Research note

Mathematics in Primary Schools (MIPS): A Study of Pupil Progress and Teacher Effectiveness, for Mathematics, in Malta, during the Second Year of the Primary School

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Contextualisation

Engaging in school-effectiveness research in Malta is a relatively new activity. Initial research has found that schools do make a difference for literacy in both Maltese and English (Mifsud, Milton, Brooks and Hutchison, 2000). Further research, particularly in mathematics is clearly needed as this curriculum context constitutes both a basic skill, and an area of study, that can be related to future career prospects (Hutchison and Brooks, 1998). This research note reports the beginning of a ground–breaking study, in the Maltese context, into pupil progress in maths education and the role that teacher effectiveness may play in that progress.

Abstract: *Value-added measures are one indicator of school effectiveness. This research note poses the question of 'How are pupil progress and teacher effectiveness related?' It asks this in the context of the Maltese education system by tracking pupil progress in primary school mathematics, from year 1 to year 2, in relation to teacher instructional style and underlying pedagogical orientation. To do so it outlines a three level school effectiveness study. This will adopt a multi-stage sample involving approximately 2,100 pupils and 99 teachers based in 40 schools of different types. The study will employ the Mathematics In Primary Schools (MIPS) methodology as its working framework, informed by the view that consistency, at the school level, involves an alignment between effective instruction, the nature of the curriculum materials themselves, grouping procedures and teacher behaviour.*

Introduction

In this study effectiveness focuses on 'value-added' in that effective schools are those whose pupils progress more than is expected in comparison with schools having similar pupil intake levels (Mortimore, 1991). Similarly, effective teachers are those whose pupils' progress more than normally expected. Conceptually Mathematics in Primary Schools (MIPS), the approach discussed in this paper, is informed by the work of Carroll (1963), Scheerens (1992) and Creemers (1994).

In MIPS pupil progress and teacher effectiveness are bounded by pupil attainment on the Maths 6 (NFER) test for mathematical attainment. At the classroom level the quality of time allotted to tasks in mathematics, and opportunities for learning mathematics, are directly related to pupil mastery (Carroll, 1963). Pupil masterly, in schools, is measured through attainment at specific points in time. This study latches onto the Carroll (1963) model by gauging the time allowed by the teacher, and school, for pupils to learn mathematics; the time pupils are mathematically engaged; and the amount of time devoted towards learning the set curriculum.

Multiple measures of pupil attainment, over time, allow the gauging of progress. In turn, the nature of attainment over time, as established by pupil progress, is underpinned by the quality of teaching pupil's experience, as it happens, within the school context. MIPS is also informed by the 'Integrated Model' (Scheerens, 1992) and the 'Comprehensive Model' (Creemers, 1994), by accepting that the extent of pupil progress is affected by contextual

and process elements (Scheerens, 1992). MIPS acknowledges that the nature of pupil progress is affected by the quality of mathematics teaching and that the linkage between progress and teaching, within classrooms, is affected by factors at the school and pupil levels. In fact it is the extent of match / mis-match between the contextual and process variables across the three school levels (pupils, classes and schools) that establish the nature of effectiveness (Creemers, 1994).

Effectiveness at School and in the Classroom

Sharing of vision, a quality environment and purposeful teaching with a strong academic focus are amongst the characteristics of effective schools (Sammons, 1999). But are effective teachers only to be found in effective schools? And what is the nature of teacher effectiveness for mathematics in the Maltese Islands? In this study teacher effectiveness is constructed as being an amalgam of instructional style and pedagogic orientation.

Research shows that effective teachers instruct effectively (Muijs and Reynolds, 2001). Teaching is made explicit in that the curriculum is split, sequenced and re-ordered as necessary. Questioning and the giving of feedback are used towards the constant monitoring of pupils. Such teachers adapt their teaching to suit the academic needs of the whole class (Borich, 1996) but manage to do so in a relaxed manner (Joyce and Showers, 1988). Over and above this, effective teachers of mathematics: use realistic teaching examples; encourage the use of, and they themselves use, various mathematical strategies; use the correct mathematics terms and encourage pupils to do so; implement mental strategies and connect their lessons to previously learnt material as well as other areas of the mathematics curriculum (Muijs and Reynolds, 2001).

Other research also indicates that more effective teachers of mathematics are ‘connectionist’ in their pedagogic orientation (Askew, Brown, Rhodes, Johnson and William, 1997), although how this relates to effective instruction is still relatively unclear. Teachers with a connectionist mathematical orientation distinguish themselves from others in their pedagogical clarity. Such teachers hold the belief that teaching and learning is based on meaningful talk and that complex links across mathematical topics need to be made explicit.

The Language Issue

In the case of added pupil progress, and effective teaching, in the Maltese context the language factor cannot be ignored. In Malta, mathematics is taught in both Maltese and / or, English. However, examinations are held in English, with textbooks and workbooks also being in English. Thus the language of mathematics instruction is linked to progress, and ultimately effectiveness, through the criteria of ‘opportunity’ (Carroll, 1963). In this study the teachers’ choice relating to the language of mathematics instruction is viewed as being underpinned by the teachers’ pedagogic orientation. In Malta, the extent and nature of the language influence for progress in mathematics, as it happens within classroom and in schools, is unknown.

Design and Method

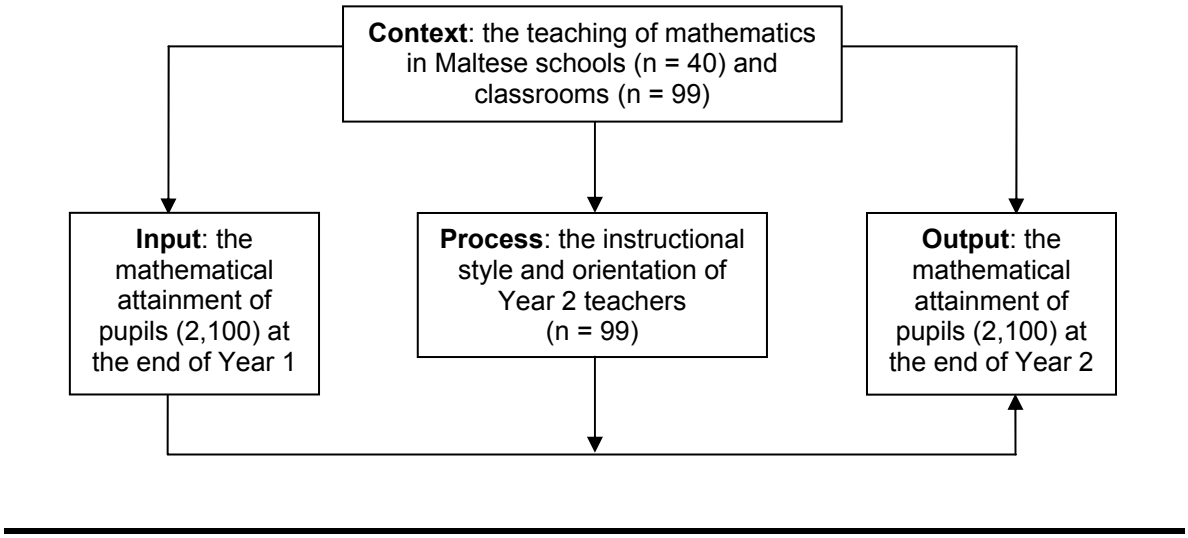
The MIPS methodology incorporates three levels of variables (*pupils* in *classrooms* in *schools*). The methodology is designed to fit in with an Input-Context / Process-Output type model (ICPO) within the school effectiveness tradition (Reynolds *et al.*, 2000). The research aim informing the study asks;

> ‘How are pupil progress and teacher effectiveness related?’

To address this question, the design of the study collates data by the tracking of pupil progress for mathematics (between Year 1 and Year 2) and by the obtaining of descriptions of the instructional style of Year 2 teachers and their pedagogical orientation. Such data allows the 'real-time' scaling of both pupil progress and teacher effectiveness. Hopefully, this should answer the more specific research questions. The first of these is to ask which, of a number of family / pupil variables, impact on pupil progress in mathematics? A further question asks which classroom / teacher variables impact on pupil progress in mathematics, and a third question asks which school / head teacher variables impact on pupil progress in mathematics.

Adopting Scheerens (1992) integrated model approach this research structure may be represented as shown in Figure 1.

Figure 1. Design of the study: the MIPS model



It will be apparent from Figure 1 that a large number of schools and pupils are involved in the research. The study is a three-level school effectiveness study. The multi-stage sample consists of approximately 2,100 pupils with 99 teachers in 40 schools (state, private church and private independent).

Pupil progress is elicited when attainment at Year 2 (output) is more than expected on the basis of attainment at Year 1 (input), after being adjusted for intervening variables (both context and process bound) at the school, the classroom and pupil levels. A list of the Family / Pupil Level variables included in the study and fitted to the ICPO model is given in Table 1.

Table 2, following, identifies the Classroom / Teacher and Teacher level variables used.

Table 1. List of Family / Pupil level and Pupil level variables included in the study

Family / Pupil Level **Input / Context-Bound Variables**	**Pupil Level** **Process / Output-Bound Variables**
Pupil age (date of birth of pupils)	Maths 5 test scores
Age of parents or guardians	Maths 6 test scores
Gender (boy or girl)	
First language (Maltese or English or other)	
Immigrant and / or refugee status	
Language (Maltese or English) of mathematics test administration (Maths 6)	
Type of family	
Number of children in the family	
Position of child in family	
Father's occupation	
Mother's occupation	
Father's education	
Mother's education	
Special educational pupil requirements	
Private tuition in mathematics	

Table 2. List of Classroom / Teacher and Teacher level variables included in the study.

Classroom / Teacher Level **Input / Context-Bound Variables**	**Teacher Level** **Process / Output-Bound Variables**
Age of teacher	Wall and table mathematics displays
Gender of teacher	Seating / classroom layout
First language of teacher	Time on mathematics task
Predominant language of instruction	Curriculum cover
Teacher qualifications and experience	Predominant instructional style of teacher
Recent training in mathematics	Teacher beliefs about what it is to be
Specialisation in mathematics teaching	Teacher beliefs about how pupils learn to become numerate
Specialisation in early years teaching	Teacher beliefs about how best to teach pupils to become numerate

Table 3, below, lists the School / Head and Assistant Head Teacher, and Head Teacher level variables to be included in the study, using the ICPO model.

Table 3. List of School / Head and Assistant Head Teacher and Head Teacher level variables included in the study.

School / Head and Assistant Head Teacher Level Input / Context-Bound Variables	**Head Teacher Level Process / Output-Bound Variables**
Age of head teacher / assistant head teacher	Head teacher beliefs about what it is to be numerate
Gender of head teacher / assistant head teacher	Head teacher beliefs about how pupils learn to become numerate
First language of head teacher / assistant head teacher	Head teacher beliefs about how best to teach pupils to become numerate
Language policy of school	
Qualifications and experience	
Recent training in mathematics	
Specialisation in mathematics teaching	
Specialisation in early years teaching	

The Sample

The study employs a multi-stage sample because it must reflect the complex social, and educational reality, to be found in schools as noted by Teddlie and Stringfield (1993). The sampling framework consists of state schools which are first sorted by type, than district, than size, and where applicable, by gender.

The Research Regime

The MIPS research instrumentation and its order of use is summarized in Table 4 below. This table summarizes the phases of data collection, the nature of the analytical approach to be applied to the data in each phase and the specific research instrument(s) to be used to gather the data in question. It is also a parallel mixed-method study in that both qualitative and quantitative measures are collated in tandem during (2004/05).

Table 4. Summary of the MIPS research instrumental and analytical approaches

Phase of Data Collation	Nature of Inquiry	Research Instrument
Phase 0 – Numeracy Survey for the Maltese Islands. Testing of pupil attainment for mathematics at the end of Year 1	Quantitative	Maths 5
Phase 1 – 1st round of classroom observation for MIPS	Quantitative / qualitative	
Phase 2 – 2nd round of classroom observation for MIPS	Quantitative / qualitative	
Phase 3 – Administering of survey questionnaires to head teachers, assistant head teachers, teachers and parents	Quantitative / qualitative	Head teacher questionnaire; Assistant head teacher questionnaire; Teacher questionnaire; and, Parental consent form with parent questionnaire
Phase 4 – Testing of pupil attainment for mathematics at the end of Year 2	Quantitative	Maths 6

This is achieved by, first, administering Maths 5 (NFER, 1999a) to all Maltese pupils (5,250) at the end of Year 1, and second, by conducting classroom observations at two points in time with 40% of the original Year 1 sample. In addition further data will be gathered by administering questionnaires to head teachers, assistant head teachers and teachers and, lastly, by administering Maths 6 (NFER, 1999b) to 40% of the original pupil cohort at the end of Year 2; thereby creating a database of 'before-and-after' data for the estimation of pupil progress and an 'in-between' database supporting the description and scaling of teacher effectiveness.

The Way Ahead

This study views the linkage between progress and effectiveness as being complex in nature, and constituted, as if in a mixture, by both contextual and process variables. Broad aspects of school effectiveness include commonality of vision, a quality environment and purposeful, focused teaching (Sammons, 1999). A number of authors have identified particular aspects of teacher effectiveness in the classroom. These include: teaching style (Borich, 1996; Joyce and Showers, 1988; Muijs and Reynolds, 2000; Scheerens, 1992), and teachers' mathematical orientation (Askew *et al*., 1997).

The Creemers (1994) framework offers an opportunity whereby the progress of Maltese pupils, in classrooms as led by teachers in schools, may be operationalised. The comprehensive model for educational effectiveness identifies the importance of consistency of educational perspective as follows:

> "Consistency at the context level means that conditions for the school level (and the classroom level) related to curricular materials, grouping procedures and teacher behaviour are in line with each other." (*ibid,* p 102)

At the process levels of the school, and the classroom, effectiveness characteristics are defined by Creemers (1994) as follows:

> "Consistency: at the school level, conditions for effective instruction related to curricular materials, grouping procedures and teacher behaviour are in line with each other." (*ibid,* p 102)

Integrating Creemers (1994) model and the MIPS design, and methodology, requires further elaboration, particularly as regards hypotheses. Currently, it is hypothesized that effective schools (as established through added pupil progress) will host a majority of effective teachers (Berliner, 1985). By extension it is also hypothesized that more effective teachers are more likely to be found in schools that reflect their particular pedagogical orientation and instructional style.

However, as yet this is still a matter of assumption, for, what needs to follow is: an extension of the comprehensive model to accommodate pedagogic perspective - in this instance for teacher orientation towards mathematics; an analysis of how the 'consistency principle' emerges from the pilot study, and how this emergent understanding may be used to link with other school / classroom based elements model. This is my current research focus.

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