EFFECTIVE MATHEMATICS LEARNING IN TWO AUSTRALIAN PRIMARY CLASSES: EXPLORING THE UNDERLYING VALUES

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Mathematics educational research on high performing countries highlights the role of cultural values. This paper reports on the qualitative phase of a project, which aims to identify some of the values underlying effective mathematics learning in the primary classroom, and to explore how these were valued by the teacher and students. Amongst the 13 values negotiated in the six hour-long lessons, 'example', 'sharing', 'resources', and 'multimodal representations' were embraced by students across all ability groups. In the negotiation of conflicting values between teachers and their students, it was found that the teacher's authority and his/her awareness of what s/he values play important roles.

WHY THE FOCUS ON VALUES

Particular mathematics pedagogical practices of high performing countries in international comparative assessments such as TIMSS and PISA have been known to be adopted by some education systems. However, a successful practice in one culture does not necessarily transfer to another culture automatically.

Problems with transplanting pedagogical practices or resources across cultures may be socio-cultural in nature. For example, commenting on the adoption of Singapore mathematics textbooks in several American states, Alan Ginsburg identified societal differences between the two countries (e.g. student exposure to mathematics tuitions after school, and differences in teacher professional development) (Gowen, 2001). These cultural differences are unlike more trivial ones such as the metric versus imperial systems of measure (which can be easily addressed), in that they reflect differences in the way societies value (mathematics) education. Similarly, Li (2007) attributed differences in algebra content in textbooks from mainland China, Hong Kong, Singapore and USA to differences in cultural values.

The role of values in shaping mathematics curricula – intended, implemented and attained – across cultures is highlighted in a report commissioned by the Nuffield Foundation (Askew, Hodgen, Hossain, & Bretscher, 2010). It started out thus:

> one of the most striking things the review has shown is that high attainment may be much more closely linked to cultural values than to specific mathematics teaching practices ….[S]tudy after study shows that countries ranked highly on international studies – Finland, Flemish Belgium, Singapore, Korea – do not have particularly innovative teaching approaches …. Culture, beliefs and dispositions have all come through strongly as powerful influences in learning mathematics and we explore these in some detail in this report. (p. 12)

The level of culture at which such values manifest themselves exists beyond the nation. In fact, it appears to be more useful to acknowledge the diversity of cultures

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within any nation. In Australia, for example, Suliman and McInerney (2006) found that despite research showing that students of non-English speaking background achieved better than other students, the same could not be said of Lebanese-background students' performance. The Lebanese-background students' valuing of *power* also negatively impacted on their attainment in school.

This paper reports on a study which aims to identify some of the cultural values that underlie effective mathematics lessons in Australian primary schools, and to explore how these were co-valued by the teachers and students involved. It is part of a wider, multinational research project, the Third Wave project, investigating how culturally-specific values underlying effective mathematics lessons might be harnessed to optimise mathematics education in schools. In the next section, the notion of values in mathematics education will be discussed. This will be followed by the research design and research context, before the results and findings are presented.

VALUES RELEVANT TO MATHEMATICS EDUCATION

Not all values relevant to mathematics education are contextualised within ethnic groups or countries. Alan Bishop had in the late 1980s proposed the construct of values based on the mathematics discipline, in the form of three complementary pairs of mathematical values, that is, *rationalism* and *objectivism*, *control* and *progress*, and *openness* and *mystery* (Bishop, 1988). The mathematical value of *objectivism* was later replaced by *empiricism* (Bishop, Clarke, Corrigan & Gunstone, 2005).

In the mid-1990s, Bishop (1996) conceptualised values relevant to mathematics education as those which are not only embedded in the discipline, but also in the learning context and in the society within which it is situated. He proposed the categories of mathematical values, mathematics educational values (e.g. *neatness*), and general educational values (e.g. *honesty*). Seah's (2005) research highlighted the influence of the education authorities and school organisation on the learning experience in the classroom, proposing an additional category of institutional values (e.g. *professional development*).

Seah's (2005) research with mathematics teachers revealed how the values subscribed to by principals, parents and students can be in conflict with those held by the teacher, as well as how these convictions were negotiated or co-valued as part of establishing the didactic contract in the class. An understanding of the values negotiation process is thus crucial to any attempt at harnessing values underlying effective pedagogy. As such, this process has also been explored in this study.

RESEARCH DESIGN

This study constitutes the qualitative phase of the sequential mixed methods design for the wider project. Working with a small group of participants in this phase has allowed for the depth of understanding required to identify underlying values and to explain how these had been negotiated in the classroom learning context. The findings arising from this study are expected to inform the construction (content and wording) of relevant data-collection instruments for the quantitative phase.

The methods adopted in this study were lesson observations, interviews and artefact analyses (of photographs and journal entries). For each class, three lessons lasting

about an hour each were visited over a month. During the lessons, each student participant was provided with a digital camera with which to record the moments when s/he felt that mathematics was learnt particularly well. The use of digital cameras as recording device served two purposes: one, photographs taken through the camera lens reveal the pedagogical context from the students' perspectives and angles. More importantly, through the production of 'photovoice' (Wang & Burris, 1997), the students became the ones nominating what constituted data. This focus on students' opinions and views reflects Loughran and Northfield's (1996) view that "quality teaching requires learner consent" (p. 124), "compared to teaching in which it is assumed that learning can be mandated" (Loughran, 2010, p. 49).

After the lessons, the students were asked to review the photographs taken. These then served as conversation stimuli during the post-lesson focus-group sessions, in which semi-structured interview questions probed for what the 'moments of effective learning' looked like, how contradicting values were negotiated, and what eventually were co-valued in the class.

On the other hand, the teacher participants maintained a journal for 4 weeks before the lesson visits, in which they shared their experiences of effective lessons taught, reflecting on what they thought were being valued by them and their students in such situations. They were also individually interviewed after each student focus-group interview, in which similar questions were posed. These semi-structured interviews also allowed the teachers to comment on what their students said in the focus-group interviews. Cross-checking of data was also achieved through preliminary analyses conducted between visits, for follow-up (if needed) in the next visits.

Interview audio-records were transcribed into verbatim format. All data were analysed through the three-stage open, axial and selective coding which typifies the grounded theory research approach proposed by Strauss and Corbin (1990).

RESEARCH CONTEXT

Two teachers, Kellie and Yasmine, from a government primary school in suburban Melbourne took part in this study. Many of the parents associated with this school are Generation Y-ers representing diverse ethnicities. That classes in the school were not streamed, that both Kellie and Yasmine were teaching in Grade 5, and that they planned their lessons together, all contributed to the similarity across the two classes.

Kellie was an experienced classroom teacher and a mathematics leader within the school. She possessed 8 years of teaching experience across different grade levels in 2 different schools. One the other hand, Yasmine was a 'first year out' teacher; having completed a pre-service primary education degree a year before. There were much communication and co-planning between these two teachers.

Each teacher was invited to nominate 6 students, 2 each of whom had been perceived by the respective teachers as being of high, average and below average abilities. The different ethnicities of the students served this study well, in that it allowed for a more comprehensive list of values operating in the Australian classroom to be made.

To identify the values associated with effective mathematics lessons, participants were asked periodically to specify what were regarded as being important to them in

relation to the 'moments of effective learning', and why. Often, these reasons would reveal underlying, cultural values. For example, schools in Japan and England may value *lesson study*, but it is only through 'peeling back the layers' would this apparent similarity give way to the culturally-different values underlying the adoption of this pedagogical approach (see Askew, Hodgen, Hossain, & Bretscher, 2010).

WHAT THE STUDENTS AND THEIR TEACHERS CO-VALUED

The values that were nominated by the students as being associated with moments of effective learning are listed in Table 1 according to teacher, gender, and ability levels. In the Table, students are represented by codes made up of two alphabets and a numeral. The first alphabet (K or Y) represents a student's teacher. The second alphabet (H, M or L, which represents high, medium and low respectively) associates the student with the ability level perceived by his/her teacher. The numeral differentiates between the two students in each ability group in each class.

Values	Kellie's students		Yasmine's students	
	Male	Female	Male	Female
Examples	KH1	KM1, KL2	YH1, YM2	YH2, YM1, YL1, YL2
Sharing	KH1, KL1	KH2, KM2, KL2		
Resources			YM2	YH2, YM1, YL1
Multimodal representations	KL1	KH2, KM1		
Explanation	KL1	KM1, KM2, KL2		YL1
Fun	KH1		YM2	YH2
Doing mathematics			YH1, YM2	
Efficiency				YH2, YM1
Competition			YH1	YH2
Questions		KM1		YM2
Certainty				YL2
Assistance				YH2
Individual effort			YM2	

Table 1. Values associated with effective mathematics lessons.

A total of 13 different values appear to be co-valued by the 2 teacher participants and their 12 students in 6 lessons, these being *examples*, *sharing*, *resources*, *multimodal representations*, *explanation*, *fun*, *doing mathematics*, *efficiency*, *competition*, *questions*, *certainty*, *assistance*, and *individual effort*. They have been listed in Table 1 in groups according to their being embraced by students across all three ability levels, any two ability levels, or unique to any one ability level. In particular, the values of *examples*, *sharing*, *resources*, and *multimodal representations* were embraced by students from all three ability levels, with implications for better catering to the learning styles and needs of mixed-ability classes.

It can be argued that the valuing of *examples*, *resources*, and *multimodal representations* during effective moments of mathematics learning emphasises the importance of concrete and semi-concrete support materials. Askew, Hodgen, Hossain and Bretscher's (2010) review had revealed that "one major finding … is the evidence of more use of formal and abstract strategies by Chinese pupils than by American counterparts" (p. 32); to what extent then does the Australian mathematics education culture reflect this difference between the East and the West? What might the implication be, given that the valuing of *challenge* was not evident in this study (which echoes Ainley, Kos and Nicholas' (2008) finding that Year 8 students in Australia did not feel challenged in mathematics lessons)?

Sharing was also valued by students across all perceived ability groups. This value was expressed through either peers sharing (e.g. student KM2), or students' own sharing with their respective peers (e.g. student KH2). It was also reflected in the effective learning that arose from groups of friends working together on mathematical tasks (e.g. student KH1). This association of *sharing* with effective mathematics learning is perhaps not surprising in the Australian (educational) culture, in which children starting formal schooling are already expected to show-and-tell regularly in front of their classmates.

In this qualitative phase, data had been gathered from only 2 classes; no claim can be made yet that they represent all the values associated with effective mathematics pedagogy in the Australian classroom. Rather, the quantitative phase of this project will be designed to derive lists of values representative of different cultural groups.

FEATURES OF THE VALUES IDENTIFIED

A feature amongst the 13 values identified in this study has been that the same one value might be expressed as different pedagogical practices. For example, *sharing* was valued both in terms of students discussing problem-solving strategies in groups, as well as in terms of individual students explaining their reasoning by the whiteboard. This focus on values rather than on specific pedagogical activities may well enable us to better cater to mixed-ability groups of students.

There were 2 male and 4 female student participants from each class. In this context, there is no evidence from Table 1 that gender affects the values associated with

effective mathematics learning. This aspect of values nomination will be probed further in the quantitative phase of the project.

As is evident in Table 1, values associated with effective mathematics learning may be common across all student ability groups (*examples*, *sharing*, *resources*, and *multimodal representations*), between the high and average ability groups (*fun*, *doing mathematics*, and *efficiency*), and between the average and below average ability groups (*explanation*). These may also be unique to high ability students only (*competition*, and *assistance*), to average ability students only (*questions*, and *individual effort*), or to below average students only (*certainty*). The high and below average ability groups did not share any value in common.

While equal representation of students in the three ability groups has allowed us to identify what were valued across these groups, the prevalence of individual values would not be immediately obvious. For example, the current data do not demonstrate how *fun* and *explanation* were highly valued in mathematics lessons (see Seah & Ho, 2009). They did show, nevertheless, that both these values were embraced by average ability students; their dominance (see Seah & Ho, 2009) can be deduced by considering the relative proportion of these students in the population generally.

HOW CONTRADICTING VALUES WERE NEGOTIATED

The teacher and his/her students bring to the lesson different values, some supporting one another, but others in conflict. As discussed earlier, values enacted through pedagogical activities in the mathematics classroom would have been negotiated between the teacher and his/her students. It is an aim of this study to explore the nature of such values negotiation processes, as situated meanings and subjective intentions are brought to bear.

The following accounts by Kellie demonstrate how she typically negotiated about differences in values between herself and her students. Here, she was talking about her valuing of (mathematical) *language* in mathematics learning:

> Sometimes I will actually be very frank with them and say, "you need to know this language, because you are not going to understand it when you get to another teacher." And they go, they sit up and go, "okay, now I really need to know. She's [Kellie] been fairly harsh." And once I do that, they go, "okay," and they take notice, and they think that's important, whereas if I don't put an importance to it, they'd just go, "okay, that's not that important." (Kellie, KI3 0138-0256)

whereas there were also times when

> I kinda listen to them [ie her students] a little, and goes, "well, this is what they think is important or they do, so I try to manipulate it to the way they like it. (Kellie, KI3 0000-0048)

Quite clearly, Kellie was aware of her authority as teacher in the classroom, and certain of the pedagogical values she embraced. Here, she valued student command of mathematical language in that it would position the students well to understand the

pedagogical discourse of other mathematics teachers. While her students appeared to respect her valuing of *language*, Kellie would also give in to certain aspects of this valuing without sacrificing the 'big picture'.

Yet, such contestation of values as they relate to mathematics pedagogy was not always a straightforward process; it could be a work-in-progress, as demonstrated by Yasmine's experience. The problems she faced in dealing with the contradictory values of *explanation* and *listening* were attributed by her to a relative lack of professional experience, wherein "I think a lot of it comes up to, probably being first year [in the job]" (Yasmine, YI3, 1131-1135).

DISCUSSION

This study constitutes the qualitative phase of a wider project. The nature of this phase has allowed for the identification of 13 different culturally-based values related to effective mathematics learning in two Australian primary school classes. While there was no evidence of gender effect, it will be probed further in the quantitative phase of the study. Student ability appeared to be a factor governing what were co-valued. Nevertheless, four values (i.e. *example*, *sharing*, *resources*, *multimodal representations*) were found to be embraced by students across all ability groups.

This study also seeks to understand how teachers and students responded to situations when their values were not in agreement with one another. The data collected suggested that with professional experience and with the authority teachers command in class, teachers' explicit knowledge of what they value in (mathematics) education is a key factor in guiding the way in which contradictory values are negotiated.

Given the small participant size in this study, these findings are by no means generalisable. Rather, the findings will inform the construction of relevant data collection instruments in the next, quantitative phase of the project, such as the questionnaire survey, the interview protocol, and the lesson observation protocol.

Nevertheless, these findings highlight the roles which (cultural) values play in facilitating effective mathematics pedagogy. An understanding of what these are and how they are co-valued in the didactic contract as they relate to mathematics teaching and learning should not be a complement to other approaches to mathematics education research and professional practice, but an integral part of these.

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