'HOW APPROPRIATE IS THIS TASK FOR MY CLASS?' EXPLORING TEACHERS' CLASSROOM DECISION-MAKING PROCESSES AS THEY WAVER BETWEEN 'PRACTICAL' AND 'IDEAL' POSITIONS

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Abstract – *This paper is based on a qualitative study that explored the classroom assessment practices of twelve mathematics teachers in a Maltese sixth form college. As part of the data gathering process, these teachers were presented with four tasks (which varied along a continuum from the traditional examination-type to the non-traditional type) and were asked to comment about the appropriateness of using them inside their classroom. The analysis revealed that teachers' task selection largely reflects what they consider 'to work within their context' rather than what they consider as 'ideal'. Three levels of context that influence, both on their own and interactively, the way in which teachers make their classroom decisions were identified. These are the national, school and personal contexts.*

Situating the paper within teacher thinking research

The term 'teacher thinking', albeit used fairly loosely by educational researchers, 'has come to unite a body of research which, although starting from a variety of different backgrounds and focusing on diverse educational issues, has a common concern with the ways in which knowledge is actively acquired and used by teachers and the circumstances that affect its acquisition and employment' (Calderhead, 1987, pp. 4-5). It is particularly relevant here that the 'teacher thinking movement', which started in the 1970s, has created a view of teachers as conscious 'decision makers' (see Clark, 1986; cited in Korthagen & Kessels, 1999). This encourages us to recognise teachers as active agents in the development of their own practice, as decision-makers using their specialist knowledge to guide their actions in particular situations, and underlines the autonomous and responsible aspects of teachers' work (Calderhead, 1987). The recognition of teacher agency, which 'is based on relationships teachers make between personal meanings, their work and their acquisition of new ways of teaching' (Sawyer, 2001, p. 40), opposes the traditional perception of teaching as the mastery of a series of effective teaching behaviours that can be observed, measured and quantified at will. Teacher thinking research consequently acknowledges the inadequacy of logico-deductive methods (i.e., research that is

mainly based on measuring a predetermined set of variables to test hypotheses through complex statistical techniques) for capturing the spontaneity and complexity of teachers (Cole, 1997), and recognises the need for more qualitative data gathering processes (Day, Pope & Denicolo, 1990). As it is guided by a more integrated notion of teacher thought and action (Cole, 1997), teacher thinking research has shifted the focus from studies on teacher behaviour to studies on teacher thought processes (Fang, 1996).

The findings presented in this paper form part of a more comprehensive study in which I explored the classroom assessment practices of twelve sixth form teachers teaching pure mathematics at Intermediate Level[1] (see Buhagiar, 2005). I will however limit myself here to gaining insights into teachers' decision-making processes during the planning stage as they ponder about the appropriateness for classroom use of different forms of tasks. When I speak of 'decisions at the planning stage', I include both the thought processes that teachers engage in prior to classroom interactions as well as the thought processes or reflections that they engage in after classroom interactions (Fang, 1996). Being mostly concerned with the decision-making phase, I am particularly interested in shedding light on the reasons that motivate teachers to select their classroom tasks rather than in evaluating the effectiveness of these choices. Put differently, I am 'not so much striving for the disclosure of 'the' effective teacher, but for the explanation and understanding of teaching processes as they are' (Halkes & Olson, 1984, p. 1). In line with teacher thinking research, my concern with how teachers cope with the complexities of their teaching-learning situations translates itself in 'trying to understand and interpret ways in which teachers make sense of and adjust to and create the educational environment within their schools and classrooms' (Pope, 1993, p. 22).

Teachers as decision-makers inside classrooms

Each day, teachers make thousands of choices that reflect a constellation of forces and processes (Sawyer, 2001). But whilst the degree of decision-making power held by teachers varies widely, depending on the type of power and activities examined, teachers enjoy the highest levels of autonomy over instruction inside the classroom (Ingersoll, 1996). They are in fact autonomous to take decisions in the classroom based upon their view of what is in the best interest of the student (Day, 1999). Teachers' decision-making power however remains relative as 'Schools are marked by a 'traditional influence pattern' in which decisions are differentiated by locale and position … administrators making strategic decisions outside of classrooms and teachers make operational decisions

inside classrooms' (Conley, 1991, pp. 237-238; cited in Ingersoll, 1996). As teachers make many decisions inside classrooms and do so quickly, often with little time for deliberation (Hargreaves, 1993), it may become hard for them to reflect-in-action (i.e., during instruction). On the other hand, teachers may find more time to reflect-on-action once outside the classroom. However, both reflection-in-action and reflection-on-action are necessary conditions for teacher learning, and are vital elements in teachers' professional development (Day, 1993b). At the same time, although we know that teacher reflection is linked with the decision-making process, 'We do not know very much … about how it is that teachers make decisions based upon reflection' (Day, 1993a, p. 137).

As classrooms are busy places in which teachers face complex situations and competing demands, teaching decisions are often a compromise amongst costs and benefits (Calderhead, 1987). Teacher 'practical deliberation' – which Wiggins (1978; cited in Clark & Yinger, 1987) describes as 'a process of searching for an 'adequate specification' of the situation, a constant re-making and re-evaluation of concerns, an evolving conception of the point of acting, and a reciprocal relation between the agent and the world' (p. 100) – is thus an important component of the decision-making process. At issue is the understanding that 'Better decisions tend to be made when the person making the decision considers the consequences of the decision in advance of actually making it' (Anderson, 2003, p. 148). In the process of making practical decisions, teachers formulate alternative problems and solutions – a process that actively involves their curriculum orientations or values (Hannay & Seller, 1990). In particular, teachers' planning and decision-making are governed by what they know about teaching, learning and curriculum, and about the manifestations of these phenomena in classroom events (Carter & Doyle, 1987).

Along similar lines, Wilson, Shulman & Richert (1987) maintain that teachers draw upon many types of 'prior knowledge' when making decisions. In particular, they mention: (i) teacher's *content knowledge* that includes their understanding of the facts or concepts within their subject domain, as well as their grasp of the structures of the subject matter; (ii) teachers' *knowledge of educational aims, goals and purposes*; (iii) teachers' *knowledge of other content*, that is, knowledge that is not directly related to the discipline they are teaching; (iv) teachers' *general pedagogical knowledge*, that is, knowledge of pedagogical principles and techniques that is not bound by topic or subject matter; (v) teachers' *knowledge of learners* that includes knowledge of student characteristics and cognitions, as well as knowledge of motivational and developmental aspects of how students learn; and (vi) teachers' *curricular knowledge*, that is, their understanding of the programmes and materials designed for the teaching of particular topics and subjects at a given level. But then, in certain cases, teachers' classroom decisions

may be driven by the logic of classroom management (e.g., keeping students busy at work) rather than by the logic of content (e.g., presenting students with meaningful experiences) (Carter & Doyle, 1987).

The varied knowledge base upon which teachers base their decisions, apart from pointing towards the complexity of classroom practice, makes it also possible

> '… to recognise, for instance, that the knowledge teachers use in planning is highly specific, relating to particular children, school contexts or curriculum materials; to recognise that planning also involves issues of values and beliefs; to recognise that much of the knowledge that teachers use can only have been abstracted from lengthy experience … .' (Calderhead, 1993, p. 15)

Teachers' decisions are moreover based on a simple yet deeply influential 'sense of practicality' – they have a powerful sense of what works and what doesn't for 'this' teacher in 'this' context (Hargreaves, 1994). This renders their decision-making processes inherently situated. Their 'situational appreciation' – which is characterised by the ability to bring 'to bear upon the situation the greatest number of genuinely pertinent concerns and genuinely relevant considerations commensurate with the importance of the deliberative context' (Wiggins, 1978, pp. 146-147; cited in Clark & Yinger, 1987) – consequently represents one of the keys to teachers' practical deliberation. Likewise, teachers' 'situational understanding' plays a fundamental role during the planning and decision-making processes (see Elliott, 1993). This situational understanding develops as teachers initially discriminate and then synthesise the practically significant elements of a situation into a unified and coherent picture of the whole. By so doing, teachers create from their understanding of concrete and complex practical situations a holistic picture that is meaningful for them. Notwithstanding this, 'Teachers' classroom decisions usually are not 'once and for all'. Rather, they are made incrementally and adjusted on the basis of subsequent information' (Shavelson, Webb & Burstein, 1986, p. 77; cited in Fang, 1996). In other words, as an individual's understanding of his or her situation may change over time, nothing is beyond question or can be taken for granted (Elliott, 1993). It so appears that teachers' decisions and situational understanding are two ongoing and highly interactive processes that inform and influence each other:

> 'In reflecting in action the practitioner is observing the situation as (s)he participates in it. (S)he is gathering evidence, analysing it and synthesizing his/her insights in a form which inform his/her subsequent decisions. These in turn change the situation in ways which reveal previously hidden

> dimensions of the situation that are significant for practice. … [Thus] reflection not only informs decision making but decision making informs reflection and is an integral component of an inquiry which aims to develop situational understanding.' (Elliott, 1993, p. 69)

The success of this interactive and reciprocally illuminative coexistence between teachers' situational understanding and decision-making processes clearly depends on the acclaimed notions of reflection and reflective practice by teachers. But even though 'reflective teaching offers promise of an alternative conceptualisation that appropriately recognizes the thoughtful and professional aspect of teachers work' (Calderhead & Gates, 1993; cited in Cole, 1997), schools still do not encourage or support reflective practitioners or reflective practice (Cole, 1997).

Presenting the tasks

The American National Council of Teachers of Mathematics (NCTM) (1995), which defines 'task' as 'An authoritatively specified or assigned, purposeful, contextualized activity' (p. 91), strongly recommends the use of 'mathematically significant tasks'. 'These activities provide all students with opportunities to formulate problems, reason mathematically, make connections among mathematical ideas, and communicate about mathematics' (NCTM, 1995, p. 11). This is in line with current learning theories that configure the teacher's role as that of helping students find, create and negotiate their meanings by providing them with meaningful and purposeful activities from the students' perspective (Murphy, 1996). Classroom tasks need to be 'authentic' – in the sense that they make explicit links between school learning and out-of-school practices – if they are to facilitate the development of students' understandings into knowledge that can be applied in real-life contexts (Murphy, 1996). Moreover, 'The assessment tasks that a teacher selects will send clear messages to students in the class … about what parts of mathematics are important to learn' (Bryant & Driscoll, 1998, p. 34). All this shows how critical is the choice of task for achieving the learning goals (Black, 1998). The teacher's role as a task selector clearly carries with it great responsibilities that call for a skilled and multi-dimensional foresight on his or her part, including reckoning with constraints of time, of facilities, and of the starting-point of the pupils (Black, 1998).

Black (1998) points out that any task can be specified to students in a variety of ways. For instance, he suggests that the degree to which the task is left open or closed can be varied by defining more or less clearly the nature of its outcome. Whilst closed tasks are linked to standard textbook questions, school-learned

methods and rules (i.e., tasks that encourage the development of procedural knowledge in students), open tasks are linked to practical and investigative work that requires students to make their own decisions, plan their own routes through tasks, chose methods, and apply their mathematical knowledge (i.e., tasks that encourage the development of conceptual knowledge) (Boaler, 1998). Moreover, closed tasks, which typically only have a single correct answer (i.e., close-ended), have a high element of scaffolding (i.e., closed-middle) built in them so that the task structure itself leads students towards a solution through known algorithms and procedures. On the other hand, open tasks, which are typically not tied to one correct answer (open-ended), are either less scaffolded or unscaffolded (open-middle).

Black & Wiliam (1998) refer to a scheme developed by Dumas-Carre & Larcher in 1987 that can be used to produce a comparative and descriptive analysis of tasks:

> 'This scheme distinguished tasks which (a) presented a specific situation identical to the one studied, or (b) presented a 'typical' problem but not one identical to the one studied, requiring identification of the appropriate algorithm and its use, rather than exact replication of an earlier procedure as in (a), and (c) a quite new problem requiring new reasoning and construction of a new approach, deploying established knowledge in a new way.' (pp. 31-32)

Clearly, as one moves from (a) to (c), the level of student thinking involved in working with such tasks evolves from lower level (characterised by mere recall of factual information) to higher level (characterised by the application, analysis and synthesis of factual knowledge in order to solve new problems). It may be that the thinking level demanded by a task is inversely proportional to its classroom use because, as Carter and Doyle (1987) point out, higher order tasks are rarely given in class. And when potentially demanding tasks are set, teachers avoid classroom conflicts by 'redefining or simplifying task demands' (Doyle, 1988). This teacher reluctance to spend time on what are basically nonroutine activities characterised by conceptual understanding, explorations, construction of meanings and invention results from their perception (which is often correct) that these are irrelevant to students' examinations (Goldin, 1992).

To explore what teachers consider to be appropriate tasks for classroom use, I presented the twelve participants in the study with a set of four tasks that I picked (and adapted in one case) from various sources (see Appendix I). Basing myself on deliberative theory, according to which curriculum decisions involve generating alternatives and selecting an alternative based on reasoned judgement (see Reid, 1978; cited in Hannay & Seller, 1990), my idea was to gain insights into

teachers' reasoned judgements or decision-making processes as they 'juggle' with my four pre-selected alternatives or tasks. Moving from Task 1 to Task 4, the nature of the tasks evolves along a continuum from the traditional examination-type to the non-traditional type. In particular, Task 1 and Task 2 may be described as 'routine' or 'traditional examination-type' tasks, with Task 1 being close-ended and highly scaffolded, and Task 2 being similarly close-ended but less highly scaffolded. On the other hand, Task 3 and Task 4 are 'nonroutine' tasks. Whilst both are unscaffolded, Task 3 is close-ended and Task 4 is open-ended. In addition, Task 1 and Task 2 may be categorised as lower order tasks as they only require lower level thinking from students, whilst Task 3 and Task 4 are higher order tasks as they require higher level thinking from students.

Gathering and analysing the evidence

The teachers in the study (which spread over three years of fieldwork) taught the Pure Mathematics at Intermediate level (PMI) option in a Maltese sixth form college. Albeit not all of them had teaching qualifications, all were mathematics content specialists of at least first-degree level, and represented a reasonable good mix with regards to gender, age and teaching experience. A case study methodology was chosen as it offered me 'a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. Anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon' (Merriam, 1998, p. 41). I worked within a reflexive research framework, viewing the research design as a reflexive process that operates throughout every stage of the project. Within my emergent and integrated research design that draws on ethnographic principles, the data collection, hypotheses construction and theory building were not three separate phases, but were interwoven into one another. Whilst in the field, I utilised the complete set of qualitative data collection methods mentioned by Patton (1990), namely: (i) in-depth, open-ended interviews (I interviewed each PMI teacher individually on three different occasions); (ii) direct observations (I kept a 'research journal' in which I recorded observations, both inside and outside the classrooms, together with my reflections); and (iii) written documents (both official and personal ones).

The evidence reported here is however limited to parts of the semi-structured interview (see Merriam, 1998) in which the participants expressed their views about the appropriateness of the four tasks for classroom use. The interpretations, though, are embedded within and reflect my knowledge and analyses of the wider research data. Seeing the interview as 'a purposeful conversation … between two

people … that is directed by one in order to get information' (Bogdan & Biklen, 1982, p. 135), I presented the teachers during the third and final interview with the four tasks, each on a separate size A4 paper. After allowing them ample time to read through all the tasks, to reflect and to ask for any clarifications, I invited the teachers to share with me their thoughts. I was particularly interested to learn whether and how they would consider using these tasks in their classrooms, and to understand the motivations behind their decisions. Typically, the teachers indulged in both singular and comparative analysis of the four tasks, often citing factors within their teaching environment to explain their positions. More importantly, our conversations often served as a catalyst for broader insights, well beyond the specificity of the four tasks themselves, into what PMI teachers consider as appropriate classroom tasks from both 'practical' and 'ideal' perspectives.

Every effort was made in the study to follow the canons of qualitative research. First, I tried as a researcher to act in ways that are ethically acceptable. In particular, I strove for a research relationship with each teacher (all names are pseudonyms) that underlines 'respect for the rights of the individual whose privacy is not invaded and who is not harmed, deceived, betrayed or exploited' (Burgess, 1989, p. 60). Second, I was concerned that the meanings and perceptions of the teachers are allowed to emerge. Thus, once the interviews were recorded and transcribed fully, the participants were encouraged to go over their transcripts and to make any alterations they wished. However, my initial efforts to submit the analysis of the data to the teachers in order to check the interpretations made and to generate further insights (see Broadfoot, 1996) had to be discontinued once I realised that the participants were primarily interested in identifying 'who was saying or doing what'. Finally, although in the field there is no definite point at which data collection stops and analysis begins (Patton, 1990), I started my data analysis proper (i.e., when, after sensing that I had tapped all the available evidence, I felt the need to organise it and to start making sense out of it) by reviewing (through reading in most cases) and reflecting upon the various data sources collected during the study. As I immersed myself within the data, literally months on end, I began coding into what I am calling 'units of meaning'. During this process, I attached my initial isolated meanings and understandings to the interview transcript phrases and sentences, observational notes and the documentary sources. As the units of meaning began to pile up from this cocktail of evidential sources, I gradually started to notice new links and meanings within and amongst the different data sources. As a result, localised meanings began evolving into more general themes. These new and deeper understandings eventually led to my data interpretation proper.

The 'wishes', 'ifs' and 'buts' of teachers' decision-making

In line with Calderhead's (1993) observation that the knowledge that teachers use in planning is highly specific, the analysis of the data suggests that context related factors play a major motivational influence on teachers as they deliberate and decide upon the appropriateness of particular tasks for classroom use. The word 'context' is used here in a wide sense to include the national (e.g., external assessment system) and the school (e.g., contact time with students) contexts, as well as the teachers' personal 'conceptual context' (see Grossman & Stodolsky, 1999). This wide definition permits me to include teachers' values (e.g., the type of tasks they consider worthwhile) and beliefs (e.g., their views about students) as an integral component of the 'context' in which they operate. I have divided the results and interpretations into two sections. In the first section, I analyse the participants' reactions to the four tasks and summarise their subsequent decisions. In the second section, I adopt a more holistic perspective to explore the contextual underpinnings that help explain their 'reasoned' decisions

(i) Teachers' reactions and decisions

Most teachers tended to classify the four tasks under two general categories. That is, those similar to the work they normally set in class, namely Tasks 1 and 2, and those that are different, namely Tasks 3 and 4. By doing so, the teachers pushed the ensuing discussion towards the two far ends of the routine-nonroutine task continuum rather than along its full stretch as I had originally intended when selecting the four tasks. This unforeseen dichotomisation channelled our discussions and my subsequent interpretations strongly within the realities of their work environment. Andrew expressed this 'crude' task division very clearly:

> *Tasks 1 and 2 … (at least the 'usual' parts of Task 2) … are very much related to what we do in class … but this does not apply to Tasks 3 and 4!*

This typical comment indicates the pervasive use within PMI classrooms of closed, routine, examination-type tasks that normally do not require students to go beyond mere factual recall of procedures learned previously in class – a reality that echoes Carter and Doyle's (1987) assertion that higher order tasks are rarely given in class. It thus appears that, according to the scheme developed by Dumas-Carre and Larcher (see Black & Wiliam, 1998), PMI students are being exposed to tasks reminiscent of categories 'a' and 'b', but not 'c'. This practice (which is likely to encourage students to develop procedural, rather than conceptual, mathematical knowledge) goes against the current emphasis on the application of tasks that are

mathematically significant (see NCTM, 1995) and authentic (see Murphy, 1996). These are tasks that facilitate the development of students' mathematical understandings into outside classroom usable knowledge. Basing myself on teachers' task specific comments (which I have summarised hereunder), particularly with regards to their usability inside classrooms, I tend to think that this situation is very unlikely to change in the foreseeable future unless the 'context' in which teachers operate evolves into a 'more permitting' one.

TASK 1: Describing the task as 'typical', 'normal', 'standard', 'traditional', and even 'classic', the teachers unanimously commented that it is appropriate for various classroom functions, be it classwork, homework or class tests. Their positive reception was invariably linked to the notion that this task 'fits the system'. They argued that Task 1 is a worthwhile classroom activity as it:

- is the method type (i.e., once students identify the correct method, the solution follows without difficulty) and is well structured (i.e., the task structure itself guides students towards the solution);
- serves good practice (being so typical of textbook and examination questions) to prepare for the examination ;
- integrates two mathematics topics (i.e., Partial Fractions & Integration) – something that they value highly.

Although all the teachers spoke in favour of using Task 1, I could notice however that their favourable comments still sounded exceedingly 'dry'. Not only did they speak very briefly about Task 1, at least when compared to the other tasks, but also without much 'enthusiasm'. Above all, I sensed nothing more than 'routine acceptance' on their part. This is how Ray transmitted this feeling:

> *There's really nothing much I could say about it … it's quite simple and fair … there are no tricks involved … I think it's OK.*

TASK 2: The teachers generally agreed that this task could be used with PMI classes, especially if some of its parts are either adapted or eliminated. Their suggestions as to how it can be made more appropriate for classroom use included:

- not to replicate information, as this may confuse students (i.e., to give the volume either as 'half a litre' or '500 cm^3', not both);
- make the task more 'direct' by asking students to 'minimise the surface area';
- removal of diagram (considered too childish with 16+ students);

- not to require students to state their 'assumptions' and to discuss the 'shape of the can' (things that could however be discussed informally in class).

To justify their proposed changes, the teachers argued that their students would have difficulty understanding long descriptive tasks written in English. They also pointed out that examination questions are usually very direct and do not require students either to state assumptions or to analyse particular shapes. For certain, their suggestions presented a strategy to make Task 2 'fit the system' by rendering it more traditional or routine. Mario helped me to understand this point:

> *If you had to remove the complications of the 'assumptions' and the 'shape discussion' bit, Task 2 would become a normal, run of the mill problem … then you could even use it in a class test.*

A few teachers did appreciate however that the task, as presented, encourages students also to think as opposed to merely recalling and using 'past' information. But these teachers, even though they saw this as a desirable outcome, still expressed fear that the original task would be 'too much' for their students. Indeed, they concurred with their colleagues that, to render the task more appropriate, it should be stripped of its 'thinking' parts before it is presented to students.

TASK 3: This activity was highly acclaimed by most teachers. For instance, Andrew argued that Task 3 not only informs the teacher about how students think, but also helps students to develop their mathematical thinking. But some teachers again expressed doubts about their students' ability to tackle such descriptive tasks in English. As the teachers read through the task and started considering ways in which it can be tackled, it became invariably apparent that this task presented a 'real' challenge to both their students and themselves. Carmel elaborated on this feeling:

> *I sincerely think that if I had to give my students something like this, I would first have to think quite a lot myself before even I could work it out!*

The need for teachers to actually 'think' before proceeding with the solution places this task apart from the routine ones that they normally present to their students. Indeed, routine tasks need hardly stretch the students themselves more than the barest minimum before they establish and follow some well-known 'solution procedure'. In other words, typical classroom tasks hardly require any real thinking from students, let alone teachers. Ironically, in spite of its many recognised merits, the teachers seemed unwilling to use it extensively in their classrooms. They claimed to consider using similar tasks very occasionally at

best, and only as basis for teacher-led classroom discussions. Unlike Task 2, not only does Task 3 not fit within the system, but the teachers also appeared unable to come up with any suggestions of how to make it fit. This 'failure' to adapt Task 3 to fit the system may well explain why most of them claimed to prefer excluding similar tasks from their practice.

TASK 4: Most teachers described Task 4 as interesting and challenging, and also acknowledged that this task would stimulate students to think mathematically. Notwithstanding this, only a few of them said that they would consider using similar tasks, even if only occasionally, with their PMI classes. There was also a general consensus amongst these few that should such a task be used in class, it would have to be during a teacher-led classroom discussion. A couple of teachers remarked that there was 'something missing' in the task, namely that no measurements had been provided. These teachers argued that measurements should be added, as students would otherwise have problems in dealing with it. Renzo had this to say:

> *I find Task 4 a little ambiguous! Even if you've told them that the tent must be big enough for two adults to sleep in, what can students do without any measurements?*

As with Tasks 2 and 3, the suggestion to add 'measurements' appears to be an attempt on teachers' part to rewrite the task in a more traditional 'teacher-and-student-friendly' form. The intention here was probably to downsize the 'uncertainty' of this unscaffolded and open-ended activity (i.e., all reasonable answers are judged to be correct) by turning it into a close-ended one (i.e., only one specific answer is correct).

(ii) Understanding teachers' decisions from a contextual perspective

The reactions and decisions reported above show a clear teacher preference for the application of the more traditional tasks inside classrooms. In particular, it appears that the further a task moves away from the traditional end of the routine-nonroutine continuum, the lesser is the likelihood that teachers would want to use it. It was further noted that teachers, whenever possible, tend to 'reformulate' tasks through small alterations – their way of 'saving what is saveable' in an effort to render tasks less nonroutine and thus more acceptable for classroom use. Teachers' efforts in this direction cannot however be taken as an indication of what they consider to be the 'ideal' task Indeed, with so many contexts influencing the choices that teachers make in relation to practice (Sawyer, 2001), their decisions

are often characterised by compromises (Calderhead, 1987). More than anything else, it seems that teachers tend to decide and act in a very context conscious manner. The present analysis has identified in fact three levels of context that influence, both on their own and interactively, the way in which teachers make their classroom decisions. These are the national, school and personal contexts.

The National Context: The study data suggests that teachers' selection of classroom tasks is influenced by outside school factors (which in Malta, given its size and still essentially centralised educational system[2], are frequently national ones). The single most pressing influence amongst them is external assessment that, in the case of the PMI option, consists of a summative examination characterised by routine questions. Such questions – which are usually scaffolded and certainly close-ended – tend to be easily identifiable either within a specific syllabus topic or a number of topics with 'well-established' links. This structure generally directs students towards a 'known' solution procedure from a range of class-taught ones. This is how Rita crystallised this widespread link between external assessment (read 'examination') and teachers' perception of task appropriateness for classroom use:

> *I would use Tasks 1 and 2 as they are examination-type questions … using them would serve as good practice for the examination … The fact that I have never seen questions in an examination paper like Tasks 3 and 4 holds me back from using them in class.*

One teacher even declared a 'resistance' to dealing with tasks that are not directly linked to the examination. Angelo said:

> *I only make use of MATSEC examination-type questions in class … when students ask me about questions that are not this type, I tell them to forget all about them. There's no point in working them!*

With most teachers, a task (just like Tasks 3 and 4) that fails to satisfy the canons of traditional examination questions gets automatically excluded from the classroom. This exclusion is better understood once one appreciates that in Malta, where 'a failure in exams is almost always judged as a failure of the family' (Calleja, 1988, p. 32), examination success is considered crucial. Suffices to say that although all the participants spoke very appreciatively of the benefits of higher order thinking tasks, many of them remain unwilling to use them. That is, at least until external assessment (or the 'system', as Matthew put it) starts reflecting such levels of thinking. Renzo, like some others, admitted to using nonroutine tasks only just then:

Once examinations start including similar questions, we would then include them in class, as there are many positive things that we can get out of them.

But it still does not appear that things would 'really' change by simply introducing higher level thinking questions in external examinations. The externally set PMI syllabus was in fact identified by a number of teachers as a limiting factor on their task selection. Claiming that the syllabus is 'vast' and 'time consuming', these teachers argued that the use of nonroutine tasks, however mathematically worthwhile, would take too much of their limited classroom time and would risk syllabus coverage. Matthew spoke firmly against this possibility:

Task 3 would take up a whole lesson … that's just not possible! We must keep in mind that there's a syllabus to be covered … with such investigative questions, however much they stimulate students to think, we would end up covering only half of it.

Some teachers also referred to their 'disaffection' with the Ordinary Level mathematics syllabus to explain their classroom exclusion of nonroutine tasks. A rather common view held amongst the participants was that the secondary mathematics syllabus does not equip students well enough to face the higher intellectual demands of the more open tasks. Secondary school mathematics is seen to fail students both with regards to the manner in which it accustoms them to do mathematics and the inadequacy of its content knowledge. Andrew elucidated the effects of the first point:

Students are accustomed to work things out by using some formula or recipe … this is something that they bring over with them from the secondary school … How can I use Tasks 3 and 4 with them if they are not accustomed to think?

Matthew spoke of the restrictions that 'inadequate content knowledge' imposes on task selection:

Do you realise that the teacher would have to go back and teach students geometrical constructions if they are to be given Task 3? Personally, I wouldn't do it! … Today's students are very poor in this regard! Things are not what they used to be!

Matthew's reluctance (and that of many others) to revisit at sixth form level what has traditionally been regarded as secondary level material, even if only for the sake of presenting students with stimulating and rewarding activities, echoes the pervasive teacher practice to discard tasks, regardless of their worth, that do

not fit within the present system. The teachers in fact appeared unwilling to 'make up' for the 'perceived shortcomings' of a system that, as Hargreaves (1994) points out, fails to consult them and practically excludes them from the decision-making process. Mario spoke out most strongly about this:

> *These basics should have been taught at secondary school, not here! We should have been consulted before people started messing things up at the lower level! There's nothing we can do now …*

Mario's final comment reflects the prevalent attitude amongst the participants that, as students are largely capable of only doing routine, method-type questions, teachers have to accept the inevitable and be practical about it. It is a defeatist attitude that offers no redemption.

The School Context: The students emerged as key factor (which is only second to external examinations) that teachers take into consideration when they weigh the pros and cons of using particular tasks. According to my data, most teachers view PMI students as 'largely unmotivated', 'not really interested in mathematics', 'lacking mathematical knowledge', 'unable or unwilling to think mathematically', 'not accustomed with non-traditional questions', and 'more than happy with a simple pass mark in their external examination'. Some of the teachers presented this student characterisation as an explanation for their reliance on traditional tasks. Drawing on their knowledge of learners when making decisions (see Wilson et al., 1987), these teachers argued that method-based, lower thinking level tasks are more suitable for their students. This is how Renzo mapped out the suitability of such activities and the unsuitability of higher level thinking activities:

> *I find Task 1 excellent … students can work it out without too much trouble … they just have to establish the method and work through … [But] most students won't get Task 3 correct … not because it is difficult … it just requires that little extra amount of thinking, but they are not accustomed to that!*

The teachers' belief that students are not accustomed to think (and consequently being largely incapable of working on their own) explains why routine activities such as Task 1 and, to a certain extent, Task 2 are so pervasively used inside classrooms. The teachers see in such tasks – which are repeatedly legitimised by their use in external examinations – perfectly acceptable activities that 'respect' the students' way of doing mathematics. These 'system fitting' tasks tend to be very straightforward and keep descriptions to a bare minimum. Their

'basic' structure appears to be another reason why the participants favour their use over nonroutine tasks that tend to be rather descriptive. In fact, a quite common concern amongst the teachers was that their students' mathematical performance suffers because many of them lack mastery of the English language. Kathleen expressed these widespread preoccupations:

> *Even though all our students have at least an Ordinary Level pass in English, I find their English particularly weak … when they approach me with some difficulty or other, sometimes I realise that they wouldn't even have understood the question in the first place.*

In turn, these teacher fears have direct repercussions on the type of tasks to which students are being exposed in class. Indeed, many teachers judged Tasks 3 and 4, and to a certain extent also Task 2, as inappropriate for classrooms use also because of their descriptive nature. Such evidence – which collaborates Carter and Doyle's (1987) observation that teachers' classroom decisions at times follow the logic of classroom management rather than the logic of content – suggests that one problem is leading to another. It appears that students' mathematical understanding and progress is being stifled by their linguistic deficiencies that, in turn, discourage teachers from presenting them with the kind of activities that would stimulate just that.

Insufficient time allocation inside classrooms is another school factor that further 'pushes' teachers to decide against the use of nonroutine time-consuming tasks and in favour of the relatively time-efficient routine tasks. In spite of adding an extra teaching hour each week[3], most teachers still maintained not to have the necessary time on their hands that permits them to use activities similar to Tasks 3 and 4. Revealing an awareness of the limiting effects that this decision has on students' mathematical experiences, some teachers expressed regret at 'having to reach it'. For instance, Matthew lamented:

> *By not doing work similar to Task 3 in class, we're missing out on important aspects of mathematics!*

Such suffered decisions reveal how teacher practices can be better understood within the very complex context in which they are taken and for which they are intended (see Lowyck, 1984).

The Personal Context: The present study corroborates O'Hanlon's (1993) conclusion that professional decisions are greatly influenced by personal factors. It indeed appears that teachers' values, beliefs, and experiences influence and guide their task selection. For instance, there are strong suggestions that teachers

are more likely to use tasks with which they are better acquainted and feel more comfortable. It may thus be that teachers are still reproducing in class those same experiences or activities that had positively impressed them as students. Stephen elucidated this cyclic nature of classroom practices with reference to tasks:

> *Personally, I am more accustomed with tasks similar to 1 and 2 … that's my background ever since I was a student. And I think the same applies to our students. Since we only accustom them with tasks like 1 and 2, they're bound to feel lost when faced with tasks like 3 and 4.*

This phenomenon appears to be rooted within the teachers' personal and collective histories. For it appears necessary to go further back than what Calderhead (1988) calls 'teachers' practical knowledge' (i.e., the knowledge formed as a consequence of their actions inside the classroom) to explain their task choices. Indeed, whilst teachers' decisions are certainly influenced by their 'experiential learning' as they move from 'novice' to 'expert' (see Elliott, 1993), one also has to recognise the impact of their own student days.

Teachers may possibly include or exclude a task according to the 'mental images' it elicits. One particular entry in my field journal highlights this point:

> *I immediately felt that the teacher became uneasy when asked to comment on Task 3. It was as if the professional security, which had previously characterised comments about Tasks 1 and 2, had suddenly disappeared … only after the teacher admitted to having no idea of how to deal with the task, and I offered some explanations, could our discussion proceed.*

This incident shows how a particular task can foster in the teacher a self-image of professional insufficiency that lashes out at his or her 'sense of control' over the classroom situation (see Borko, Livingston, McCaleb & Mauro, 1988). Apparently, the 'newness' of this authentic activity had momentarily deskilled the participant. For when the formality of mathematics was 'inserted' into the picture, the teacher's uneasiness and hesitation were soon overcome. But, even now, I cannot help wondering the extent to which the initial 'feelings of insecurity' had to do with the teacher's eventual decision to judge Task 3 as inappropriate.

The insistence of many teachers not to use nonroutine tasks, which they invariably linked to long time frames, for fear of not covering the syllabus brought to the fore the security aspect of decision-making. Their predominant mentality of 'security first and foremost' appears to originate from some of their views on the national and school contexts. Faced with what they see as a vast syllabus and inadequate time provisions inside classrooms, the teachers tend to choose 'safe' traditional tasks. Not only do these tasks mirror examination-type questions, but

they also permit teachers to play what Ellis (2001) calls the 'coverage game' – a concentrated effort on their part to make sure that all the course content is covered irrespective of the depth that is often lacking. Fears of 'persecutory guilt', which arise from accountability demands and bureaucratic controls outside one's classroom, lead 'many teachers to concentrate on covering the required content, rather than ignoring it or subverting it to develop more interesting materials and approaches of their own' (Hargreaves, 1994, p. 143).

The mental images that a task elicits need not necessarily give rise to insecurity in order for it to be excluded from the classroom. In fact, Jackie partly justified her decision not to include Task 4 as a classroom activity by her 'repulsion' as a student for a closely related mathematics topic. On his part, Angelo admitted to exclude *a priori* Tasks 3 and 4 because of the unorthodox and 'non-mathematical' manner in which they are written:

> *My students may accept them, but I don't … I'm not accustomed to such things! Give me rather something like 'solve the equation' or 'form an equation' … not these trivialities!*

By thus minimising the value of these two nonroutine tasks, Angelo emerges as one of the few 'privileged' teachers in the study who are actually working with tasks that reflect their view of mathematics – namely, as a highly formal and theoretical subject. Some others, albeit acknowledging the educational benefits of nonroutine activities, explained their practice of only using traditional tasks by the 'nature' of the mathematics option they teach. In their eyes, teaching 'pure' as opposed to 'applied' mathematics makes all the difference. This is how Andrew put it:

> *Our syllabus is based on theory, not practical ideas … Tasks 3 and 4 are more 'applied' than 'pure' …After all, we mustn't forget that we're teaching pure mathematics, not applied!*

The practice of discarding tasks that seek applications of theory in practical situations however defeats the purposes of authentic assessment (see Murphy, 1996). The participants' comments suggested strongly that teachers of pure mathematics are more interested in their students' ability to demonstrate competence at theoretical level than in how they can apply this knowledge in real life situations. But even though the teachers generally showed, for some reason or other, very little consideration for the integration of theory and application in their tasks, they seemed rather positive about tasks that integrate the various branches of mathematical knowledge (e.g., Task 1, which they regarded highly in this respect). Teachers thus appear to prize and select tasks according to how much

these activities can integrate mathematics from within rather than with out-of-school practices.

The 'practicality' of teachers' decision-making

The results presented here seem to herald the unchallenged continuation of the long established practice of presenting students with traditional activities that many teachers, by their own admission, do not even think too highly of. The participants' insistence on traditional tasks is arguably in line with Black's (1998) claim that teachers keep in mind their students' starting-point when choosing classroom activities, but shows at the same time very little of what Black calls 'multi-dimensional foresight'. For instead of forward-looking, their task selection is almost exclusively concerned with and driven by the immediate present as conditioned by the past. Faced with a highly context-dependent situation (I had invited teachers to discuss the appropriateness of 'specific' tasks within 'specific' classrooms), the participants offered an equally highly context-dependent form of argumentation. Indeed, they could ably explain their classroom decisions by referring to the, at times obscure, mechanisms of their teaching environment. This awareness suggests that teachers' decisions (and the processes that lead to them) need to be understood and interpreted within the specific contexts in which they are produced.

Teachers emerge from this study as persons who, however much they waver cognitively between 'ideal' (read 'best, but unattainable') and 'practical' (read 'not necessarily the best, but attainable') positions, end up almost invariably choosing the 'practical' rather than the 'ideal' when making decisions. Stephen succinctly exposed this reality:

> *It's useless to theorise about things! Theories and ideals – no matter how good and interesting – won't get us anywhere! … One has to be practical! … As long as MATSEC keeps dishing out examination questions like Tasks 1 and 2, that's what I'll be doing in class … what I think about them, doesn't really have to matter!*

This means that in a 'wish-if-but' situation, teachers are likely to postpone gratifying their 'wishes' until the 'ifs' are satisfied, and to continue following in the meantime practices that fully respect the 'buts'. This study presents little evidence of teacher compromise amongst the costs and benefits that, according to Calderhead (1987), often characterises teaching decisions. The teachers studied seemed instead rather determined and unbending about the overall direction of their teaching decisions. As a matter of fact, albeit the participants were generally

very appreciative of the educational benefits attached to using Tasks 3 and 4, they made it equally clear that these tasks represent only an ideal form of practice that they are not ready to follow until their work environment changes in ways that makes this possible. Instead, the same teachers welcome tasks (e.g., Tasks 1 and 2) inside their classrooms that may hold, even in their view, 'dubious' educational value beyond the strict 'teaching-for-examination' context, but which nevertheless 'work' within the system. Teachers' 'sense of practicality' (see Hargreaves, 1994) appears to channel them towards classroom activities (read 'traditional type questions') that do not take too much of their time, students can perform on their own without too much trouble, and serve as important practice for the traditional high stake external examination that awaits students at the end of the PMI course. All of which is strong evidence of the interactive coexistence between teachers' decisions and their situational understanding (see Elliott, 1993).

I suspect that when teachers, as some of the participants suggested, claim to be ready to do all that is necessary for their students, this does not include 'fighting against the system'. My understanding is that teachers not only want to live inside the system, but also to win. And if winning, which in most cases is taken to mean success in external examinations, means putting 'ideals' aside, they are ready to do it. Their 'sense of practicality' has even led some teachers to comment about the futility of trying to fight the system inside the classroom. This is how Andrew put it:

> *If you had to ask me, 'Do you see Tasks 3 and 4 as a waste of time?' I'll say 'Yes'. Although these two tasks undoubtedly help to broaden students' ideas, in the present circumstances we can't afford to go through with such ideas.*

I find that this philosophy of 'practicality before ideals' betrays a sense of 'helplessness' on teachers' part. Realising what little control they have over their work (Cole, 1997), teachers try to accommodate the system instead of fighting it. Rather than teachers being practical in an effort not to 'miss the wood for the trees', their practicality appears to be a strategy aimed largely at survival that, according to Cole (1997), is the upper most thing on teachers' minds. It is a 'neutral' form of practicality that neither challenges nor tries to improve the system that many of them readily acknowledge as in need of reform. Indeed, the teachers emerge as primarily interested in working as best they can within the present circumstances. But by so doing, teachers may be further contributing to position themselves as mere pawns delivering a curriculum over which they have little or no control. Whilst their resigned acceptance may be, at least in part, an effort to appease their 'persecutory guilt', this stance definitely distances them

from the image of autonomous professionals trusted to exercise the power and expertise of discretionary judgement in the classrooms they understand best (see Hargreaves, 1994).

This raises the issue of the extent to which teachers are autonomous decision-makers inside their classrooms. The tendency of the participants to favour the practical over the ideal suggests that even though teachers retain a measure of decision-making power inside classrooms, this is greatly curtailed by a seemingly *a la carte* menu selection imposed upon them by other forces from both inside and outside schools. In a scenario in which teacher choices are essentially 'closed', their classroom decisions appear to follow a reactive damage-containing stance, rather than a proactive one. This reality, which does not however challenge the image of the teacher as an autonomous decision-maker using his or her specialist knowledge to guide classroom practice (Calderhead, 1987), somewhat qualifies how teachers process their prior knowledge when making decisions. In particular, the present study suggests that teachers filter the various types of knowledge they bring to the decision-making situation (see Wilson et al., 1987) through their situational understanding (see Elliott, 1993). It follows that teachers' decisions and practices do not readily reflect their ideals, but are instead governed to a large extent by the way they experience and interpret the various contexts in which they operate. A clear indication, I find, of the situatedness of teachers' decision-making processes.

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Notes

1 The Matriculation Certificate (of the Matriculation and Secondary Certificate Examinations Board [MATSEC] of the University of Malta) requires Maltese sixth form students to study two subjects at Advanced Level and four subjects at Intermediate Level (loosely defined as one-third of an Advanced Level).

2 Maltese schools, in spite of political and legal efforts aimed at decentralisation, still find it hard to practise autonomy within an educational system that remains burdened with the vestiges of centralisation (Fenech, 1994).

3 PMI classes now have three one-hour lessons per week instead of the original two hours allocation.

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References

Anderson, L. W. (2003) *Classroom Assessment: Enhancing the Quality of Teacher Decision Making*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Black, P. (1998) *Testing: Friend or Foe? The Theory and Practice of Assessment and Testing*. London: The Falmer Press.

Black, P., & Wiliam, D. (1998) 'Assessment and classroom learning.' *Assessment in Education: Principles, Policy and Practice*, Vol. 5(1), pp. 7-74.

Boaler, J. (1998) 'Open and closed mathematics: student experiences and understandings.' *Journal for Research in Mathematics Education*, Vol. 29(1), pp. 41-62.

Bogdan, R. C., & Biklen, S. K. (1982) *Qualitative Research for Education: An Introduction to Theory and Methods*. Boston: Allyn & Bacon

Borko, H., Livingston, C., McCaleb, J., & Mauro, L. (1988) Student teachers' planning and post-lesson reflections: patterns and implications for teacher preparation. In J. Calderhead (ed.) *Teachers' Professional Learning*. London: The Falmer Press.

Broadfoot, P. M. (1996) *Education, Assessment and Society: A Sociological Analysis*. Buckingham: Open University Press.

Bryant, D., & Driscoll, M. (1998) *Exploring Classroom Assessment in Mathematics: A Guide for Professional Development*. Reston, VA: National Council of Teachers of Mathematics.

Buhagiar, M. A. (2005) *Mathematics Teachers' Classroom Assessment Practices: A Case Study in a Maltese Sixth Form College*. PhD thesis submitted to the School of Education, University of Nottingham, UK.

Burgess, R. G. (1989) Grey areas: ethical dilemmas in educational ethnography. In R. G. Burgess (ed.) *The Ethics of Educational Research*. New York: The Falmer Press.

Calderhead, J. (1987) Introduction. In J. Calderhead (ed.) *Exploring Teachers' Thinking*. London: Cassell.

Calderhead, J. (1988) The development of knowledge structures in learning to teach. In J. Calderhead (ed.) *Teachers' Professional Learning*. London: The Falmer Press.

Calderhead, J. (1993) The contribution of research on teachers' thinking to the professional development of teachers. In C. Day, J. Calderhead & P. Denicolo (eds) *Research on Teacher Thinking: Understanding Professional Development*. London: The Falmer Press.

Calleja, J. (1988) Thoughts on the concepts and practice of the Maltese educational system. In C. J. Farrugia (ed.) *Education in Malta: A Look to the Future*. Malta: UNESCO.

Carter, K., & Doyle, W. (1987) Teachers' knowledge structures and the comprehension processes. In J. Calderhead (ed.) *Exploring Teachers' Thinking*. London: Cassell.

Clark, C. M., & Yinger, R. J. (1987) Teacher planning. In J. Calderhead (ed.) *Exploring Teachers' Thinking*. London: Cassell.

Cole, A. (1997) 'Impediments to reflective practice: toward a new agenda for research on teaching.' *Teachers and Teaching: Theory and Practice*, Vol. 3(1), pp. 7-27.

Day, C. (1993a) The development of teachers' thinking and practice: does choice lead to empowerment? In J. Elliott (ed.) *Reconstructing Teacher Education: Teacher Development*. London: The Falmer Press.

Day, C. (1993b) The importance of learning biography in supporting teacher development: an empirical study. In C. Day, J. Calderhead & P. Denicolo (eds) *Research on Teacher Thinking: Understanding Professional Development*. London: The Falmer Press.

Day, C. (1999) *Developing Teachers: The Challenges of Lifelong Learning*. London: The Falmer Press.

Day, C., Pope, M., & Denicolo, P. (1990) Introduction. In C. Day, M. Pope & P. Denicolo (eds) *Insights into Teachers' Thinking and Practice*. London: The Falmer Press.

Doyle, W. (1988) 'Work in mathematics classes: the context of students' thinking during instruction.' *Educational Psychologist*, Vol. 23(2), pp. 167-180.

Elliott, J. (1993) Professional education and the idea of a practical educational science. In J. Elliott (ed.) *Reconstructing Teacher Education: Teacher Development*. London: The Falmer Press.

Ellis, A. K. (2001) *Teaching, Learning and Assessment Together: The Reflective Classroom*. Larchmont, NY: Eye On Education.

Fang, Z. (1996) 'A review of research on teacher beliefs and practices.' *Educational Research*, Vol. 38(1), pp. 47-65.

Fenech, J. (1994) Education policy and school autonomy. In C. Farrugia (ed.) *A New Vision for Primary Schools*. Malta: Malta Union of Teachers.

Goldin, G. A. (1992) Toward an assessment framework for school mathematics. In R. Lesh & S. J. Lamon (eds) *Assessment of Authentic Performance in School Mathematics*. Washington, DC: American Association for the Advancement of Science Press.

Grossman, P. L., & Stodolsky, S. S. (1999). Content as context: the role of school subjects in secondary school teaching. In R. McCormick & C. Paechter (eds) *Learning and Knowledge*. London: Paul Chapman Publishing Ltd.

Halkes, R., & Olson, J. K. (eds) (1984) *Teacher Thinking: A New Perspective on Persisting Problems in Education*. Lisse: Swets & Zeitlinger.

Hannay, L., & Seller, W. (1990) The influence of teachers' thinking on curriculum development decisions. In C. Day, M. Pope & P. Denicolo (eds) *Insights into Teachers' Thinking and Practice*. London: The Falmer Press.

Hargreaves, A. (1994) *Changing Teachers, Changing Times: Teachers' Work and Culture in the Postmodern Age*. London: Continuum.

Hargreaves, D. H. (1993) A common-sense model of the professional development of teachers. In J. Elliott (ed.) *Reconstructing Teacher Education: Teacher Development*. London: The Falmer Press.

Ingersoll, R. M. (1996) 'Teachers' decision making: power and school conflict.' *Sociology of Education*, Vol. 69(2), pp. 159-176.

Korthagen, F. A. J., & Kessels, J. P. A. M. (1999) 'Linking theory and practice: changing the pedagogy of teacher education.' *Educational Researcher*, Vol. 28(4), pp. 4-17.

Lowyck, J. (1984) Teacher thinking and teacher routines: a bifurcation? In R. Halkes & J. Olson (eds) *Teacher Thinking: A New Perspective on Persisting Problems in Education*. Lisse: Swets & Zeitlinger.

Merriam, S. B. (1998) *Qualitative Research and Case Study Applications in Education* (2nd ed.). San Francisco: Jossey-Bass Publishers.

Murphy, P. (1996) Defining pedagogy. In P. F. Murphy & C. V. Gipps (eds) *Equity in the Classroom: Towards Effective Pedagogy for Boys and Girls*. London: The Falmer Press.

National Council of Teachers of Mathematics (NCTM) (1995) *Assessment Standards for School Mathematics*. Reston, VA: Author.

O'Hanlon, C. (1993) The importance of an articulated personal theory of professional development. In J. Elliott (ed.) *Reconstructing Teacher Education: Teacher Development*. London: The Falmer Press.

Patton, M. Q. (1990) *Qualitative Evaluation and Research Methods* (2nd ed.). Newbury Park, CA: SAGE Publications.

Pope, M. (1993) Anticipating teacher thinking. In C. Day, J. Calderhead & P. Denicolo (eds) *Research on Teacher Thinking: Understanding Professional Development*. London: The Falmer Press.

Sawyer, R. D. (2001) 'Teacher decision-making as the fulcrum of teacher development: exploring structures of growth.' *Teacher Development*, Vol. 5(1), pp. 39-58.

Wilson, S. M., Shulman, L. S., & Richert, A. E. (1987) '150 different ways' of knowing: representations of knowledge in teaching. In J. Calderhead (ed.) *Exploring Teachers' Thinking*. London: Cassell.

APPENDIX I

The Four Tasks

TASK 1

Express $\frac{2x-8}{(x^2+4)(x+1)}$ in partial fractions and hence or otherwise evaluate

$$\int_0^1 \frac{2x-8}{(x^2+4)(x+1)}dx$$

TASK 2

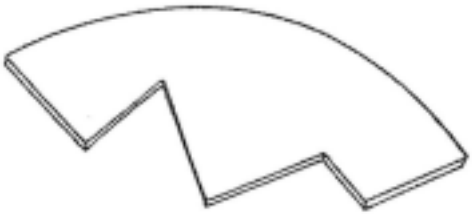
A cylindrical can, able to contain half a litre of drink, is to be manufactured from aluminium. The volume of the can must therefore be 500cm^3.

* Find the radius and height of the can which will use the least aluminium, and therefore be the cheapest to manufacture. (i.e. find out how to minimise the surface area of the can).

State clearly any assumptions you make.

* What shape is your can? Do you know of any cans that are made with this shape? Can you think of any practical reasons why more cans are not this shape?

TASK 3



The circular glass top of your neighbor's coffee table breaks. Your neighbor is very upset and would like to replace the glass top but does not know exactly how big it was. He brings you a piece of broken glass that contains part of the boundary of the original top. Describe exactly what you would do in order to figure out the exact size of the original glass tabletop.

TASK 3

Your task is to design a tent like the one in the picture

It must be big enough for two adults to sleep in

Show how you will cut the material to make the tent. Show all the measurements clearly