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Identity as a Lens to Understand Learning Mathematics: Developing a Model

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In this discussion article we consider mathematics learning as a process of developing a mathematical identity. This process is constituted by relationships between three key components – the teacher, the students and the discipline of mathematics. It is posited that the teacher's role is to facilitate the development of students' mathematical identities by relationally bridging student and the subject. Fundamentally, this requires that mathematics teachers have well-developed personal mathematical identities.

Research over many years has highlighted a number of persistent issues related to participation and engagement in mathematics (e.g., Australian Academy of Science, 2006; Grootenboer & Zevenbergen, 2007). Despite being well aware of these problems for some time, there appears to have been little progress towards improving the situation and still many students hold unhelpful and unhealthy views of mathematics, and participation in mathematics classes at the higher levels continues to diminish. Recently, some researchers and writers (e.g., Boaler, 2002) have turned to an *identity* conceptual framework to try and better understand learning in mathematics and possible approaches for tackling these tenacious issues.

In this discussion paper we consider a concept of identity as a framework for theorising learning in mathematics. An initial model is presented that simply captures some of the salient features of the learning milieu of the mathematics classroom, and it posits that the teacher's role is to facilitate the development of students' mathematical identity by relationally bridging student and subject. The implications of this view of learning mathematics are then discussed with particular reference to the need for teachers at all levels to have a personally well-developed mathematical identity.

Learning in Mathematics

Many researchers and theorists have considered how mathematics is learned, each foregrounding different aspects of the learning process and viewing it from a range of theoretical frameworks. More recently, the notion of *identity* has been employed to try and bring about greater understanding of learning in mathematics, and perhaps provide some insights into how the perennial issues facing mathematics education may be addressed.

Identity is a term that has been employed by writers and researchers from a range of theoretical perspectives including the psychological (e.g., Erikson, 1968), the socio-cultural (e.g., Boaler, 2002), and the post-structural (e.g., Walshaw, 2004). There are clear epistemological differences between these perspectives, but Grootenboer, Lowrie and Smith (2006) suggested that the plurality of theoretical lenses may indeed provide a richer and more comprehensive understanding of the issues of identity in mathematics education. While we do not want to ignore, simplify or diminish the theoretical debate about the concept of *identity* (see Sfard & Prusak, 2005), in this article we want to focus on the development of student's identity in mathematics, and the relationship between students' mathematical identities and the discipline of mathematics. For this purpose we view identity as "how individuals know and name themselves . . . , and how an individual is recognized and looked upon by others" (Grootenboer, et al., 2006, p. 612). Identity is a unifying and connective concept that brings together elements such as life histories, affective qualities and cognitive dimensions.

In their mathematics classes, students learn more than just mathematical concepts and skills, and they are involved at more than just a cognitive level (Boaler, William, & Zevenbergen, 2007). Furthermore, Putman and Borko (2000) stated that, "how a person learns a particular set of knowledge and skills, and the situation in which a person learns, become a fundamental part of what is learned" (p. 4). With this in mind, identity is a useful concept to explore and understand mathematical learning because it includes the broader context of the learning environment, and all the dimensions of learners' selves that they bring to the classroom. Furthermore, the goal of mathematics education is to develop students' mathematical identities.

A focus on students' mathematical identities does not diminish the need for the development of mathematical skills and knowledge, but rather it encompasses them alongside other important dimensions such as attitudes,

beliefs, emotions and dispositions. Moreover, because the various dimensions are complexly inter-related, a focus on the identity means they can be considered simultaneously.

The development of students' mathematical identities has become increasingly important as technological advancement requires greater mathematical competence and confidence (Kilpatrick, Swafford, & Findell, 2001; Zevenbergen, 2005). Problems of disengagement and non-participation in mathematics have tenaciously persisted for many years, as have concerns about mathematical achievement and poor attitudes and dispositions, and it is hoped that an investigation of mathematical learning as identity development may offer some new insights into how these issues can be ameliorated.

The Learning Milieu of the Mathematics Classroom

As highlighted above, the mathematics classroom is made up of many interacting and complex dimensions. Three significant aspects are the student, the classroom community, and the discipline of mathematics (see Figure 1). The teacher is the key dimension of the classroom community, hence it is highlighted in Figure 1 below. These are not exclusive dimensions or clearly defined, because, for example, the student is part of the classroom community, and each aspect is complexly networked to a diverse range of other individuals and communities beyond the immediate classroom context.

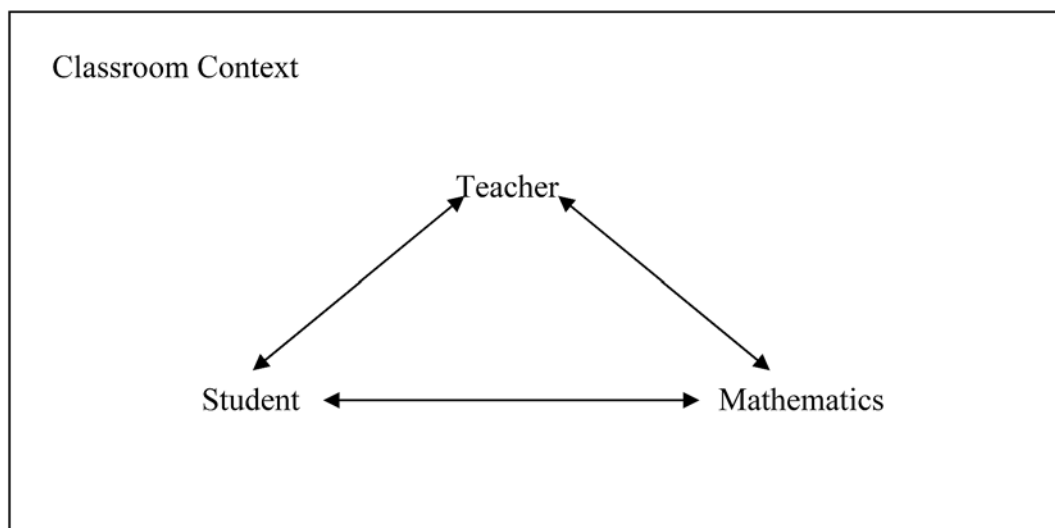


Figure 1: The learning milieu of the mathematics classroom

The Student

The student's identity has many facets (or some would say that they have multiple identities) formed through their life history and engagement with their peers, family, etc. Their identity incorporates their knowledge, abilities, skills, beliefs, dispositions, attitudes and emotions, and these broad conceptions of 'who the student is' are brought to the mathematics classroom. The student comes to the mathematics classroom as a member of some sort of family community and they will be immersed in, and a part of a generational culture, meaning that their perspectives can be quite different from that of their teachers. Zevenbergen and Zevenbergen (2007) discussed the characteristics of *millennials* and the implications of this new generation of students coming to school, particularly in the context of different cultural identities meeting in the mathematics classroom. While there are a range of affordances and issues inherent in this coming together of generational identities, the key point here is students enter the mathematics classroom with dimensions to their identity that are an integral part of their mathematics learning.

As noted above, students' (and teachers') identities incorporate a range of dimensions, including knowledge, abilities, skills, beliefs, dispositions, attitudes and emotions related to mathematics and mathematics learning – their mathematical identity. These will have been significantly influenced by their previous experiences of mathematics education, and, they will be integral to their future learning on mathematics.

The Discipline of Mathematics

The discipline of mathematics is an important dimension because it is the distinguishing characteristic of the learning context. We have been concerned that the *mathematics* of mathematics education is being diminished in recent years, and pedagogy is largely generic with the mathematics only providing the particular flavour. While we agree that there is value in considering pedagogy in general, we think that this is insufficient for the development of mathematics education. Our firm conviction is that mathematical pedagogy is fundamentally different from other subject pedagogies, because the nature of practices of mathematics are fundamentally different from other disciplines. Indeed, we think it is important that greater attention is paid to the *mathematics* of mathematics education if progress is to be made with the perennial issues outlined in the introduction. The focus on the development of students' *mathematical identity* provides an appropriate focus on the discipline of mathematics and the learner.

Previously (Grootenboer & Zevenbergen, 2007) we have discussed the importance of considering the nature of mathematics and the practices of mathematicians when theorising about learning mathematics. After studying classrooms in Britain, Boaler (2003) found that the mathematical epistemology that underpinned the teacher's pedagogy significantly influenced the mathematical identity developed by the students. While the nature of mathematics is a contested notion (Davis & Hersh, 1998), it appears that the characteristic of *school mathematics* is often quite different from the nature of mathematics undertaken by mathematicians. This was noted by Burton (1999, 2001, 2002) when she found that the mathematical identities of mathematicians were characterised by emotional, intuitive, and affective dimensions, and their practices were usually collaborative and about finding connections.

The Classroom Community

The third important aspect is the classroom community, and this has the teacher as a significant feature (hence the significant place of the teacher in Figure 1), but it also includes the other students and the physical environment. The classroom community is complex and is significantly constituted and influenced by factors and connections beyond the immediate 'classroom walls'. Nevertheless, the mathematics classroom is to a certain extent a loosely bounded community where the intended focus is the development of students' mathematical identities.

Wenger's (1998) social theory of learning clearly related the development of a sense of identity and *communities of practice*. Within this perspective, identity is a constant process of becoming, where an individual continually negotiates who they are through their practices as they become and belong to a community (Smith, 2006). In the mathematics classroom, the community of practice includes all the students in the class, but is usually dominated by the teacher. Other defining factors in the community can be the curriculum, text books, and urban myths and stories about mathematics and mathematics teaching and learning.

The three dimensions (student, mathematics, and community) outlined above are each important, but if the goal of mathematics education is to develop a strong mathematical identity, then the critical focus is the relationship between the student and the discipline of mathematics. The facilitating context for the development of this relationship is the classroom community, and specifically the teacher, but the classroom community is temporal, and it will be the mathematical identity (the connection between student identity and mathematics) that will remain.

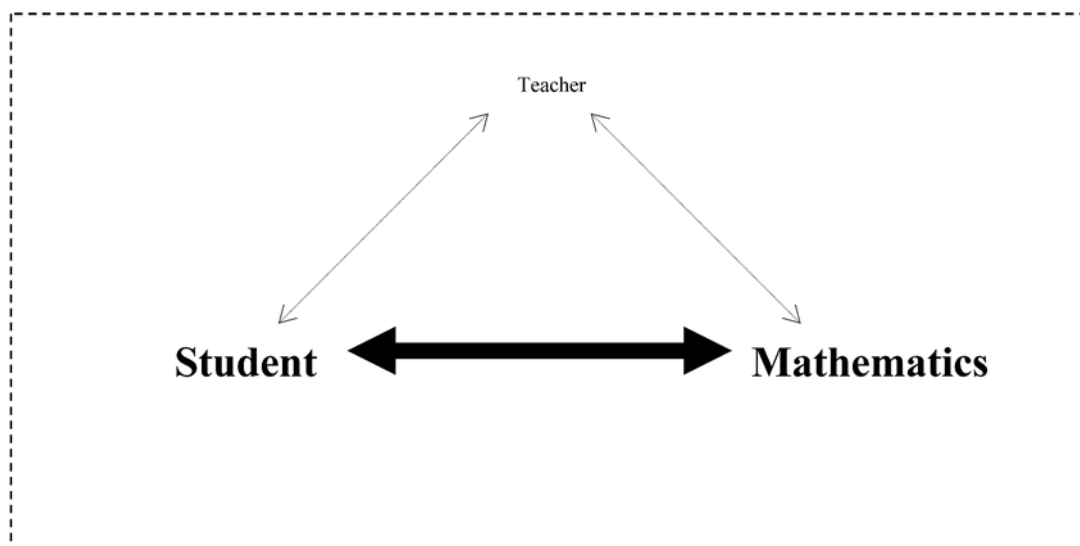


Figure 2: The relationship between student and mathematics is what remains

The Teacher: Bridging Student and Mathematics

At the beginning of a new teaching period when the students and teacher are united within a mathematics classroom setting, even the youngest children begin with a mathematical identity (or identities). Of course, this means that mathematics teachers in their role of developing mathematical identities, are not beginning with a blank slate, but in many respects it is a fresh start.

If a teacher is to be effective in developing students' mathematical identities, then the teacher must themselves have a well-developed mathematical identity. This would include significant mathematical knowledge and skills, but also a positive attitude towards the subject, a sense of joy and satisfaction in undertaking mathematical practices. Furthermore, they must see mathematics as an integral part of their broader identity, and something that has helped define their sense of self and vocation. Mathematics must be more than just an inert body of information and skills that they try to pass onto to students. In describing effective teachers, Palmer (1993) suggested that they have and display a friendship-type relationship between themselves and their subject. Through this, "students are affirmed by the fact that this teacher wants them to know and be known by this valued friend" (p. 104).

The classroom context also requires that the teacher has a relationship with the students. In this sense, the relationship is more than just a social connection and includes pedagogical approaches. There has been much written about the characteristics and nature of quality pedagogical relationships between teacher and student, but here we want to highlight the importance of the student – teacher connection in building students' mathematical identity. Palmer (1993) suggested that effective teachers are able to connect with both student and subject, and in the process they facilitate the students' relationships with the subject – their mathematical identity.

The teacher, who knows the subject well, must introduce it to the students in a way one would introduce a friend. The students must know why the teacher values the subject, how the subject has transformed the teacher's life. By the same token, the teacher must value the students as potential friends, be vulnerable to the ways students may transform the teacher's relationship with the subject as well as be transformed. If I am invited into a valued friendship between two people, I will not enter unless I feel that I am valued as well. (p. 104)

The teacher's role in facilitating the development of students' mathematical identity is one of bridging student and subject. The goal of this bridging is to allow and invite students to develop a strong, enabling and warm relationship with mathematics – something the teacher themselves already enjoys.

Discussion and Implications

There are a number of issues that emerge from viewing mathematics learning as a process of identity development:

- the mathematics integral to mathematics classes must indeed be mathematical, and, the pedagogical approaches employed in mathematics classes need to be consistent with the nature of mathematics;
- the teacher must have a strong personal mathematical identity; and
- the teachers' role is temporal, and at the end of the teaching period it is the students' mathematical identities that will endure.

These issues and their implications will now be briefly outlined and discussed in turn.

Mathematics Education that is Mathematical

While this point would appear to be rather obvious, we are concerned that the form of mathematics presented in school mathematics classrooms is not consistent with the practices of mathematicians or the nature of the discipline. There is a concern that participation rates in mathematics are diminishing, and it could be that students are not rejecting mathematics per se, but rather the form of mathematics they experience at school. While we accept that there is much conjecture about the nature of mathematics, even amongst mathematicians, we believe that there needs to be philosophical discussion and debate about the epistemological foundations of mathematics education practice. This debate needs to extend beyond the walls of the university and engage with practitioners and teachers who ultimately enact and embody the forms of mathematics that pervade the classroom.

An inspection of most curriculum or syllabus documents will reveal some form of statement about the nature of mathematics and mathematical activity, often explicitly in an introductory section. These will often present mathematics as a unified, coherent and engaging discipline. However, what then ensues is a list of outcomes and objectives that, perhaps inadvertently, atomise mathematical knowledge into a series of small discreet pieces. Mathematics teaching that attends to the small details of the outcomes and ignores the 'big picture' of the introduction, leads to a form of mathematics that is disjointed and inconsistent with the nature of the discipline. In this way students can know 'bits of mathematics', but not know 'mathematics' in the same way that one can have pieces of a jigsaw without ever seeing the big picture of the puzzle.

The recent promotion in Australasia of numeracy, as the application of mathematics to real-life situations, has arisen to partly address this problem. The utilitarian epistemological foundation of numeracy attends to the misconception of many students that mathematics is useless and irrelevant. If indeed, students can see mathematics as integral to their life-world beyond the classroom, then they are more likely to engage with the material and develop a mathematical identity grounded in utilitarianism. However, mathematics is more than just numeracy and school experiences based only on the utilitarian value of mathematics will be denuded of much of the richness of the discipline. While there is not scope here to discuss this fully, we believe that it is crucial at this time to consider the impact of the numeracy-based approach to mathematics education and the developing mathematical identities of students.

Teachers' Mathematical Identities

As was highlighted previously, the mathematics teacher's role is as a relational conduit between the student and mathematics. To facilitate the development of students' mathematical identities the teacher shares their relationship with mathematics through their pedagogical relationship with the students. Of course, this is difficult if the teacher does not have a healthy and fond relationship with mathematics themselves – their mathematical identity. One wouldn't consider a music teacher who has no musical aptitude or appreciation, or a physical education teacher who is personally unhealthy and adverse to physical activity, and similarly a mathematics teacher who dislikes mathematical tasks and does not engage in mathematical activity should be an anathema. However, this is problematic at both the secondary and the primary level.

At the secondary school level, the shortage of well-qualified mathematics teachers has been known for some time and clear solution paths still appear elusive. Often mathematics classes are taught by non-specialist teachers, particularly at junior levels, and so their commitment to mathematics is at best divided, and frequently limited. Indeed, the problem is perhaps compounded by the decreasing number of students

studying mathematics at higher levels, thus creating a vicious cycle as there are less mathematics graduates who can become mathematics teachers. Furthermore, it appears that some mathematics teachers who have robust mathematical identities are perceived as being less committed to their pedagogical relationships with students (Picker & Berry, 2000, Grootenboer, 2001), thus they are still limited in their capacity to bridge student and subject.

Primary school teachers have the difficult task of teaching a range of disciplines. The idea of the teacher as a relational conduit between student and discipline sees the primary school teacher as needing to have a well-developed identity in a range of subject areas, including mathematics. While primary teachers do have strong discipline-based identities in a range of areas, it appears that often mathematics is not one of the favoured ones (Schuck, 1997). Again, this is not a problem that will be easily resolved, and quick solutions that are based on limited conceptions of mathematics need to be avoided. Perhaps, if there was a greater focus on the development of personal mathematical identities in preservice teacher education and professional development programs in mathematics, then teachers could appreciate and understand mathematics, and relate to it in a more personal manner.

The Temporal Role of the Teacher

The goal of learning in the mathematics classroom is the development of students' mathematical identities – their relationship with the discipline of mathematics. At the completion of the teaching period, the teacher is in a sense, removed from the triangle of relationships as shown in Figure 2, although they remain in the memories of the students and in the influence they have over the mathematical identities the students have developed. Because the teachers' role is ultimately finite and temporary, they need to teach their students so that they can become obsolete, and this implies that their pedagogical task will change over the course of the teaching period. What remains are the students' mathematical identities, and if they then go on to study further mathematics, this will be the foundation from which their new learning experiences will ensue. Regardless, it is important that students develop a robust and enabling mathematical identity.

Concluding Comments

In this paper we have tried to present some ideas and thoughts about learning and teaching mathematics using an identity framework. These ideas are not seen as comprehensive, but it is hoped that they may add another perspective to our understanding of students' mathematical learning. The relational model of mathematical identity development presented in this paper highlighted some issues of particular concern, particularly related to the nature of mathematics and the mathematical identities of teachers. We suggest that it is vital that classes that are named *mathematics* are indeed based on experiences that are consistent with the nature of mathematics. Also, we think that it is essential that teachers of mathematics (at all levels) have well-developed personal mathematical identities.

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