score	S.d.
Boys	2,260	15.4	4.1
Girls	2,124	15.8	3.7
Total	**4,384**	**15.6**	**3.9**

On average the girls scored approximately 0.4 of a mark more than the boys on the test. This difference in performance in favour of girls is slightly smaller than that obtained in the literacy studies in Year 2 and Year 5 (Mifsud et al., 2000, 2004a). This would be expected, since boys typically do relatively better compared to girls in Mathematics and science subjects. Until relatively recently, boys could be expected to outperform girls in Mathematics, but some recent trends have shown girls being more successful (MacCann,1995 and Machin & McNally, 2005).

However, in order to investigate differences in performance thoroughly, it is important to consider simultaneously all other factors. This was addressed through multilevel modelling. In the pilot study, tables were presented comparing the performance of different groups of pupils. In this report, the corresponding results are shown in the 'unadjusted' part of the multilevel analyses (see Table 5.2).

Chapter 5

Findings: Multilevel Modelling

In this section, the results of the multilevel analyses are described.

5.1 Multilevel Modelling

In education, as in many other areas of research, data occur in a structured arrangement. Schools are made up of classes, which in turn are made up of pupils. In general, it happens that there is a degree of similarity between the lower-level elements within a higher-level element. This hierarchical quality is not acknowledged in the standard 'traditional' statistical techniques used in 'school effectiveness studies up to about the mid-1980s'. This resulted in 'biases in the estimation, especially of statistical significance' (Hutchison, 2003:32). The technique of *multilevel modelling* (Goldstein, 2003; Raudenbush and Bryk, 2002) has been developed precisely to take account of hierarchical structures. This technique has been used in this study. Two levels are considered: pupil and school. The programme used in this project was MlwiN (Rasbash *et al*., 2000).

5.2 Background Variables

Table 5.1 shows the background variables used in the multilevel modelling analyses, with their subcategories.

Table 5.1: Background Variables Used in Multilevel Modelling, with Subcategories

Variables	Subcategories
Pupil variables	
Gender	Male Female
Age	In completed months at date of testing*
First Language**	Maltese English
Special Educational Needs	No SEN SEN

Years of Pre-school Education	None
	One year
	Two years
	Three years
	Not known
School variables	
Type of School	Primary A State School Primary C State School Private Independent School Private Church School
District of the School	Southern Harbour
	Northern Harbour
	South Eastern
	Western
	Northern
	Gozo and Comino
Number of Year 1 Classes in the School	1 – 6
Class Size	Number of pupils in each class
Home variables	
Family structure	Other
	Parents deceased
	Separated parents
	Single parent separated
	Single mother
	Both parents
Mother's Education	Other
	No formal schooling
	Primary school
	Secondary school
	Pre-university courses and vocational courses
	Tertiary education
Father's Education	Other
	No formal schooling
	Primary school
	Secondary school
	Pre-university courses and vocational courses
	Tertiary education
Mother's Occupation	Other
	Professional
	Managerial and administrative
	Higher clerical, skilled craftsmen, technicians
	Skilled manual workers, foremen
	Semi-skilled, unskilled workers, labourers

Father's Occupation	Other
	Professional
	Managerial and administrative
	Higher clerical, skilled craftsmen, technicians
	Skilled manual workers, foremen
	Semi-skilled, unskilled workers, labourers

* Date of testing: April 2004

** All but two pupils are described as having been tested in their home language. The variable 'Language' is taken as referring to both first language and language of testing.

These factors were considered individually as well as globally. The outcome variable for these analyses was the raw score. We decided to use raw scores rather than age-standardised scores, so that the effect of other variables could be compared to that of age. For example, the effect of gender in the adjusted analysis is 0.25, approximately equal to the coefficient for age in months (0.26). This could be interpreted to mean that the girls are ahead by an amount approximately equivalent to one month's progress at this stage. Using raw scores also makes for comparability of approach with the earlier literacy study (Mifsud *et al.,* 2000). Two different multilevel models were employed. First each of the variables was included in the model individually. This allows to determine the impact of each of the factors separately. This is known as the '*unadjusted*' model. The second model included all the variables together so that each variable was considered simultaneously with all the other factors that might affect pupil performance. This is referred to as the '*adjusted*' model. The multilevel modelling results are presented in Table 5.2.

Unless otherwise stated, only results considered statistically significant at least at the 5 percent level are reported.

Table 5.2: Unadjusted and Adjusted Results

		Unadjusted model Adjusted model				Adjusted model		
		N	Coefficient	s.e.	Chi-square	Coefficient	s.e.	Chi-square
Pupil variables								
Gender	Male	2,260	0	-	6.53*	0	-	4.79*
	Female	2,124	0.32	0.13		0.26	0.12	
Age	In completed months	4,384	0.26	0.02	245.21***	0.25	0.06	241.59***

First Language	Maltese	3,804	0	-	5.81*	0	-	1.07
	English	580	0.67	0.28		0.28	0.27	
SEN	No SEN	4,290	0	-	44.79***	0	-	40.27***
	SEN	94	-2.67	0.40		-2.41	0.38	
Pre-School	None	49	0	-	23.16***	0	-	21.14***
	One Year	267	0	0.62		0.24	0.59	
	Two years	3,846	0.97	0.57		0.90	0.54	
	Three years	184	1.76	0.64		1.13	0.61	
	Not Known	38	0.17	0.85		1.20	0.81	
School variables								
Type of School	Primary A State School	1,255	0	-	2.22	0	-	3.03
	Primary C State School	1,374	0.23	0.40		0.01	0.50	
	Private Independent School	688	0.57	0.50		-0.68	0.53	
	Private Church School	1,067	0.56	0.44		-0.26	0.51	
District	Southern Harbour	915	0	-	8.52	0	-	12.18*
	Northern Harbour	1,335	-0.17	0.39		-0.36	0.36	
	South Eastern	496	0.16	0.50		-0.08	0.47	
	Western	609	0.15	0.49		-0.18	0.44	
	Northern	653	1.01	0.52		0.70	0.51	
	Gozo and Comino	376	-0.54	0.48		-1.21	0.45	
Number of Year 1 Classes	1	674	0	-	1.86	0	-	15.70**
	2	1,311	-0.34	0.35		-0.28	0.31	
	3	1,047	-0.28	0.41		-0.59	0.39	
	4	675	-0.46	0.52		-0.85	0.55	
	5	410	0.08	0.70		-0.17	0.72	
	6	267	0.32	0.94		-0.25	0.98	
Class Size	Size	221	0.053	0.15	0.15	0.081	0.149	0.89
	Size squared	221	-0.00118	0.0038		-0.0024	0.00369	
Home variables								
Family Structure	Other	158	0	-	44.86***	0	-	11.91*
	Parent deceased	19	1.57	0.93		-0.05	0.94	
	Separated parents	232	1.15	0.40		-0.63	0.52	
	Single parent separated	39	-0.35	0.68		-1.82	0.72	
	Single Mother	105	0.62	0.49		-0.74	0.58	
	Both parents	3,831	2.10	0.32		-0.17	0.50	
Mother's Education	Other	240	0	-	123.72***	0	-	43.18***
	No formal schooling	6	1.22	1.56		0.06	1.63	
	Primary School	91	0.12	0.47		0.19	0.57	
	Secondary School	2,733	1.53	0.26		0.92	0.40	
	Pre-university courses and vocational courses	880	2.35	0.28		1.37	0.42	
	Tertiary Education	434	2.86	0.31		1.47	0.46	
Father's Education	Other	386	0	-	143.22***	0	-	11.64*
	No formal schooling	10	1.69	1.21		0.89	1.27	
	Primary School	194	0.16	0.34		-0.71	0.41	
	Secondary School	2,443	1.33	0.21		0.03	0.32	
	Pre-university courses and vocational courses	741	2.22	0.24		0.38	0.35	
	Tertiary Education	610	2.52	0.26		0.20	0.38	

Mother's occupation	Other	3,090	0	-	77.94***	0	-	17.72**
	Professional	230	1.67	0.27		0.64	0.32	
	Managerial and administrative	190	1.00	0.29		0.39	0.29	
	Higher clerical, skilled craftsmen, technicians	518	1.21	0.19		0.76	0.19	
	Skilled manual workers, foremen	249	0.21	0.25		0.01	0.24	
	Semi-skilled, unskilled workers, labourers	107	-0.18	0.37		-0.04	0.36	
Father's occupation	Other	604	0	-	143.73***	0	-	26.16***
	Professional	361	2.72	0.27		1.54	0.34	
	Managerial and administrative	620	2.30	0.23		1.32	0.28	
	Higher clerical, skilled craftsmen, technicians	860	1.77	0.21		1.03	0.25	
	Skilled manual workers, foremen	1,443	1.26	0.19		0.79	0.23	
	Semi-skilled, unskilled workers, labourers	496	1.15	0.23		0.72	0.27	

* p<.05 ** p<.01 *** p<.001

5.2.1 Pupil Variables

5.2.1.1 Gender

Girls performed better than boys by around one third of a mark on average on the test. Since there is no obvious reason to expect that gender is correlated with other background factors, it was found, as expected, that adjusting for background factors makes little difference.

5.2.1.2 Age

Age was considered as a continuous variable. Older pupils performed significantly better than younger pupils by about 0.26 marks for every month older. This implies a difference of approximately 4 score points between the youngest and eldest in the sample. Again, this is essentially unaffected by adjusting for other factors.

5.2.1.3 First Language

Pupils who spoke Maltese as their first language performed less well in the test than those who spoke English by approximately two thirds of a mark. (Only two pupils were identified as speaking other languages at home, that is, other than Maltese or English. These pupils were not tested.) When other background factors were accounted for, the difference was not statistically significant.

5.2.1.4 Special Educational Needs

Special Educational Needs on average had the most effect on pupils' raw score of any of the background variables considered. Pupils assessed as having special educational needs scored on average between two and three points lower than pupils without any SEN. This significant difference in achievement was largely unaffected when all other factors were taken into consideration. Many, though not all, pupils who were classified as having Special Educational Needs had learning difficulties.

5.2.1.5 Pre-school

The preponderance of pupils (nearly 90 percent) had attended two years of pre-schooling. It is almost as if there had been a voluntary lowering of the school entry age. The greater the amount of pre-schooling, the better children appeared to perform. It is likely that children were introduced to some elements of Mathematics during their preschool time.

5.2.2 School Variables

5.2.2.1 Type of School

The differences between types of school, in favour of private church and private independent schools, were not statistically significant either in isolation or after allowing for other factors.

5.2.2.2 Districts

The differences in performance between the districts were not statistically significant in either the 'unadjusted' model or the 'adjusted' model.

5.2.2.3 Number of Classes

Some differences in raw scores were detected depending on the number of Year 1 classes in the school. However, these differences were not statistically significant, even when taking other factors into consideration.

5.2.2.4 Class Size

Effects of class size were not statistically significant. In extreme cases, where class size was over 28 the class performance was below the population average, whereas where class size was below 10, these classes performed above the population average.

5.2.3 Home Variables

5.2.3.1 Family Structure

The stability of the home relationship seems to be an important factor in school attainment. There was a highly significant relationship between the latter and attainment. Some of the groups were relatively small. Despite this, it appears that pupils from families with both parents did better than pupils without one or both biological parents present, or pupils whose parents were separated and one of the parents was absent. Such disadvantageous situations do not occur in isolation. Allowing for other background factors meant that these effects were no longer statistically significant.

5.2.3.2 Mother's Education

The level of mothers' education had a statistically significant impact on their children's performance. The higher the mother's educational level, the higher the score obtained by the child. After adjusting for other factors this pattern was reduced but, in contrast with that for fathers' education, was still statistically significant.

5.2.3.3 Father's Education

The level of fathers' education had a statistically significant impact on their children's performance. The higher the father's educational level, the higher the score the child obtained in the test. After adjusting for other factors this pattern was reduced and not statistically significant.

5.2.3.4 Father's Occupation

The fathers' current occupation had a statistically significant impact on their children's raw score and followed the ordering of the classification itself. This pattern was reduced, but it was still evident and statistically significant after adjusting for other factors. The higher the father's occupation, the higher the score the child obtained in the test.

5.2.3.5 Mother's Occupation

The preponderance of mothers fell into the group labelled 'Other' (that is, homemakers), and this was used as a baseline. However, there was a statistically significant difference in performance between the various categories of mother's occupation. This difference showed a comparable pattern to that of father's occupation. As with the father's occupation, the differences were reduced after allowing for other background factors. However, they remained statistically significant, albeit at a lower level.

5.3 Further Analyses

This section presents, in graphs, some of the findings introduced in the previous section.

5.3.1 Overall Results by Process Category

Figure 5.1 presents the percentage scores for each process category for the whole population.

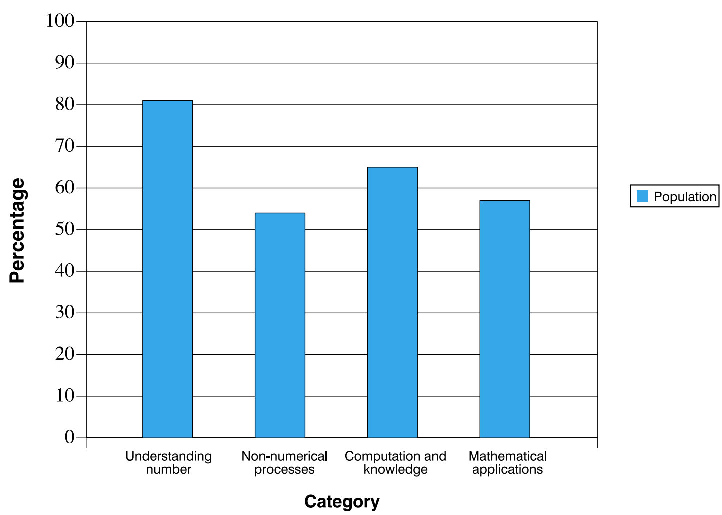

Figure 5.1: Process categories for whole population

Maltese children do best on the Understanding Number (81%) and on the Computation and Knowledge (65%) process categories.

5.3.2 Results for Each Process Category by Gender

Figure 5.2 presents the percentage scores for each process category according to gender.

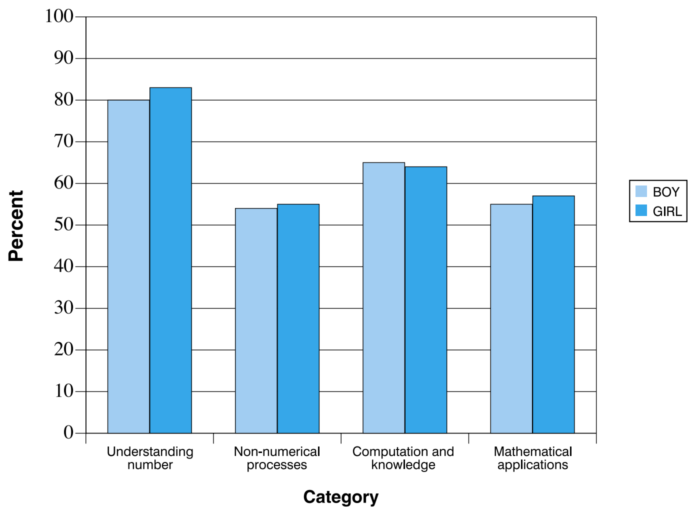

Figure 5.2: Process categories by gender.

Girls performed better than boys even when adjusting for background factors.

5.3.3 Results for Each Process Category by Age

Figure 5.3 presents the percentage scores for each process category according to age group. The younger group included pupils up to 69 months (N=2256, 51.5%). The older group included pupils in the 70 months and over age range (N=2128, 48.5%).

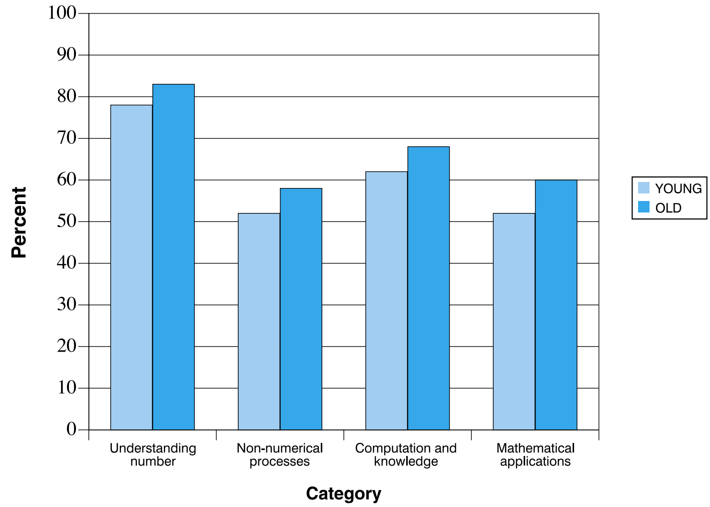

Figure 5.3: Process categories by grouped age.

Older pupils performed significantly better than younger pupils. This difference is unaffected when adjusting for other factors.

5.3.4 Results for Each Process Category by First Language

Figure 5.4 presents the percentage scores for each process category according to first language.

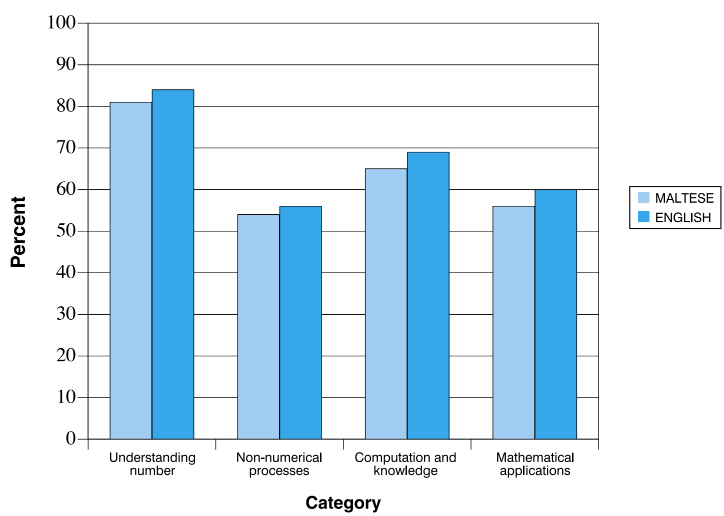

Figure 5.4: Process categories by first language.

Pupils who spoke Maltese as their first language performed less well than those who spoke English. However, when other background factors were accounted for the difference was not statistically significant.

5.3.5 Results for Each Process Category by Special Educational Needs (SEN)

Figure 5.5 presents the percentage scores for each process category according to SEN.

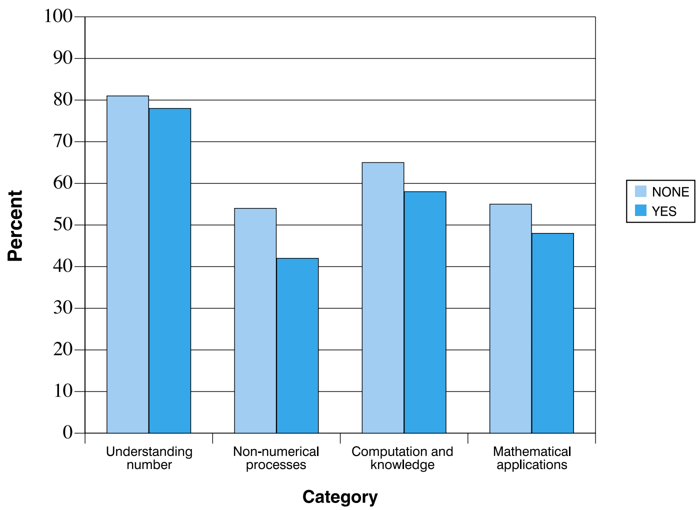

Figure 5.5: Process categories by special educational needs.

Special Educational Needs on average had the strongest effect on pupils' raw score of any of the background variables considered. The significant difference in achievement was largely unaffected when all other factors were taken into consideration.

5.3.6 Results for Each Process Category by Island

Figure 5.6 compares the percentage scores for each process category for Malta and Gozo.

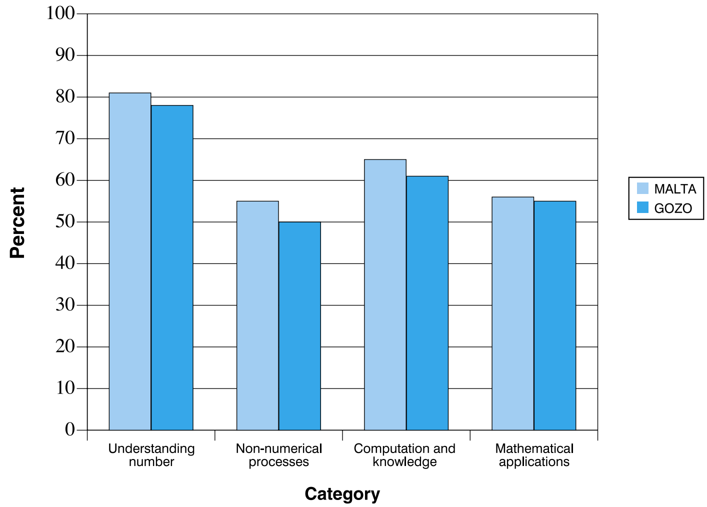

Figure 5.6: Process categories by island.

The differences between Malta and Gozo were not statistically significant in either the 'unadjusted' model or the 'adjusted' model.

Chapter 6

Discussion

The analysis of the Malta National Mathematics Survey showed that, as in the literacy studies, girls performed better than boys. This follows the relatively recent trend observed in some other countries in which girls are catching up with and overtaking boys, even in traditionally male-oriented subjects such as Mathematics and Science. This may be of some concern if boys are not to be left behind in a future where educational attainment is of increasing importance in the job market.

It is not surprising to observe that children whose parents have had more education, both mothers and fathers, and children whose fathers are in higher status jobs do better. This was also observed in the 1999 Literacy Study (Mifsud *et. al.,* 2000). It is perhaps slightly more surprising that children whose mothers work in skilled or white-collar jobs do better than those (the majority) whose mothers describe themselves as homemakers. This finding does not have a parallel in the 1999 Literacy Survey. The latter did not collect information on mother's occupation, since only a small proportion was actually in employment.

Children who attended pre-school appeared to do better at this stage, than those who did not. The longer the time they had attended, the higher the score. The experience of attending pre-school goes some way towards socialising pupils who are then more ready to meet the demands of formal education. Another possibility is that in pre-school, children are given some tutoring in the rudiments of mathematical skills. However, from the evidence collated, it does seem that attending pre-school increases performance. This highlights the importance of strengthening further the quality of early childhood education programmes.

In contrast to the 'unadjusted' findings of the literacy studies, the better performance of pupils in private church and private independent schools was not statistically significant. Indeed, after allowing for background factors state schools seem to have fared better. Considering the very early stage (Year 1), this should not induce complacency in state schools, or indeed panic in the other schools.

6.1 Class Size

An important question is that of class size. To what extent do pupils do better in smaller classes in the Maltese situation? While everyone 'knows' that small classes are better, the research is not completely unambiguous. A useful review of the evidence is presented in Wilson (2002).

A particular concern is that the classes being compared are not in fact comparable. For example, it sometimes happens that 'low-achieving' classes are smaller in order to enable teachers to give better attention to the pupils who need it most. However such an arrangement could give an apparent picture of pupils doing worse in small classes. For this reason it is important to take account of possible differences in the characteristics of the pupils involved. Therefore 'unadjusted' results are first described by simply looking at the raw scores of the pupils concerned. Then the results are examined after allowing as much as possible for differences in pupil characteristics using multilevel modelling.

Some findings have suggested that the effect of class size is either curvilinear, or a threshold effect. Figure 6.1, presents the difference between actual and predicted pupil attainment (referred to here as

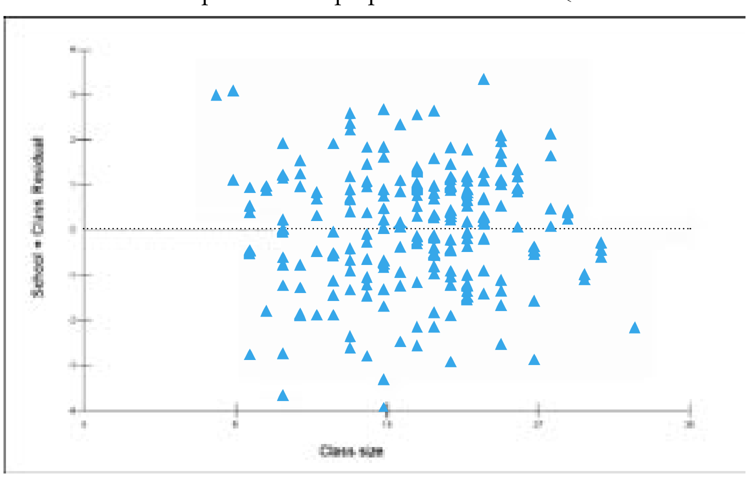

Figure 6.1: Unadjusted school + class residual vs class size.

residual) plotted against class size.

Visual inspection does not reveal any apparent trend in achievement against class size. To check this, a multilevel model was run including size and size-squared, the latter to check for curvilinear effects. Introducing these two elements had no statistically significant effect.

It could be that the apparent absence of effects occurred because the different types of classes were not in fact comparable. For this reason, a multilevel model was also run allowing for the available background factors. However, this does not completely answer the question. The recommended method of investigating such questions is using a randomised trial, as even within the paradigm adopted there is no allowance for pre-existing differences in mathematical competence.

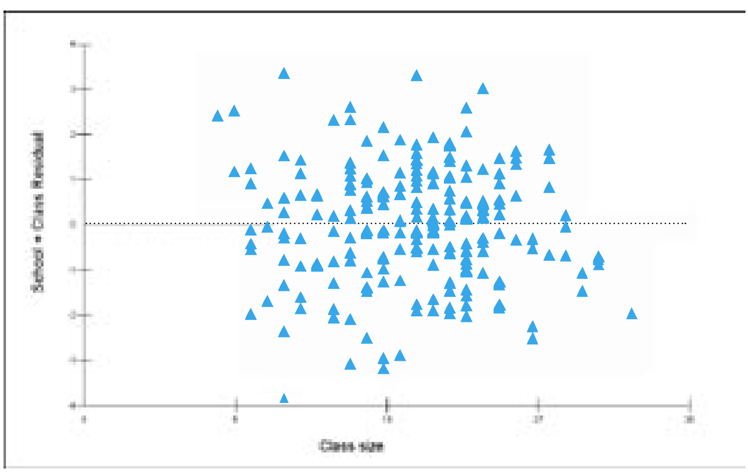

Figure 6.2: Adjusted school + class residual vs class size

Figure 6.2 shows the residual plotted against class size. As in the raw attainment case, there is no obvious relationship between the two, though it may be relevant that the largest class sizes, that is, over 28, are all below the population average while the smallest, that is under 10, are above. The multilevel analysis as shown in the second part of the table, namely the 'adjusted' results, confirms that there is no statistically significant relationship within the main range of attainment.

6.2 Making International Comparisons

The Malta National Mathematics Survey of Year 1 pupils used the *Mathematics 5* test, which forms part of the *Mathematics 5-14* series. The tests have been standardised in a UK context on a nationally representative sample. This gave the opportunity to compare the Maltese national performance on this test with the national UK average. The manual for this gives norms and age equivalents, thus offering the opportunity for comparison with the UK.

Table 6.1: Mean Test Scores for Malta

Mean score	N	Mean Age (months)
15.6	4,384	69.4

The *Mathematics 5* manual states that the test was standardised on a national sample of 2,722 children from 543 schools in England, Wales, Scotland and Northern Ireland, that were randomly selected from the national register of maintained and independent schools. Further details are given in Hagues *et al.*(2001b). The results quoted in the *Mathematics 5* manual for age equivalents give an age equivalent of 59 months for a score of 16, compared with the figures from the Malta National Mathematics Survey of 69 months for the same score to the nearest whole number (see Table 6.1). There is a difference of just over ten months in achievement in favour of the UK pupils. Two possible explanations are suggested.

The first is that there are difficulties of incompatibility between home and teaching language, and possibly between either of these and the language of the textbooks. The teaching of Mathematics is heavily dependent upon language. It was reported in this study that the large majority of pupils are taught Mathematics in Maltese at this stage, however almost all Mathematical terminology is in English. Powney (1997) and Gillies (1989) have indicated some of the difficulties faced by bilingual children in this respect. This may become even more of a problem in later stages, when the language of instruction for Mathematics is English.

The second possible explanation is the amount of teaching the pupils have received. Some pupils in England start Reception when they are little over four years old. The largest part of the UK sample (85%)

came from England. This may mean that Maltese pupils may in general start formal schooling at a later age than their English contemporaries, though this may not explain all the difference.

These are early stages of schooling yet, and one should not read too much into such comparisons. The start of formal teaching of Mathematics at an earlier age may not necessarily translate into a particularly high performance at later stages and moves in this direction should probably be resisted. In addition, many voices have been raised in the UK against the particularly early age of starting school.

Figure 6.3 compares the percentage scores for each process category for Malta and the UK.

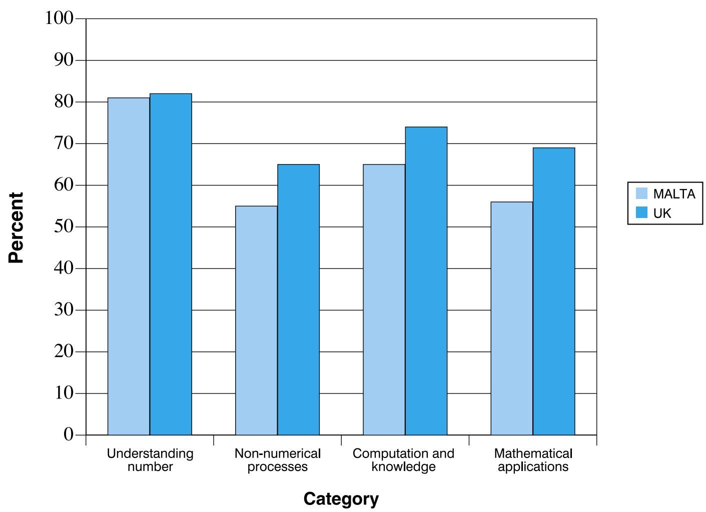

Figure 6.3: Process categories by country

A more detailed analysis by item is presented in Table 6.2. This compares the performance of Maltese and United Kingdom pupils item by item. This differs from the table in Annex 5, which relates to a within-Malta comparison between pupils whose home language is Maltese and those whose home language is English.

Difference in performance was not uniform over all the questions in the test. A DIF analysis, taking into account the overall difference in performance, identified items where Maltese children did relatively well, or relatively badly. On some items the UK-Malta difference was larger, and this showed DIF against Maltese children. On other items, the difference was smaller and these items were said to show DIF in favour of Maltese children. While on some items this meant that Maltese children actually outperformed UK children on average, it was perfectly possible for an item to show DIF in favour of Maltese children, since the difference was smaller than the average, while the Maltese performance was still below that of the UK children on the same item.

Table 6.2: Malta National Mathematics Survey DIF Analysis Malta versus UK

Item	Facility		Coefficient	s.e.	Significance	Favours	Severity
	Malta	UK					
Item1	0.84	0.87	0.22	0.08	**	Malta	Negligible
Item2	0.91	0.9	0.53	0.1	***	Malta	Medium
Item3	0.27	0.53	-0.83	0.06	***	UK	Large
Item4	0.89	0.85	0.98	0.08	***	Malta	Large
Item5	0.27	0.45	-0.4	0.06	***	UK	Negligible
Item6	0.86	0.89	0.27	0.09	**	Malta	Negligible
Item7	0.78	0.83	0.09	0.07			
Item8	0.79	0.77	0.86	0.07	***	Malta	Large
Item9	0.57	0.64	0.07	0.06			
Item10	0.52	0.68	-0.38	0.05	***	UK	Negligible
Item11	0.73	0.86	-0.61	0.07	***	UK	Medium
Item12	0.61	0.75	-0.43	0.06	***	UK	Medium
Item13	0.87	0.82	0.91	0.08	***	Malta	Large
Item14	0.29	0.31	0.75	0.07	***	Malta	Large
Item15	0.68	0.83	-0.53	0.07	***	UK	Medium
Item16	0.55	0.59	0.3	0.06	***	Malta	Negligible
Item17	0.52	0.63	-0.16	0.05	**	UK	Negligible
Item18	0.95	0.96	0.11	0.13			
Item19	0.34	0.39	0.42	0.06	***	Malta	Negligible
Item20	0.62	0.76	-0.37	0.06	***	UK	Negligible
Item21	0.91	0.94	-0.04	0.1			
Item22	0.37	0.53	-0.34	0.05	***	UK	Negligible
Item23	0.72	0.79	-0.01	0.07			
Item24	0.76	0.89	-0.71	0.08	***	UK	Large

** p<.01 *** p<.001

The second and third columns show the overall performance on each item for Maltese and United Kingdom pupils. Therefore we can see that on item 3 (Addition), the UK pupils do better than the Maltese, while there is very little difference on Item 8 (Domino). However, such findings are in themselves not of primary concern, since the overall average for the UK population is above that for Malta. What is now of interest is those performances which are substantially above, or substantially below, on the same item, after allowing for the overall difference. This is equivalent to a Differential Item Functioning (DIF) analysis and the remaining columns deal with this question.

We see that the large majority of items appear to show a statistically significant DIF one way or the other. However, approximately half of these are classified as 'negligible' and can be ignored. Those described as 'medium' or 'large' can be expected to be of more interest.

Maltese children do relatively better on item 2 (clocks), item 4 (telephone number pad), item 13 (money) and item 14 (shopping). Two of these (items 4 and 13) form part of the Understanding Number Process Category. All of these items are more related to practical aspects of Mathematics encountered in 'everyday' situations. However, UK children do relatively better on item 3 (addition), item 11 (ordering a series of events), item 12 (comparing shapes), item 15 (subtraction) and item 24 (counting shapes). Most of these (items 3, 11, 15 and 24) form part of the Mathematical Application Process Category.

Apparent differences could arise because of what the children had actually been taught, the emphasis given to different items in the curriculum, and the order in which they were introduced. The UK children may be introduced earlier to more formal Mathematics, such as addition and subtraction.

Chapter 7

Implications

The Malta National Mathematics Survey provides the first ever baseline study of Mathematics attainment in Malta and Gozo. During the analysis of the test scores, various variables were taken into consideration. Some of these variables had a statistically significant effect on the pupils' performance in the test. For instance, children who attended pre-school do better in Year 1 as they seem to be more ready for the demands of formal education.

The results of the Maltese and Gozitan pupils were also compared to UK results. Generally Maltese pupils perform well. However, when compared to their counterparts in the UK, they performed relatively better in the more practical aspects of Mathematics while their performance was not as good in the more formal aspects. This may be the result of the amount of teaching pupils have received as well as the incompatibility between the language spoken at home and the teaching language. However, at this stage, one should neither read too much into such comparisons nor promote that the formal teaching of Mathematics should start earlier.

7.1 Implications for Schools

Through a process of self-improvement, schools may take measures to address weaknesses in the four process categories: Understanding Number, Non-Numerical Processes, Computation and Knowledge, and Mathematical Application. The Teacher's Guide for the nferNelson Mathematics 5 test provides suggestions about how schools can address these issues. The following notes have been adapted from this Guide.

When surveying its results, it is important for a school to consider all incorrect answers and to diagnose whether the error is due to (a) carelessness, (b) lapse of memory, (c) lack of understanding, or (d) the fact, concept or process not having been met before. In the case of the first two reasons, extra practice or revision is necessary. Errors due to the other reasons indicate that further teaching is required.

7.1.1 Understanding Number

When any new skill or concept in Number is introduced, the first stage of learning is to understand the process. The initial introduction will be through direct teaching using appropriate resources and language. Pupils will require as many different experiences as possible to achieve understanding. The test items under this category require an understanding of the numerical processes to be used when answering. If there is a weakness in this category, then reteaching may be necessary. This may mean either presenting the same process or technique in a slightly different way or providing similar experiences to develop the appropriate language and concepts.

7.1.2 Non-numerical Processes

When any new skill or concept in Shape, Space and Measures is introduced, the first stage of learning is to understand the concept, skills and language involved. The initial introduction will be through direct teaching using appropriate resources and language. Pupils will require as many different experiences as possible in order to be able to apply non-numerical processes to solving problems that do not have a significant numerical content. If there is a weakness in this category, then reteaching may be necessary. This may mean presenting the same content in a slightly different way.

7.1.3 Computation and Knowledge

This category presents us with two aspects: the ability to quickly recall number facts or well-rehearsed pencil and paper techniques, and the ability to recall mathematical facts and terminology. Both of them require use of memory. The test items are either mechanistic or rely on memorizing mathematical facts and language. A weakness in this category suggests a memory lapse, insufficient practice or unfamiliarity with the terminology used.

7.1.4 Mathematical Application

A major aim of mathematics teaching is the application of acquired skills and concepts. Once skills or concepts have been understood and abstracted, pupils need the opportunity to apply them in solving mathematical problems. A weakness in this category may indicate insufficient experience in the areas of understanding and computation.

Chapter 8

Recommendations

It would be valuable to conduct this assessment regularly. Since the test has been standardised for Year 1, when the children are 5-6 years old, it would be convenient to use these same tests on the same age group annually. Regular assessment of Mathematics and numeracy skills has become a widespread trend. 'In Australia, for example, all state education ministers have recently introduced annual statewide Year 7 literacy and numeracy tests', while in the USA President Bush also recognized the importance of annual literacy and numeracy assessment (Kalantzis *et al.,* 2003). In England, pupils are assessed in Mathematics and English at the age of 7, and in Mathematics, English and Science at the age of 11.

A comparable study of literacy attainment, in Year 2 in 1999, was used as a base to launch a value added study by following up the same pupils in Year 5. This provided much valuable information on the functioning of the system as a whole. The most important contribution to the success of this exercise was that of the schools. Their contribution was not overlooked and they were involved in a series of one-to-one seminars conducted by the Education Division and the University of Malta in conjunction with the National Foundation for Educational Research, UK. The aim was to discuss with schools what insight they could gain on the performance of their schools. It is recommended that the current study be used as the basis of a further national value added study, this time in Mathematics, collecting further results from pupils in Year 3. Such an interval would give time to identify the success or otherwise of programmes for boosting attainment of lower-attaining pupils, and also to take further action, if necessary.

It would also be useful to have a second follow-up study at either Year 5 or Year 6. Year 6 would be preferable as a corresponding Mathematics test could be used as part of the standard assessment at the end of primary education. Failing this, the corresponding element of the *Mathematics 5-14* series could be administered in Year 5, as was the case for the literacy study. In either case, the repeat study could be analysed to determine whether there was any tendency for pupils who performed less well in this study to catch up. The tendency appeared to be limited in the Year 5 literacy study, despite the efforts that had been put into booster programmes between the Year 2 and Year 5 literacy studies.

The findings of this study have confirmed the findings of the literacy study that nursery attendance seems to boost attainment. This implies that it could be a very valuable investment to ensure that there are high quality programmes in early childhood education.

Conclusion

This study, together with the literacy studies carried out in these last few years by the Education Division and the Literacy Unit of the University of Malta, has helped to present the situation in Maltese primary schools. It is hoped that the awareness of schools in Malta and Gozo regarding Mathematics is raised through the National Mathematics Survey.

Good mathematical skills, even more than literacy skills, are associated with better-paid jobs (DfES Research Brief RB490, 2003). Increased opportunities to acquire skills for life should lead to better employment opportunities and fulfilment in life.

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Annex 1a

National Mathematics Survey

SCHOOL INFORMATION SHEET

(TO BE COMPLETED BY THE HEAD OR THE ASSISTANT HEAD)

It would be very helpful if you could provide the following background information on your school. Please tick (✔) one answer for each item. Thank you.

1. Type of School

1	Primary A State School	☐
2	Primary C State School	☐
3	Private Independent School	☐
4	Private Church School	☐

2. Geographical region of the school

1	MT011 Southern Harbour District	☐
2	MT012 Northern Harbour District	☐
3	MT013 South Eastern District	☐
4	MT014 Western District	☐
5	MT015 Northern District	☐
6	MT026 Gozo and Comino	☐

3. Number of Year 1 classes in 2003/2004: ☐

4. Number of pupils in Year 1 in 2003/2004:

boys ☐ girls ☐

THANK YOU VERY MUCH FOR COMPLETING THIS INFORMATION SHEET.

School stamp

Annex Ib

Annex to School Information Sheet

Geographical Classification for the Republic of Malta
Based on:
Nomenclature des Unités Territoriales Statistiques (NUTS)

1 Southern Harbour District (MT011):

Valletta, Vittoriosa, Senglea, Cospicua, Żabbar, Fgura, Floriana, Kalkara, Luqa, Marsa, Paola, Santa Lucia, Tarxien, Xgħajra

2 Northern Harbour District (MT012):

Qormi, Birkirkara, Gżira, Ħamrun, Msida, Pembroke, Pietà, St.Julian's, San Ġwann, Santa Venera, Sliema, Swieqi, Ta' Xbiex

3 South Eastern District (MT013):

Żejtun, Birżebbuġa, Gudja, Għaxaq, Kirkop, Marsaskala, Marsaxlokk, Mqabba, Qrendi, Safi, Żurrieq

4 Western District (MT014):

Mdina, Żebbuġ (Malta), Siġġiewi, Attard, Balzan, Dingli, Iklin, Lija, Rabat (Malta), Mtarfa

5 Northern District (MT015):

Għargħur, Mellieħa, Mġarr, Mosta, Naxxar, St.Pauls' Bay.

6 Gozo and Comino (MT026):

Rabat (Gozo), Fontana, Għajnsielem, Għarb, Għasri, Żebbug, Kerċem, Munxar, Nadur, Qala, San Lawrenz, Sannat, Xagħra, Xewkija, Żebbug (Gozo).

Annex 2a

SURVEY NAZZJONALI TAL-MATEMATIKA (Year 1)

Id-Diviżjoni ta' l-Edukazzjoni flimkien ma' l-Università ta' Malta qed tagħmel Survey Nazzjonali tal-Matematika ma' l-istudenti kollha tal-Year 1. L-informazzjoni li se tingħabar se tintuża biex ikun hemm titjib fil-ħiliet tal-matematika fost l-istudenti. Nitolbukom tipparteċipaw f'dan il-proġett billi timlew din il-formola.

(**F'każ ta' diffikultà, ċempel____________ jew ikkuntattja l-iskola.**)

Din l-informazzjoni qed tingħabar skond l-Att dwar il-Protezzjoni u l-Privatezza tad-Data 2001. L-informazzjoni se tintuża biss għal skopijiet ta' riċerka marbuta ma' dan il-proġett u se tkun trattata bl-akbar kunfidenzjalità.

Isem u kunjom ibnek / bintek [ ]

Data tat-twelid: Jum [ ][ ] Xahar [ ][ ] Sena [ ][ ][ ][ ]

I.D. ta' ibnek / bintek [ ][ ][ ][ ][ ][ ][ ]

Jekk ma tafhomx, ittikkja l-kaxxa (✔) biex din l-informazzjoni tingħata mill-iskola.

Il-livell ta' edukazzjoni tal-ġenituri (Ittikkja (✔) skond il-ħtieġa.)

	Missier	**Omm**
L-ebda skola	☐	☐
Skola primarja	☐	☐
Skola sekondarja	☐	☐
Sixth Form jew Korsijiet Vokazzjonali	☐	☐
Edukazzjoni terzjarja	☐	☐
Ma nafx	☐	☐

Impjieg tal-missier:	Impjieg ta' l-omm:

(NOTA: Jekk taħdem għal rasek, agħti l-impjieg partikulari; jekk mara tad-dar, ikteb 'mara tad-dar'.)

Informazzjoni dwar il-familja (Ittikkja (✔) jekk japplika.)

Il-missier mejjet	☐	Il-ġenituri separati	☐
L-omm mejta	☐	Omm weħidha (single mother)	☐
Il-ġenituri mejtin	☐	Missier waħdu (single father)	☐

Jekk ibnek / bintek jippreferi li nkellmuh bl-**Ingliż**, ittikkja (✔) l-kaxxa. ☐

Jekk ibnek/bintek ġie ċċertifikat li għandu Special Educational Needs, ittikkja l-kaxxa. ☐

Firma tal-ġentitur / kustodju ________________________

Jekk jogħġbok agħti din il-formola lill-Kap ta' l-Iskola.

Grazzi talli mlejt din il-formola.

Timbru ta' l-iskola

Annex 2b

NATIONAL MATHEMATICS SURVEY (Year 1)

The Education Division in conjunction with the University of Malta is conducting a National Mathematics Survey of all Year 1 pupils. The data which is being collected will serve to improve the pupils' mathematical skills. We kindly ask you to participate in this project by filling in this form.

(**In case of difficulty, please phone ____________ or contact the school.**)

This information is being collected in compliance with the Data Protection Act 2001. The information will be used solely for the purpose of research related to this survey and it will be treated with strict confidentiality.

Name and surname of child ☐

Date of Birth (Day, Month, Year) ☐☐☐☐☐☐☐☐ Child's I.D. Number ☐☐☐☐☐☐☐

If unavailable, tick box (✔) so that these will be provided by school.

Father and mother's level of education (Please tick (✔) as necessary.)

	Father	Mother
No formal schooling	☐	☐
Primary school	☐	☐
Secondary school	☐	☐
Sixth Form or Vocational Courses	☐	☐
Tertiary Education	☐	☐
Not known	☐	☐

Father's occupation: Mother's occupation:

(NOTE: If self-employed, please name occupation; if housewife, write 'housewife'.)

Family background (Please tick (✓) <u>if applicable</u>.)

Father deceased	☐	Parents separated	☐
Mother deceased	☐	Single mother	☐
Parents deceased	☐	Single father	☐

If your child's preferred language of communication is **English**, please tick box. ☐

If your child has been certified as having Special Educational Needs, please tick box. ☐

Parent's / Guardian's signature ______________________

Kindly return this form to the Head of School.

Thank you for completing this form.

School stamp

Annex 3

National Mathematics Survey 2004: Test Administrators' Questionnaire

School: ☐

1. In your opinion, how suitable was the Maths test for the pupils who took it?

Very suitable ☐ Fairly suitable ☐ Borderline ☐ Unsuitable ☐

2. In your opinion, how suitable were the maths materials (shapes, coins) for the pupils who took the test?

Very suitable ☐ Fairly suitable ☐ Borderline ☐ Unsuitable ☐

3. In your opinion, how manageable to administer was the Maths test?

Very manageable ☐ Fairly manageable ☐ Borderline ☐ Unmanageable ☐

Please write any comments about the test.

THANKS FOR COMPLETING THE QUESTIONNAIRE

Annex 4

Item Characteristics

Table A4.1: Malta National Mathematics Survey Test Item Statistics

Item	Mean score	Max. score	Facility	% Omitted	% Not Reached	Discrimination
ITEM1	0.84	1	84	2	0	0.35
ITEM2	0.91	1	91	1	0	0.30
ITEM3	0.27	1	27	1	0	0.34
ITEM4	0.89	1	89	0	0	0.30
ITEM5	0.27	1	27	1	0	0.26
ITEM6	0.86	1	86	1	0	0.35
ITEM7	0.78	1	78	0	0	0.32
ITEM8	0.79	1	79	3	0	0.40
ITEM9	0.57	1	57	1	0	0.27
ITEM10	0.52	1	52	1	0	0.21
ITEM11	0.73	1	73	1	0	0.24
ITEM12	0.61	1	61	0	0	0.20
ITEM13	0.87	1	87	0	0	0.25
ITEM14	0.29	1	29	0	0	0.38
ITEM15	0.68	1	68	1	0	0.42
ITEM16	0.55	1	55	2	0	0.31
ITEM17	0.52	1	52	1	0	0.23
ITEM18	0.95	1	95	1	0	0.24
ITEM19	0.34	1	34	0	0	0.32
ITEM20	0.62	1	62	0	0	0.34
ITEM21	0.91	1	91	1	0	0.20
ITEM22	0.37	1	37	3	0	0.22
ITEM23	0.72	1	72	1	1	0.33
ITEM24	0.76	1	76	1	1	0.33

Annex 5

Differential Item Functioning (DIF) in the Malta Administration of the *Mathematics 5* Test

A test should measure what it aims to measure, and success or failure on it does not depend upon characteristics irrelevant to the characteristic to be measured. In particular it is important that tests should not discriminate against groups in the population because of details in the wording.

Test designers spend quite a lot of energy checking that the items in their tests are fair. An item in a test is defined as exhibiting positive (negative) Differential Item Functioning (DIF) for a group if pupils of the same measured ability in that group do better (or worse) on that item than other pupils.

Since the test was standardised in the UK, and not in Malta, there was obviously no account taken of the possible problems of administering it to Maltese-speaking children. The test was administered in the language in which instruction took place and there was no written element to the instructions given to the pupils, so, prima facie, there is no reason to assume that non-English-speaking pupils would find certain items relatively more difficult, but there is always the possibility that the way in which one of the languages expresses a particular concept is more straightforward than another.

Table A5.1 shows the results of DIF analysis where the two groups are Maltese-speaking and English-speaking pupils. Eleven of the 24 items apparently show DIF, but this is largely because of the relatively large numbers of pupils involved.

Table A5.1: Malta National Mathematics Survey DIF Analysis by Language

Table A5.1: Malta National Mathematics Survey DIF Analysis by Language

Item	Maltese	English	Coefficient	s.e.	Significance	Favours	Severity
ITEM1	0.83	0.88	-0.17	0.15			
ITEM2	0.9	0.94	-0.25	0.2			
ITEM3	0.26	0.31	-0.01	0.11			
ITEM4	0.88	0.93	-0.39	0.19	*	English	Negligible
ITEM5	0.27	0.31	0.01	0.1			
ITEM6	0.86	0.89	0.08	0.16			
ITEM7	0.78	0.78	0.29	0.12	*	Maltese	Negligible
ITEM8	0.78	0.88	-0.6	0.15	***	English	Medium
ITEM9	0.57	0.56	0.25	0.1	*	Maltese	Negligible
ITEM10	0.52	0.57	-0.06	0.1			
ITEM11	0.72	0.77	-0.05	0.11			
ITEM12	0.61	0.6	0.22	0.1	*	Maltese	Negligible
ITEM13	0.88	0.84	0.64	0.13	***	Maltese	Medium
ITEM14	0.27	0.41	-0.58	0.11	***	English	Medium
ITEM15	0.67	0.73	0.02	0.12			
ITEM16	0.55	0.55	0.24	0.1	*	Maltese	Negligible
ITEM17	0.51	0.57	-0.08	0.1			
ITEM18	0.95	0.95	0.52	0.22	*	Maltese	Medium
ITEM19	0.33	0.38	0.02	0.1			
ITEM20	0.61	0.68	-0.13	0.11			
ITEM21	0.91	0.93	0.05	0.18			
ITEM22	0.37	0.36	0.24	0.1	*	Maltese	Negligible
ITEM23	0.7	0.79	-0.27	0.12	*	English	Negligible
ITEM24	0.75	0.81	-0.14	0.12			

The programme divides items in those showing:

a) No DIF

b) Negligible DIF

c) Medium DIF

d) Severe DIF

We can ignore the items showing Negligible DIF. There are none showing Severe DIF. This leaves us with four showing Moderate DIF. They may not necessarily be a problem since sampling fluctuation is likely to give rise to a certain degree of apparent DIF. However, they are now investigated in more detail.

These are:

a) Item 8 (English) – Dominos

b) Item 13 (Maltese) – Money

c) Item 14 (English) – Coins

d) Item 18 (Maltese) – Buttons

If there were something about the wording of the problem that made it more difficult in one language than another, then this would be DIF that needed to be considered.

The language differences were considered in detail. The language difference may be attributed to the fact that most English-speaking students attend private church and private independent schools, while Maltese-speaking pupils are more likely to attend state schools. So the language difference on these 4 items may be due to school rather than language.

However there were some differences in the two languages that may have influenced the pupils' performance. These are discussed below:

Item 8: Dominos

The Maltese equivalent for 'dots', which is 'tikek', may be much harder for 5-year- olds than the English word, and Maltese-speaking children may have actually been more familiar with the word 'dots' (i.e. the word in English). This is why this Item may have favoured English-speaking pupils.

Item 13: Money

The word 'worth' may have been too hard and English-speaking pupils may have not been familiar with this word. In Maltese the word used is 'tiswa' and this may be much easier for this age group. Maltese-speaking pupils may have been familiar with this concept while English-speaking pupils were not familiar with the term 'worth'.

Item 14: Shopping

In Maltese 'coins' is translated as 'muniti' but Maltese children may be more familiar with the English word 'coins' so this is why this item may have favoured English- speaking pupils.

Item 18: Counting Buttons

A possible explanation here is that although 'most' as a concept is featured in the Year 1 syllabus, the actual term itself is introduced later on. The Maltese version of 'most', that is 'l-iktar', is used more frequently in everyday situations.

How Big are the Resulting Differences?

To investigate how important such effects are likely to be, we used different techniques to compare the Maltese-speaking and English-speaking pupils. This was done in two ways, first using all 24 items, and then dropping the four items in question. It could be that while the items on their own showed at least medium DIF, when they are taken together, these effects cancel out. Table A5.2 shows the results of this analysis.

Table A5.2 Effect of Dropping Four Medium Items from Test

	N	All items	SD	Items less four	SD
Maltese	3,804	15.5	4	12.6	3.4
English	580	16.4	3.8	13.3	3.2
Difference		0.9		0.7	

There is a small reduction in the difference between Maltese- and English-speakers as a result of removing the four medium DIF items, but that it is rather small, of the order of 0.2 score marks. Therefore, one concludes that, overall, DIF between Maltese- and English-speaking pupils is not a problem in this instance, and that the arrangements for administering the test in the two languages have worked well.

Gender DIF is also investigated, though this is less likely to be important since gender effects have already been investigated in a UK context. For completeness we also investigate gender DIF in Malta. The results are shown in Table A5.3.

Table A5.3: Malta National Mathematics Survey DIF Analysis by Gender

Item	Males	Females	Coefficient	s.e.	Significance	Favours	Severity
ITEM1	0.83	0.85	-0.05	0.09			
ITEM2	0.9	0.92	-0.07	0.12			
ITEM3	0.26	0.27	-0.04	0.08			
ITEM4	0.87	0.91	-0.28	0.11	**	Girls	Negligible
ITEM5	0.28	0.27	0.13	0.07			
ITEM6	0.86	0.87	0.05	0.1			
ITEM7	0.76	0.81	-0.24	0.08	**	Girls	Negligible
ITEM8	0.78	0.8	0.01	0.09			
ITEM9	0.55	0.58	-0.04	0.07			
ITEM10	0.49	0.56	-0.24	0.06	***	Girls	Negligible
ITEM11	0.72	0.74	0.03	0.07			
ITEM12	0.61	0.61	0.05	0.07			
ITEM13	0.86	0.89	-0.09	0.1			
ITEM14	0.3	0.27	0.33	0.08	***	Boys	Negligible
ITEM15	0.67	0.69	0.02	0.08			
ITEM16	0.53	0.57	-0.11	0.07			
ITEM17	0.58	0.47	0.57	0.07	***	Boys	Medium
ITEM18	0.94	0.96	-0.22	0.16			
ITEM19	0.34	0.34	0.09	0.07			
ITEM20	0.6	0.63	-0.04	0.07			
ITEM21	0.89	0.94	-0.5	0.12	***	Girls	Medium
ITEM22	0.38	0.37	0.11	0.07			
ITEM23	0.7	0.73	-0.1	0.07			
ITEM24	0.75	0.77	0.01	0.08			

Table A5.3 shows the results of DIF analysis where the two groups are boys and girls. Six of the 24 items apparently show DIF, but this is largely because of the relatively large numbers of pupils involved. Of the six items that are identified as statistically significant, five are of negligible impact. The sixth (sorting shapes) exhibits medium DIF towards girls. There seems to be no obvious reason for this, so one can conclude that it is simply a sampling effect.

Annex 6

Age-Standardisation

The pupils in this study ranged from five years four months to six years three months. In this age-group performance is very much dependent on age. Within a certain age bracket, most published tests in the United Kingdom provide a conversion from raw-scores to age-standardised scores with the aim of enabling fair comparisons, at least, between pupils of different ages.

For these reasons, the results of this test were age-standardised on the population in the study. These results may be used in future administrations to groups or individual pupils in a Maltese context. The method used is described in Schagen (1990).

Table A6.1 Standardisation Table for Malta National Mathematics 5 for Malta

	Age in Years and Completed Months												
Raw Score	**5.04**	**5.05**	**5.06**	**5.07**	**5.08**	**5.09**	**5.10**	**5.11**	**6.00**	**6.01**	**6.02**	**6.03**	**Raw Score**
0	69	69	69	69	69	69	69	69	69	69	69	69	**0**
1	69	69	69	69	69	69	69	69	69	69	69	69	**1**
2	69	69	69	69	69	69	69	69	69	69	69	69	**2**
3	69	69	69	69	69	69	69	69	69	69	69	69	**3**
4	69	69	69	69	69	69	69	69	69	69	69	69	**4**
5	69	69	69	69	69	69	69	69	69	69	69	69	**5**
6	72	72	71	70	69	69	69	69	69	69	69	69	**6**
7	76	75	74	73	72	71	71	70	69	69	69	69	**7**
8	78	78	77	76	75	74	74	73	72	71	70	69	**8**
9	82	81	80	79	78	77	76	75	75	74	73	72	**9**
10	85	84	83	82	81	80	79	78	77	76	75	75	**10**
11	88	87	86	85	84	83	82	81	80	79	78	77	**11**
12	92	91	89	88	87	86	85	84	83	82	81	80	**12**
13	95	94	93	92	91	89	88	87	86	85	84	83	**13**
14	99	98	97	96	94	93	92	91	89	88	87	86	**14**
15	103	101	100	99	98	97	96	94	93	92	91	90	**15**
16	106	105	104	103	102	101	99	98	97	96	95	94	**16**
17	110	109	108	107	106	105	104	102	101	100	99	98	**17**
18	114	113	112	111	110	109	108	107	106	104	103	102	**18**
19	118	117	116	115	114	113	112	111	110	109	108	107	**19**
20	122	121	121	120	119	118	117	116	115	114	113	112	**20**
21	126	125	125	124	123	123	122	121	121	120	119	118	**21**
22	131	131	130	129	129	128	127	127	126	125	125	124	**22**
23	140	139	139	138	137	137	136	135	135	134	133	133	**23**
24	141	141	141	141	141	141	141	141	141	141	141	141	**24**
	Standardised Dec 04												

Annex 7

Technical Glossary of Some Statistical Terms

Adjusted

Where given characteristics have been included in a statistical model, this means the results have been adjusted for these characteristics. In such a model, schools (and/or pupils) are compared on a like-with-like basis.

Correlation

A correlation is a measure of the strength of the relationship (which is not necessarily causal) between two quantities. Correlations have values in the range +1 to -1. A value of +1 indicates a direct positive relationship, whereas a value of –1 indicates a direct negative relationship, and 0 indicates no relationship all. Correlations based on fewer than 1000 cases should be treated with caution.

Differential Item Functioning (DIF)

Differential Item Functioning (DIF) investigates the items in a test, one at a time, for signs of interactions with sample characteristics. It determines if test questions are fair and appropriate for assessing the knowledge of different groups. It is based on the assumption that test takers who have similar knowledge (based on total test scores) should perform in similar ways on individual test questions regardless of their characteristics.

Mean Score

This is another term for the average score

Median

The median is the mid-point of an ordered set of data. The median divides the observations (in this case, pupils) into two equal parts.

Multilevel Modelling

Multilevel modelling is a particular type of statistical model, which takes account of data which is grouped into similar clusters at different levels. In this report individual pupils are grouped within schools. There may be more in common between pupils within the same school than with other schools, and there may be elements of similarity between the school's test results at different time points. Multilevel modelling allows us to take account of this hierarchical structure of the data and variables at the different levels so as to produce more accurate predictions.

'Predicted' or Expected Value

The predicted value is the value given by a statistical model at any specified point. It represents the performance of a 'typical' school or pupil with a given set of characteristics.

Raw Score

This is the number of marks obtained by a pupil in a test. A raw score on one test is not comparable to a raw score on another test. This is because the tests may be of different length or difficulty. A raw score does not include any allowance for a pupil's age.

Residual

A residual is the difference between one school's (or pupil's) actual value and the 'predicted' value.

Scatterplot

When relationships between two measures on the same set of objects are to be investigated, it is often useful to plot them on a graph with one measure on the X-axis and the other on the Y-axis. Each object or individual then appears as a point on the graph, and relationships can be seen quite easily.

Standardised Score

This is the pupil's raw score put onto a different scale. Using a common scale means that standardised scores from one test can be compared with standardised scores from another test. Also, an age-allowance is included which means that pupils of different ages can be compared. Statistically, the 'average' standardised score is 100. A higher score is above 'average' and a score below 100 is below 'average'. About two thirds of pupils will have standardised scores between 85 and 115. The minimum age-standardised score for the tests used for this evaluation is 69 and the maximum is 141.

Statistical Significance

There is a statistically significant difference between two groups in some quantity if the probability of that difference arising by chance, i.e. if there were no real difference, is less than a preset value (usually five percent).

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