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Research Paper

Influences On Maltese Pupils' Mathematical Outcome: A Description Of Challenges

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Contextualisation

Initial school effectiveness research in the Maltese context, has found that pupil's mathematical attainment varies, depending on the characteristics of schools and their pupils (Mifsud, Milton, Brooks and Hutchison, 2005). Further local research is needed, given that mathematical skills, more so than literacy skills, are associated with better jobs and higher salaries (Brooks and Hutchison, 1998). Tracking pupils' mathematical progress from early on in their school career has led to ground-breaking insights into the learning gains of Maltese pupils. This involved an examination of pupils' mathematical progress as contextualized by a number of factors. These included: the introduction of ABACUS as a mathematics textbook to be used in all Maltese schools; social differences due to pupils' first language (Maltese or English) and the type of language predominantly used in the teaching of mathematics. By adjusting for a number of factors such as prior attainment and instructional behaviour, it is hoped that improved understanding concerning the practice of mathematics in Maltese schools and their classrooms, will provide useful information which may be then fed back to schools and teachers and serve as a basis for school improvement initiatives.

Abstract*: Measures of instructional behaviour are specific process indicators reflecting teacher effectiveness. The Mathematics in Primary Schools (MIPS) study poses the question of: 'How is pupil progress and teachers' instructional behaviour, within schools, related?' This is conducted by tracking pupil progress in primary school mathematics from Year 1 to Year 2 and by collating a number of contextual/process variables situated at the pupil/classroom and school levels. This paper, which adopts, a multi-stage, stratified sample, involves 1,786 pupils, 99 teachers and 40 schools, within the statistical framework of a 3-level hierarchical linear model. This paper also reports the findings of the pilot study. Although the paper is limited by the inability to use multilevel statistical techniques due to the relatively small sample size of the pilot study and, the as yet, unstandardised pupil scores on Maths 6 (NFER), the utility of this paper lies in its description of the challenges faced when engaging in school effectiveness research.*

Introduction

In the Mathematics in Primary Schools (MIPS) study, the definition of effectiveness was that of 'value-added'. Thus effective schools are those whose pupils progress more than is expected in comparison with other schools having similar types of pupil intake (Mortimore, 1991). Likewise, more effective teachers tend to be located within the more effective schools (Berliner, 1985) although this does not exclude the possibility that effective teachers may be located in less effective schools. The effect that classrooms and their teachers, as located within schools, play on pupils' mathematical progress is currently unexplored within the Maltese Islands.

At the school and classroom levels contextual factors integrate with each other, thus influencing pupils' mathematical outcome (Scheerens, 1992). As advocated by Creemers (1994), the Comprehensive Model extends this theoretical concept by showing how the aligning of contextual factors and the consistent implementation of process factors, particularly those situated at the classroom level, produce a 'synergistic effect' that impact positively on pupil outcome.

Creemers (1994) further argues that the aggregation of these factors within classrooms and the consistent proximity of these aggregated factors to pupils accounts for variations in pupil outcome. Implicit in this is that the more these factors are aligned consistently with one another, both within and across the school levels, the more educational effectiveness is fostered. This 'consistency principle' and its positive impact on pupil outcome is referred to by many researchers (Hargreaves, 1995; Mortimore *et al*, 1988; Reynolds *et al*, 1996). However, debate does exist as to whether pupil gain *is really* the result of consistency (Driessen & Sleegers, 2000). This is because it is difficult to associate the extent of these differential effects with the consistent, or inconsistent, implementation of the school and/or classroom factors known to correlate with effectiveness.

At the classroom level teachers clearly impact on pupil achievement (Scheerens and Bosker, 1997). Creemers (1994) attributes the importance of the teacher to the fact that pupils' academic outcomes are more dependent on classroom procedures and activities than on those of the school. Without the agency of the teacher, learning as a consequence of teaching and the subsequent progress, as registered by pupils, cannot be achieved (Creemers, 1997; Munro, 1999; Scheerens and Bosker, 1997). More specifically, it is the quality of teacher-pupil interaction that affects pupil progress (Caldwell and Spinks, 1993; Smith et al, 2003).

Furthermore, The Effective Teachers of Numeracy (Askew *et al*, 1997) project clearly shows that the pedagogical orientation of primary teachers for mathematics distinguishes the more effective teachers from others. In the Askew *et al* (1997) study it is teachers with a 'connectionist' orientation who are the most effective. Connectionist teachers are those who make links across the curriculum explicit. They do so with the aim of facilitating learning. These teachers are different because their beliefs tend to be firmer and connected more strongly with their practice. Hence, this suggests that the instructional behaviours of teachers are influenced by the quality of their beliefs. The theoretical framework as elaborated by Askew *et al* (1997) suggests a latent relationship between teachers' beliefs, their classroom practices and differences in pupil outcome for mathematics. This assumption is plausible in that Kyriakides (2002) and Kyriakides and Campbell (2003) similarly discuss evidence showing that teacher behaviour, teacher subject knowledge and knowledge of pedagogy, teacher beliefs and teachers' sense of self-efficacy are inter-related.

As noted by Sammons (1999), teacher effectiveness is associated with purposeful teaching. Such teachers instruct by splitting, sequencing and re-ordering the curriculum, and using questioning/feedback as monitoring tools (Mujis and Reynolds, 2001). They are also flexible in adapting their instructional practice to suit the needs of their pupils (Borich, 1996). More recently Campbell, Kyriakides, Muijs and Robinson (2004) have listed the factors associated with effective teaching. These factors include: (1) the psychological characteristics of the teacher such as personality, attitude, experience, aptitude and achievement; (2) the quality of the academic activity undertaken such as pacing of instruction, classroom management and quality of teacher behaviours; (3) the quality of lessons such as the giving of information, the asking of questions and provision of feedback; and (4) the nature of teacher beliefs and pedagogical knowledge when teaching a subject.

This paper offers an exploration of a limited range of school, classroom/teacher and pupil factors that impact on pupil outcome. In particular it offers a description of the many challenges faced during the pilot study of a large-scale effectiveness project. The ensuing discussion gives an account of the design and methods used in the pilot. The analysis of the pilot data explores the association between pupil outcome on the Maths 6 test, at the end of

Year 2 (age 6/7) and the impact that the instructional behaviour of Maltese Year 2 teachers exerts on mathematical outcome.

Design and Method

The pilot study commenced in October 2003 and ended in April 2004. The main aim of this study was to assess the suitability of the research instrumentation and to explore factors influencing pupils' mathematical outcome. Three research questions informed the pilot study: (1) Are Maltese schools equally effective for their pupils' mathematical progress; (2) Are Maltese classrooms equally effective for their pupils' mathematical progress; and (3) What teacher behaviours are linked with pupils' mathematical progress? For the purpose of this paper this last question is limited to instructional behaviours in that teacher beliefs for mathematics were piloted in a later phase of the pilot study.

The Sample

The pilot sample consisted of three sub-samples: schools, classrooms and pupils. Eight schools, 19 teachers and 355 pupils were included. Six state schools, one from each district, and two private schools (one church and one independent school) were randomly sampled. These two schools were not stratified by district because the catchment areas did not match the district boundaries. The achieved sample was made up of eight schools, 17 teachers and 338 pupils. Seventeen pupils were not given the parental consent required for participation.

Study Variables

An effectiveness study with a 3-level hierarchical design is data hungry. This demands the collating of data relating to an array of pupil-level, classroom-level and school-level data. The advantage of this is that more complex models may be employed. The disadvantage is that this entails a high degree of organisation and efficiency when collating the data.

The pilot study was successful in collating key data situated at the pupil, classroom and school levels. At the pupil level, quantitative data, was collated, for: pupil attainment, at Year 2, and on the Maths 6 test, age, gender, first language (Maltese or English), language of Maths 6 test. At the classroom level for: age of teacher, gender of teacher, first language of teacher, teacher qualifications and experience, the instructional behaviour of the teacher, the seating arrangement and the language of mathematics' instruction. At the school level for: age of head teacher, gender of head teacher, first language of head teacher and head teacher qualifications and experience. However, the pilot was unsuccessful in collating some pupil background data including: number of children in the family, age of parents/guardian, type of family and parental occupation and education. This was due to the low response rate (25%) elicited from the administration of the Parent/Guardian questionnaire.

The Research Instrumentation

Assessing the suitability of the research instrumentation is connected to the trialing of administration procedures, and, checking for the validity and reliability of the research instruments. There were two distinct phases in the pilot study. During the first phase (October to December 2003), naturalistic classroom observations were conducted and survey questionnaires administered to head teachers, assistant head teachers, teachers and parents. During the second phase (January to March 2004), a mathematics specific classroom observation tool (MECORS) was piloted; the survey questionnaires re-administered and Maths 6 test administered to Year 2 pupils. The re-administration of the survey questionnaires served to increase the user-friendliness of these questionnaires.

During the first phase of the study each classroom was observed twice. This served to explore the links between the characteristics of effectiveness such as teachers' instructional behaviour, with pupil outcome for mathematics. Each observation lasted from 45 to 90 minutes depending on the topic being covered. The same researcher took detailed notes about the classroom environment focusing on the teaching of mathematics. However the lack of variation emerging indicated that a more sensitive tool was needed.

In the second phase of the pilot study, the Mathematics Enhancement Classroom Observation Record (Schaffer, Muijs, Kitson and Reynolds, 1998), was trialed by observing each classroom more than once. Selection of this instrument was done on the basis that it focuses on instructional processes specific to mathematics. At 0.81 (sig. $p < 0.001$) between four observers, the inter-rater reliability of the Mathematics Enhancement Classroom Observation Record (MECORS) is high. Again, observations took between 45 to 90 minutes. First, the same researcher, took notes about the general classroom environment. During the mathematics lesson the researcher took specific notes relating to the instruction of mathematics, by the teacher, according to the following categories: (1) classroom management techniques; (2) maintaining appropriate classroom behaviour; (3) maintaining attention on the lesson; (4) providing students with review and practice; (4) demonstrating skills in questioning; (5) demonstrating mathematics enhancement strategies; (5) demonstrating a variety of teaching methods; and, (6) establishing a positive classroom climate.

The four survey questionnaires: The Head Teacher Questionnaire, the Assistant Head Teacher Questionnaire, the Teacher Questionnaire, the Parent(s)/Guardian(s) Questionnaire and the School Data Form were piloted between November 2003 and March 2004. The Head Teacher, the Assistant Head Teacher and the Teacher Questionnaires were piloted three times. Feedback obtained from the participants at each round was used towards updating the questionnaires. The third version of each questionnaire was piloted during March 2004. From this final round it was determined that the Parent(s)/Guardian(s) Questionnaire was overly unwieldy. Parents commented that they were asked too many questions. As a result of this, for the purposes of the main study, questions yielding data that could be obtained from other reliable sources were omitted.

The Pupil Assessment Tool took the form of the Maths 6 (NFER) test, administered during the last two weeks of April 2004. The purpose of using this test lay in assessing two research concerns: (1) whether, or not, the test was appropriate for use with Maltese Year 2 pupils; and, (2) to trial the Maltese translation of the test.

Ethical Considerations

Permission to conduct research in the state schools was obtained from the Education Division, within the Ministry for Education, and from the head teachers of the two private schools. Only 2 teachers, from the same state school, declined to participate. Parental consent was sought and only those pupils whose parents had consented took part in the Maths 6 (NFER) test. In order to minimize the effect of testing on the pupils the test was only administered between 9:00 to 12:00pm.

Analysis of the Pilot Data

The statistical strategies employed for the purposes of the pilot data included analysis of variance and regression techniques. Multilevel modelling techniques could not be used at this stage, due to the small sample of pupils, classrooms and schools involved. Therefore, the findings presented in this paper are limited, in terms of the main study design, in that they cannot adjust for the differential impact that the 3 educational levels (the pupil, classroom and school level) have on variations in pupils' mathematical progress. Above all the current analysis does not reveal whether the classroom or the school level contributes more towards variations in pupil progress. In this way the link between pupils' mathematical progress and educational effectiveness, within Malta, still remains theoretical.

First, ANOVA was employed to check for differences in the influence attributable to gender, first language and type of school. Age was not included within this analysis because age differences are implicit in that it is known that older pupils tend to score more than younger pupils. Factorial ANOVA, using a Type III model, was constructed in SPSS. Then, linear regression techniques were employed to quantify the extent of variance attributable to pupil outcome and with variables relating to age, gender, first language and type of school. Finally, another regression analysis was conducted assessing the influence of instructional variables. Pupil background and instructional variables situated were treated separately because a simple regression model cannot account for the hierarchical nesting of individuals within groups (Snijders and Bosker, 1999).

Findings

The emergent findings do offer a reasonably reliable exploration of some of the influences known to impact on pupils' mathematical outcome and offer insight as to the variables, useful for inclusion, within the multilevel analysis. Prior to discussing the influence of background variables and instructional processes, on pupils' mathematical outcome, descriptive information about the schools, classrooms and pupils is presented.

Schools

All eight participating schools used ABACUS as its mathematics scheme. This scheme is based on the direct and interactive method. The Education Division, the governmental body for education, set this textbook for all schools; state and private, in 2001. All of the pilot schools had a set timetable. In private schools the approach to timetabling was strict in that this was set by the head teacher and was to be strictly adhered to. All head teachers, except for one, were aged over forty-five (45).

Classrooms

All 17 teachers were female. The age of teachers varied, ranging from 26 to 65 years. Thirteen teachers had a Bachelor in Education degree, three were college trained and 1 had obtained a PGCE in Secondary Education. It is useful to note that the Bachelor in Education is a four-year honours degree. The University of Malta has offered this since the late 1970's. Prior to this, teachers were college-trained. This two-year training led to a Diploma in Education. None of the sampled teachers had specialised in mathematics. Each state classroom was served by an out-of-class complementary teacher, offering out-of-class support to pupils with reading difficulties and by a facilitator offering in-class support to one / two pupils with severe mental disability and/or behavioural problems.

Three types of seating arrangements were noted across the 17 classrooms. Predominant was the small group arrangement in twelve classrooms. Three classrooms had paired seating and another two had a U-shaped arrangement. Interestingly, though not surprisingly, a connection was noted between seating arrangement and the type of mathematics' tasks assigned to pupils. In seven classrooms, pupils were mainly assigned co-operative tasks. These were seated in small groups. However, in three of the 'small group classrooms' tasks assigned were mainly competitive between groups. In two classrooms tasks assigned were mainly competitive between individuals. The 'task mood' in the classrooms with paired arrangements may be described as being more competitive than when pupils worked in small groups or within the U-shaped arrangement

In terms of the language used for Mathematics instruction, language mix varied, no teacher taught using only Maltese or only English. Thirteen teachers delivered the mathematics lesson predominantly in English whilst the remaining four, all in state schools, delivered the lesson predominantly in Maltese.

Training in the use of ABACUS was problematic: from informal discussions held with teachers it became clear that they had received minimal training in ABACUS. Teachers had to familiarise themselves with the scheme and learn how to use this through their everyday classroom practice. All teachers liked best, the prescriptive elements of ABACUS as regards: learning objectives, lesson planning, detailed descriptions of in-class maths activities, resource production and on-going assessment. However, all complained that the additional work involved was excessive and 10 teachers highlighted the fact that they still did not understand very well, how to use the scheme. Interestingly, those teachers who appeared to be coping better promoted a cooperative working mood in their classrooms. This suggests that such teachers are in some ways different: perhaps in their pedagogical orientation towards mathematics.

Pupils

All pupils had attended pre-school between the ages of 3 to 5 and all pupils had, at least one parent who was Maltese. Data relating to a number of pupil/family level variables including: level of parental education, occupation type, size of family, position of pupil within the family was not obtained due to the very low response rate relating to the Parent/Guardian Questionnaire (16%, n = 57). From discussions with head teachers it emerged that the pupils in state schools usually had fathers with clerical, skilled, semi-skilled/unskilled occupations whilst pupils in private schools usually had fathers with professional, business/managerial and clerical occupations. This information aligns with the findings of the Numeracy Survey (2005).

During the week of Maths 6 testing, the average age of pupils was 6 years 7 months (79.28 months). Eighty-eight percent of pupils had Maltese as their first language. Twelve percent of pupils had English as their first language. The majority of Maltese-speaking pupils (80%) attended state schools whilst the remaining 20 percent of Maltese speaking pupils attended private church schools. All pupils attending private independent schools had English as their first language. The chi-square statistic, gave significant differences $x^2=338$, $p<0.001$, df =2 in the type of school attended (state, private church, private independent) and the first language spoken by pupils.

It is essential that a test should not discriminate between members of a group. If it did this would invalidate its purpose. Although the sample size was not large enough to statistically check for bias in Maths 6, a number of steps were taken to ensure that the choice of test suited its purpose. Using Cronbach's alpha the reliability of the Maths 6 test was found to be satisfactory at 0.89. Prior to the pilot study the suitability of using Maths 6 with the Maltese population was assessed by comparing the mathematics' topics in Maths 6, with those in the textbook (ABACUS 1). This compatibility is illustrated in Appendix 1. Furthermore, during the pilot study, notes taken during the course of Maths 6 administration provided useful insight in identifying problematic items in the test. For example, all pupils, regardless of their first language, had difficulty with items 16, 19 and 25, suggesting that these items required further scrutiny prior to the main data collation exercise.

Pupil Influences on Mathematical Outcome

Pupils' raw outcomes ranged from a minimum of 1 to a maximum score of twenty-six. With a mean raw score of 20.5 and a median of 22, this clearly demonstrates a ceiling effect. Age differences are known to affect outcome. Younger pupils usually obtain less marks than older pupils. A univariate analysis of variance (ANOVA) was conducted to analyse the relationship between raw outcome and age. The Levene statistic shows that differences in scores differ significantly by age (F=3.292, p<0.001, df = 11). As expected, older pupils score more than younger pupils and this relationship is generally linear. A description of this is offered in Table 1.

Table 1: Differences in raw score by pupil age

Age in Years and Months	Mean	s.d.	N
6.02	19.04	5.646	26
6.03	18.88	5.897	25
6.04	19.06	4.905	31
6.05	20.57	5.007	28
6.06	18.76	6.340	33
6.07	21.46	5.665	37
6.08	22.62	4.002	37
6.09	21.48	3.027	21
6.10	19.78	6.393	27
6.11	19.82	4.751	34
7.00	22.13	4.536	23
7.01	23.63	1.962	16
Total	20.50	5.254	338

Differences in pupil outcome are also attributable to gender, first language and type of school. The influence relating to type of school (η^2=0.093) is stronger than that of gender (η^2=0.020) or of first language. Furthermore differences in mean scores relating to type of school attended (F=34.308, p<0.001, df=1) and gender (F=6.859, p<0.001, df=3) are significant

Table 2: Mean scores by gender, first language and type of school

	1st Lang	School	Mean	s.d	n
Boy	Maltese	state	18.89	5.349	130
		private	22.00	3.000	17
	English	private	24.42	2.193	12
Girl	Maltese	state	19.29	5.592	108
		private	23.88	2.528	43
	English	private	24.89	1.370	28

However comparison of mean raw scores, in Table 2, achieved by Maltese and English speaking pupils reveals that English speaking pupils obtained higher mean scores than the

Maltese speaking pupils. Although differences due to first language were not significant there appears to be a mediating effect in that English speaking pupils attending private schools obtained slightly higher mean scores than English speaking pupils attending state schools. Furthermore, English speaking girls obtained, in private schools, higher mean scores than their male counterparts.

Regression analysis investigating the combined influence of age, first language, gender and type of school attended by the pupilsand shows that together these accounteds for 22% of the variance (R^2=0.224, F=24.098, p<0.001).

Table 3: Pupil influences

Variable Descriptor	**b**	**s.e**	**Beta**
Pupil age	0.324	0.079	0.199***
First language	0.840	0.524	0.080^{ns}
Gender	1.781	0.954	0.110^{ns}
Type of school attended	3.958	0.687	0.344***

The Beta statistic, in Table 3, also shows that for every month that pupils aged the raw score on the Maths 6 test increased by 0.199 of a mark. Furthermore, pupils in private schools gained 0.344 of a raw score more, on the same test, than pupils attending state schools.

Classroom Influences on Mathematical Outcome

Data yielded by the administration of the classroom observation tool MECORS (Appendix 2) was analysed using regression techniques. Results showed that the computed variables accounted for 48% of the variance in pupil outcome. However, not all variables could be included within the regression model. Forty-six (46) items showed extreme multi-collinearity. Multi-collinearity is when a perfect linear relationship between two or more predictors is elicited. In this case, this is not negative, in that this may be interpreted as the MECORS tool being underpinned by a common instructional construct. This, in fact, supports the suitability of MECORS as choice for a classroom observation tool relating to teachers' instructional behaviour for mathematics. Unfortunately, for the purposes of assessing the influence of instructional behaviour on pupils' mathematical outcome, multi-collinearity is limiting. This is, however, not unheard of, given that prior to the advent of multilevel modeling techniques (Goldstein, 2003; Raudenbush and Byrk, 2002), problems of multicollinearity were rife and constituted the analytical limitations of early school effectiveness studies. The results relating to the influence of teachers' behaviours organized by instructional category are provided in the following tables. It is important to note that only results for variables not exhibiting multicollinearity are provided. The full list of variables may be referred to in Appendix 2.

In Table 4 results relating to the influence of how teacher manages the classroom are given. The findings do show a mixed pattern of influence. For example, the minimizing of disruption in the classroom during the mathematics' lesson and ensuring that time is employed effectively, or not, from one lesson influences pupil outcome. However, the influence is not in the same direction.

Table 4: Classroom management techniques

Variable Descriptor	b	s.e	Beta
The teacher starts the lesson on time (within 5 minutes)	-0.221	0.571	-0.055^{ns}
The teacher uses time during class transitions effectively	-1.699	0.530	-0.353***
The teacher takes cares that tasks/materials are collected/distributed effectively	0.356	0.867	0.083 ^{ns}
There are no disruptions in class	.199	0.159	0.429***

Note: ns, denotes non-significance; ***, denotes significance <0.001

In fact, teachers having less disruption in class during the mathematics' lesson influence pupil outcome positively but that teachers' use of transition time is negatively related to pupil outcome. Interestingly, scrutiny of the observation notes reveals that thirteen teachers did not make use of transition time in any academic way, nor did they plan for this. However, these same teachers were adept at minimizing disruption from within and outside the classroom during the mathematics' lesson. This indicates that teachers place more emphasis on minimizing disruption, so as to secure the steady flow of the mathematics' lesson, rather than plan on using this time more effectively.

In Table 5 results relating to the influence relating to how the teacher maintains behaviour are given.

Table 5: Maintaining behaviour

Variable Descriptor	b	s.e	Beta
The teacher uses a reward system to manage student behaviour	1.738	0.145	0.554***
The teacher corrects behaviour accurately	-2.924	1.063	-0.379**
The teacher monitors the entire classroom	1.152	0.665	0.239^{ns}

Note: ns, denotes non-significance; **, denotes significance p<0.01; ***, denotes significance p<0.001

In Table 6 results relating to the influence of how the teacher maintains attention are given.

Table 6: Maintaining attention

Variable Descriptor	b	s.e	Beta
The teacher clearly states the objectives/purposes of the lesson	-0.420	0.324	-0.108 ns
The teacher emphasises key points of the lesson	1.110	0.345	0.284***
The teacher uses a brisk pace	-1.188	0.416	-0.248**

Notes: ns, denotes non-significance; **, denotes significance p<0.01; ***, denotes significance p<0.001

Maltese teachers who use a reward system have a positive influence on outcome but the influence of teachers who correct misbehaviour is negative. Though not expected, a similar finding, has been reported for maths (Mujis and Reynolds, 2000). Individuals tend to learn faster if they are reinforced for correct behaviour during learning. But, once learning is achieved, it is better, for their gains, if they are corrected intermittently. Perhaps, Maltese teachers over correct some behaviours, and this impacts negatively on pupil learning. Teachers who emphasise the main points of the lesson influence outcome positively but the relationship between a brisk teaching pace and outcome is negative. It seems that pupils do better when the pace is slower.

In Table 7 results relating to how the teachers provide pupils with review and practice is given. Whilst most of the review and practice behaviours influence significantly, in one way or another, pupil outcome

Table 7: Providing pupils with review and practice

Variable Descriptor	b	s.e	Beta
The teacher checks for understanding	-6.439	0.631	-1.401***
The teacher or students summarise the lesson	-3.190	0.642	-0.830***
The teacher re-teaches if error rate is high	3.564	0.620	1.046***
The teacher is approachable for pupils with problems	-1.446	0.481	-0.462**
The teacher uses a high frequency of questions	1.316	0.175	0.424***
The teacher asks academic mathematical questions	5.634	1.085	1.288***
The teacher asks open-ended questions	0.840	0.500	0.187ns

Note: ns, denotes non-significance; **, denotes significance p <0.01; ***, denotes significance p<0.001

Revising pupil errors when high, the amount of questions and the asking of academic questions all influence positively pupil outcome. Surprisingly, when the teacher checks for understanding, when the lesson is summarized and when the teacher is approachable to pupils, the relationship to outcome is negative. Observation notes indicate less teachers engaging in these last three behaviours with many teachers expressing that the use of these strategies slows down the pace of the lesson. However, the results in Table 7 show that Maltese teachers are probably wrong in seeking to increase the lesson pace because pupils with 'slower teachers' do better.

In Table 8 results relating to how the teachers establish a positive classroom climate are given.

Table 8: Establishing a positive climate

Variable Descriptor	b	s.e	Beta
The teacher communicates high expectations for pupils	0.374	0.175	0.137*
The teacher exhibits personal enthusiasm	0.620	0.245	0.207*
The teacher displays a positive tone	0.577	0.343	0.180^{ns}
The teacher knows and uses pupils' names	1.300	0.279	0.300***
The teacher prepares an inviting and cheering classroom	-1.190	0.349	-0.348***

Note: ns, denotes non-significance; *, denotes significance p <0.05; ***, denotes significance p <0.001

Teacher use of pupils' names positively influences pupil outcome. As expected communicating high expectations and showing enthusiasm influences outcome positively. Surprisingly, preparation of an inviting and cheerful classroom does not influence positively, pupil outcome! Once more, scrutiny of the observation notes shed further insight. Teachers with classrooms richer in displays did appear to exhibit a brisker lesson pace with less time being devoted to mathematics activities. Although the establishment of an attractive classroom environment does not appear to be directly related to outcome the findings suggest that this mediates in some way other classroom factors that impact directly on outcome.

Conclusion and Recommendations

The pilot study was successful in its objectives. It checked if the variables under scrutiny were worth investigating and it trialed the research instrumentation. Patterns emerging from the pilot findings confirm that after adjustment for age, gender, type of school attended and first language, the influence of age and type of school still accounts for close to a quarter (22%) of the variance resulting from pupil factors. This confirms that it is worthwhile investigating the differential effects of Maltese schools on pupil achievement, as this takes place between the end of Year 1 until the end of Year 2. Furthermore, given that nearly half of the variance (48%) is attributable to teachers' instructional behaviours, incorporating a deeper analysis relating to the influence of classroom factors, is necessary.

The pilot study also highlighted the need for further consideration of the following issues: (1) the 'ceiling effect' in pupil scores; (2) improvements in the questionnaire relating to the collation of pupil background data; (3) establishing inter-rater reliability for MECORS; (4) age-standardising the Maths 6 test for Malta; (5) assessing bias in the Math 6 test; (6) validating the instructional categories, in MECORS, for Malta; and, (7) assessing the possibility using structural equation modeling techniques to better illustrate the influence of instructional variables, and possibly their latent relationship, with pupil progress.

The 'Ceiling Effect' is an issue that clearly needs to be considered further. Although it is important it does not seem to be problematic in that it appears to be a local feature of pupil attainment. For example, a similar effect was elicited in the Numeracy Survey (Mifsud *et al*, 2005), in the Literacy Surveys (Mifsud *et al*, 2000) and in the Value-Added Literacy for School Improvement study (Mifsud *et al*, 2004). For the purposes of the MIPS study it is recommended that after collation of the main pupil data the severity of this effect is statistically checked so as to assess the need for transformation of the data.

Issues around pupil background d were also apparent: an improved and easier way of collating pupil/family data must be sought. Given the low return elicited during the pilot study, it is preferable if this data needs to be collated from more than one source. Furthermore, ways of integrating the retrieval of this information by incorporating them for example with the parental consent form are being sought.

In terms of inter-rater reliability, the pilot study showed that Maltese teachers do demonstrate most of the behaviours itemized by the MECORS classroom observation instrument. However, given that 99 teachers will be observed during the main study, one researcher cannot conduct this part of the data collation exercise. Thus, inter-rater reliability for this instrument must be properly established prior to the onset of the main data collation exercise.

Age-standardisation of Maths 6 was an issue as age is known to impact directly on pupil performance. It is also a fact that differences in performance due to age vary depending on the population. Thus, it is, essential that pupil scores on the Maths 6 test are standardised for the local population so that multilevel analysis of pupil progress employs age-standardised scores. The number of pupils targeted for inclusion as part of the main study should suffice for age-standardisation purposes. This will be conducted according to the Schagen (1990) methodology.

Test Bias was apparent in a number of respects. The issue of language bias within the Maths 6 test and how language bias varies (1) depending on the language of the test (Maltese or English); and (2) across the Maths 6 test items has not been resolved. Once the main pupil data is collated, logistic regression analysis employed as a differential item analytical technique employed to assess the nature of uniform and non-uniform differences in the 26 Maths 6 items between the Maltese and the English versions of the test (Zumbo, 1999).

The range of instructional variables was an issue; due to multi-collinearity issues when analysing the instructional data the relationship between instructional variables within each of the 8 instructional categories in the MECORS tool and how they group together must be confirmed. Although MIPS does not aim to cluster teacher behaviour into styles because: (1) such classifications tend to be simplistic and not replicable (Campbell *et al*, 2004); and, (2) variance within styles is far greater than that between styles (Bennett, 1976; Mortimore *et al*, 1988) it is useful, by way of reducing the data, to aggregate variables. The use of principal components analysis will ascertain the statistical validity and reliability in employing MECORS as observation tool.

Whether MIPS analysis of the main data will focus on differences in pupils' mathematical progress across teachers and across schools or between teachers across schools is still unclear. In fact this decision rests on whether it is the school or the teacher level that contributes more to the variance in pupils' mathematical progress. Should the teacher-level contribute more, towards this variance, than the school level, then a random intercepts model will show the across-teacher factors that impact differentially on pupil progress. However, should the school level contribute more towards variations in pupil progress, it would be more interesting to assess, the differences between teachers within the school groups. Should this latter scenario be the case it means the construction of a random intercepts and slopes model.

The MIPS Way Forward

MIPS has covered much ground in establishing the design and methodological framework required to set the study in motion. However, much still remains to be achieved! From the number of recommendations made, it is clear that engaging in effectiveness research is an arduous and challenging task! Fraught with logical risks and statistical hurdles! However, the pilot findings are encouraging, in that, similarly to other Maltese effectiveness studies, albeit on a smaller scale, they confirm that the mathematical attainment of Maltese Year 2 pupils varies. More importantly, this variation in outcome is influenced by the instructional behaviours of their teachers. This is a first for Maltese educational research, in that, teachers' instructional behaviours, have never been observed, less still evaluated, in any way.

More MIPS work is needed as to the development of the conceptual and policy aspects of the study. MIPS may be described as 'original' in that it aims to track one cycle of pupil progress, after adjusting for pupil background factors with effective teaching. Implicit in this is the assumption that teachers' behaviour varies and that variations in such behaviours impact differentially on pupils' mathematical progress. However, in Malta, the extent of variation in teacher behaviour still needs mapping! By mapping the teacher effectiveness territory, as defined by the value-added scores of pupils, this will establish, a conceptual framework, for educational effectiveness, specific to mathematics and for the Maltese Islands: this will help unravel a number of issues.

The issues in question include: which educational factors contribute more towards the mathematical progress of Maltese pupils; Whether school level factors contribute more than the classroom level factors, or vice-versa; To what extent teacher behaviours contribute towards pupil progress? Ultimately, it is hoped that the findings, analysis, discussion and recommendation arising from MIPS as research project will drive the improvement of educational policy in Malta. Educational policy, that spearheads school improvement initiatives, not in a crude 'league-table' manner, but in a more sensitive equitable way, whereby both the value-added, in pupil learning, and the effectiveness of schools and their teachers, are monitored in an ongoing way, both quantitatively and qualitatively, incorporating both summative and formative modes of assessment. However, how this may be practically implemented, is another story!

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Appendix 1: Pupil Responses on Maths 6

Item	Processes	Description of Item	Links with ABACUS	Correct	Incorrect	% Correct
1	MI	Simple sets	Data handling and problem-solving	329	9	97
10	MI	Simple block graph	Data handling and problem-solving	288	50	85
2	CK	Identifying 2D shapes	Shape and space	290	48	86
5	CK	Doubling	Multiply and divide	251	87	74
17	CK	Identifying 3D shapes	Shape and space	281	57	83
18	CK	Subtraction	Addition and subtraction	289	49	85
19	CK	Addition with money	Money	225	113	66
26	CK	Telling the time	Time	302	36	89
3	MA	Sharing money	Money	290	48	86
6	MA	Simple subtraction	Addition and subtraction	298	40	88
8	MA	Grouping		255	83	75
13	MA	Simple bill	Money	262	76	77
14	MA	Simple addition	Addition and subtraction	296	42	87
16	MA	Pairing	Multiply and divide	136	202	40
25	MA	Story sum	Multiply and divide	185	153	55
4	NNP	Properties of 2D shapes	Shape and space	242	96	72
9	NNP	Flat shapes odd one out	Shape and space	273	65	81
23	NNP	Size	Measurement and estimation	303	35	90
24	NNP	Straight and curved lines	Shape and space	249	89	74
7	UN	Adding on	Addition and Subtraction	271	67	80
11	UN	Ordinal numbers	Number	273	65	81
12	UN	Adding ten	Addition and subtraction	246	92	73
15	UN	In between numbers	Number	259	79	77
20	UN	Ordering numbers	Number	302	36	89
21	UN	Recognition of simple fractions	Fractions	269	69	79
22	UN	Stories of nine	Number	266	72	79

Note: MI, Mathematical Interpretation; CK, Computation and Knowledge; MA, Mathematical Application; NNP, Non-Numerical Processes; UN, Understanding Number

Appendix 2: List of Instructional Variables Organised by Instructional Category as in Part B of the MECORS Classroom Observation Tool with Minor Adaptations.

	Classroom Management Techniques	**1**	**2**	**3**	**4**	**5**
1	Rules and consequences are clearly understood by pupils					
2	The teacher starts lesson on time (within 5 minutes)					
	The teacher follows the ABACUS activities as planned					
3	The teacher uses time during class transitions effectively					
4	The teacher takes care that tasks/materials are collected/distributed effectively					
5	There are disruptions in class					
	Maintain Appropriate Classroom Behaviour	**1**	**2**	**3**	**4**	**5**
6	The teacher uses a reward system to manage student behaviour					
7	The teacher corrects behaviour immediately					
8	The teacher corrects behaviour accurately					
9	The teacher corrects behaviour constructively					
10	The teacher monitors the entire classroom					
	Focus and Maintain Attention on Lesson	**1**	**2**	**3**	**4**	**5**
11	The teacher clearly states the objectives/purposes of the lesson					
12	The teacher checks for prior knowledge					
13	The teacher presents material accurately					
14	The teacher presents material clearly					
15	The teacher gives detailed directions and explanation					
16	The teacher emphasises key points of the lesson					
17	The teacher has an academic focus					
18	The teacher uses a brisk pace					

Note: Key: 1, Never observed; 2,Occasionally observed;
3, Sometimes observed; 4, Frequently observed; 5, Consistently observed.

Appendix 2: List of instructional variables organised by instructional category as in Part B of the MECORS Classroom Observation Tool with Minor Adaptations. *Continued*						
	Provides Students with Review and Practice	**1**	**2**	**3**	**4**	**5**
19	The teacher clearly explains tasks					
20	The teacher offers effective assistance to individuals/groups					
21	The teacher checks for understanding					
22	The teacher or students summarise the lesson					
23	The teacher reteaches if error rate is high					
24	The teacher is approachable for pupils with problems					
25	The teacher uses a high frequency of questions					
26	The teacher asks academic mathematical questions					
27	The teacher asks open-ended questions					
	Demonstrates Skills in Questioning	**1**	**2**	**3**	**4**	**5**
28	The teacher probes further when responses are incorrect					
29	The teacher elaborates on answers					
30	The teacher asks pupils to explain how they reached their solution					
31	Students are asked for more than one solution					
32	The teacher uses appropriate wait-time between questions and responses					
33	The teacher notes students' mistakes					
34	The teacher guides students through errors					
35	The teacher clears up misconceptions					
36	The teacher gives immediate mathematical feedback					
37	The teacher gives accurate mathematical feedback					
38	The teacher gives positive academic feedback					

Note: Key: 1, Never observed; 2,Occasionally observed;
3, Sometimes observed; 4, Frequently observed; 5, Consistently observed.

Appendix 2: List of instructional variables organised by instructional category as in Part B of the MECORS Classroom Observation Tool with Minor Adaptations. *Continued*						
	Demonstrates MEP Strategies	**1**	**2**	**3**	**4**	**5**
39	The teacher uses realistic problems and examples					
40	The teacher encourages/teaches the pupils to use a variety of problem-solving					
41	The teacher uses correct mathematical language					
42	The teacher encourages pupils to use correct mathematical language					
43	The teacher allows pupils to use their own problem-solving strategies					
44	The teacher implements quick-fire mental questions strategy					
45	The teacher connects new material to previously learnt material					
46	The teacher connects new material to previously learnt material to other areas of mathematics					
	Demonstrates a Variety of Teaching Methods	**1**	**2**	**3**	**4**	**5**
47	The teacher uses a variety of explanations that differ in complexity					
48	The teacher uses a variety of instructional methods					
49	The teacher uses manipulative materials/instructional aids/resources (number lines, coins)					
	Establishes a Positive Classroom Climate	**1**	**2**	**3**	**4**	**5**
50	The teacher communicates high expectations for pupils					
51	The teacher exhibits personal enthusiasm					
52	The teacher displays a positive tone					
53	The teacher encourages pupil interaction and communication					
54	The teacher conveys genuine concern for pupils (emphatic, understanding, warm, friendly)					
55	The teacher knows and uses pupils' names					
56	The teacher displays pupils' work in the classroom (ample amount, attractively displayed, current work					
57	The teacher prepares an inviting and cheering classroom					
Note: Key: 1, Never observed; 2,Occasionally observed; 3, Sometimes observed; 4, Frequently observed; 5, Consistently observed.						