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ABSTRACT

Results of a study into secondary school students' and teachers' conceptions of what mathematics is and the purposes of school mathematics are outlined. A total of about 220 first year engineering students and 600 high school students in Australia were involved in the surveys while 40 students, 19 teachers, 2 career counselors, and 2 administrators were involved in interviews. Students and teachers held broad views of the content or discipline of mathematics, while their interpretations of mathematics within a wider sociocultural context reflected additional, influential, personally and socially derived factors: social status of mathematics, utility of mathematics, career aspirations, and interest or disinterest in mathematics. The role of the researcher in identifying such factors, as well as determining the focus of a research study and the perspective for analysis and interpretation, are examined. How mathematics means different things depending upon the context and an individual's interactions with an environment, including cognitive, social, and political contexts, are discussed. In addition, the role of mathematics in secondary education is questioned in relation to current curriculum movements in education. Contains 20 references. (Author/MKR)

Contextual Perspectives of School Mathematics: What Determines Mathematical Understanding?

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INTRODUCTION

Recent trends in the mathematics education literature on learning have challenged the use of traditional epistemology of a mind separated from the body and world, and the individual as essentially an individualistic or independent thinker. They are also challenging the often taken for granted special place mathematics educators have from which to reflect, comment and provide solutions to problems encountered in teaching mathematics. Constructivism, situated cognition, sociocultural perspectives, feminism, post modernism and other theories have in a growing voice challenged the Cartesian duality of mind/body and the hunt for an overarching universal theory on learning, knowledge and understanding. Cobb (1994), in reflecting on these trends, takes the challenge further by arguing "that mathematical learning should be viewed as both a process of active individual construction and a process of enculturation into the mathematical practices of a wider community" (p.13). He concludes by urging mathematics educators to use multiple perspectives, and in particular, to explore ways of coordinating constructivist and sociocultural perspectives (p.13).

Noddings (1994) comments on the challenge by philosophers and sociologists to Cartesian notions of the constituted subject. The view of what constitutes a learner is moving away from that of a unitary mind working in a knowable world, with actions described in terms of causal chains in a world of universal laws (p.89).

Concepts of knowledge and power are believed instead to reside in language, structure and institutions, rather than in human agents, with the human subject being constituted by "its situation, by its temporality, language, and cultural, racial and gender identities" (p.89). Yet Noddings notes that "mathematics educators have rarely asked how they themselves are constituted – why they think as they do and what influences their recommendations" (p.89). She reflects on this point by recognizing how her own views arise from "a set of situations and conditions" (p.102), while she questions the emphasis in the mathematics education literature "on mathematics for all students" (p.89).

Both Cobb and Noddings pick up the growing belief amongst many researchers that it is necessary to rethink relationships within educational communities, specifically between the student, the teacher, and the mathematics education researcher. They acknowledge the existence of a researcher's position being personal and particular for defining and addressing specific problems in specific contexts for specific reasons, rather than the existence of some neutral position from which to provide some universal solution to a 'recognized' universal problem.

Kieren, in an interview with Kieran (1994) on 25 years of mathematics education research reported in the *Journal for Research in Mathematics Education*, commented on the shift in that time of the noti[illegible]arning and understanding mathematics. He stated:

> . . . I think we realize learning and knowing and such things don't reside in our heads, nor do they reside in a library. . . . It's in the interaction. That I think is one of the big changes in how we view learning and in how we view understanding. It's a much more situational, social kind of thing. . . . understanding is an ongoing activity, not an achievement, not an accomplishment or attainment (p.589).

Kieren goes on to reflect on the changes in attempts to define understanding in the *Journal for Research in Mathematics Education* and proffers that "each represent a different way of thinking about understanding. Each still has the notion of connectedness and coherence, but rather than being a criterion, now it's part of the sense of the observer" (p.590). There is now recognition that theorization about learning, thinking and understanding is part of the researcher's practice, rather than necessarily clarifying some part of an underlying universal law about learning or understanding.

The papers by Cobb (1994), Kieran (1994) and Noddings (1994) capture in part a growing concern that 'traditional' research in mathematics education does not provide a framework within which practitioners (particularly teachers) can work towards solutions. What is not often questioned is the researcher's own understandings of what mathematics education is about, or why one thinks or interprets in particular ways. Although aware of the role an observer's personal background, perceptions and interpretations in interaction with particular contexts can have on one's perceptions of a problem, the extent of such factors on how research is personally framed is not well understood until literally the 'wheels fall off' one's attempts to rationalize or theorize. We, the researchers of this paper, found our own sense of how we understand mathematics learning, knowledge and education was foregrounded abruptly soon after commencing a study into student choices of mathematics study pathways in secondary schooling. Soon after commencing the research program, during initial surveying and interviewing of grade 10 mathematics students, we were confronted with a series of 'irrational' statements of what mathematics is. For example: (I is the interviewer)

(Grade 10 male with average achievement in a top stream class)

I: What do you think mathematics is?

Grant: Sums [four operations + - x ÷, and worksheets]. Numbers.

I: Sums. Numbers. Anything else?

Grant: A boring teacher.

I: Does the teacher make a difference?

Grant: No. [pause] Yes, he's good. I like the teacher. . . . He makes it interesting.

A first interpretation of Grant's statements might be that he sees mathematics as numbers and basic arithmetic, and that he has had mathematics teachers that he found boring. Most people would see such an interpretation as sensible. However, if one steps back and tries to look at Grant's responses as a whole, rather than as individual lines, then a different picture can emerge to challenge what the interpreter chooses *not* to focus on. For example, Grant's last statement appears contradictory in that after stating mathematics is a boring teacher he comments that his own teacher makes it interesting. At several other times in this interview Grant made other statements that appeared self-contradictory. For example, when asked what he thought about mathematics when he was in class his response was: "It's alright. A bit boring. Just want to get out of there." He also spoke several times of algebra and such things as the quadratic formula. Yet when asked what mathematics was he immediately responded with: "Sums. Numbers."

What might all Grant's responses, taken together, mean? To attempt to answer this question some aspects of the interview process need to be noted. First, during the interviews, the researchers resisted overlaying a personal framework with predetermined focus for confining an interviewee's responses. More specifically, although the questions were pre-determined and the same for all students or teachers, they were open-ended in nature, and the follow-up questions used were those that sought clarification or elaboration, for example by asking "why" or asking the individual to "say more." Thus, both in conducting the interviews and in analyzing the subsequent data, the researchers attempted to form interpretations holistically, intentionally taking as relevant the wide array of things a student or teacher mentioned in response to questions. Comments made by them that appeared to the researchers to be disconnected from or irrelevant to the initial question were accepted as connected to or relevant from the perspective of the student or teacher. Adopting this holistic approach to interpretation of data led to a more encompassing perspective of the students' relationships with study, teachers and future choices, or the teachers' interpretations of students' experiences. However, it also challenged beliefs about mathematics in schools.

As another example of how an interpretation can influence the researchers' categorization, consider the following short excerpt from an interview with a grade 10 female who was achieving at an average level in a middle stream class:

I: Well what do you think maths is?

Jenny: Maths is learning about numbers and everything about numbers. Like infinity, it's just infinity. It's like - it's a hard question. . . . it's just - it's a subject for geniuses. For people with brains.

I: Anything else you want to say?

Jenny: Some people just look at it as another subject in school they have to go to, like the classroom. Some people look at it as something they're going to have to do later in life, and there's just all ways of looking at it.

If one were to look at Jenny's reply to the first question from the perspective of "What is the content of mathematics?" one might be tempted to ignore that Jenny's reply also includes a view that mathematics is related to people, specifically smart people. On the other hand, it one views the same reply from the perspective of "What is the doing of mathematics?" one could interpret the same few lines differently, perhaps focusing predominantly on Jenny's connection of mathematics with smart people.

Grant and Jenny, as with most of the other students, included much more into what mathematics is than anticipated. It was not anticipated in that formulation of the interview questions during reviews of the mathematics education literature did not suggest mathematics as a subject being more than what was reflected in mathematics content and processes. For example, studies by Crawford, Gordon, Nicholas & Prosser (1993) and Galbraith & Chant (1993) examined views about mathematics and found people's ideas were generally related to mathematics as numbers, rules, formulae, logic, and problem solving, while mathematics learning was thought of as rote memorization, doing lots of examples, or gaining a relational understanding of theory and concepts. Additionally, if one looks in the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), the Curriculum Standards for Grades K-4 (p.15), Grades 5-8 (p.65) and Grades 9-12 (p.123) outline aspects of the content and processes of mathematics, but do not place these explicitly within learners' perspectives or interpretations of what mathematics is. Rethinking was required on our part of the context and views of what mathematics is to participants in a secondary school. What was needed was a broader perspective on what mathematics is than that as a subject being taught in a classroom.

In much the same way as Cobb, Noddings, and Kieren reflected on their views, as noted earlier, we set about trying to coordinate perspectives to make better sense of our problem of understanding the students' points of view. This was necessary in recognition that people say things in terms of the meaning it has for them than in respect to frameworks or constructs we the researchers project into their worlds (Blumer, 1969).

It can be argued that little is known of students' understandings of what mathematics is and what it means to them to understand mathematics. For example, Steffe (1993) argued that mathematics education researchers need to better understand the mathematics of children, while Frid (1992) identified ways students approach their mathematics learning in relation to issues of determining correctness and validity (sources of conviction). Since students are the key recipients of school mathematics and related school practices, what their views are of mathematics, and in particular what it means to understand mathematics, should be seen by the research community as a key component in any discussions of how mathematics is learned. Further, since teachers also interact at the primary interface of students' mathematics learning, their views on mathematics, students and students' understandings must also be better acknowledged and further examined. Thus, the main aim of our revised study (detailed in Frid & White, 1995) was *to examine factors in students' and teachers' constructions of their world views of the nature and relevance of mathematics*. Specifically, the study focussed on the following three questions:

1. What do students and teachers think mathematics is?
2. What do students and teachers think are the intentions of mathematics study and why mathematics is included in school programs?
3. What do teachers think students think about studying mathematics and how do these views compare with those of students?

These questions were framed within three underlying components of the researchers' own world views of the nature and relevance of mathematics (that is, with the role of interpreter explicitly acknowledged):

- society in general sees high school mathematics study as important;
- students' interpretations of experiences with mathematics influence their learning of mathematics;
- present mathematics curricula and current curriculum reform moves tend to ignore student world views of mathematics.

This paper is concerned with the issue raised by recent critiques of mathematics education research as reflected, for example, in the paper by Cobb (1994), Noddings (1994) and Kieran (1994). Our study has made us aware of the importance of recognizing how our own beliefs and values were shaping the research, not only in the choice of problems, methods and frameworks for analysis, but in particular with what was meant by 'mathematics', 'understanding' and 'student'. Following a brief outline of the actual study (found in detail elsewhere at this conference in Frid & White, 1995) are discussions and conclusions connecting the study to the issues raised so far in relation to how the researcher is constituted, how interpretations of understanding are from an observer's point of view, how coordination of individual and social perspectives on learning might be informative, and how mathematics means different things to different people.

METHOD AND DATA SOURCES

This study used an interpretive approach to research (Erickson, 1986), explicitly acknowledging the role of the researchers in all aspects of the research, including the framing of the research questions, the choice of data sources and data collection methods, and the framework for analysis and interpretation of data. This approach is in line with current shifts in educational research practices as they acknowledge the complexities of the interactions that occur in educational contexts. Thus, being concerned with the context of learning and related descriptions of teachers' and learners' mathematical interpretations, this study employed a blend of quantitative and qualitative research methods. The resultant eclectic approach enabled the researchers to document and analyze the experiences of teachers and learners in the broad encompassing social and academic complexities of classrooms, schools, personal and professional lives (Moss, 1994).

In particular, the study used classroom observations, student achievement records, questionnaires, and inter iews. The achievement records and classroom observations were used to set the background and to guide formulation of the questionnaire and interview questions. Questionnaires were used to elicit student views about their experiences in mathematics classes, with items open-ended in nature. The in-depth interviews were aimed at elaborating and broadening the questionnaire findings, and were semi-structured in nature.

The subjects of the study were mathematics students and their teachers from each of the following three educational contexts in Western Australia: first year engineering at a university with a mix of Australian and Asian students; grades 10, 11 and 12 at an elite, all female, metropolitan high school; and grades 10, 11, and 12 at a suburban government high school. A total of about 220 first year engineering students and 600 high school students were involved in the surveys, while a total of 40 students, 19 teachers, 2 career counsellors and 2 administrators (one principal and one deputy principal) were involved in the interviews. The selection of students included students representative of high, middle and low achievement in mathematics, and except at the all female school, included a gender balance. To promote students speaking openly and comfortably, students chose whether to be interviewed individually, or in a group of two or three. The teachers were all interviewed individually. The interview findings addressed the three research questions with the intent of explaining why and how in relation to the largely descriptive findings of the survey component of the study. An inductive reasoning approach for data analysis was adopted for the interview data (Glaser and Strauss, 1967; Powney and Watts, 1987).

RESULTS

Students' and teachers' views about mathematics, as interpreted by the researchers, were composed of four major interwoven and overlapping factors: social status of mathematics, utility of mathematics, career aspirations, and interest or disinterest in mathematics. The factors were interwoven in that each appeared to be an element in defining each other. That is, although each factor had strong identifying characteristics, they were not independent of each other. Altogether the factors create a web of beliefs that are the individuals' conceptions of mathematics and what it means to 'understand' mathematics. Each of the four factors are outlined here to give the subsequent discussion a foundation upon which to build. Since the focus of this paper is upon ramifications of the findings, full details of the factors are not included here. Detailed analysis and discussion of them can be found in Frid and White, 1995.

Social Status of Mathematics

Students' conceptions of mathematics reflected a social norm that mathematics is an 'important' and essential subject to study. They saw it as a subject with much prestige in the eyes of the community, especially employers. Many had questioned the validity of this status, but had accepted that it was a social value or convention that they must acknowledge in their choice of subjects for upper secondary or post-secondary studies. They believed society at large (ie. people in general) highly values mathematics success, and sees mathematics success as something people should strive for.

The students' interpretations of the status attributed to mathematics success within society also indicated they saw such status as, at least in part, invalid. They felt that part of the reason mathematics is seen as an important and paramount subject is that it is generally seen as a difficult subject, and thereby a mechanism by which to filter students. That the study of 'abstract' mathematics, as opposed to 'vegie' mathematics is a filter for segregating people was something of which the students were clearly aware. Most teachers expressed views about the status of mathematics that were similar to those of the students. In particular, they generally saw the high status attributed to mathematics as unwarranted.

Utility of Mathematics

Students' views of the utility of mathematics fell within two distinct categories: (1) the use of basic mathematics concepts and related skills in one's daily life, and (2) the potential use of more advanced mathematics concepts and skills within professional endeavours. What they often actually described as relevant mathematical knowledge in relation to needs within daily life was mathematics taught primarily in elementary school. A third category was evident in the teacher interview data: (3) the use of mathematics as a reflection of human thinking or culture. Both students and teachers frequently questioned the degree to which it would actually be necessary to use advanced mathematics within professional activities. However, although they questioned the reasons for mathematics to be a major requirement for entry into particular career paths or related programs of study, they also acknowledged the reality of these requirements. Thus, career aspirations and the relationship of mathematics study requirements to career aspirations was an integral component of their conceptions of mathematics.

Career Aspirations

Many of the answers in interviews on what mathematics is and why mathematics is taught in school were comments on career aspirations. There was both diversity and conformity in students' and teachers' conceptions of mathematics in relation to career aspirations. Conformity appeared in the form of the recognition of the pre-requisite necessity of mathematics study for certain career paths, particularly in relation to university entry. There was also a high degree of belief that many of these pre-requisites were an unwarranted constraint. Thus, students were motivated to study mathematics to enhance their prospects for a particular profession or job, to keep their career options open and maximised, or to assist their chances of gaining acceptance at a post-secondary institution. However, they were also often frustrated. Many of the students, as well as many of the teachers felt as though someone else, or the system, had imposed unnecessary or unreasonable demands upon students' choices. Students who were not aiming at university study were more explicit in their condemnation of the value of high school mathematics. Thus, the diversity or conflicts that arose amongst students were a result of the extent to which they either needed or desired to "leave their options open". Choosing whether to study mathematics or what specific courses to study at upper secondary level then became a dilemma for some students. They did not see how mathematics would be useful to them, or did not enjoy mathematics study, yet were faced with externally imposed requirements or societal values and expectations.

Mathematical Interest or Disinterest

A few students expressed an interest in mathematics related to it as a discipline of thinking and they referred to a sense of intellectual fascination and challenge it provided. These students were not necessarily the most able students. In general however, few students enjoyed mathematics for its own sake. A strong interest in mathematics was sometimes expressed in relation to career aspirations and the social importance of mathematics, with enjoyment achieved through being successful in relation to these other key components. In particular, there was evidence that interest in mathematics is linked with a sense of personal success in mathematics, findings that are not new within the realm of mathematics education research. For the students of this study, there was correlation between students who had been successful with mathematics and were intending to or who were already enrolled in university entry mathematics courses.

DISCUSSION AND CONCLUSIONS

Students have 'understanding' of mathematics that is dependent upon context. They define mathematics in a school sense as well as a personal sense. More specifically, students generally have well-formed conceptions from a mathematics 'content' perspective of what mathematics is and where it comes from, yet these conceptions are not taken into account when students are asked to give personal meaning to mathematics in relation to their lives. For example, in this study students' views of mathematics included seeing mathematics as numbers, rules and formulae, as a logical process or way of thinking, as a practical tool to solve problems, as a connected hierarchy that studies patterns and relationships, and as a sort of technology or human endeavour for addressing human needs and problems (Frid & White, 1995). However, when speaking of mathematics in relation to themselves, students' comments about what mathematics is were quite different. Their personal perspectives appeared to give meaning or understanding to mathematics only in relation to social factors, including the social status of mathematics, the utility of mathematics, career aspirations, and interest (of lack of interest) in mathematics. That is, students reflected a wider cultural and community perspective of mathematics than what mathematics educators generally aim for. More specifically, students put mathematics in a whole school, career and life perspective, but mathematics education research does not presently adequately address this broad viewpoint, nor recognize its effect on what is understood in the mathematics classroom.

Thus, it could be said that 'understanding' mathematics is neither a goal nor a necessary component of students' mathematical learning, at least not in the sense mathematics educators might define 'understanding' in relation to "correctness, coherence, and connectedness" (Kieren, in Kieran, 1994). Students 'understand' mathematics when they are meeting their goals as described in relation to their career aspirations and sense of the social importance of mathematics. Mathematics learning needs to be seen as more than a process of active cognitive reorganization or social interpretation of classroom experiences. It is also in the active processes by which students continue to understand their own motives, careers, fears, and successes (Noddings, 1994). Students in our study made sense of mathematics studies in a social sense that encompassed much more than interacting with mathematics content in a classroom, or in a school. From their perspective, much of classroom mathematics experience was pointless in relation to what, to them, is mathematics now or in the future. But this did not mean mathematics was not important or necessary. In fact they recognized mathematics *study*, rather than mathematics in its own right, as an essential passport for entry into many careers.

What also is of interest is how the four components identified within the context of the intents of mathematics study conflict with the ideals of how mathematics educators identify problems present in mathematics education practices. For example, understanding generally is associated with a range of interconnecting, cognitive frameworks that can be utilised to explain concepts and solve problems (National Council of Teachers of Mathematics, 1989). Further self-analysis is needed by the research community into their own interpretations of what mathematics is, what it means to learn mathematics, what it means to understand mathematics, what is the nature and role of mathematics education research and how mathematics education research functions in research and other educational contexts. Recognition is needed for how students view curriculum because this study indicates students do not separate mathematics from their personal or social contexts. They do not perceive of mathematics as one might describe mathematics as a discipline, but rather, describe mathematics in relation to a range of socially derived components. Researchers' capacities are restricted whilst they persist with neglecting school and community contexts and a view of mathematics that virtually ignores students' views.

The interdependence of the factors must be noted explicitly because the common practice in educational research of categorizing qualitative data, although it is a useful cognitive organizational tool, should not be interpreted as a model of reality. Rather, categorization of data into distinct factors-based groupings is an interpretive framework developed by the observers/researchers for analysing the data. It reflects much of the values and beliefs of the researchers' own world views (Cobb, 1994). Categorization is not inherent in the data itself (Lakoff, 1987). Instead, the value of one particular categorization over another is perhaps "in terms of its potential to address issues whose resolutions might contribute to the improvement of students' education" (Cobb, 1994; p.18), including supporting one's beliefs of what is 'good' education and what in theory constitutes educational progress. For us, the researchers, it is a way of making sense of experiences in our world view within our research community or target audience. In this study, the adoption of a perspective that intentionally acknowledged the existence of different world views of mathematics was to address the issue of interpreting students' understandings of what mathematics is.

The 'stepping back' in this study was not to gain a better 'God's eye view' of the landscape of reality, but to situate and constitute ourselves in the observer's theorized landscape. The recognition that students'/interviewees' contradictory or nonsensical statements are to them rational and intended to make sense is an acceptance of the partiality of knowledge (Haraway, 1988), and of knowledge interdependence with interaction with one's beliefs and values with context and situation. What mathematics is for students in secondary school was not the same as what it is for teachers of mathematics in the same school, or for the administrators in that school, or for researchers visiting the school. Further, what mathematics is did not remain the same for the students when reflecting on 'mathematics' in different situations. In the interviews the students were asked to comment on mathematics in the context of their mathematics classroom, other classes, outside of school, and in their intended career. Further, our own reflections on the interviews suggested that our understanding of what mathematics is fluctuated in relation to who the discourse was with, be that students, teachers, or administrators.

The process of articulating a multiple perspective to explicitly include ourselves in the picture helped us recognize how we ourselves articulate many versions of what mathematics is. We the researchers have been involved with mathematics in industry, as secondary mathematics teachers, as post-secondary mathematics teachers, as curriculum writers, as mathematics educators, as mathematics education researchers, and as users of mathematics. We recognize how we ourselves vary in understanding of what mathematics is when interacting with fellow mathematicians, teaching colleagues, parents, research colleagues, the public, a research grants committee, students, or shopping assistants, whether in a situation of using, describing, teaching, criticizing, or promoting mathematics. To distil the essence of what is mathematics out of all these situations and call it the mathematics to be taught reflects particular beliefs and values of the distiller and promoters of what is to count. What counts is therefore an ideology of some particular distilling community, in this case the mathematics community of which many mathematics educators are potential gatekeepers. In this sense mathematics learning becomes acculturation to our way of thinking (Bishop, 1988; Rogoff, 1988).

We agree with Cobb's (1994) assertion that individuals' mathematical activity is profoundly influenced by participating in encompassing cultural practice. However, although Cobb says "it is appropriate to take a perspective [on mathematics learning] that locates classroom events within a wider sociopolitical setting" (p.19), he discusses only the perspectives of the individual or the individual in a classroom. We see the findings of this study as pointing to a need to consider not just the classroom contexts, but all life practices including schooling, work, home, qualifying for post-secondary entrance, and peer interaction.

We also agree with Noddings' (1994) concerns that mathematics education researchers should ask themselves where they come from, and question why we insist on mathematics for everyone:

> Perhaps the guiding principle is that we should care for and respect all our students and that we do this by working with them closely enough to know what their interests are and the sorts of futures they envision. Of course, we should guide and shape those visions and interests, but we should not force them into one model, nor should we suppose that a mathematics program, however good it may be for some, can meet the purposes of all (p.100).

An implication of Noddings' points is that we as researchers should not ignore the 'noise' present in research data. What to us is noise because it interferes with a 'reasonable' description and interpretation, might be the essence of the situation from another's perspective (Bauersfeld, 1988). As researchers, our sense of coming to understand the objects of our research (for example, students and students' learning of mathematics) needs to be seen as a "continually ongoing thing" (Kieren, in Kieran, 1994; p.589) that is constituted by the "sense of the observer" (p.590). The sense of understanding of the observer (researcher) must however coexist with the sense of understanding of the observed (often the student). Our work with students, as teachers, reading across diverse fields and theories and our belief that the students were believing they were making sense required us to stop, step back on ourselves and listen to students.

Hence, this paper is a parital resolution of a problem of our own making, within a perspective (or multiple perspectives) to arrive at a framework of the four factors outlined earlier from which to understand mathematics in schools. As a partial resolution, we do not claim to have reached a vantage point from which to interpret others' comments on mathematics in ways that simultaneously make sense to ourselves as well as them. Many issues about the nature and role of mathematics remain unresolved and in need of consideration and debate by the mathematics education community. Perhaps then we will be able to better integrate our work with the perspectives of those for whom we claim to be working for – students and teachers. And perhaps we will then be able to address the concerns of teachers such as Louis:

I: Why do we teach mathematics at secondary school?

Louis: Because societies value it. Societies somehow have this opinion that if you can do maths you are clever. . . . apparently once you have a maths degree, one that shows you can think about a lot of extremely abstract problems, you can immediately switch over into real life stuff and - um - do it. Which I think is a very strange idea. I don't believe it is so. I mean when I look at my builder [doing house renovations] he does not use too much Pythagoras and yet he can put a building together and he keeps thinking all the time. But to try and teach the thinking he's thinking in a classroom is totally stupid, isn't it? It's just a silly idea. In fact half the qualifications he needs to be a builder is actually to completely fail at school because if he really was good at maths what would he be doing? He might be a maths teacher and he would not be living in the real world.

I: What do you see is the role of maths in high school?

Louis: You mean why do we push it? Because the system values it and it's a ticket to somewhere else. You are not going to use it. You use very little maths. . . . we teach a lot of stuff that is not going to be used again. The kids all know that.

Perhaps the kids do think that way? What might we as mathematics educators do about that?

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