The Third Wave: Australian Students’ Perspectives of Effective Mathematics Learning in Primary Schools

Wee Tiong SEAH
Monash University, Australia
WeeTiong.Seah@education.monash.edu.au

Abstract
This study is the Australian component of an international research project which documents student-reported convictions co-valued by them and their teachers during moments of effective mathematics learning in class. The 2 primary school teachers and their 12 students associated effective mathematics learning with 13 different values. Although the teachers planned their lessons together and were teaching similar topics, there were differences in what were co-valued. Of the 13 values, examples, sharing, resources, and multimodal representations were found to be commonly valued by students across the ‘ability’ groups, while the others related to particular ‘ability’ groups. Teacher and student negotiation of values is observed to be works-in-progress, although teacher knowledge, confidence and identity remain significant factors.

Keywords: Values, Effective Learning, Australia, Primary School, Values Negotiation

This paper reports the findings of the Australian component of an ongoing multi-institution, international research project, The Third Wave: Study of values in effective mathematics education. It documents aspects of effective mathematics learning that are valued by students (and their teachers). In particular, the identification of values was stimulated through students’ perspectives, and these are seen to have been negotiated with and co-valued by their respective teachers.

Reflecting the wider, Third Wave study (see also Kor, Lim & Tan, this volume; Law, Wong & Lee, this volume; Peng & Nyroos, this volume), the values approach to pedagogy represents an unique perspective to the facilitation of learning, one which cuts across both cognitive and affective approaches. It is assumed that this third perspective to understanding pedagogy may well be the missing piece of the puzzle that makes up the composite picture of (mathematics) teaching and learning in the school classroom.

The discussion in this paper begins with a discussion of the constructs of effectiveness and of values in the context of mathematics education. A brief outline of the research design is followed by the presentation and interpretation of the results.

Effectiveness in Mathematics Education
The term effectiveness has different meanings to different people in different (mathematics) education contexts. For some, effective teaching may relate to high student achievement gains. In this perspective, Askew, Brown, Rhodes, Johnson and William’s (1997) study in the UK in the late 1990s with 90 primary school teachers and more than 2,000 students revealed that student performance was not necessarily related to specific teaching styles. Instead, effectiveness was associated with teachers who had ‘connectionist’ orientations (as opposed to ‘transmission’ or ‘discovery’ orientations), focused on students’ mathematical learning (rather than on provision of pleasant classroom experiences), provided a challenging curriculum (rather than a comforting experience), and held high expectations of initially low-attaining students.
Similarly, in identifying effective practices in mathematics teaching, the Australian study *What’s making the difference*: Achieving outstanding numeracy learning outcomes in NSW primary schools (Australia DEST, 2004) was guided by student performance in the Numeracy Assessment Instrument. "The schools which demonstrated greater than expected growth in numeracy achievement over the 18-month period focused on either the language of mathematics or the use of practical resources to support concept development in numeracy" (Australia DEST, 2004, p 162). Thus, as in Askew et al’s (1997) study, factors of effectiveness are phrased in generic ways, which can be actualised through several possible strategies in different contexts.

The various international comparative studies such as the Third International Mathematics and Science Study (TIMSS), and Programme for International Student Assessment (PISA) generally arrive at similar conclusions that effective teaching is more about responding to and valuing the sociocultural aspect of the pedagogical process than it is about adopting particular teaching methods. For example, the TIMSS 1999 Video Study data revealed that successful teaching of mathematics was not associated with any one pedagogical method; in fact, it was evident that amongst the high achieving countries a variety of teaching methods had been employed (Hollingsworth, Loken & McCrae, 2003).

These and other studies imply that effective teaching/learning of mathematics involves relatively macro-level valuing of relevant non-context specific convictions (such as the connectionist orientation), rather than any one particular teaching method. While a context-free quality such as understanding might be valued in a classroom situation, there can be various context-specific ways in which this is enacted, perhaps reflecting students' cognitive readiness. Effectiveness, then, is facilitated through socially-mediated practices and norms that are responsive to the unique sociocultural context of the classroom. Put differently, two classes with their inherent differences can both produce effective teaching and learning through the common valuing of a macro-level, context-free quality, which is actualised through differential actions and norms at the micro- and context-dependent level. Thus, an understanding of the values at work in effective classrooms, and professional enactment of these in ways which reflect the peculiar socio-cultural contexts of individual classrooms, might be another key to success in mathematics pedagogy.

**Values in Mathematics Education**

Values in mathematics education are "the deep affective qualities which education fosters through the school subject of mathematics" (Bishop, 1999, p. 2). They represent "an individual's internalisation, 'cognitisation' and decontextualisation of affective constructs (such as beliefs and attitudes) in her socio-cultural context. Values related to mathematics education are inculcated through the nature of mathematics and through the individual's experience" (Seah, 2005, p. 43), thus becoming the personal convictions which an individual regards as being important (Seah & Kalogeropoulos, 2006) in the process of learning and teaching mathematics.

Seah and Ho (2009) worked with 110 first-year pre-service primary teachers in Melbourne and Singapore, inviting them to draw their mental pictures of what the most effective moments of mathematics learning looked like in their experiences as learners. Values inherent in and expressed through the drawings were interpreted first by the individual researchers, then analysed together. It was found that the valuing of fun, whole-class interaction (see also Shimizu, 2009), and group interaction were dominant across Melbourne and Singapore.

The Third Wave project builds on the developing knowledge of the role of values and of valuing in optimising the effectiveness of mathematics teaching and learning. It seeks to unlock through students' perspectives the 'cultural codes' (Rapaille, 2006) that are negotiated and co-valued in mathematics lessons. From a sociocultural perspective,
the lesson represents an event which brings together a community within which complex interactions and discourses take place, where subjective intentions, situated meanings (Gee, 1999), and decisions are contested and negotiated. In Shimizu’s (2009) view, this co-construction of classroom practices “can be conceived as being in a mutually supportive relationship” (p. 79).

Specifically, this (Australian) component of the project seeks to shed light on the following research questions:

(a) what convictions are co-valued in the Australian classroom environment when middle years students find themselves learning mathematics particularly well?
(b) how are these values negotiated and co-emphasised by teachers and their students?

Research Design
The two teacher participants reported in this paper, Kellie and Yasmine, were practising in the same state primary school in suburban Melbourne. Many of the parents enrolling their children in the school are Generation Y-ers representing a multitude of ethnic cultures. Not only were Kellie and Yasmine teaching at the same level (grade 5), they also planned their lessons together. Given that students were not streamed into classes, the two classes were indeed similar in many ways, thus allowing for a sharper focus on the respective teachers’ roles in negotiating the range of values that played out in their own classrooms.

For each participating teacher, 6 students from her class were identified as potential student participants, based on teacher-nominated pairs of students exhibiting high, average and below average ‘abilities’ in mathematics learning. Parents of all these 12 students consented to their children taking part in this study.

Data were collected from lesson observations, interviews and artefact analyses (of photographs and journal entries). 3 lessons lasting about an hour each were observed for each class over a period of one month. During the lessons, the student participants were requested to identify and record (with the digital still cameras provided) moments when they found themselves learning mathematics particularly well. The student participants were earlier shown how to use the cameras (with the flash disabled). This way, student participants were able to exercise ‘control’ over the nomination of ‘moments of effective learning’, thereby enabling the production of ‘photo-voice’ (Lim, 2010). Another feature of student-generated photographs is the unique window into effective mathematics lessons from students’ perspectives and angles, as seen by them through the camera lens.

These photographs of ‘moments of effective learning’ also served as conversation stimuli during the post-lesson focus-group discussion sessions, in which semi-structured interview questions probed further for what were co-valued by students and teachers in effective mathematics learning, and how these were negotiated.

At the same time, data were also collected from the teachers, via the completion over a month of a teacher journal, as well as semi-structured interview sessions which were held after each student focus-group conversation session. Prompts in the teacher journal encouraged teacher participants to reflect and share what the features of their respective teaching practices were, and what might be regarded as important. Scheduling the interview sessions after having talked to the students had allowed for cross-checking with the relevant teachers aspects of academic interest that arose in the lessons observed and in the focus-group conversations that followed.

Lesson fieldnotes and digital audio recordings of both forms of interview sessions were transcribed into verbatim format immediately after each research site visit. Tentatively identified values and clarification questions were thus able to be followed up with the relevant participants in the next research site visit if required.

Preliminary analyses of data collected took place between visits to the research sites.
The cross-checked information that was subsequently gathered was transcribed and added to existing data files. All data were then analysed through a multiple-pass approach, utilising the three-stage open, axial and selective coding that typifies the grounded theory research approach proposed by Strauss and Corbin (1990).

Results

Kellie was an experienced classroom teacher with 8 years of experience, having taught in two different schools and across different year levels. She was a mathematics leader in the school visited. On the other hand, Yasmine was a ‘first year out’ teacher, having completed a pre-service primary education degree the year before. There was very close professional communication between Kellie and Yasmine, and planning lessons together was one of these articulations.

The values that have been identified by students as being associated with moments of effective learning are listed in Table 1 according to classes, gender, and teacher-nominated student ‘ability’ levels. In the Table, student codes (e.g. YS3) ending with 1 and 2 refer to students from the high ‘ability’ group; 3, 4, average ‘ability’ group; and 5, 6, below average ‘ability’ group. The values are also presented in 3 groups, namely, values that were embraced by students across all 3 ‘ability’ groups (the first 4 values), values embraced by students across any 2 ‘ability’ groups (the next 4 values), and values embraced uniquely by students in particular ‘ability’ groups (the last 5 values).

Table 1. Values associated with moments of effective mathematics learning

<table>
<thead>
<tr>
<th>values</th>
<th>Kellie’s students</th>
<th>Yasmine’s students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>examples</td>
<td>KS1</td>
<td>KS3, KS6</td>
</tr>
<tr>
<td>sharing</td>
<td>KS1, KS5</td>
<td>KS2, KS4, KS6</td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>multimodal</td>
<td>KS5</td>
<td>KS2; KS3</td>
</tr>
<tr>
<td>representations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>explanation</td>
<td>KS5</td>
<td>KS3, KS4, KS6</td>
</tr>
<tr>
<td>fun</td>
<td>KS1</td>
<td></td>
</tr>
<tr>
<td>doing mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>competition</td>
<td>YS1</td>
<td></td>
</tr>
<tr>
<td>questions</td>
<td>KS3</td>
<td></td>
</tr>
<tr>
<td>certainty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>working out myself</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Content analyses of interview transcripts, journal entries, and field notes reveal the co-valuing of 13 different convictions amongst the 2 participating teachers and their 12 students during moments of effective learning and teaching. Of the 13 values, 4 were observed operating across the 2 classrooms, with the remaining 9 being classroom-specific (1 in Kellie’s, 8 in Yasmine’s).

Rather than listing the 13 values according to frequency counts, they are arranged in the table according to the extent students from different ‘ability’ groups had associated them with effective moments of learning. That is, in this study, a conviction that is valued by students across ‘ability’ levels will be regarded as being more significant than one that is valued by any one ‘ability’ level.

As suggested at the beginning of this paper, the valuing of any conviction can take on different forms. For example, the co-valuing of sharing in Kellie’s class was operationalised in a variety of ways, such as through peer sharing in group settings,
and through individual students going up to the whiteboard to explain their reasonings. The values approach has allowed us to look beyond specific teacher or student actions to uncover an underlying factor (in this case, sharing) of effective mathematics learning. Observations arising from the data analysis process relate to the ways in which different values were evident in the two classrooms, the values which were common across and unique within student ‘ability’ groups, and the contestation of values in teacher-student and student-student interactions. These will be briefly discussed below.

The Teacher Factor
Given the various similarities between the two classes, it is noted that the co-valuing of sharing and explanation were overwhelmingly reported by Kellie’s students, whereas Yasmine’s students reported the co-valuing of resources in their effective learning of mathematics. This co-valuing of resources was demonstrated through the availability of different resources around the class, and the variety of resources utilised in classroom teaching. It appears then that Yasmine’s pedagogical scaffolding activities were at a more concrete level than Kellie’s, whose emphasis on sharing and explanation promotes interactions at a more abstract level. This observation reflects differences between Kellie and Yasmine, in terms of both professional experiences and identity.

There appears to be no evidence to suggest that boys and girls value different convictions. In each class, 2 boys and 4 girls participated in this study. Similar ratios between boys and girls are also reflected across the values shown in Table 1. However, the two boys in Yasmine’s class valued doing mathematics and working out myself when no other student participant (including the other boys) did. This possibly adds another dimension to the teacher factor of values manifestation.

The ‘Ability’ Factor
Student participants across all three teacher-nominated ‘ability’ groups had identified the co-valuing of examples, sharing, resources and multimodal representations during moments of effective learning. Additionally, the high and average ‘ability’ students also valued fun, doing mathematics, and efficiency, whereas the average and below average ‘ability’ students valued explanation. The high ‘ability’ students were also unique in their valuing of competition and hints, whereas only their peers at the other end of the spectrum valued certainty. Questions and working out myself were identified by the average ‘ability’ students only. It is also worthy to note that none of the values was commonly embraced by high and below average ‘ability’ students only. While the valuing of the same convictions by students in ‘neighbouring’ ability groups reflects the fine line that separate the groups, this difference in what is valued by the high and below average ‘ability’ students also highlights the priorities that differ amongst different learners, and how their respective learning may be best facilitated.

The co-valuing of examples, sharing, resources and multimodal representations across all ability groups in both classrooms is significant, given the oft-heard concern amongst teachers of the challenges of catering to the learning needs across a range of student ‘abilities’. This observation of common values across ability groups may indeed provide us with a way of organising and making sense of the variety of specific pedagogical actions that are known to relate to effective learning by different students.

Additionally, the findings also indicate what students of particular ‘ability’ groups value when they were learning mathematics particularly well. Although other students from similar grade levels in Australia had been found to value fun and explanation predominantly in mathematics lessons (see Seah & Ho, 2009), purposive sampling of student participants in this current study has allowed for a richer understanding of how these two values were valued by students of different ability groups, specifically, the high/average and average/below average ‘ability’ levels respectively. That students from the average ‘ability’ level valued both fun and explanation probably explains the
dominance of these values in that earlier study, whereas these two were not so
dominant in this study. This finding has implications for teachers facilitating optimal
mathematics learning of specific groups of students in classrooms. Similar conclusions
might be inferred from the high ‘ability’ group’s valuing of competition and hints, and of
the below average ‘ability’ students’ valuing of certainty.

Negotiation of Values in the Classroom
The interactions between teachers and their students invariably involve different values
crossing paths with one another as situated meanings and subjective intentions are
negotiated, resulting in the co-valuing of particular convictions. What might this
negotiation process look like?

An example pertains to the negotiation of the extent to which (mathematical)
language is co-valued in Kellie’s mathematics lessons. Although Kellie appreciated the
educational value in articulating the correct fraction language, co-valuing of language
by her students apparently took time to develop.

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
got 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 on it, they’d just go, “okay, that’s not that
important.” (Kellie, KI3 0138-0256)

Such negotiation of different values that are brought into the classroom discourse
has certainly not been unidirectional. For Kellie, for example, there are times when
I kinda listen to them [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 0135-0148)

The contestation of values is not a straightforward process, and may indeed be work-
in-progress. In Yasmine’s class, for example, her valuing of listening (to one another
sharing their mathematical ideas) had meant a pedagogical approach that was in
conflict with her and her students’ co-valuing of (teacher) explanation. Her attempts at
facilitating group activities to emphasise the pedagogical potential of listening was
challenged by students wanting her to explain the relevant mathematical content to
them instead. One reason why Yasmine valued listening was that
it’s like I’m not an expert [in mathematics], and sometimes I don’t know the
answer. So I’ll encourage, like, .... I mean, everything we’re investigating at
the moment like in Grade 5, 6, I pretty know, but if a word comes out, we’ll
sort of investigate together. (Yasmine, YI3 0932-1001)

At the same time, Yasmine attributed her valuing of explanation to the relative lack of
professional experience, in which
I think a lot of it comes up to, probably being first year, but I think, “oh, they
need to know this by the end of the year possibly.” I mean, to get that out, I
need to teach them all of these things. I don’t know if I, I mean, I guess it’ll
take time to ... I want to get better at them not relying on me, and so it’s
kinda scary that they do rely on me .... I don’t want to feel like I’m
regurgitating answers to them. I don’t want them to be thinking like that.
That is a bit scary. (Yasmine, YI3 1131-1216)

Yasmine did not appear to have resolved this contestation between her valuing of
both listening and explanation, although the latter was also valued by her students. In
the meantime, Yasmine’s practice reflected both values. It is possible that this
contestation of values would be resolved over time. Assumptions many be made that
as Yasmine becomes increasingly experienced, she might value explanation less.
However, given the reasonable argument that professional experience also contributes
to the confidence in one's content knowledge, listening may also become less important to Yasmine in the way she talked about it above. It would be interesting indeed to see how the contestation between student listening and explanation might take on a different form as professional experience increases, since this will likely lead to a corresponding de-emphasis of both values.

**Discussion**
This study seeks to identify the shared convictions associated with effective primary school mathematics lessons. The privileging of student voice represents a research methodology which aims to complement existing academic knowledge representing the voices of teachers and other adult stakeholders (e.g., see Anthony & Walshaw, 2008; Bryan, Wang, Perry, Wong, & Cai, 2007). This was achieved through the students nominating lesson moments which were significant to them. This approach also promoted student recall and stimulated conversations during the focus group interviews.

Two main findings will be discussed in this paper. The first finding relates to the values which students associate with effective mathematics learning. Kellie's valuing of sharing and explanation, compared to Yasmine's valuing of resources, indicated that the kinds of things that 'made the lesson click in my mind' appear to reflect the respective teachers' knowledge, confidence and identity. Given that the two classes were otherwise similar, it is noteworthy that nearly all student participants could personally relate at least one of these values to effective learning! On the other hand, while the co-valuing of examples, sharing, resources, and multimodal representations was evident across all three ability groups, additional convictions were identified by students belonging to specific ability groups. Both 'types' of values are of pedagogical significance, in terms of optimizing mathematics learning in mixed-ability classes and providing for specific ability groups within these classes.

The second finding demonstrates the complex nature of the negotiation of values in contestation, both intra- and inter-personally. Despite the several structural similarities between the two classes, the teachers experienced differently the contestation of values in negotiating their respective pedagogical discourse in class, thus highlighting the personal nature of values. Kellie's experience includes a certain amount of flexibility, of 'give-and-take'. On the other hand, in one of Yasmine's value negotiations, she seemed to be personally valuing both the values in question, even though her students were favoring one of these. For both teachers, the value negotiation processes continued to be works-in-progress, evolving as they did as teacher and students engaged with mathematics and with one another together in the classroom. The discussion in the previous paragraph suggests that teachers' knowledge, confidence and identity might be a significant influence, although what the class values as a whole is also a factor. Further research conducted through ongoing and future studies such as the Third Wave project should further deepen our understanding of the dynamics of value negotiation, and how teachers can possibly regulate this process to further enhance their pedagogical practices in mathematics and numeracy education.

**REFERENCES**
Australia Department of Education Science and Training [DEST] (2004). What's 'Making the Difference': Achieving Outstanding Numeracy Learning Outcomes in
NSW Primary Schools (Main Report). Canberra, Australia: Australia Department of Education Science and Training.


Copyright (c) 2010 Wee Tiong SEAH. The author grants a non-exclusive license to the organisers of the EARCOME5, Japan Society of Mathematical Education, to publish this document in the Conference Proceedings. Any other usage is prohibited without the consent or permission of the author.
PROCEEDINGS

The 5th East Asia Regional Conference on Mathematics Education (EARCOME5)

THEME:

IN SEARCH OF EXCELLENCE IN MATHEMATICS EDUCATION

Volume 2

Editors:
Yoshinori Shimizu
Yasuhiro Sekiguchi
Keiko Hino

Organizer:
Japan Society of Mathematical Education

Co-organizers:
The Association of Mathematical Instruction
Mathematics Education Society of Japan

August 18-22, 2010
Tokyo, Japan

ICMI-International Commission on Mathematical Instruction