

THE IMPACT OF TEACHERS' PERCEPTIONS OF STUDENT CHARACTERISTICS ON THE ENACTMENT OF THEIR BELIEFS

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This paper reports on one aspect of a larger study and comprises an analysis of the beliefs concerning mathematics, its teaching and its learning, and the classroom practice of one secondary mathematics teacher. It focuses on the question, "What specific teacher beliefs about students are relevant to teachers' classroom practice in various classroom contexts?" The teacher's practice was examined in relation to several of his mathematics classes and significant differences, consistent with the teacher's beliefs in regard to the various classes, were found. The findings confirm the contextual nature of beliefs and highlight the importance to teachers' practice of specific teacher beliefs about the various students that they teach.

BACKGROUND AND THEORETICAL FRAMEWORK

A fundamental premise of teacher beliefs research has been that an individual's behaviour is ultimately a product of his/her beliefs (Ajzen & Fishbein, 1980; Cooney, 2001). Consequently, any attempt to change the practice of teachers must, of necessity, involve change in the beliefs of teachers. Teachers' beliefs have, therefore, long been regarded as critical to the reform of mathematics education (Cooney & Shealy, 1997). Despite this there is no agreed definition of the concept of beliefs (McLeod & McLeod, 2002). It is thus the responsibility of researchers in the area to make clear the meaning that they attach to the term (Pajares, 1992). In this paper "beliefs" is used to mean anything that a person regards as true, and is essentially the meaning assigned to the word by Ajzen and Fishbein (1980). Furthermore, since beliefs must necessarily be inferred (Pajares, 1992), more certainty can be attached to the existence of a belief that is evident in both the words and the actions of an individual. Indeed, the degree to which a subject's actions and statements in other contexts are compatible with a given stated belief, the more centrally held (Green, 1971) that belief is likely to be. It is also recognised that individuals may hold beliefs that they do not articulate for a variety of reasons, including the fact that they may not be consciously aware of their existence (Buzeika, 1996).

Wilson and Cooney (2002) observed that since the 1980s context has been increasingly recognized as relevant to studies of teaching and learning and that the teacher's beliefs in fact constitute part of the context in which classroom activity occurs. In their theory of planned behaviour, Ajzen and Fishbein (1980) emphasised the context specificity of beliefs and Green (1971) also asserted the relevance of

context to the enactment of beliefs, suggesting that the relative strength with which various beliefs are held is dependent upon the particular context.

Contextual constraints have also been recognised as exerting significant influence on the relationship between beliefs and practice (Sullivan & Mousley, 2001) while Hoyles (1992) described all beliefs as situated as a consequence of their being constructed as a result of experiences which necessarily occur in contexts. Hoyles (1992) argued that it is thus meaningless to distinguish between espoused and enacted beliefs or to examine the transfer of beliefs between contexts since differing contexts will, by definition, elicit different beliefs. Thus, rather than contextual factors constraining teachers from implementing certain of their beliefs, such factors in fact give rise to different sets of beliefs which are indeed enacted. Such a view is consistent with that of Ajzen and Fishbein (1980). Pajares (1992) also stressed the contextual nature of beliefs and the implications of their being held, not as isolated entities, but as part of belief systems as described by Green (1971).

Context is thus relevant to both the development and the enactment of teachers' beliefs, as well as to the particular beliefs that are relevant in a given situation. Hence an important challenge for researchers is to identify specific teacher beliefs that significantly impact their practice and that, while context specific, are relevant across a sufficiently broad range of contexts to be generally applicable. Hoyles (1992) described the emergence within PME of research that contributes to this end. In particular, she cited Romberg (1984) as identifying a relationship between teachers' beliefs about students' ability and the nature and difficulty of the tasks that they assign to them. Hoyles (1992) also called for more attention to be paid to the study of teachers' beliefs as they exist in relation to various specific contexts and particularly in relation to the characteristics of their students.

In spite of this there is still little knowledge regarding specific teacher beliefs in relation to students that are likely to be helpful or otherwise in the creation of classrooms that reflect the principles of mathematics education reform. Exceptions include the finding of Stipek, Givvin, Salmon and MacGyvers (2001) that teachers who believe that students' mathematical ability is fixed are more likely to hold traditional views of mathematics teaching, and Cooney, Shealy and Arvold's (1998) findings regarding the beliefs of pre-service secondary mathematics teachers. While acknowledging the context specificity of beliefs they identified a number of beliefs that such teachers tend to hold about themselves and their role as a teacher and also made use of aspects of Green's (1971) description of belief systems in accounting for both the varying impacts of these beliefs on teachers' practice and their susceptibility to change. This paper reports on an examination of the variations between classes in the beliefs and practice of an individual experienced mathematics teacher, enabling insight into the nature and place within the structure of the teacher's beliefs system, of his beliefs with respect to students.

Practice, in the current study, was considered in terms of the extent to which the teacher's classroom environments could be characterized as constructivist. This was done cognisant of the facts that constructivism is not prescriptive in relation to teaching (Simon, 2000) and that any teaching strategy could be part of a constructivist learning environment (Pirie & Kieren, 1992). Rather a constructivist classroom environment was considered to be one in which: students were able to act autonomously with respect to their own learning; the linking of new knowledge with existing knowledge was encouraged and facilitated; knowledge was negotiated by participants in the learning environment; and the classroom was student centred in that students have opportunities to devise and explore problems that are of relevance to them personally (Taylor, Fraser & Fisher, 1993). Such elements align well with the principles and standards promoted by the National Council of Teachers of Mathematics (NCTM) (2000).

THE STUDY

The subject

Andrew had been teaching secondary mathematics and science for 25 years. He had studied mathematics for three years at University as part of his B.Sc. and had since completed an M.Ed. Andrew was currently teaching mathematics to two classes in grade seven and one in grade ten. Both of the grade seven classes were heterogeneous while the majority of students in the grade ten class were in the average ability stream with a few studying a separate mathematics course designed for low ability students.

Instruments

Data concerning Andrew's beliefs were collected using a survey requiring responses on a five-point Likert scale, to twenty six items relating to beliefs about mathematics, its teaching and its learning, and from a semi-structured interview of approximately one hour's duration. The survey items were taken from similar instruments devised by Howard, Perry, and Lindsay (1997) and Van Zoest, Jones, and Thornton (1994) and were originally part of a forty-item survey that was shortened after use in a pilot study. The audio-taped interview required Andrew to: reflect upon his own experiences of learning mathematics; describe an ideal mathematics classroom and compare this with the reality of his own mathematics classes; respond to 12 statements about the nature of mathematics based upon the findings of Thompson's (1984) case studies of secondary mathematics teachers; and respond to a further 12 statements about the teaching and learning of mathematics derived from the same source. The 12 statements regarding the nature of mathematics consisted of four each that represented Problem Solving, Platonic, and Instrumentalist views of mathematics as defined by Ernest (1989), and the 12 statements relating to the teaching and learning of mathematics were similarly representative of three corresponding views of mathematics teaching and learning.

Observations of approximately six lessons with the classes in each grade provided data on Andrew's classroom practice as well as further opportunities to gather data from which his beliefs could be inferred. Data on Andrew's classroom practice were also gathered from the interview and from both teacher and student versions of Constructivist Learning Environment Survey (CLES) described by Taylor et al. (1993) and requiring respondents to indicate on a five-point Likert scale, their perceptions of the frequency of various teaching/learning practices in their mathematics classroom. The CLES measures the four aspects of a classroom environment described above and respectively named Autonomy, Prior Knowledge, Negotiation and Student-Centredness (Taylor et al., 1993).

Procedure

Andrew completed the beliefs survey during the first few weeks of the school year. After a gap of several weeks he was asked to complete the teacher version of the CLES with respect to at least of two of his mathematics classes (one grade seven and the grade ten), and then to give the student version of the survey to students in these classes. Interviews were conducted in early October and observations of Andrew's mathematics lessons occurred throughout November and December. Inferences concerning Andrew's beliefs were made on the basis of the complete data set. That is, Andrew's interview transcript and the detailed notes made during and after each observation period were examined for evidence supporting, contradicting or clarifying his belief survey responses and the CLES responses of both Andrew and his students. A set of five centrally held beliefs that emerged as most relevant to Andrew's practice were suggested and put to him, along with details of the data analysis, for comment and verification.

Results and discussion

Andrew's belief survey responses indicated that he held a Problem Solving view of mathematics (Ernest, 1989) and a constructivist view of mathematics learning. This was exemplified by his agreement or strong agreement with statements such as the following:

Mathematics is a beautiful, creative and useful human endeavour that is both a way of knowing and a way of thinking.

Ignoring the mathematical ideas that children generate themselves can seriously limit their learning.

A vital task of the teacher is motivating children to resolve their own mathematical problems.

However, Andrew seemed unsure as to the most effective pedagogical approach to employ in enacting those beliefs. For example, he was undecided about the following items:

Mathematical material is best presented in an expository style: demonstrating, explaining and describing concepts and skills.

Providing children with interesting problems to investigate in small groups is an effective way to teach mathematics.

Students in one of Andrew’s grade seven classes and his grade ten class completed student versions of the CLES. Andrew opted to complete just one CLES (teacher version) survey rather than one for each class. The three sets of responses were similar for three of the four scales with the exception being the extent to which the classroom environments were perceived to be Student-centred. Both classes perceived their classrooms to be less Student-centred than did Andrew, with the difference being greatest in the case of the grade tens. Individual items that contributed to these differences are shown in Table 1. While individual differences are small, the data suggest that in his grade ten class Andrew was more likely than in his grade seven class to set the tasks and to be the arbiter of correct solutions.

Table 1: Items contributing to differences in Student-Centredness

In this class...	Teacher	Grade seven (av. response)	Grade ten (av. response)
I/the teacher give the students problems to investigate	Seldom	Sometimes	Often
The activities students do are set by me/the teacher	Often	Often	Very often
Students learn my/the teacher’s method for doing investigations	Sometimes	Often	Often
I/the teacher show(s) the correct method for solving problems	Often	Often	Very Often

Andrew’s interview responses confirmed his Problem Solving view of mathematics and his constructivist view of learning as conveyed in his belief survey responses.

The following quotations are illustrative:

I’ve swung in the past from being a Platonist to being more a social constructivist. So mathematics is, I don’t think it’s out there, I don’t think there is a number one sitting somewhere in the ether however effectively it sits there because we as a society have created it.

Mathematics to me is for exploring, conjecturing..., well, there’s probably no such thing as right answers to any problem.

His ambivalence regarding teaching approaches was also evident in that he expressed agreement that one of the ways that students learn is “by attentively watching the teacher demonstrate procedures and methods for performing mathematical tasks, and by practising those procedures”, but was careful to stress that this was just one way

that they learn, and that “there’s got to be a big balance”. Andrew described his own teaching as follows:

I suppose I’m very teacher directed but at the same time what I like to do is not to give the kids the answers, but what I try to do is to make them think ...

Andrew talked primarily about his grade seven classes and described his grade tens as “a totally different kettle of fish”. He described them as more difficult to motivate, and also talked about what he regarded as the inappropriateness of much of the content of the course designed for grade ten students in the middle ability level, suggesting that these students needed “survival numeracy skills” and not “space and all these other things”. In the lessons observed, the grade ten class worked from worksheets on coordinates and mapping. Apart from brief introductions there was no whole class teaching. Rather students worked with minimal noise either individually or in twos or threes as they chose. Andrew rarely directly answered students’ questions about the mathematics, but instead made suggestions. Several of the students did very little work, and this was largely ignored provided that their behaviour was not disruptive.

In contrast with his grade ten, Andrew’s grade seven lessons consisted primarily of whole class discussions facilitated and guided by Andrew. Both of the grade seven classes seemed accustomed to being asked to explain their answers and comfortable with going to the board to write their answers. Questions such as, “How did you do it?”, “Is it right?” and “Will it always work?” were recurrent with the students sometimes using them too. The students consistently appeared to be engaged in genuinely grappling with the meaning of the mathematics. In one lesson on multiplying fractions, Andrew allowed the students to run with a conversation without comment until a student articulated that the effect of multiplying by a number greater than one makes it bigger and multiplying by a number smaller than one makes it smaller. Such conversations remained orderly, with one person speaking at a time and everyone else listening.

Andrew’s beliefs and practice

Three beliefs emerged as centrally held and relevant to Andrew’s teaching in both the grade seven and grade ten classes. These were:

1. The teacher has a responsibility to maintain ultimate control of the classroom discourse.
2. The teacher has a responsibility actively to facilitate and guide students’ construction of mathematical knowledge.
3. The teacher has a responsibility to induct students into widely accepted ways of thinking and communicating in mathematics.

However, although Andrew’s teaching in both contexts was consistent with constructivist principles there were clear differences. Andrew agreed that he was less

inclined than with the grade seven classes to make the effort to maximize the engagement of all students in the grade ten class, or to establish the social norms required to make whole class teaching effective for all students. Two further centrally held beliefs underlay this, namely:

4. Older students of average ability are not interested in mathematics.

and,

5. Mathematics that is suitable for older students of average ability is not interesting.

CONCLUSION

While the teacher in this study held beliefs that were essentially consistent with the aims of the mathematics education reform movement it is clear that his beliefs in relation to older students of average ability had a significant impact on his practice in their lessons and in fact limited the extent to which at least some students in this class were likely to engage in mathematical thinking as embodied in the NCTM's (2000) process strands. Thus if our aim is to promote teaching that is consistent with a constructivist view of learning then it is insufficient to assist teachers to develop beliefs that are considered helpful to this end without attending to other beliefs that they may hold in relation to specific contexts.

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