THE CONFLICT BETWEEN TEACHERS' BELIEFS AND CLASSROOM PRACTICES

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The relationships between the beliefs and practices of mathematics teachers have been shown to be complex. In this case study of one mathematics teacher, it was found that while the teacher had clear and quite strongly held beliefs about mathematics and its teaching and learning, his classroom practices did not always reflect these beliefs. In some lessons other factors meant that the lessons was not conducted in a way which reflected the teacher's beliefs. However, the teacher was aware of this contradiction.

Many factors influence the classroom practices of mathematics teachers. Thompson (1992) noted that not only do teachers' beliefs about mathematics and its teaching and learning appear to have a significant effect on their approaches to teaching, but also that the relationship between beliefs and practice is complex. Studies have demonstrated "varying degrees of consistency between teacher's professed beliefs about the nature of mathematics and the teachers' instructional practices" (Thompson, 1992, p. 134). The aim of this case study was to explore the relationships among beliefs, context and the mathematics teaching practices of one year 8 mathematics teacher. The case study was part of a larger study into the use of writing activities in mathematics classrooms.

BELIEFS AND PRACTICE

Lerman (1983) described mathematics teachers' beliefs as a continuum from "absolutist" at one end to "fallibilist" at the other extreme. Ernest (1989) proposed three descriptions as follows: the "problem-solving view" in which mathematics is seen as an expanding field in which the process of inquiry is central; the "Platonist view" in which mathematics is seen as a static, unified body of interrelated structures; and the "instrumentalist view" in which mathematics is seen as a set of unrelated facts, rules and procedures which can be used in specific situations. Thompson (1992) noted that research has shown that "the beliefs professed by individual teachers concerning the nature of mathematics have been found to be generally consistent" (p. 134).

Teachers' practices, which are a function of their beliefs, have been characterised in various ways. In this study a set of four descriptions by Kuhs and Ball (cited in Thompson, 1992) were used.

1. *Learner-focused*: Mathematics teaching that focuses on the learner's personal construction of mathematical knowledge;

2. *Content-focused with an emphasis on conceptual understanding*: mathematics teaching that is driven by the content itself but emphasises conceptual understanding;

3. *Content-focused with an emphasis on performance*: mathematics teaching that emphasises student performance and mastery of mathematical rules and procedures; and

4. *Classroom-focused*: mathematics teaching based on knowledge about effective classrooms. (p. 136)

Thompson noted that teachers are often not able to clearly enunciate their approaches to teaching and that there has been considerable inconsistency in the results of studies aimed at linking teachers' beliefs about teaching and their instructional practices.

Ernest (1988) described three factors that appear to influence the practices of mathematics teachers, the teacher's beliefs, the social context and the "teacher's level of thought processes

and reflection" (p. 1). He discussed the interrelatedness of beliefs about mathematics, approaches to teaching, ideas of learning and the thought processes of the teacher and associated his three conceptions of mathematics, the instrumentalist, Platonist and problem-solving views, with three teacher roles, namely instructor, explainer and facilitator respectively. Using data from the *Second International Mathematics Study*, Sosniak, Ethington and Verelas (1991) found that teachers did not appear to hold coherent points of view about the nature of mathematics and its teaching. They concluded that the apparent inconsistencies might be due to the need for teachers to contend with many different views and pressures in the day-to-day act of classroom teaching.

METHODOLOGY

An ethnographic case study was adopted for this research. The researcher became immersed in the group so as to present an "holistic depiction of an uncontrived group interaction over a period of time, faithfully representing participant views and meanings" (Goetz & LeCompte, 1984, p. 51). This was an interpretive study that sought to interpret the data at two levels, firstly from the viewpoint of those being studied and secondly "from the perspective of someone who is aware of other systems and of theoretical perspectives on sociocultural systems" (Eisenhart, 1988, p. 105), that is, from the perspective of the researcher. The case for this six-month study was one experienced mathematics teacher and his two year 8 mathematics classes.

A range of data collection methods was utilised in this study. Nickson (1992) described the four typical methodologies used for data collection in such studies, these being "participant observation, ethnographic interviewing, a search for artefacts (available written or graphic materials related to the topic of study), and researcher introspection" (p. 107). She noted that other data could be obtained by surveys and questionnaires. All of these data collection methods were applied to the study.

The researcher engaged in participant observation as a regular visitor to the classroom (at least once each week over a six month period, sometimes without notice), becoming closely acquainted with the teacher and students. During visits, some lessons were audio-recorded and field notes were kept. Informal discussions also took place with the teacher and individual students, the researcher acting as an additional tutor when the students worked in groups or individually. The teacher was interviewed at length at the completion of the classroom phase of the study. By this time the teacher and researcher were well acquainted and it was more like a conversation which was audio-taped and the researcher's used an "interview guide approach" (Best & Kahn, 1993, p. 201). A series of general questions was used as a basis for the discussion.

Two students were also interviewed for the study. They were chosen as "key informants" (Goetz & LeCompte, 1984, p. 119) and were interviewed three times outside the classroom as well as interacting with the author during normal class time. The aim was to gain further insights of an "insider's" view of what was taking place. Samples of writing were collected from all of the students at the commencement of the study, at intervals during the study, and in the last week of the study. The writing samples were analysed by a previously described method (Shield, 1995) and were used to support conclusions regarding students' apparent views of mathematics. In order to clearly establish the overall context of the study, several other documents were collected. These included syllabus documents, the school's work-program in mathematics, other planning documents written by the teacher, and the textbook used by the classes.

The mathematical beliefs of students and the teacher were examined using an existing questionnaire based on an instrument developed by Schoenfeld (1989) and modified for use in Australia by Southwell and Khamis (1992). The version used in this study had 46

items in common with the Southwell and Khamis version, 40 of these being common with the Schoenfeld version. A version of the instrument was also prepared for the teacher.

The extensive, mostly qualitative data were examined in order to develop detailed descriptions of the context in which the teacher worked and of the teacher himself, including characterisations of his beliefs and his classroom practices. These descriptions were grounded in the multiple data sources that were searched for examples which either supported or conflicted with ideas expressed verbally by the teacher.

RESULTS

While extensive written descriptions of the teacher and his working context were developed, space limitations here allow only for samples of the descriptions to be presented. The samples have been chosen to represent key concepts in the teacher's beliefs and practices.

The Context

The school at which the case study was conducted is a Catholic co-educational high school in an outer Brisbane suburb with approximately 600 students in years eight to twelve. In the interview, the teacher involved in the study (referred to forthwith as Ken) noted that this principal treated teachers as professionals and had good relationships with teachers and students. There is a wide range of abilities apparent in the students as well as a range of other needs, especially associated with language difficulties. The school provides one full-time and one part-time English as a Second Language (ESL) teacher with specific language skills in Spanish and Vietnamese respectively. There is also a full-time student counsellor and a full-time remedial teacher.

The year 8 mathematics curriculum is based on the Years 1 to 10 Mathematics Syllabus (Department of Education Queensland, 1987). The syllabus represents a significant departure from previous syllabuses in its intent, although some schools' interpretations have adhered to past approaches. The school involved in this study has implemented the syllabus in line with its intentions, at least at the year 8 level. The syllabus requires a broadening of approaches to the teaching of mathematics including the use of activity based learning, discussion, problem solving and investigation. Language use is also given prominence in the syllabus.

In year 8 mathematics, a textbook (Shield & Wallace, 1988) was used for most of the topics and was supplemented by a range of other materials, some developed by Ken. The school has a formal work program, which is not often referred to by the classroom teachers. There is also a "working" document, much smaller than the work program and written mostly in terms of the textbook. Ken was the leader for year 8 mathematics and took two of the four classes himself, working closely with the other two teachers involved. The teachers mostly used the same classroom activities as Ken although there were occasions when they adhered more closely to the textbook presentations than he did.

The students were allocated randomly to the four year 8 mathematics classes and records from primary schools showed a very wide range of mathematical abilities in each class. A survey of students' beliefs about mathematics was administered to the classes two weeks after the commencement of the school year. The beliefs being expressed would therefore be based on their seven years of primary school and other personal experience. The results on most of the 46 items were very similar to those recorded by Schoenfeld (1989) with tenth and eleventh grade students in the United States and to those of Southwell and Khamis (1992) with both primary (grades 4 to 6) and secondary (grades 7 to 10) students in Australia. Characteristics included: school mathematics consists mainly of facts and procedures; some people are good at mathematics and some are not; teacher questions usually require memory of the right answers; and good teachers show students lots of ways to look at the same

questions and show students how to answer the questions on tests. The examples of student writing about mathematics collected on five occasions during the study demonstrated that the students saw mathematics as mostly involving the reproduction of set procedures.

The Teacher

At the time of the study, Ken had a total of 22 years of teaching experience. He commenced teaching in primary schools. In his sixth year, Ken transferred to secondary teaching in mathematics and physics, having studied pure mathematics to third-year university level. Ken had taught at the school involved in this study for 14 years. In addition, he lectured part-time to pre-service teachers and had completed a Master of Education degree.

When asked in the interview for his view of mathematics, Ken had some difficulty providing an answer. He firstly talked about the importance of students liking mathematics. Later he stated the following.

> I don't see mathematics as just computing. . . . algorithms, starting and following a procedure, that sort of thing. So what I'm really thinking of is mathematics is a much broader area than that. I'd like to say it's certainly got a problem-solving focus.

In the questionnaire, Ken answered "very true" to the items about mathematics being creative and problem solving being important and answered "not true at all" to items relating to mathematics already being known by mathematicians and problems only being able to be done one way. These items helped to elucidate the ideas which Ken had difficulty expressing in the interview. He appeared to hold a view of mathematics that could be classified generally as a fallibilist or problem-solving one. However, in the interview, Ken several times gave a pragmatic qualification to his views. For example, having just mentioned the problem-solving focus, he stated the following.

> That's my ideal. But I think when we come back to the real, I've got a syllabus dictating what I've got to do. I've got a school program that's dictating what I have to do. . . . I can do a little bit of work around it. . . . it's just a matter of survival almost. You've got so many deadlines to meet.

Later in the interview Ken also mentioned:

> so-called recipe or rote learning . . . there's a certain amount of that, it's going to happen.

The transcripts of the recorded lessons were searched to identify examples which would either confirm or refute his apparent problem-solving, fallibilist view. In the lesson on 5 March, Ken introduced an activity based on a diagram from a previous lesson. The class had been working on the geometry of plane shapes for several lessons. The diagram consisted of a circle with three diameters at 60 degrees to each other. The following instruction was issued.

> I want you to write down below it anything you can tell me about that final diagram. Write down all the things you can observe in it.

Within a short time, students had written up to ten observations. Ken responded with enthusiasm to responses such as: the lines intersect; 6 angles; 6 parts, like fractions (a reference to the type of diagram used in fraction work); 6 sectors; acute angles; all the same size. He particularly complimented the student who used the word sectors. After the lesson, Ken remarked that he had simply wanted to have the students think more widely and possibly associate other ideas with the work they had been doing.

In the lesson on 11 March, the class was again working in the topic of geometry, this time on ruler and compass constructions. Two students provided alternative methods for making an angle of 120 degrees. The teacher responded with the following statements.

> I like that. That's really good thinking. . . . What do you think? Wasn't that good. That's exciting, one of those different methods you can think of.

The two examples from the lessons reported above support the earlier conclusions about Ken's view of mathematics and its teaching and learning. He was stimulating creative approaches from the students and fostering a problem-solving climate in which alternative methods are valued.

In the lesson on 18 May, Ken used what could be described as a problem-solving approach in developing the procedure for multiplying two common fractions. While he led the discussion, students were involved in answering questions. Ken used a 10 by 10 grid and worked through three examples using the lengths of the sides of rectangles to represent the fractions and an area model to represent the product. Students then had to state a general rule for finding the product of two common fractions. A similar approach was used on 24 May to develop the idea of multiplying and dividing numbers by 10, 100, 1000 and so on.

Not every lesson observed could be classified as being supportive of an active, problem-solving view of mathematics. For example, in the lesson on 31 March, students were learning how to find the highest common factor and lowest common multiple of pairs of numbers. This time Ken stated and explained the methods with an emphasis on setting out and the use of language. He later stated that he needed to achieve a particular end required by the program and was aware of the instrumentalist approach he was using. In the interview, Ken described how in his teaching he attempts to use an investigative approach and tries to encourage student contributions to the discussion. However, he further acknowledged accepting that, in some circumstances, telling the students the way to do it may be necessary.

One of the strongest points about teaching mathematics made by Ken in the interview was the need to foster positive attitudes in students. He repeated several times how much he strives to ensure that his grade 8 students finish the year liking mathematics. He mentioned a number of aspects of his teaching that might contribute to this including the use of concrete materials, group work and cooperative learning, and encouraging students to discuss answers. Further insights into this were provided by the students. One key informant (Alison) expressed her lack of interest in some of the concrete activities, preferring to move on with doing the algorithms. The other key informant (Jenny) demonstrated in one interview her difficulty with the concrete model used by Ken in the previous lesson. The general views of mathematics and its teaching and learning expressed by the group on the questionnaire saw it as a set of facts and procedures to be learnt. The students' writing, which did not change in style during the study, also demonstrated a view of mathematics as set procedures. Their difficulties in talking about the mathematics they were learning indicated a lack of experience with this approach.

A survey of the transcripts of the recorded lessons revealed that in these lessons, Ken did most of the talking. The student responses were quite brief. Ken did attempt to have students explain as on 11 March, when he asked the class:

> Okay I'm going to ask you then to try to describe in your own words, best of all come to the board and use my compass and ruler and other things and tell how we go about some of these.

The first student chosen appeared to have some idea of the mathematical method but experienced great difficulty in articulating this. Ken needed to prompt her throughout the explanation. A similar pattern occurred in other lessons. The students' use of terminology in the brief responses was mostly accurate. However, they generally had difficulty expressing their understandings.

In the interview, Ken also identified writing as an element of his teaching. This was an activity that he used from time to time and in various forms. Sometimes students created their own exercises and problems in written form. At other times they were asked to write an explanation in prose, as occurred in the lesson on 18 May.

> Right, I want you now, in your own words, to write down what you think the pattern of doing the multiplication of common fractions is, ... write down in your own words what you think will be the way we do the multiplication.

In the interview, Ken lamented the fact that he hadn't used writing as much as he would have wished, once again the practicalities of the situation coming into play.

> And I would have liked to have done a heck of a lot more actual writing where they write in their own words, but I didn't get organised enough to get more of it done.

DISCUSSION

Ken was a teacher who reflected on his teaching practices. His stated beliefs about the nature of mathematics were generally in line with Ernest's (1988) problem-solving view. There was considerable evidence of practices that mirrored this view. Alternative solutions to problems were encouraged and rewarded and the relationships among mathematical ideas were emphasised. Activities in lessons often involved the use of concrete materials and discussion. Investigations were used and students' errors were capitalised on for the purpose of learning. Ken's teaching could be described as "content-focused with an emphasis on conceptual understanding" but tending towards "learner-focused". While it was apparent that most students enjoyed the lessons and participated willingly in the classroom activities, there were also evidently a number of conflicts between the students' expectations and the classroom practices.

There were some lessons in which the practices were directed much more towards a "content-focused with an emphasis on performance" approach reflecting an instrumentalist view of mathematics. It was clear in the interview that Ken was well aware of the differences in approach which he used, and he appeared to be a little frustrated by this. In explaining these contradictions, Ken noted various pressures related to the context in which he worked. In the interview he expressed strongly how at times he felt the demands of the syllabus and the school's program limiting what he could do in the classroom. However, with the year 8's Ken enjoyed a high degree of autonomy and his preferred approach was very much in line with the requirements of the syllabus. He was in charge of running the program and he set the tests. Perhaps the perceived pressure was not a result of the immediate needs of the year 8 program but more a response to the known expectations of the other teachers who would teach these students in year 9 and beyond. While Ken wanted his students to learn their mathematics with understanding, he was conscious of the demand for student proficiency with mathematical procedures as a requirement for later learning. There is also the possibility that, as a teacher of 4 classes other than the two grade 8 groups, at times Ken was simply too busy to devote the time to planning to teach in the way that he preferred. As he stated in the interview: *It's just a matter of survival almost. You've got so many deadlines to meet.*

CONCLUSION

This case study of the beliefs and practices of one mathematics teacher provides some insights into the complex interactions involved. Conflicts can arise between what a teacher believes is best for students and what can actually be achieved in the classroom. This could indicate a lack of a coherent view of mathematics as noted by Sosniak et al. (1991). However, other evidence may indicate strongly held beliefs that are reflected in practice. It is likely that the day-to-day pressures of teaching mean that at times teachers may need to make curriculum decisions that do not meet their ideals.

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