EXPLORING TEACHER CLARIFICATION OF VALUES RELATING TO MATHEMATICS EDUCATION

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[Mathematics teacher Kieran and a few colleagues were participating in a teacher focus group discussion. At one point Kieran referred to a particular student who was not keen to learn. Colleagues who were also teaching this student agreed that the student cannot learn anything.]

Interviewer: Most of you indicated in your own journal that you believe that all students can learn, and that includes you, Kieran, right?
Kieran: Yeah.
Interviewer: So what could be the issue in this case, such as -
Colleague A: Oh, but it is only a belief! It is not easy, you see.

Values assume an important role in the optimisation of (mathematics) teaching and learning. The most complex / internalised educational objectives in both the cognitive and affective domains of the Taxonomy of Educational Objectives (Bloom, 1956; Krathwohl, Bloom, & Masia, 1964) — namely evaluation and characterisation — are concerned with values. This paper explores the possibility of facilitating teachers' relevant language and conceptualisation relating to values in mathematics education, through an approach which examines beliefs and is complemented by teacher reflection on their own pedagogical practice. Broader implications are outlined.

Introduction

The affective aspect of mathematics teaching and learning should not be understated (McLeod, 1992), especially if we recognise that issues (in mathematics pedagogy) have both cognitive and affective components (Schlöglmann, 2001). In its statement of the goals of school mathematics learning, the Victorian 'Curriculum and Standards Framework' highlights this relationship with phrases such as "confidently and competently" and "understand and appreciate" (Board of Studies Victoria, 2000, p. 6). In addition, the document stresses that "fulfillment of these goals requires that learning mathematics at school is a positive experience in which students develop confidence and a sense of achievement from what they learn" (Board of Studies Victoria, 2000, p. 6). At the same time, the significance of one of the affective variables, values, is increasingly being emphasised in mathematics education research (e.g. Bishop, 2001; FitzSimons, Bishop, Seah, & Clarkson, 2001; Jurdak, 1999). In general, these research highlight the relevance of values in mathematics education, the roles played by mathematics teachers in the transmission of values about mathematics and mathematics learning to their students, and how a greater understanding by teachers of their own values contributes to a more effective mathematics learning process for students. Yet, perhaps because the notion of values in mathematics education is a relatively new concept, teachers of mathematics often find it difficult to discuss and examine the relevant values. In particular, there is a need for the relevant language and for a more developed conceptualisation of values (FitzSimons, Bishop, Seah, & Clarkson, 2001). This paper is an attempt at exploring the possibility of promoting teacher language and conceptualisation in this regard from an essentially self-help perspective, acknowledging the potential of teacher self reflection in improving pedagogical practice and professional growth. At the same time, it is also a means of complementing professional development support and collegial interactions.

This teacher self clarification process capitalises on our greater familiarity with another set of affective variables, namely beliefs, relating to mathematics and mathematics teaching/learning. While the role of beliefs in optimising mathematics education has been researched upon for a relatively longer period of time, a matter of concern has been that the connection between (teacher/student) beliefs and practice may not always be a consistent one (see Gondoseputro, 1999; Schoenfeld, 1989; Sosniak, Ethington, & Varelas, 1991). The incident quoted at the very beginning of this paper highlights one such example which took place during a recent teacher focus group discussion. This is clearly undesirable if an understanding of one's own beliefs does not inform one (or others) of the possible decisions and actions one will likely make and demonstrate in class.

Beliefs and Values

In order to explore the relationship between beliefs and values, let us refer to one of the three Taxonomies of Educational Objectives, the one pertaining to the affective domain (Krathwohl, Bloom, & Masia, 1964). This Taxonomy classifies affective objectives along a continuum of increasing internalisation. The categories and subcategories are

1.	receiving (attending)	1.1	awareness
		1.2	willingness to receive
		1.3	controlled or selected attention
2.	responding	2.1	acquiescence in responding
		2.2	willingness to respond
		2.3	satisfaction in response
3.	valuing	3.1	acceptance of a value
		3.2	preference for a value
		3.3	commitment (conviction)
4.	organisation	4.1	conceptualisation of a value
		4.2	organisation of a value system
5.	characterisation by a value or value complex	5.1	generalised set
		5.2	characterisation

According to the Taxonomy, internalisation in its most basic form is concerned with an individual's attention being drawn to some phenomenon, progressing through differentiation to valuing so that eventually, "the internalization and the organization processes reach a point where the individual responds very consistently to value-laden situations with an interrelated set of values, a structure, a view of the world" (Krathwohl et al., 1964, p. 35). In this context, beliefs are positioned within level 3, and the different levels of certainty of beliefs reach their peak at sublevel 3.3, associated with a sense of conviction, devotion, absolute certainty, and even faith (Krathwohl et al., 1964). At this sublevel of 'commitment', "the person who displays behavior … is clearly perceived as holding the value …. There is a tension here which needs to be satisfied; action is the result of an aroused need or drive. There is a real motivation to act out the behavior" (Krathwohl et al., 1964, p. 182). Thus, action is guided by values, a point also supported by Kluckhohn (1962), and Raths, Harmin and Simon (1987).

McLeod's (1992) review of research on affective constructs in mathematics education makes a distinction among beliefs, attitudes and emotions, by considering

> the degree to which cognition plays a role in the response, and in the time that they take to develop …. Therefore, we can think of beliefs, attitudes, and emotions as representing increasing levels of affective involvement, decreasing levels of cognitive involvement, increasing levels of intensity of response, and decreasing levels of response stability. (pp. 578-579)

Values as internalised beliefs, associated with structure and certainty, may then fit in well here, as representing relatively lower levels of affective involvement, higher levels of cognitive involvement, lower levels of intensity of response, and higher levels of response stability.

The high level of cognitive involvement associated with values is a significant characteristic in our understanding of values. This is evident from an examination of terms which have been used to describe values, such as 'psychological constructs' (Jurdak, 1999) and 'conceptions' (Kluckhohn, 1962). In fact, Raths, Harmin, and Simon (1987) perceive valuing as a process involving choosing, prizing and acting, all of which are largely cognitive in nature. Interestingly, this may account for McLeod's (1992) omission of values in his review of a range of affective variables related to mathematics education!

Characteristic of continua of phenomena, there is no clear boundary between beliefs and values at sublevel 3.3 of the Taxonomy. But if we want to be more aware of our values related to mathematics and mathematics education, and to be able to monitor our transmission of these values in our mathematics class, then it is important for us to be able to at least know what beliefs and values each 'look like' to help us mentally sort them apart.

One possible way of arriving at a possible distinction is to look at the terms often associated with beliefs and values. Beliefs have been attached to categories like 'true/false' and 'correct/incorrect' by Kluckhohn (1962). This is reflected in belief statements such as

'mathematics consists of computation, concepts, problems, and skills',

'real math problems can be solved by common sense instead of the math rules you learn in school', and

'in mathematics something is either right or it's wrong'

(see Cooney & Shealy, 1995, p.2; Schoenfeld, 1989, pp. 352-353). On the other hand, the category of values has been linked to the notion of worth (e.g. Begg, 2001; Swadener & Soedjadi, 1988). Thus, values may be concerned with the idea of 'important / unimportant'. A mathematics teacher who subscribes to values like 'logical thinking', 'problem-solving' and "technology' would be expected to perceive these to be important aspects in his/her mathematics teaching repertoire. Often, this personal sense of importance and worth results in a kind of strong emotional attachment, thus providing the impetus for action.

Bishop (1988) identifies three complementary pairs of mathematical values, namely 'rationalism', 'objectism', 'control', 'progress', 'mystery' and 'openness'. Chin and Lin's (2000) report on a group of mathematics students' values identifies the following: 'uncertainty', 'fun' and 'certainty'. Thus, while belief statements are contextualised (such as those in the last paragraph), values are generally context-free. Indeed, one-word terms are often the very responses to questions about values amongst teachers I have come across. This characteristic about values is also evident in values listed in curriculum statements and in national value documents (Seah & Bishop, 1999). Thus, another way of distinguishing values and beliefs is to see values as being transcendental (across objects and situations) (Rokeach, 1973) and context-free, whereas beliefs draw their meanings from the contexts within which they situate. Afterall, deciding whether a belief statement is true or not relies on the presence of a context to the phenomenon. Further, the notion of values being context-free goes well with the Taxonomy's view that values characterise the individual and are generalisable (see level 5 of the Taxonomy).

Values as internalised beliefs so characterise the individual that they influence the kinds of beliefs he/she subsequently holds. Thus, the interaction between beliefs and values may be perceived as being two-directional. Consider a teacher of middle years mathematics who holds beliefs like 'fractions (such as 1/3) should not be expressed as approximated decimals (such as 0.333 3)'. Beliefs such as this may be internalised into the value of 'accuracy'. When this teacher is deployed to teach VCE Mathematics Methods, this valuing of 'accuracy' is likely to lead him to believe that 'it is not important for students to learn about the Trapezium rule; rather, they should spend more time improving their capability to use integration rules', so as to arrive at exact values of areas.

Exploring Values through Examining Beliefs

That values influence the individual's formation of beliefs as much as beliefs may be internalised to become values is significant in facilitating teacher clarification of values. This relationship between beliefs and values implies that an examination of one's own beliefs helps to uncover those underlying qualities which one actually values. For most of us, defining what our beliefs are is easier than attempting to isolate our values, partly because we are relatively more familiar with beliefs, and partly because our consideration of beliefs does not require us to move beyond the context of the situation at hand. An understanding of our own beliefs relating to mathematics and mathematics education may be facilitated through reflecting on our professional experiences and identifying situations which we believe to be true. For example, as we read mathematics professional development papers and articles, we may evaluate the conjectures, arguments or proposals made to determine if they are valid and true in the context of our own professional experience. When we engage in conversations / discussions with our colleagues in the staff room, we may want to take note of those things which we believe to be true. These beliefs may be 'students are not getting enough practice out of class', or 'the new Mathematics Methods (CAS) subject — currently on trial — brings the real world one step closer to school mathematics'. What about the speaker who led the professional development session (or who was invited to talk during the last school Curriculum Day): what are the beliefs which the session has reaffirmed? What are those points presented which we feel to be true? We may also examine the 'Curriculum and Standards Framework' or the VCE Study Design for one of the several mathematics subjects. What are our views with regards to the outcomes, for example? Do we agree with the statement that for students, "judging the reasonableness of answers is to be fostered" (Board of Studies Victoria, 2000, p. 18)?

Having identified our own beliefs pertaining to mathematics and to mathematics pedagogy, we may then make use of this 'list' of beliefs to ascertain those underlying principles we attach personal significance and importance to. For example, a teacher who holds the belief that 'student mathematics portfolio is a good alternative assessment for Year 9 students' will need to ask himself/herself what is it about portfolio as alternative assessment which is of value to him/her. Does he/she value 'process', 'holistic assessment' and/or 'context'? For another teacher who shares the belief stated in the 'Curriculum and Standards Framework' that student "judging the reasonableness of answers is to be fostered" (Board of Studies Victoria, 2000, p. 18), the value may be 'estimation' and/or 'evaluation', etc. At times the associated value is not directly obvious: this teacher may embrace this belief because he/she values 'subordination' as a staff member of the school, and the school principal is a supporter for this kind of alternative assessment mode!

Exploring Values through Reflecting on Practice

The exploration of our values relating to mathematics and to mathematics teaching/learning should also be carried out on another indicator of values, i.e. our professional practice. Bishop (2001) provides some good information in this regard, and this section aims to complement that. As teachers, we are always modelling our values to our students through our own teaching and our interaction with them, although we may not always be aware of this transmission. Decisions made by us for and during our lessons, including those happening at critical incidents (Tripp, 1993), also reflect our own values. All this teaching of values shapes the evolving value systems of our students in powerful and enduring ways. Teacher reflection on their pedagogical decisions and actions represents a complementary approach to finding out what is/are valued and considered important by the teacher himself/herself. Such decisions are made, and actions demonstrated, in various aspects of our professional lives as teachers, from lesson planning, to lesson execution, to assessment. Our language and understanding of values should be developed enough from our examination of beliefs earlier, so that values are explored directly at this stage.

Lesson planning

The ways in which we plan and structure the teaching of particular topics reflect the values we hold about mathematics and about how it is best taught/learnt. Do we plan for a lesson with close reference to the school mathematics textbook, or do we develop our own notes taking into account the needs and abilities of our students? Whichever planning style we adopt (these two are but examples of the variety in reality), it is worthwhile to challenge ourselves to clarify what the associated value(s) is/are, to suggest the important ideas/constructs which have guided our selection of content and sequencing of knowledge. If you structure in many student investigative activities in the teaching of a topic, and if your colleague teaching the same topic chooses to adopt the board-and-chalk technique, what different values are both of you portraying to your respective students? What is a teacher valuing when he/she consistently relates mathematical concepts to the mathematicians who first formulated them? What does a teacher value when he/she introduces a problem at the beginning of a topic, expects students to solve it as the teaching of the topic progresses, then summarises the topic with student presentation of the heuristics and newly-acquired concepts used in solving the problem? What different value would another teacher be portraying if problems are only issued to students at the end of a topic, after he/she is satisfied that the students have acquired the necessary skills and concepts with which to solve the problems?

We may now discover several values which we did not identify earlier through the examining of beliefs. This is to be expected since we are now 'casting our net' over a bigger context of our professional experience, and naturally more personal values are identified. Perhaps, at this stage, some of us are beginning to get a bit worried that this larger number of personal values are producing seemingly conflicting value pairs, such as 'technology' and 'mental computation'. In fact, they may well complement each other in our mathematics teaching, i.e. such values need not be related in conflicting ways even though they are equally valued by us.

Lesson execution

What values are further portrayed by the execution of our lesson plan? Let's look at some examples. When Annabelle teaches, she uses everyday language to explain mathematical concepts and to substitute for mathematical terms (e.g. 'four-sided figure' for 'quadrilateral'); Boris explains in plain language, and uses it to introduce mathematical terms which he expects his students to use in their mathematical discourse; Carl's teaching is characterised by formal and technical vocabulary. When there is a computation to be carried out during her teaching, Deanne invites her students to compute; in a similar situation, Eng Seng would go for his calculator, which he habitually carries in his shirt pocket; in Fatimah's case, she mentally computes on-the-spot and challenges her students to do likewise. Giles allows his students to ask questions only at the end of his explanation/exposition, or when he invites them for queries, suggestions or comments. On the other hand, Heidi's teaching style encourages student active input throughout any phase of her mathematics lessons. Indira's planned lesson was interrupted by about a third of her students who claimed that they have forgotten some assumed knowledge, and her on-the-spot response was to issue the rest of her students some group task, while she revised the relevant concepts/skills with those students - Indira 'dropped' whatever she had originally planned. When Johnson encounters a similar incident, his typical response is to ask those students to revise the concepts/skills on their own, to seek for his help if they meet with difficulties. This is followed by Johnson continuing to teach what has been planned. Evidently, the decisions and actions of each of these 10 teachers reflect different kinds of mathematical and mathematics educational values. What might some of yours be like?

Assessment

The ways in which we assess our students' progress in mathematics learning is yet another channel through which students perceive what we value most in our mathematics teaching (Clarke, 1988). Consider a teacher who believes that communication skills should be taught in/through mathematics, but whose design of assessments is very much traditional (e.g. tests and examinations). Requiring students to answer a certain number of mathematics questions / problems on paper within a set time does not provide much opportunities for them to demonstrate their abilities to communicate mathematically, unlike some of the process-oriented, alternative assessments such as student presentations, portfolio compilations, and writings. Students will be quick to discern what the teacher really values in mathematics learning simply by noticing what get assessed and what do not. Similarly, the extent to which assessment questions test students across the range of cognitive educational objectives (i.e. knowledge, comprehension, application, analysis, synthesis, evaluation) (Bloom, 1956) also conveys teachers' values relating to the nature, purpose and applicability of mathematics. What about the ways in which we phrase our assessment questions (or our class assignment and verbal questions, for that matter)? What values are implied by questions which begin with imperatives (e.g. 'calculate'. 'evaluate', 'solve', 'prove') and end with question marks? On the other hand, what different values are portrayed by questions phrased in statement forms? Are there questions which are contextualised in realistic or daily life situations, and what do you value when you phrase/select such questions? Lastly, does your marking scheme / scoring rubric reflect your valuing (or not) of 'process', 'organisation', 'rationalism', 'co-operation', 'communication', etc?

Concluding Remarks

These reflections may of course be facilitated through notes or personal diary entries. Importantly, the above represents an attempt at helping us identify more explicitly what some of our values relating to mathematics and mathematics education are. It involves our examining our beliefs to explore what are valued, building on an argument that there exists a mutual influence between beliefs and values. This approach is complemented by teacher reflection on what is normally done in the mathematics classroom. Perhaps these two approaches may be collectively seen as *thinking* about how we *feel* and what we *do*! As an exploratory attempt, the fuzzy boundary and the complex relationship between beliefs and values are acknowledged. While this paper is aimed at assisting us teachers to understand more about values through beliefs, it does not assume that a clear difference between these two qualities always or necessarily exists.

The relatively unstable nature of beliefs, as well as observed inconsistencies between beliefs and subsequent actions, have meant that a more explicit awareness of our mathematical and mathematics educational values is professionally crucial. In particular, this consciousness should lead to our portrayal of a more consistent set of values, which may relate to the nature of mathematics, to the learning of the subject in school, and even to living in the society. The implications certainly go beyond our mathematics lessons to also include general educational considerations, which may be 'democracy', 'communication' and/or 'co-operation', for examples. Thus, the importance of a more explicit and consistent values transmission to the young of our nation through our pedagogy and practice should not be understated. Ultimately, this more explicit and consistent values teaching through mathematics teaching/learning would also contribute to a more positive experience in the classroom for the students, leading them to value *mathematics in society*, and to *value mathematics* in society.

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