Students' Pedagogical Knowledge: A Source of Pedagogical Content Knowledge

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This paper presents the results of interviews with Year 5 and 6 students about their views of effective teaching practices in mathematics. The students interviewed were part of a large-scale study into improving middle years mathematics and science. Their views confirm findings from the literature and other data sources from the project, and provide valuable insights into student perceptions of effective teaching practice in middle years mathematics.

> In our efforts at "school improvement" we need to tune into what pupils can tell us about their experiences and what they think will make a difference to their commitment to learning, and, in turn, to their progress and achievement. (Rudduck & Flutter, 2000, p. 75)

A fact we often forget is that students have more experience of teaching practices than any other group. In other words, their *fund of knowledge* (Moll & Greenberg, 1990) of teaching practice is extensive. However, whether they are able to articulate their knowledge to assist teachers make teaching practices more effective is an open question.

This present research was stimulated, in part, by van den Heuvel-Panhuizen (2005). In the research reported at the *International Symposium Elementary Maths Teaching* (SEMT), van den Heuvel-Panhuizen interviewed two very articulate students. These girls had a clear idea of what they saw as good teaching practice, and what was not. This appeared to come from the professional background of their parents; they knew and used educational jargon. Examples of their insights included those related to explaining: that teachers should use visuals to aid their explanations, and that the "why" should be explained as well as the "how".

This paper presents the results of interviews with four Year 5 and 6 students about their views of effective teaching practices in mathematics.

Background

The student interviews were conducted as part of the *Improving Middle Years Mathematics and Science: The role of subject cultures in school and teacher change* (IMYMS) project, which investigated the role of subject knowledge and cultures in mediating change processes in the middle years of schooling. The project worked with 5 secondary and 27 primary schools located in urban, regional, and rural areas of Victoria. The project had its roots in the *Science in Schools* research project, which developed a successful strategy for improving teaching and learning science (Gough & Tytler, 2001).

IMYMS is based on an action planning process that involves auditing the practice of mathematics and science in schools. The major foci of the audit are teacher practice and beliefs, and student perceptions and learning preferences (e.g., Doig, Groves, Tytler, & Gough, 2005). Students also took part in written and performance assessments.

Methodology

At the end of the 2005 school year, four students who were part of the IMYMS project sample at one urban primary school were selected for a group interview. As Osborne and Collins (2001, p. 443) point out, (focus) group interviews offer "a means of exploring the principal issues of interest in a dynamic manner which utilizes the group interaction to challenge, and probe, the views and positions espoused by individual members in a non-threatening, relatively neutralized social setting". As in van den Heuvel-Panhuizen's (2005) *student consultancy study*, students were selected on the basis of their likelihood to be able to give informed advice on effective teaching. In this case, the students were chosen based on their results on the IMYMS written mathematics assessment, and their teachers' assessment that these four students were very capable in mathematics and likely to be articulate in an interview situation.

Two boys, Ian (Year 5) and Nick (Year 6), and two girls, Ursula and Eve (Year 6), were interviewed by the authors. A semi-structured interview protocol was used, with most subsidiary questions following up students' responses to the main questions. As with the IMYMS survey, the emphasis was on how students believe they best learn mathematics and hence how it should be taught. Students were told at the start of the interview that they were regarded "as consultants about good ways of teaching and learning and your thoughts about teaching and learning maths and science". The five "main questions" were:

1 The first question for us is just your thoughts on – well let's say do you enjoy maths … why do you like it?
2 So if you were going to be the maths teacher for next year, for Year 6 somewhere, how would you make things different? What would you do?
3 How do you think you actually learn maths best? What's the best way of learning maths?
4 What about the kids who are not doing so well or find it harder? … What's the best thing for the teacher to do to help those kids?
5 Any other suggestions for us? Things you would recommend, like to see, or think would help?

The interview was audio-taped and transcribed. The authors examined the transcript of the interview and identified phrases in the students' comments that were qualitatively and substantively different from one another. Phrases with like focus were then placed into categories that then formed the basis for this paper.

Results and Discussion

Only data relating to mathematics are reported here, with the three major themes emerging for mathematics being discussed below.

Challenging but Accessible Content

Due to the way students were chosen for the interview, it was not surprising that they all liked mathematics. However, a frequent complaint was that the way it was taught was boring. For example, Nick, the most articulate of the four students, commented:

Nick: Well I like maths just full stop, but I don't really like the way we do it. … [it's] boring, that's the word. … [they make] us do really easy things over and over and over again.

While the students were very aware that they were not typical in their mathematics classes and were "probably the wrong people to ask" about students who are weak at maths, they demonstrated a great deal of insight into the problems teachers face:

Nick: The teacher's trying to teach the whole class … It's a bit hard 'cos there's a massive range of abilities in maths and … people who understand it as soon as they saw it would get really bored.

When Australian teachers are faced with a wide range of mathematical abilities, their most likely strategy is to use groups – in most cases heterogeneous groups. However, all the students advocated the use of ability grouping, although they had some reservations:

Nick: The problem [is] the people who aren't so good at maths … don't like being put in a group by themselves … Even if they probably learn better that way, they're not happy doing it that way.

Eve: Yeah so it's hard to make them feel good.

Ursula: But some people like just accept the fact that they're not so good at maths and they want to learn more. Different people's personalities.

The strength of feeling was evident by the fact that when asked at the end of the interview what advice they would give to trainee teachers, three of the students responded:

Ursula: Put your students into groups. Different working groups.

Eve: And make sure that the people who are better at maths don't get put [into] like easier maths. They sort of need to be challenged more.

Ursula: And yeah other way round. The people who aren't so good at maths don't get really hard work that they can't even do or understand because that doesn't do anything.

Eve: We don't really get challenged. …

Ian: Instead of easy maths all the time for the people who aren't so good [need] different levels.

Teaching Strategies to Support Learning

Mirroring the IMYMS student survey, the students were asked how they best learn mathematics. There were divergent views on the role of teacher explanation:

Eve: I like the teachers sort of explaining how you do it and then just doing it. I think the worksheet helps you and then she'll come around and if you don't understand something she can tell you.

Ursula: I don't really like it when they explain 'cos they go on for hours and hours and you kind of lose concentration.

Eve: Well she just sort of explains it on the floor and then we go to our desks. But the people that still don't understand it, they go back on the mat to do it again. So maybe get them back on the mat and explain it more than what she's explaining.

However, except for the social aspects, the use of worksheets was, by and large, condemned by the students:

Nick: They make photocopies of text books.

Ursula: Yeah, and they give us a sheet and we stick it in the maths book. … [but mainly] she'll put up lots of sums on the board ... which is all right because I work with my friends … [that's] fun 'cos we sort of talk and do it as well instead of just sitting at your desk and not talking.

Ian: Yeah, we get lots of work sheets every time we have maths, yeah.

Nick's single piece of advice to trainee teachers was:

Nick: Don't take the easy way out by just giving us just tons of worksheets!

Students also advocated teachers probing student understanding to avoid repetition:

Nick: I'd probably find out who needs to like revise something 'cos if the whole class knows it there's no point going over it. But if only one or two people need to revise it, you could just work with those one or two people while the others can do something. So instead of going over it for the whole class, just go over it for a few people … Wouldn't it be better to give them like a one page test at the start of the year … just to see where you're at?

Linking Mathematics to Students' Interests

While condemning worksheets, students were in favour of more "hands-on" work:

Nick: It would be better if we could do more hands-on things. Actually instead of just getting a worksheet and have to do sums … it would be better if we could actually like – this is just an example to teach you how to multiple and minus and stuff – pretend to run your own shop or something and people would come and buy things, just pretend. …

Ursula: Going outside measuring the basketball court. Like finding the area, perimeter, and so on.

The three Year 6 students, who were in extension classes for a while, particularly appreciated the project work they did:

Ursula: That was like going around the school plotting things in a project.

Nick: Well some of it was hands-on and the rest of it was boring like normal maths. … Oh yeah, the projects were good.

Ursula: Like water usage and we made a ramp, did actions for a ramp.

Nick: And you were allowed to do … choose what you wanted … and how much solar panels cost and things like that. … Actually doing things. Like you're never just going … like once you go from high school, if you go to uni and stuff, you're never just going to get a sheet, you won't probably just get a sheet of sums for no reason whatsoever. It would be better if we actually used them in context of what we're actually going to use them for.

Conclusion

The high-achieving students interviewed felt frustrated by the repetition of mathematical content they felt that they had already mastered. They did not believe that the mathematics they were doing provided them with sufficient challenge, nor that lower-achieving student were being well served by the strategies their teachers were employing. Moreover, students maintained that applying mathematics to real situations was better than completing many, similar, context-free, arithmetic exercises. This, of course, resonates with the literature on effective mathematics teaching (e.g., Doig, 2005; Department of Education, Science and Training, et al., 2004).

These results also confirm those from the IMYMS student surveys, where the four items (of the 24) that most primary students found "very helpful" for learning mathematics were: "Being able to choose how I present things"; "Doing hands-on activities"; "Doing investigations or projects of my own choice"; and "Doing activities that challenge me to think". "Doing worksheets" only rated fifteenth. The results align with the IMYMS *Components of Effective Teaching and Learning* that focus on conceptual challenge,

supporting meaningful understanding, and linking with students' lives and interests (Doig, et al., 2005).

The reactions of pupils to what occurs in the classroom has been identified, by teachers themselves, as one of the most important determinants of their practice in several studies, with the influence that pupils exert on teachers being seen by Bishop and Nickson (1983) as stemming from "the part they play in the social arena of the classrooms" (p. 15). Although the results from the interviews may be seen as only confirming other data, these students' comments provide richer insights for teachers and researchers than would otherwise be available. As in McIntyre, Pedder, and Rudduck's (2005) study, students provided constructive advice on what helps their own and other students' learning. However, unlike that study, the timing of our interview meant that there was no opportunity for teachers to act on these views. Although teachers in the IMYMS project were provided with summaries of the student responses to the written surveys, based on our experience with the interview we would recommend that projects focusing on improving classroom practice consider the incorporation of student interviews at an early stage.

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