# Bridging Understandings, Interest and Identity Gaps in a First Year Numeracy Subject

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Improving quality in the learning process, from a socio-cultural perspective, clearly involves more than adopting best instructional methods. This paper focuses on an attempt to provide a *quality* inquiry based instructional program for preservice teachers. Volunteered survey responses reveal contextual conditions which facilitate and constrain the bridging of gaps in conceptual understanding, identity and interest in mathematics. The paper may be of interest to teachers and teacher-educators, researchers and policymakers interested in providing quality learning experiences through flexible delivery methods.

A significant amount of research has been done on the development of mathematical proficiency and improving the *quality* of mathematics teaching and learning. Often this research is centered on what content should be taught and how it should be taught (Ball, 2003). However, as Walshaw and Anthony (2008, p. 517) state, "an understanding of what quality mathematics pedagogy looks like, specifically in relation to the vision of communal production and validation of mathematical ideas, is still in its formative stages." The *Years 1-10 Mathematics Syllabus* (Queensland Studies Authority [QSA], 2004) suggests that learning improves when students are engaged in an inquiry-based, thinking and reasoning learning processes. To be numerate for teaching mathematics effectively one has to have deep understandings beyond knowing what is needed to routinely carry out a procedure (Ball, Hill & Bass, 2005); learning to think mathematically and thinking mathematically to learn (Kilpatrick, Swafford & Findell, 2001) are also important. The aim of this paper is not to find the *best* approach, pedagogically speaking, but to identify contextual features that may improve the quality of the learning process in mathematics teaching and learning in teacher education. The research goal is to understand features of the learning context that facilitate or constrain the bridging of gaps to preservice teachers' conceptual understandings, identities and/or interest in mathematics.

## Method

This small scale research project investigates preservice teachers' perceptions about the possible reasons their disposition, understandings or interest in mathematics teaching and learning, or the discipline of mathematics, changed. The questionnaires were emailed to all 149, external and internal participants of a semester long subject, *Numeracy in Education* (ED1491) (Klein, 2008). The aim of the subject was to promote a learning process that would help preservice teachers develop strategic ways of thinking about, and working with, mathematics that could be applied to classroom contexts. Five questionnaires were returned from internal participants and 19 from external participants.

The questionnaire consisted of 'attitudinal questions' (Lankshear & Knobel, 2005) to specifically address the project objectives and to draw out possible reasons why (or why not) preservice teachers believed their mathematical identity, conceptual understandings and/or mathematical interest altered. The responses were divided into three sections, the learning process, the sociocultural context, and the inter/intra personal context. Questions were randomly placed in the questionnaire in order to cross check responses for

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consistency. The responses were then analysed to draw out recurring themes. Recognising the influence of the sociocultural context (Pressick-Kilborn, Sainsbury & Walker, 2005), a qualitative content analysis (Weber, 1990) was used to make valid inferences from data as intended by the participants. However, this sample cannot be generalised to a broader population; it is one instance to highlight potential reasons for action (Burns, 2000). Because understandings and learning contexts evolve, replicability of the results would be difficult. For brevity, the paper is divided into three sections; each section recounts what is known from past research and discusses the relevant findings of this project. The paper concludes with possible future research directions.

## The Context of a Process Approach to Learning Mathematics

For the quality of mathematics teaching and learning to improve, teachers need to learn and understand the specific practices that proficient learners and users of mathematics do, which should begin in preservice programs (Ball, 2003). These *mathematics practices* involve representing mathematical ideas through pictorial or symbolic notation, using these representations to justify the how and why of mathematical ideas, and then formulating mathematical generalisations. Thinking is enhanced when mathematical ideas can be represented internally in ways that enable the mind to operate on them (Hiebert & Carpenter, 1992), clearly evident in one preservice teacher's reflection:

> In the exam there was a question about the fraction 4/5 and initially I thought "I have no idea what that is in decimals etc." And then in my head it all clicked and a whole bunch of different representations came to mind and it all made sense.

Mathematics practices "play an important role in a teacher's capacity to effectively teach," although they are often left implicit in mathematics instruction (Ball, 2003 p. 34). As the preservice teachers investigated mathematical ideas, I encouraged them to use the practices to enhance effective communication and representation of mathematical ideas and relationships. I envisaged the learning process would help sense-making and validation of mathematical ideas, and for some it appeared mathematics was finally making sense:

> I felt it [mathematics] was all silly computations that made no sense at all. Now I can see that it is all interrelated and that it is possible to understand ...
>
> Instead of maths being a jumbled set of ideas ... I know have a much clearer idea of how to work things out for myself ... Instead of fear I now have a plan.
>
> I understand that it isn't about knowing everything, but about exploring the ideas and coming to my own understandings ... a challenge to my previous way of thinking.

Theoretically, the practices enabled the preservice teachers to cognitively develop Skemp's (1986) 'relational understanding' through recognising mathematical relationships. Also, it seems that for some, their appreciation of mathematics and their perseverance and persistence to make sense of mathematical ideas was increasing. However, the quality of the learning process was contextually bound showing interesting consequences.

## Mathematics Learning as a Socially Bound Context

As Vygotsky (1934) suggested, thinking is an interactive dialogue one has within the self, until people explain their thoughts, they are not sure what they are actually thinking. All respondents reported that as they represented, communicated and justified mathematical ideas, their mathematical conceptual understandings evolved. However, to

promote quality engagement in discussion that facilitates growth encompasses more than providing a conceptual framework to scaffold thinking. It involves a culture built upon support whereby participants respond and accept input without judgement (Groundwater-Smith, Ewing & Le Cornu, 2003). As Cobb (1994) argued, learning mathematics involves both a process of individually constructing knowledge and a process of enculturation into mathematical ways of being; one provides the background for the other. Whilst all respondents reported growing confidence and understanding, an underlying attitude of fear was prevalent, fearing discussion or fear of 'getting it wrong.' Although Kilpatrick et al. (2001, p. 129) minimised the contextual effect in saying, "they need only check that their reasoning is valid", both cohorts exhibited nuances suggesting a high need for validation of mathematical ideas and ways of working.

> Still have a fear of getting it wrong and not wanting to discuss my ideas.
>
> This is how I approached it, I am not sure if it is correct, but ...
>
> I have no idea if I am on the right track. But am comfortable to submit my answers...

However, different features of learning were evident in the two contexts. For example, the time delay as part of online discussion enabled participants to read, digest, reflect and then comment intelligently. They could reflect on the dialogue and recognise connections between the ideas, thereby promoting cognitive development (Skemp, 1986).

> Ok, done some more thinking ... Here's what I come up with...

Conversely, the immediacy of face-to-face discussion limited contemplative time. Hence, those with reflective natures were inclined to sit on the periphery and leave more articulate students to dominate both actions and discussion, as pointed out in previous studies (Baxter, Woodward & Olsen; and Ball; in Walshaw & Anthony, 2008).

Whilst dominance may be problematic in face-to-face learning contexts, this was a positive feature of the online learning environment. For instance, one person dominated discussion in six of the 10 online discussion groups, or maybe the term 'led' is more applicable. This person was positioned as the expert other shifting the reliance from the teacher to peers. Whether the positioning was self or group created is uncertain. Initially, I was concerned; if others were being positioned or positioning themselves as novices, discussion may be inhibited. However, to my surprise, greater group participation was evident in these six groups than the other four; between 247 and 314 posts compared to between 33 and 129 posts. The challenge is to create an equitable learning context, face-to-face or virtual, whereby all participants recognise themselves as becoming experts.

## Mathematics Learning – An Identity Crisis

Adding on to the cognitive and sociocultural domain is the notion of identity–how learners perceive themselves. This paper examined the sociocultural context of identity, focussing on how preservice teachers' identities are constructed or transformed in relation to other participants, and in relation to the mathematics and the learning of mathematics. Engagement in quality learning processes does not necessarily facilitate changes to interest levels or identity constructs. The desire to change comes from within, unless [preservice] teachers feel a sense of ownership over new professional development ideas they may be hesitant to change (Farmer, Gerretson & Lassak, 2003). For instance, at the start of the semester one group of preservice teachers positioned themselves at the back of the room, talked through lectures, and left at the earliest possible opportunity. As the semester drew

to a close this same group had repositioned themselves around a large table to enhance collaborative investigation. These comments capture the essence of their experience:

> What this subject did for me was explain some of the reasoning behind some of the rules that I had been directly taught instead of being lead to discover for myself. For example, the formula of a circle was something I always knew however now I know how and why it works.
>
> Now I realise that my anxieties have been cause by my [past] experiences in the subject, not the subject itself.

Certainly there were changes. Knowing how to represent mathematical ideas in ways that others could make sense of the mathematics was considered effective and facilitated change. However, self perception can constrain change. For instance:

> To be honest, I would still probably prefer that there was a relief teacher who would come in every time there was a maths lesson to be undertaken, but there has been a definite lessening of apprehension.

In conclusion, the context and individual are not separate from the curriculum, whilst the mathematics being delivered may be of 'high quality', the context through which collaborative investigation takes place is constantly evolving as is the way in which one communicates with oneself in the form of inner speech. The quality of inner speech is a lingering issue that needs further investigation, in relation to what it takes to unlearn negative thoughts about one's own mathematical competence and confidence.

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