Teacher Identity and Numeracy: Developing an Analytic Lens for Understanding Numeracy Teacher Identity

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This paper reviews recent literature on teacher identity in order to propose an operational framework that can be used to investigate the formation and development of numeracy teacher identities. The proposed framework is based on Van Zoest and Bohl's (2005) framework for mathematics teacher identity with a focus on those characteristics thought to be particularly important for numeracy teacher identity.

Numeracy is identified in the Australian Curriculum as one of seven general capabilities and involves students developing "the knowledge and skills to use mathematics across all learning areas at school and in their lives more broadly" (Australian Curriculum Assessment and Reporting Authority, 2012, p. 24). The cross curriculum nature of numeracy and the role of *all* teachers in developing the numeracy skills of students has long been recognised (Council of Australian Governments, 2008; Department of Employment Education Training and Youth Affairs, 1997; Thornton & Hogan, 2004) but remains problematic. For example, a national survey of beginning secondary teachers from all disciplines found that only 55% saw themselves as teachers of numeracy and only a third felt that they were well prepared to teach numeracy (Milton, Rohl, & House, 2007). Although the percentages were higher for specialist mathematics teachers, it is of concern that 30% indicated that they did not feel adequately prepared to teach numeracy. A similar study focussing on practicing teachers does not appear to have been conducted, however there is no evidence to suggest that the situation is different for experienced teachers.

From 2013 the Australian Professional Standards for Teachers (Australian Institute for Teaching and School Leadership, 2012) will be used as the basis for teacher registration and renewal across Australia. Included in these standards, as part of the content and pedagogical knowledge required by all teachers, is the need to have appropriate knowledge and understanding to effectively support students' numeracy development. This along with the introduction of the Australian Curriculum makes it an opportune time to investigate the teaching of numeracy in all learning areas.

The Australian Curriculum for each learning area uses icons and online filters to identify the numeracy demands inherent in that learning area (e.g., Australian Curriculum Assessment and Reporting Authority, 2011); however an audit of the *Australian Curriculum: History* (Goos, Dole, & Geiger, 2012) revealed that although the numeracy demands were identified, there were numerous learning *opportunities* that were dependent on the teacher identifying them and choosing appropriate learning activities. As mathematics is the discipline that underpins numeracy this means that teachers must be able to recognise the mathematics inherent in a learning area and to use this mathematics confidently (Thornton & Hogan, 2004). In order to do this they need to see themselves as teachers of numeracy, in other words, develop an identity as a teacher of numeracy.

Interest in research into teacher identity has grown over the last decade. In an early review of literature in this area Beijaard, Meijer and Verloop (2004) found that teacher identity was defined in different ways and in some cases not defined at all. The studies they reviewed focussed on teachers' identity formation or on the characteristics of

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teachers' professional identity, or were the stories teachers told about how they saw themselves. This paper provides an overview of recent literature on teacher identity and, in particular, mathematics teacher identity in order to propose a framework that can be used to guide future research that investigates how teachers form and develop a numeracy teacher identity.

Defining Teacher Identity

Gee (2001) has argued that identity can be used to effectively explore issues in educational research. He states that a person's identity comes from "Being recognised as a certain 'kind of person' in a given context" (p. 99) and is the result of that person engaging in a particular combination of activities within that context. According to Wenger (1998) a person's identity is a negotiated experience as they reconcile multiple identities that result from their participation in various communities of practice (Lave & Wenger, 1991; Wenger, 1998) into a core identity (Gee, 2001) that holds across these contexts. For teachers their multiple identities will be derived from their participation in communities that include students in the classroom, colleagues and administrators in the school, and those they interact with outside the school context.

Sfard and Prusak (2005) argue that the definition described above doesn't acknowledge the important role of learning in providing a mechanism whereby individuals can move from their *actual* identity, the one that they currently have that is based on past experiences, to where they would like to be, their *designated* identity. They define identity as "those narratives about individuals that are *reifying*, *endorsable* and *significant*" (p.16). As such these stories describe who a person currently is, always hold for that individual, and are considered significant because any change in the stories indicates a change in identity. The inclusion of learning in the definition of identity is important as it recognises the dynamic nature of identity (Beijaard et al., 2004) and provides a mechanism for moving from a current to a designated identity. Sfard and Prusak's definition also recognises the role that past experiences or life histories play in forming an actual identity but does not include the need for individuals to reconcile multiple identities into a core identity. The process by which an individual moves from an actual identity to a designated identity is complicated because it involves learning in communities in which the individual participates but is also influenced by what Gresalfi and Cobb (2012) call the *normative identity for teaching*.. This is the set of attributes needed to be considered competent in a particular context and may vary depending on what the context is. For example the pedagogical practices promoted in a professional development context and adopted by a teacher may be in contrast to what is considered to be appropriate for teaching in their school context.

The preceding discussion identifies learning through participation in communities and life histories as contributing to teacher identity but to consider only these would be simplistic. Philipp (2007) draws on previous literature to define identity as:

> the embodiment of an individual's knowledge, beliefs, values, commitments, intentions and affect as they relate to one's participation within a particular community of practice; the ways one has learned to think, act and interact. (p. 259)

This definition, although not including consideration of multiple identities is useful from a practical point of view as it identifies characteristics that can be investigated through empirical research.

Characteristics of Teacher Identity

A comprehensive framework for the identity of mathematics teachers, developed by Van Zoest and Bohl (2005), incorporates the cognitive and social aspects included in Philipp's (2007) definition but omits the past experiences that teachers draw on (i.e., their life histories) to develop role models that shape their identity (e.g., Williams, 2011). The cognitive aspects in Van Zoest and Bohl's model include teachers' knowledge and an affective domain that includes *beliefs, intention and commitments* while the social domain is constituted by the teacher's participation in a number of communities of practice (Wenger, 1998). Although there is some debate as to whether beliefs belong in the affective or cognitive domain they will be included in the affective domain for this discussion.

Hobbs (2012) investigated what she called the aesthetic dimension of "teacher passion, coherence and identity" (p. 718), again combining knowledge and affective domains but not considering the social domain which others have found to be an important influence on teacher identity (Kelly, 2006; Lasky, 2005). Other researchers have reported on how confidence (Graven, 2004), emotion (Beauchamp & Thomas, 2009), motivation (Gresalfi & Cobb, 2012), and critical reflection (Beauchamp & Thomas, 2009; Bjuland, Cestari, & Borgersen, 2012; de Freitas, 2008; Goodnough, 2011) influence teacher identity. Despite this complexity Grootenboer and Zevenbergen (2008) describe identity as a "unifying and connective concept" (p. 243) because it brings all these characteristics together.

The characteristics that influence teacher identity formation and development do not act in isolation but are intimately connected, for example, lack of pedagogical content knowledge influencing confidence (Hobbs, 2012) and professional learning providing opportunities for increased critical reflection and confidence (Goodnough, 2011) The number of characteristics involved and their interconnectedness make it difficult for any study to adequately investigate all characteristics. As a result most research on teacher identity has focussed on one or two characteristics but this ignores the complexity of teacher identity. An alternative approach is to focus on those characteristics that have most impact in a given situation. Teachers have multiple identities (Beijaard et al., 2004; Gee, 2001; Wenger, 1998) that include their identities as teachers, as teachers of a discipline (if they are secondary teachers) and as teachers of numeracy. Therefore developing an operational framework that can be used to investigate numeracy teacher identity requires examination of each of the characteristics known to influence teacher identity to see which will have most impact. In doing so it is recognised that within this core numeracy teacher identity there will be multiple sub-identities that are context dependent.

Numeracy Teacher Identity

A framework for numeracy teacher identity needs to focus on those aspects of identity that seem to be particularly relevant to teachers providing opportunities for students to develop their numeracy capabilities. Focusing on these characteristics will provide a picture of the actual numeracy teacher identity of an individual and give some insight into what they perceive to be their designated identity.

The Knowledge Domain

The framework for mathematics teacher identity developed by Van Zoest and Bohl (2005) incorporates the seven categories of knowledge (content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge;

knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational ends, purposes, values and their historical and philosophical grounds) required for teaching (Shulman, 1987). Although all the knowledge categories are important those that are likely to be particularly relevant to numeracy teacher identity are mathematical content knowledge and the related pedagogical content knowledge because of the central role of mathematics in numeracy. These two types of knowledge can be defined in terms that are particular to the context of numeracy and there are several issues that can be identified for teachers in developing them. The mathematical content knowledge required is knowledge of the mathematics that is relevant to the learning area as well as well as an understanding of where and how this mathematics is used. Teachers must be able to identify not only numeracy demands but also learning opportunities (Goos et al., 2012). The pedagogical content knowledge needed will be an understanding of how to embed the numeracy so it becomes an integral part of learning (Thornton & Hogan, 2004). Central to this is an understanding of what numeracy is and what it means to be numerate, especially in the context of the learning area.

Participation in senior secondary and tertiary mathematics courses has been falling for some years suggesting that prior experiences of mathematics result in students having a lack of "confidence in [mathematics], do not enjoy or see personal relevance in it and are unlikely to continue its study voluntarily" (Council of Australian Governments, 2008, p. 21) Some of these students may enter pre-service teacher education courses with "general fear of contact with mathematics" (Hembree, 1990, p. 45) commonly known as 'maths anxiety' and negative attitudes towards mathematics (Carroll, 2005). Hembree (1990) found the highest levels of maths anxiety in college students were among students preparing to be primary teachers. High levels of maths anxiety in pre-service primary teachers were also found in a recent study by Gresham (2008) who also identified a link between high levels of maths anxiety and low levels of self–efficacy, in particular the pre-service teachers' beliefs in their ability to teach mathematics effectively. For primary teachers and secondary teachers whose discipline is not mathematics, their past experiences of mathematics that have caused these feelings will have impacted on their engagement with mathematics and therefore on the development of their mathematics content knowledge. Hodgen and Askew (2011) argue that in the case of primary teachers these negative experiences can lead to a disconnection with mathematics and that there is emotional difficulty involved developing the strong disciplinary bond that is necessary for teaching any subject. In secondary schools this can lead to the view that numeracy is the responsibility of the mathematics teachers (Thornton & Hogan, 2004). It seems reasonable to assume that secondary mathematics teachers would have the required mathematics content knowledge and pedagogical content knowledge for teaching numeracy. However, this may not be the case as a recent Australian research study found that one fifth of those teaching secondary school mathematics have not studied mathematics beyond first year at university and one in six have not undertaken any mathematics teaching methods courses (Harris & Jensz, 2006). For all teachers their pedagogical content knowledge related to numeracy will have been shaped by their beliefs about what numeracy is and how it should be taught.

The Affective Domain

Affective issues have long been recognised as important in the area of mathematics education and will therefore be important in numeracy education. As mentioned previously past experiences of school mathematics can lead to teachers disconnecting with

mathematics. Several studies (Grootenboer & Ballantyne, 2010; Hobbs, 2012; Hodgen & Askew, 2011), however, have found that it is important for teachers to make a connection to a discipline in order to teach it effectively. This makes the affective domain, especially confidence and beliefs about numeracy, important for numeracy teacher identity.

In order to have a strong numeracy teacher identity, teachers must have confidence in their ability to provide numeracy learning opportunities for their students. Lack of pedagogical content knowledge can lead to lack of confidence Hobbs (2012) but can be addressed by participation in professional learning (Goodnough, 2011; Graven, 2004). This professional learning can also lead to increased reflection, especially if the professional learning involves investigation of their own practice, as is the case in action research projects (Bjuland et al., 2012; Goodnough, 2011; Goos, Geiger, & Dole, in press).

Teachers' beliefs include their beliefs about content and how it should be taught, beliefs about students, beliefs about curriculum, and beliefs about themselves. Beliefs about numeracy and how it should be taught stem from teachers' understandings of what numeracy is and what it means to be numerate while beliefs about whether or not they can be effective numeracy teachers will be related to their knowledge and confidence. Beliefs are subject to change and can be influenced by teachers' interactions with others.

The Social Domain

Although teachers participate in a number of communities both within and outside the school environment, their interactions with colleagues, school administrators and professional learning communities are likely to have most impact on their numeracy teacher identity. Participation in these communities can promote or constrain their identity development as each community may have a different normative teaching identity and teachers must reconcile these when developing their core identity. This can lead to tension and sometimes practices that seem to be inconsistent with their identity in a particular context. For example, Hodges and Cady (2012) reported on how a middle school mathematics teacher reconciled her identities in the district, school, classroom and professional development communities in which she participated. They found that although the teacher's identity was moving towards becoming consistent with the professional learning community, on occasions her classroom practices were inconsistent with the views she expressed in the professional development context. These apparent inconsistencies can be viewed as part of the process of teacher identity development as teachers negotiate their identity across the different communities in which they participate.

In secondary schools in Australia teachers tend to be grouped into departments structured around learning areas. The normative teaching identity within this departmental community can influence their teacher identity. For example, Beisiegel and Simmt (2012) found that the developing teacher identities of graduate students as they became teachers of post-secondary mathematics were influenced by expectations of colleagues and workplace constraints. The normative teaching identity of the departmental community may be one that sees numeracy as mathematics in contrived contexts (Boaler, 1993) or as the responsibility of mathematics teachers (Thornton & Hogan, 2004).

School leadership can influence the development of teacher identity through school policies and by the way in which the professional development is promoted and supported. For example, Kendall-Jones (2011) found lower levels of negative attitudes towards mathematics in primary school teachers where the principal promoted coherent and sustained professional development in mathematics compared to teachers in a school where this was not the case.

Outside the school context teachers can be involved in professional learning communities that provide opportunities for "exploring new ways of being that lie beyond our current state" (Wenger, 1998, p. 263) thereby opening up the possibility for a new designated identity. Teachers will be able to move towards this new designated identity if they can see a pathway from their actual identity and they can see that the effort required to make the changes is worthwhile (Gresalfi & Cobb, 2012)

Future Research on Numeracy Teacher Identity

Investigating teacher identity is difficult because of its complexity but important because well-developed teacher identities are needed for effective teaching (Grootenboer & Zevenbergen, 2008). Therefore it is proposed that an operational framework that can be used to gain a better understanding of how teachers form and develop a numeracy teacher identity should focus on some characteristics known to influence teacher identity over others. This is not meant to downplay the contribution that other characteristics make to numeracy teacher identity but to acknowledge that some characteristics or nuances of these characteristics are more relevant for numeracy teacher identity than for the other identities that teachers have, such as their discipline teacher identity.

The proposed framework, based on Van Zoest and Bohl's (2005) framework for mathematics teacher identity, sees the following characteristics as crucial to numeracy teacher identity and is organised in four interconnected domains. Although life histories were not discussed separately they are placed in a separate domain because of the influence they have on characteristics of each of the other domains.

- Knowledge domain: mathematical content knowledge and pedagogical content knowledge
- Affective domain: beliefs and confidence
- Social domain: school communities and professional communities
- Life histories domain: past experiences of mathematics and teaching

Selection of these characteristics allows data to be collected so that case studies of individual teachers can be developed. Research questions that could be addressed using this framework include:

1. How do key characteristics contribute to the development of a numeracy teacher identity?
2. Are there differences between the factors that influence primary, secondary mathematics and secondary non-mathematics teachers? If so, what are they?
3. How can teachers be supported to develop a strong numeracy teacher identity?

Conclusion

The introduction of the Australian Curriculum (Australian Curriculum Assessment and Reporting Authority, 2012) and the Australian Professional Standards for Teachers (Australian Curriculum Assessment and Reporting Authority, 2012) provides an opportunity for teachers of all learning areas to develop effective teaching strategies for numeracy in the context of their learning area. An understanding of how teachers form and develop a numeracy teacher identity will assist in identifying mechanisms that can support their future development. This paper has reviewed literature on teacher identity in order to develop an operational framework that can be used to guide future research in this area.

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