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ORIGINAL ARTICLE

Developing an analytic lens for investigating identity as an embedder-of-numeracy

Anne Bennison

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Abstract One of the capabilities needed for effective participation in modern society is numeracy, which is the ability to cope effectively with the mathematical demands of life. While the development of numeracy continues beyond the school years, schools nevertheless have a responsibility to provide opportunities for students to expand their numeracy expertise. In Australian schools, there is a renewed emphasis on numeracy brought about by the introduction of a new curriculum, teacher professional standards and measures of accountability. The first two of these developments provide an opportunity for teachers of all disciplines to increase their capacity to promote growth in the numeracy capabilities of their students. However, they will be unable to do this unless they see themselves as teachers of numeracy and have the capacity to embed numeracy into the subjects they teach. This theoretical paper extends existing knowledge on teacher identity by developing a conceptual framework for identity as an *embedder-of-numeracy* that recognises the complexity of teacher identity while at the same time is amenable to empirical studies. The framework is organised around five *domains of influence* (knowledge, affective, social, life history and context) and includes characteristics that evidence from the literature suggests greatly impact on this particular situated identity. Studies using this framework could inform the design of professional development to support teachers to develop an identity as an embedder-of-numeracy. The mechanism for developing the framework described in this paper could also be used to create frameworks to investigate teachers' other situated identities.

Keywords Identity · Numeracy · Across the curriculum · Sociocultural perspectives

Introduction

The role of school education is to prepare students for life beyond school by assisting them to develop the capabilities that they need for life in the twenty-first century. One of these capabilities is “the ability to access, use, interpret and communicate

A. Bennison (✉)

School of Education, The University of Queensland, Brisbane, Queensland 4072, Australia
e-mail: a.bennison@uq.edu.au

mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life” (OECD 2012, p. 36). This is the definition of numeracy used by the OECD for the Programme for International Assessment of Adult Competencies (PIAAC). The OECD (2012) argues that numeracy, along with literacy and problem solving in technology-rich environments, is needed by adults to cope with the changing demands for skills resulting from the rapid technological changes that are taking place in modern society. Findings from the Adult Literacy and Life Skills Survey (ALLS), the predecessor of PIAAC, showed that higher levels of numeracy were related to lower unemployment and participation in occupations requiring higher skills, and resulted in higher wages (OECD and Statistics Canada 2011).

Even though the development of numeracy capabilities does not cease when a person leaves school, it is of concern that results for Australian students from the 2012 Programme for International Student Assessment (PISA) reveal that 20 % of 15 year olds do not meet internationally accepted minimum standards for numeracy (Thomson et al. 2013). Thomson et al. also reported that since 2003, there has been a significant decline in the number of Australian students reaching the minimum standard and in the mean score achieved by students. These results suggest that more needs to be done to support Australian teachers so that they are better able to promote growth in the numeracy capabilities of students.

The *Melbourne Declaration on Educational Goals for Young Australians* (MCEETYA 2008) has guided the development of a national curriculum (ACARA 2012a), professional standards for teachers (AITSL 2012) and a national programme of assessment and reporting (ACARA 2012b). The Australian Curriculum, being progressively implemented in Australian schools from 2011, identifies numeracy, along with literacy, information and communication technology capability (ICT), creative and critical thinking, personal and social capability, ethical behaviour and intercultural understanding, as general capabilities to be developed across all curriculum areas (ACARA 2012a). Secondly, the Australian Professional Standards for Teachers (AITSL 2012), which is now used as the basis for the accreditation of pre-service teacher education programmes (AITSL 2011) and teacher registration and renewal, includes what teachers need to know and be able to do to support students’ numeracy development as part of the content and pedagogical knowledge required by all teachers. Finally, the *Measurement Framework for Schooling in Australia* (ACARA 2012b) requires reporting of student performance in numeracy against national minimum standards as measured through the National Assessment Plan—Literacy and Numeracy (NAPLAN) and international testing (e.g. PISA). While the third of these developments places considerable pressure on schools to improve NAPLAN results and can lead to a narrow focus on numeracy as mathematical skills, the new curriculum and teacher professional standards can be seen as providing opportunities for teachers of all disciplines to develop the capacity to effectively promote growth in students’ numeracy capabilities.

While mathematics is the discipline that underpins numeracy, in Australia, it has been argued for some time that development of students’ numeracy capabilities should take place across the curriculum and is the responsibility of teachers of all school subjects (ACDE 1998; COAG 2008; DEETYA 1997; Thornton and Hogan 2004). However, this goal remains problematic. For example, a national survey of beginning

secondary teachers from all disciplines found that, while 90 % saw themselves as teachers of literacy, only 55 % saw themselves as teachers of numeracy (Milton et al. 2007). If these beginning teachers do not see themselves as teachers of numeracy, in other words, have an identity as a teacher of numeracy, it is unlikely that they will exploit the numeracy learning opportunities present in the Australian Curriculum. Although a similar study focussing on practising teachers does not appear to have been conducted, Milton et al.'s findings raise the question of whether this is also the case for practising teachers. Nevertheless, the findings together with the performance of Australian students in PISA 2012 suggest a need for professional development that can assist teachers from all disciplines to develop an identity as a teacher of numeracy. However, in order to do this, it is first necessary to have an understanding of what such an identity entails.

Teacher identity is complex; however, Gee (2001) has argued that identity can be used to explore issues in educational research and it is suggested in this paper that one such issue that could be explored using the construct of teacher identity relates to how teachers develop the capacity to embed numeracy across the curriculum. In early studies on teacher identity reviewed by Beijaard et al. (2004), the construct of teacher identity was defined in different ways or not defined at all. One of the reasons for this lack of clarity may have been the multi-faceted nature of teacher identity and the number of characteristics that contribute to shaping a teacher's identity. Therefore, one of the challenges facing educational researchers is to capture the complexity of teacher identity while defining it in a way that makes it amenable to investigation through empirical studies (Enyedy et al. 2005). This dilemma can be seen in the framework for mathematics teacher identity developed by Van Zoest and Bohl (2005). This framework encompasses a large number of cognitive and social characteristics and is, therefore, quite complex. While claiming that this complexity gives their framework theoretical strength, Van Zoest and Bohl concede that the complexity, along with lack of definition of individual characteristics within the framework, causes practical limitations for empirical studies.

Although interest in research on teacher identity has grown over the last decade, perhaps because of the issues outlined above, the approach taken by most researchers has been to focus on one or two characteristics known to influence a teacher's identity such as confidence (e.g. Graven 2004) or confidence and pedagogical content knowledge (e.g. Hobbs 2012). However, limiting research to one or two characteristics ignores the number of characteristics involved and their interconnectedness. As teachers have multiple identities (Wenger 1998), or sub-identities (Gee 2001), that are context dependent, an alternative approach is taken in this paper by developing a framework for one of these situated multiple identities. While it is recognised that all of the characteristics identified through the literature review affect identity, only those that seem to be particularly relevant for a teacher in the context of developing the numeracy capabilities of students are included in the framework.

The framework for identity as an embedder of numeracy developed in this paper extends existing knowledge on teacher identity by building a conceptual framework that considers the complexity of teacher identity while at the same time is practicable in the sense that it does not impose onerous limitations on empirical studies. Limiting the framework to a small number of selected characteristics enables empirical studies to be designed so that the focus is on these characteristics, thereby making data collection

and analysis feasible. The purpose for developing this conceptual framework is to guide the design of a study that will explore how teachers develop an identity as an *embedder-of-numeracy*. The process by which the framework is developed provides a mechanism for creating frameworks suitable for investigating other situated identities that teachers have.

Central to the process of constructing a conceptual framework for identity as an embedder-of-numeracy is an understanding of what numeracy is and what it means to be an embedder-of-numeracy. The interpretations that underpin the framework are articulated, and this is followed by a discussion that aims to draw together various viewpoints from the literature on identity and, in particular, teacher identity. A conceptual framework, organised around five *domains of influence*, is proposed; arguments are presented to justify the inclusion of certain characteristics within the domains and some possible research questions that could be investigated through an empirical study using the framework are suggested.

Being numerate

There are many definitions of numeracy and descriptions of what it means to be numerate (e.g. Cockcroft 1982; DEETYA 1997; OECD 2012; OECD 2013; Steen 2001; Willis 1998) that illustrate the complexity of numeracy by emphasising different aspects. The term numeracy was first defined in the Crowther Report (Ministry of Education 1959) as the mirror image of literacy, which was described as much more than the ability to read and write. While numeracy is a term that is widely used in Australia and other countries including the UK, the terms quantitative literacy and mathematical literacy (e.g. OECD 2013; Steen 2001) are used in the USA and elsewhere. Since the Crowther Report common usage of the term numeracy has focused on basic mathematical skills and school mathematics. Although mathematics is an important aspect of numeracy, a person with strong mathematical knowledge is not necessarily numerate (Willis 1998). According to Willis (1998), being numerate requires a person to be able to choose and use the appropriate mathematics in a range of situations. Hogan (2000) described this as “a blend of mathematical, contextual and strategic knowledge” (p.19). He also noted that many situations require the capacity for critical numeracy, which is the capacity to make judgements about the use and potential misuse of mathematics. A definition that has been widely accepted in Australia for over a decade is that being numerate involves the capacity to “use mathematics effectively to meet the demands of life at home, in paid work and for participation in community and civic life” (DEETYA 1997, p. 15).

Common elements that are either explicit or implicit in these definitions and the OECD (2012) definition cited earlier are that numeracy incorporates having the disposition to use mathematical knowledge critically in a range of contexts. However, it is not always clear what this means and some definitions of numeracy do not explicitly acknowledge the demands placed on individuals by the technologically advanced and information rich society in which we live. Goos (2007) drew on the common elements of these definitions and developed a numeracy model to elaborate the capabilities that are needed to be numerate in the twenty-first century. She argued that in addition to having the requisite skills and techniques (*mathematical*

knowledge) for a given situation (*context*), being confident and willing to use this knowledge (*dispositions*) and being able to evaluate their results or information presented to them (*critical orientation*), a person also needs to be able to use a range of representational, physical and digital *tools*. The three types of tools include maps and tables; models and measuring instruments; and computers and calculators; respectively (see Goos et al. 2011 for further elaboration of this model). The importance of being able to use tools is also acknowledged in the OECD (2012) elaboration of numerate behaviour for PIAAC and their definition of mathematical literacy for PISA 2012:

Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make well-founded judgements and decisions needed by constructive, engaged and reflective citizens (OECD 2013, p. 25).

While any of the definitions of numeracy presented above could be employed to underpin the conceptual framework for identity as an embedder-of-numeracy proposed in this paper, using the numeracy model developed by Goos (2007) has two advantages over other definitions. Firstly, it makes explicit the meaning of the five elements of numeracy (e.g. that mathematical knowledge includes mathematical skills and concepts, estimation and problem solving) and secondly, it is accessible to teachers as it enables them to articulate their personal conceptions of numeracy and describe classroom activities in terms of the numeracy capabilities that are developed (e.g. Goos et al. 2011).

From Goos's (2007) numeracy model and the other definitions of numeracy presented here, it is clear that to be numerate, a person must be able to use mathematics in a range of contexts. Developing mathematical skills and techniques can take place in the mathematics classroom but there is evidence to suggest that, even if mathematics is learnt well in this context, students are not necessarily able to apply it to new situations (e.g. Griffin 1995). Therefore, the numeracy capabilities of students need to be developed and enacted in a range of contexts, both within and outside school. While at school, this means that numeracy needs to be brought to light in all subjects. In the current environment (i.e. Australian Curriculum, professional standards for teachers and measures of performance and accountability based on national and international testing of numeracy), it is important to consider what attributes a teachers needs to be able to do this effectively.

Embedding numeracy across the curriculum

As numeracy involves more than using mathematical skills and concepts, a teacher will not be able to extend the numeracy capabilities of students by teaching mathematics or doing "numeracy activities" in subjects other than mathematics nor will a mathematics teacher be able to promote students' numeracy development by using "word problems" that provide a setting for the mathematics. These approaches potentially enable students

to extend their mathematical knowledge, increase their capacity to use tools and provide a context for the mathematics but would not necessarily foster students' dispositions towards using mathematics or develop their ability to apply a critical orientation. On the other hand, if teachers recognise that an understanding of the quantitative aspects inherent in a school subject enables students to develop a deeper appreciation of that subject and recognise that numeracy is their responsibility, then they will be better able to support students' numeracy development (Thornton and Hogan 2004). For mathematics teachers, this means providing problems where the context is needed to find a solution and this solution, as well as the choice of mathematics, needs to be justified.

In a research project involving 19 middle school teachers from eight schools that was designed to support teachers in identifying numeracy demands in their teaching area and implementing strategies for enhancing students' numeracy capabilities, Thornton and Hogan (2004) were able to identify three idealised types of teachers. The first of these was the *separatist* who recognises the importance of mathematical skills but believes that developing these skills is the responsibility of mathematics teachers, the second was the *theme maker* who recognises that there are links between mathematics and other subject areas and teaches around themes where the boundaries of subjects become blurred and the third was the *embedder* who "believes that every teacher is a teacher of numeracy ... and has a responsibility to vigorously intervene in student's learning of mathematics in that context" (p. 318). Three examples from a current research study are provided in Table 1 to illustrate how the *embedder* extends students' understanding of a curriculum area while at the same time providing opportunities for them to develop the five elements of the numeracy model developed by Goos (2007). Having numeracy as an integral part of a curriculum area in this way illustrates how teachers of all disciplines can embed numeracy into the subjects they teach.

While it is recognised that not all teachers will see themselves in this way, if it is accepted that this is the best way for teachers of all disciplines to promote growth in the numeracy capabilities of their students, then professional development should aim to

Table 1 Examples of how numeracy can be embedded across the curriculum

Curriculum area: topic	Description of task	Curriculum goal
History: Australia in 1900	Students use information about weekly wages and the cost of daily requirements such as food and transport to prepare a weekly budget.	To understand what life was like in Australia at the beginning of the twentieth century
Science: geological time	Students construct a geological time scale using a roll of paper towel and a measuring tape.	To understand the extent of geological time (i.e. how little time plant and animal life has existed when looking at the history of the Earth)
Mathematics: measure- ment	Students determine the cost of floor tiles needed for the classroom and whether it is feasible to transport these from the place of purchase to school by car.	To develop skills in using measuring tools and problem solving

support teachers to develop this particular type of identity, which is an identity as an *embedder-of-numeracy*. Therefore, the question for those designing professional development becomes what characteristics do teachers draw on to develop an identity as an embedder-of-numeracy? Conversely, what characteristics might limit their development of such an identity? The conceptual framework proposed in this paper is constructed using a process of deduction to identify these characteristics. However, it is first necessary to look at the construct of identity and, in particular, teacher identity.

Teacher identity

Sachs (2005) described teacher identity as being “at the core of the teaching profession. It provides a framework for teachers to construct their own ideas of ‘how to be’, ‘how to act’, and ‘how to understand’ their work and their place in society” (p. 15). More generally, identity is a concept that has been investigated across a range of disciplines including psychology, anthropology and sociology, resulting in a variety of interpretations. However, there is a common recognition that identity has both cognitive and social dimensions (e.g. Holland et al. 1998; Wenger 1998). For example, Philipp (2007) drew on previous literature to define (teacher) 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).

The cognitive and social dimensions of identity are also seen in the framework for mathematics teacher identity developed by Van Zoest and Bohl (2005). In this framework, the cognitive dimension was separated into a knowledge domain and an affective domain that included *beliefs, intentions and commitments*, while the social domain was constituted by the teacher’s participation in a number of communities of practice (Wenger 1998). Such an organisational structure is useful because it enables each of the domains to be examined separately, while at the same time allowing investigations into how they interact. However, there appear to be two additional domains that are also important in shaping a teacher’s identity. Firstly, Phillip’s (2007) definition of teacher identity, along with other research (e.g. Williams 2011), and Wenger’s (1998) conceptualisation of identity recognise the importance of past experiences in shaping identity, thereby suggesting the inclusion of a life history domain. Secondly, a teacher’s participation in various communities takes place in an environment that is structured by external factors that, while not directly part of a teacher’s identity, do influence the teacher’s practice and, therefore, shape their identity. These factors could be considered as part of a context domain. The absence of a context domain from Van Zoest and Bohl’s (2005) framework could be explained by its implicit inclusion in the social domain as part of a teacher’s participation in a community.

Gee (2001) portrayed identity as “Being recognised as a certain ‘kind of person’ in a given context” (p. 99) through actions, values, beliefs, spoken words and the interactions a person has with others. However, according to Wenger (1998), identity is more than what other people say or think about a person or what the person thinks or

says about themselves, but is instead a “lived experience of participation in specific communities” (p. 151) as a person engages in a particular combination of activities within those communities. He described a person’s identity as a negotiated experience as they reconcile multiple identities that result from their participation in various communities of practice (Lave and Wenger 1991; Wenger 1998) into what Gee (2001) has called a core identity that holds across these contexts. Although not referring specifically to communities of practice, Gresalfi and Cobb (2012) highlighted the importance of the contexts in which this participation takes place as a teacher develops a *personal identity*. They drew on their own work, which defined the *normative identity* for teaching as the set of attributes needed to be considered competent in a particular context, and that of Gee (2001), who described *affinity* and *institutional* identities, to explain why pedagogical practices promoted in a professional development context (affinity normative identity) may not be adopted if they are not consistent with the institutional normative identity of the teacher’s school. Gresalfi and Cobb defined the latter as the standards to which a teacher is held accountable by the school and district authorities, such as covering content for state testing. This definition makes the environmental factors explicit but the interpersonal interactions implicit (cf. Van Zoest and Bohl 2005), lending support for the inclusion of a context domain in the organisational structure for the conceptual framework for identity as an embedder-of-numeracy.

Sfard and Prusak (2005) took a different approach. They defined 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. They argued that Gee’s (2001) definition does not 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. The role of learning was also recognised by Wenger (1998) who claimed that identity development involves a learning trajectory that connects the past, the present and the future, thereby providing a context that enables an individual to determine what is important and what is not, in other words “what contributes to our identity and what remains marginal” (p. 155), thus suggesting that an individual can act as an agent in their own identity development. The inclusion of learning in the definition of identity is important as it recognises the dynamic nature of identity (Beijaard et al. 2004; Holland et al. 1998; Wenger 1998) and provides a mechanism for moving from a current to a future identity. Sfard and Prusak (2005) agreed with Gee (2001) and Wenger (1998) in recognising the role that past experiences play in the shaping of identity; however, their definition does not include the need for individuals to reconcile multiple identities into an overall teacher identity.

While common elements can be seen in the literature on teacher identity, there are also conflicting views among authors. Despite not resolving some of these conflicts, this brief review has identified that knowledge, beliefs and attitudes, social interactions, past experiences and professional context contribute to shaping a teacher’s identity.

Developing a conceptual framework for empirical research

The multiple identities that a teacher has include their identity as a teacher of one or more disciplines (if they are a secondary teacher), as a generalist teacher (as is the case for many primary school teachers in Australia) and possibly as an embedder-of-numeracy. All of the identities overlap and contribute to a core teacher identity. However, the focus of this paper is not on a teacher's overall identity, but the very specific situated identity a teacher has that enables or limits their capacity to embed numeracy into the subjects they teach. As there has been no research on teacher identity in this context, there is no conceptual framework to guide empirical studies. In developing such a framework, it is possible to take an inductive or deductive approach.

An empirical study that collects data on all of the characteristics of teacher identity that have been studied previously could be conducted, with data analysis informing the development of a conceptual framework for identity as an embedder-of-numeracy. However, this approach has practical limitations because of the large number of characteristics that contribute to a teacher's identity. While space does not permit discussion of all of these characteristics, a review of relevant literature reveals that they are numerous. For example, Hobbs (2012) investigated cognitive characteristics that she called the aesthetic dimension of "teacher passion, coherence and identity" (p. 718), but she did not consider social aspects which others have found to be an important influence on teacher identity (Kelly 2006; Lasky 2005). Williams (2011) investigated how teachers draw on their past experiences (life histories) to develop role models that shape their identity. Other researchers have reported on how confidence (Graven 2004), emotion (Beauchamp and Thomas 2009), motivation (Gresalfi and Cobb 2012) and critical reflection (Beauchamp and Thomas 2009; Bjuland et al. 2012; de Freitas 2008; Goodnough 2011) influence teacher identity. These, and the numerous other factors that influence teacher identity, do not act in isolation but are intimately connected; for example, lack of pedagogical content knowledge can influence confidence (Hobbs 2012) and professional learning can provide opportunities for increased critical reflection and confidence (Goodnough 2011). Limited resourcing, both in terms of funding and time, means it would not be possible to conduct a study that adequately investigates all of these characteristics and therefore, an alternative approach was taken.

Drawing on the literature of teacher identity, a theoretical perspective was used to develop the conceptual framework for identity as an embedder-of-numeracy. This approach suggests that as knowledge, affective, social, life history and context elements contribute to identity, it would be useful to organise the framework around five *domains of influence* (i.e. knowledge, affective, social, life history and context). These domains are necessarily broad and act as an organisational structure for the framework. The characteristics that constitute these domains can then be specified through a review of relevant literature. As identity is context dependent (Gee 2001; Holland et al. 1998; Wenger 1998), the process used was to focus on characteristics of teacher identity that seemed to have most impact in this particular situation, thereby making the framework specific for the context of teachers promoting growth in the numeracy capabilities of students through the subjects they teach. This approach has resulted in a conceptual framework that has theoretical limitations because it does not include all of the characteristics known to influence teacher identity, but addresses the challenge of acknowledging the complexity of teacher identity without imposing

onerous practical limitations on empirical studies. In the following sections, arguments are presented for the inclusion of particular characteristics in the domains of influence. While it is possible, perhaps even highly likely that some characteristics will be more influential to the identity as an embedder of numeracy of primary teachers, secondary mathematics teachers and secondary non-mathematics teachers, the purpose of this paper is to develop a framework that could be used in empirical investigations that focus on teachers within any of these groups. Therefore, no distinction between these groups of teachers is made in the following discussion, other than to point out potential challenges for particular groups of teachers where relevant.

Knowledge domain

While it is recognised that knowledge is an important part of an individual's identity, it is not always clear what knowledge is important (e.g. Phillip 2007) or how different types of knowledge are important in different contexts. On the other hand, the knowledge domain in the framework for mathematics teacher identity developed by Van Zoest and Bohl (2005) incorporated the seven categories of knowledge that Shulman (1987) suggested were necessary for teaching (i.e. 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). They collapsed these categories into a content and curriculum domain, a pedagogy domain and a professional participation domain. While using these broad domains has the advantage of including all of Shulman's categories, it also makes the definition of each domain less specific. An alternative approach, of focussing on particular types of knowledge, is taken in this paper because there are some types of knowledge that will be particularly important if a teacher is to have an identity as an embedder-of-numeracy. Three of Shulman's seven categories appear to be particularly relevant in this context. Firstly, mathematical content knowledge (MCK) is important because mathematics is the discipline that underpins numeracy, so teachers need to know the mathematics that is relevant to their subject area. Teachers also need to have sufficient curriculum knowledge (CK) to understand where and how this mathematics can be used to support learning in their subject area and the pedagogical content knowledge (PCK) to design appropriate learning activities to embed numeracy within the subject content (Thornton and Hogan 2004). Teachers with well-developed expertise in these three areas will have the knowledge base needed for an identity as an embedder-of-numeracy. However, there are several issues that can be identified for teachers in developing these types of knowledge, thereby underlining their importance in this context.

Firstly, teachers may lack the necessary MCK. Participation in senior secondary and tertiary mathematics courses in Australia has been falling for some years, suggesting that prior experiences of mathematics result in students lacking "confidence in the subject, do not enjoy or see personal relevance in it and are unlikely to continue its study voluntarily" (COAG 2008, p. 21). This may result in primary teachers and teachers of disciplines other than mathematics not having the appropriate MCK to support student learning within the context of the subjects they teach. While it may seem reasonable to assume that those teaching secondary mathematics have the

necessary MCK for teaching numeracy because they have completed the required university courses to become mathematics teachers, this may not be the case if the supply of qualified teachers is unable to meet demand. A study in Australia 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 and Jensz 2006).

Secondly, many teachers may lack the PCK required for designing learning activities that promote growth in students' numeracy capabilities. In the primary school sector, there is evidence to suggest that many teachers lack the PCK to support students' numeracy development (COAG 2008). While there appears to be no similar evidence from the secondary school sector, courses have been introduced into some Australian secondary pre-service teacher education programmes, suggesting a need in this area. (e.g. Groves 2001; White and Cranitch 2010). Groves (2001) reported on the rationale, development, delivery and evaluation of a final year course for pre-service secondary teachers designed to develop personal numeracy and the capacity to respond to students' numeracy learning needs. The latter included developing an understanding of what numeracy is, recognising numeracy demands across the curriculum and developing appropriate teaching strategies. Developing personal numeracy was also a focus of the course for pre-service secondary teachers described by White and Cranitch (2010). They found that many of the pre-service teachers who undertook the course thought they would have difficulty incorporating numeracy strategies because they did not see the relevance to their subject area (i.e. lack of awareness of numeracy in their subject) or lacked adequate personal numeracy skills.

The third type of knowledge important in the context of numeracy is CK. While the Australian Curriculum uses icons and online filters to identify the numeracy demands inherent in each curriculum area (e.g. ACARA 2011), a recent audit of the *Australian Curriculum: History* 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 (Goos et al. 2012). Despite recognising that some mathematics is required in order to teach subjects other than mathematics, the curriculum documents generally lack information about where and how this mathematics should be incorporated (e.g. Geiger et al. 2013). The issues presented here suggest that if teachers are to have an identity as an embedder-of-numeracy, they may need support in acquiring the requisite MCK, PCK and CK. Therefore, these three types of knowledge should be included in the conceptual framework.

Affective domain

Affective issues have long been recognised as important in the area of mathematics education and will, therefore, be important if a teacher is to develop an identity as an embedder-of-numeracy. Of particular importance will be a teacher's personal conception of numeracy (i.e. their beliefs about the nature of numeracy and what it means to be numerate) because a teacher won't be able to fully develop this particular type of identity unless their personal conception of numeracy is of the type described in Goos's (2007) numeracy model. Other beliefs that appear to be pertinent in this context are those a teacher has that are related to the subjects they teach and their perception of how

well prepared they are to embed numeracy into the content of these subjects. The nature of these beliefs, as well as those a teacher holds about mathematics, will impact on their capacity to develop an identity as an embedder-of-numeracy.

For many school students, their experiences of school mathematics have resulted in “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 those students preparing to be primary school teachers. A study by Gresham (2008) also found high levels of maths anxiety in pre-service primary teachers and 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. Hodgen and Askew (2011) argued that, in the case of primary teachers, negative school experiences can lead to a disconnection with mathematics and that there is emotional difficulty involved in developing the strong disciplinary bond with mathematics that is necessary for teaching any subject. This may also be the case for secondary teachers whose discipline is not mathematics, including those teaching mathematics “out of field”. Thornton and Hogan (2004) suggest that the lack of a disciplinary bond with mathematics, along with inadequate understanding of the quantitative aspects of the subjects they teach, can lead teachers to the belief that numeracy is the responsibility of mathematics teachers.

In order to have an identity as an embedder-of-numeracy, teachers need to believe that they are well prepared for this role. However, in Milton et al.’s (2007) study cited previously, two thirds of the beginning secondary teachers from all disciplines and more than 30 % of the beginning mathematics teachers surveyed reported that they did not feel adequately prepared to teach numeracy. These findings are supported, albeit by a much smaller study at one institution, by a study of pre-service and beginning Health and Physical Education (HPE) teachers that found more than one in five believed that their pre-service programme had not provided them with the knowledge and understanding of the numeracy demands of HPE (Swaby et al 2010). While these findings do not necessarily reflect the content of the pre-service programmes, they do reflect these teachers’ perceptions, which in light of possible negative attitudes towards mathematics, may lead to a lack of confidence in their ability or desire to embed numeracy into the subjects they teach.

Social domain

The social domain in Van Zoest and Bohl’s (2005) framework for mathematics teacher identity describes a teacher’s participation in a single community in terms of that they call dimensions of competence that align with Wenger’s (1998) joint enterprise, mutual engagement and shared repertoire. While this has the advantage of fully describing a teacher’s participation in this particular community, Van Zoest and Bohl (2005) concede that to portray an individual’s entire mathematics consideration of the ways a teacher participates in all of the other communities in which they are involved. Such a process would increase the complexity of the framework and impose practical limitations on empirical studies. In this instance it is more useful to look at teachers’ participation in communities in terms of Gresalfi and Cobb’s (2012) normative identities for teaching, described earlier, because the interest in this paper is on how a teacher negotiates their identity across communities rather than within communities.

Although teachers participate in a number of communities both within and outside the school environment, their interactions with students, colleagues, school administrators and professional learning communities are likely to have most impact on whether they are able to develop an identity as an embedder-of-numeracy. Each of these communities will have a particular normative identity for teaching. For example, the normative identity for teaching in a history classroom, as defined by students, may be that mathematics has no relevance in the class (i.e. a view that this is history not mathematics). The negotiation process can lead to tension and sometimes to practices that seem to be inconsistent with a teacher's identity in a particular context. 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, where there was a focus on reform oriented mathematics teaching, sometimes, her classroom practices were inconsistent with the views she expressed in the professional development context. On these occasions, her focus was primarily on procedural aspects of mathematics to prepare students for standardised achievement tests that were a school priority. These apparent inconsistencies can be viewed as part of the process of teacher identity development as teachers negotiate their identity across different communities.

In secondary schools in Australia, teachers tend to be grouped into departments structured around curriculum areas. The normative teaching identity within the departmental community can influence an individual teacher's 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 in a secondary school may be one that sees numeracy as mathematics in contrived contexts (Boaler 1993) or as the responsibility of mathematics teachers (Thornton and Hogan 2004).

School leadership can influence the development of teacher identity through school policies that value innovations, such as incorporating numeracy across the curriculum, by providing professional development and fostering a culture that is supportive of the innovation (Zawojewski and McCarthy 2007). Such policies and initiatives have the potential to increase teachers' knowledge and modify their beliefs. In another study, Kendall-Jones (2011) found that teachers displayed lower levels of negative attitudes towards mathematics in primary schools where the principal promoted coherent and sustained professional development in mathematics, compared to teachers in a school where this was not the case. In these situations, the normative identity for teaching of school leaders supports the development of an identity as an embedder-of-numeracy by enabling teachers to develop the appropriate knowledge in a positive environment.

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 future identity. Professional development that promotes a normative identity for teaching consistent with identity as an embedder-of-numeracy could enable teachers to

develop such an identity, provided they see that the effort required to make the changes is worthwhile (Gresalfi and Cobb 2012).

Life history domain

The importance of life history in shaping learning, and therefore identity development, is well recognised (e.g. Dewey 1938). A teacher's past experiences will impact on their capacity to develop an identity as an embedder-of-numeracy. Experiences of school mathematics, as mentioned earlier, may have resulted in mathematics not being studied beyond when it is compulsory (COAG 2008) or in maths anxiety (Hembree 1990). These experiences will also have created images of what a discipline is and how it should be taught (e.g. Ball 1990). For mathematics teachers, this image may be that mathematics is an abstract discipline that is context free and best taught through transmission, while for history teachers, it may be that quantitative aspects such as data are to be presented but are not an important aspect of learning history.

Pre-service teacher education provides opportunities for teachers to develop PCK and CK in their chosen curriculum area. However, teachers may not have developed the appropriate knowledge if the specific issues related to supporting the development of students' numeracy capabilities were not addressed in their pre-service programme. Opportunities to develop MCK are only available to specialist mathematics teachers and primary teachers. However, developing MCK can be challenging for primary pre-service teachers if they have high levels of maths anxiety (Gresham 2008; Hembree 1990). In addition, those who are teaching secondary school mathematics out of field are unlikely to have studied mathematics beyond first year university level (Harris and Jenz 2006).

The developing teacher identity of beginning teachers can be influenced by expectations of colleagues and workplace constraints (e.g. Beisiegel and Simmt 2012). Therefore, initial teaching experiences will be important in shaping a teacher's beliefs about numeracy, its place in the subjects they teach and the role they have in promoting growth in the numeracy capabilities of students.

Context domain

For Gee (2001), actions contribute to the way an individual is recognised, while for Wenger (1998), how an individual participates in a community of practice is related to their identity. Therefore, a teacher's classroom practice will be an important part of their identity. Consequently, factors external to the individual that provide affordances and constraints on classroom practice should be considered in the conceptual framework for identity as an embedder-of-numeracy. School policies could assist teachers to develop an identity as an embedder-of-numeracy by providing time and support for planning. Alternatively, if school results on NAPLAN tests are below what is considered acceptable, there may be pressure on teachers to prepare students for the NAPLAN test rather than provide them with opportunities to develop the numeracy capabilities described in Goos's (2007) numeracy model. School resourcing should also be considered in this domain. For example, a teacher may see technology as an important

pedagogical tool but be prevented from incorporating it into classroom practice due to lack of access.

A conceptual framework for identity as an embedder-of-numeracy

Developing a conceptual framework for identity as an embedder-of-numeracy that can be used in empirical studies is challenging. As well as recognising the complexity of teachers' multiple identities, it also has to address the situated and overlapping nature of these identities. The approach taken in this paper has been to decide on an organisational structure for the framework and to present arguments to justify the inclusion of certain characteristics. The resulting framework is built around five domains of influence that encompass characteristics that seem to be particularly relevant to an identity as an embedder-of-numeracy. The framework is summarised in Table 2.

Despite the limitations of the framework mentioned previously, following an initial study to test its robustness, it could be used as a conceptual framework in research to answer questions that include the following:

1. What characteristics known to influence teacher identity have greatest impact in shaping an identity as an embedder-of-numeracy?
2. How do these characteristics interact to shape identity as an embedder-of-numeracy?
3. What are the commonalities and differences between the factors that influence a teacher's capacity to develop an identity as an embedder-of-numeracy in primary, secondary mathematics and secondary non-mathematics teachers?
4. How can teachers be supported to develop an identity as an embedder-of-numeracy?

Table 2 Conceptual framework for identity as an embedder-of-numeracy

Domains of influence	Characteristics
Knowledge	Mathematics content knowledge (MCK) Pedagogical content knowledge (PCK) Curriculum knowledge (CK)
Affective	Personal conception of numeracy Attitudes towards mathematics Perceived preparation to embed numeracy
Social	School communities Professional communities
Life history	Past experiences of mathematics Pre-service programme Initial teaching experiences
Context	School policies Resources

Empirical studies focussed in this way could inform the design of pre-service programmes and in-service professional development. For example, if it was found that many teachers' personal conception of numeracy is that it involves only mathematical knowledge and contexts, then professional development could be designed to provide opportunities for teachers to broaden this belief.

Conclusion

Low levels of numeracy can have a negative impact on an individual's personal, professional and community life (e.g. OECD and Statistics Canada 2011). In Australia, the introduction of the Australian Curriculum (ACARA 2012a) and the Australian Professional Standards for Teachers (AITSL 2012) provide an opportunity for all teachers to develop effective ways of embedding numeracy into the subjects they teach. However, the arguments presented in this paper suggest that teachers will have limited capacity to do this, unless they develop an identity as an embedder-of-numeracy.

Investigating teacher identity is difficult because of its complexity, but important because well-developed teacher identities are needed for effective teaching (Grootenboer and Zevenbergen 2007; Kelly 2006). Understanding teacher identity provides insights into why teachers make particular instructional decisions (Enyedy et al. 2005; Gresalfi and Cobb 2012) and why teachers implement learning from professional development activities in different ways (Battey and Franke 2008). The proposition put forward in this paper is that a feasible way of investigating one of a teacher's multiple situated identities (i.e. identity as an embedder-of-numeracy) is to focus on those characteristics that are most relevant in that particular context. This approach recognises the complexity of the construct of teacher identity while at the same time minimising practical limitations that would be imposed on empirical studies if all characteristics were to be investigated.

The conceptual framework for identity as an embedder-of-numeracy that has been developed in this paper is based on two premises, specifically, that numeracy involves mathematical knowledge, contexts, dispositions, tools and a critical orientation (Goos 2007) and secondly, that a teacher needs to embed numeracy into the subject they teach (Thornton and Hogan 2004). This framework incorporates five domains of influence (knowledge, affective, social, life history and context) and includes characteristics that evidence from the literature suggests greatly impact on a teacher's identity as an embedder-of-numeracy. While not having the same level of theoretical strength as Van Zoest and Bohl's (2005) framework for mathematics teacher identity, the framework developed in this paper overcomes some of the limitations in their framework by clearly identifying characteristics that can be studied empirically and, because it has been designed to be situation specific, having a level of complexity that reduces practical limitations.

The framework for identity as an embedder-of-numeracy has been developed from a theoretical perspective, so further identification of strengths and weaknesses will only be possible when it is tested with empirical data. Following this testing, the framework will be used to guide the design of an empirical study that will investigate how teachers develop the capacity to exploit the numeracy learning opportunities that exist across the

curriculum and, therefore, an identity as an embedder-of-numeracy. By proposing a framework for one of the many situated identities a teacher has and using an approach that provides a mechanism for developing frameworks to investigate teachers' other situated identities, existing knowledge on teacher identity is expanded.

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