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Robyn Zevenbergen is a senior lecturer at Griffith University where she works in mathematics education. Her research is focused on issues of equity and social justice in mathematics education, particularly in the areas of social class and indigenous education. The work is largely from a sociological perspective in which she critically examines the role of practice in the construction of social disadvantage. Her work is mainly in the area of primary schooling but also extends in the compulsory years of secondary school. She has been involved in many school-based projects both for research and professional development. She has been involved in a number of professional organisations nationally and internationally, including secretary of MERGA. She is currently a member of the Queensland School Curriculum Council's Syllabus Advisory Committee for Mathematics.

While once mathematics was considered a discipline that could transgress linguistic and cultural boundaries, it is now acknowledged that language has a considerable role in mathematics. Increasingly language is recognised as causing difficulties for students when they come to learn mathematics. Many different levels and aspects of language can be seen to create such difficulties for students. The implications of language on learning mathematics or developing a sense of numeracy is central to this paper.

The impact of language on numeracy has been more evident in recent times where there have been attempts to ensure that mathematics makes links to the real worlds of students. This approach, while attempting to embed mathematical concepts into contexts that seek to make mathematics meaningful and relevant, brings with it significant barriers to success. In part, this is due to the application of mathematics to 'real world' problems whereby such embedding needs to be couched in language. While the intentions of the approach are to embed problems into contexts thereby creating an aura of relevance, and hence accessibility, it creates a new set of difficulties for students that are becoming recognised. How such issues are framed is dependent on the ideological orientation of the researcher and / or educator.

Within the work on numeracy / mathematics and language, there are two distinct branches that have fundamental assumptions built into them. The first seeks to identify barriers to learning but without any social or political understanding of the issue, whereas a second branch identifies the issues within a socio-political perspective. This second approach recognises and sees as central, that the issues of language and numeracy have a strong correlation with the background of students, suggesting that the barriers to effective numeracy learning are related to student background. However, this is not to suggest a deterministic reading of success in numeracy, only that it is necessary to recognise that success can be enhanced or hindered as a consequence of socio-cultural background. The fundamental tenet of this approach is that mathematics teaching and learning is a political process through which students have differential access to knowledge and power. Language is one means through which such power is exercised. It is this approach that is central to this paper since it offers insights into the barriers to numeracy learning for many students from disadvantaged backgrounds. It allows educators to critically examine numeracy education and policy for the ways in which it can be implicated in the marginalisation and legitimation of failure for these students. This approach seeks to challenge the alternative (and dominant) approaches of education where it is seen that students from such backgrounds are lacking in some ways or other.

Language, underachievement and numeracy

In the following sections, I provide a very brief overview of a theoretical understanding of the issue and provide some examples of how such a theory provides us with a model for understanding how language impacts on numeracy teaching and learning. For the purposes of this paper, I align myself with those discourses on numeracy where numeracy is seen to be the application of, and capacity to use, basic mathematics in everyday and applied contexts. For ease of communication, this means that topics such as algebra and calculus are likely to be absent from discussions on numeracy. However, basic skills such as operations, calculating percentages, and using basic statistics with contexts commonly encountered by a significant section of the community is what can be seen to be numerate. In such a working definition, language is integral to numeracy. Thinking in a numerate way does not equate with thinking in a linguistic way, rather, in terms of being numerate; being able to speak or communicate mathematically is a key aspect of numeracy. Hence to be numerate includes being able to work and communicate effectively.

When students enter formal school contexts, they will have had very different experiences based on their social and cultural backgrounds. One such experience will be in the field of language. The work of Basil Bernstein (Bernstein 1990) and Pierre Bourdieu (Bourdieu, Passerson & de saint Martin 1994; Greenfell 1998) alerts us to the impact of language on school success. This paper takes as central their notions of language as political. Bourdieu et al. (1994) summarise this position in their statement 'The more distant the social group from the scholastic language, the higher the rate of scholastic mortality' (p. 41). While providing strong framing for considering aspects of language and learning on the outcomes of schooling, they do not explicitly or systematically explore the implications that their theories have in the study of numeracy.

Language, texts and success

Hardcastle (1985) and Walkerdine (1982) argue that situating problems in familiar contexts can result in students making mistakes when replying since they select the wrong discourse within which to locate the problem. Walkerdine (1982, p.141) argues: 'That children will search for a discourse in which to situate a task is amply supported by the fact that children will interpret...tests...by picking up a feature of the task and making it the object of a familiar discourse'. Bernstein (1996) is more explicit with his pedagogic theory and proposes that students need to be conversant in the unspoken, or invisible, aspects of pedagogy. One aspect of pedagogy is the rules through which students come to participate in interactions – with the teachers, texts and so forth. He refers to such rules as recognition and realisation rules. Recognition and realisation rules occur at the level of the individual: recognition rules are the means by 'which individuals are able to recognise the specialty of the context that they are in' (Bernstein 1996, p. 31) whereas realisation rules allow the student to make what are seen as legitimate responses within a particular context. If students are not able to recognise the 'power relations in which they are involved and their position in them, [and] they do not possess the realisation rule, they cannot speak the legitimate text' (Bernstein 1996, p. 32). For example, within the context of the classroom and an interview situation, students recognise that the teacher has power and that they should conform with expectations. However, when the teacher asks questions or has particular expectations of the students, students must be able to respond in a manner that is seen as appropriate in the classroom.

Consider a task such as the following:

> Suppose you had a garden this shape and you were in a helicopter right above your garden looking down on it. Which of the following shapes would be like yours?

The mathematics embedded in the task is a recognition task whereby the students are expected to identify the oblong shapes that have been placed in different orientations to the original. In considering the responses made by students to the task, it was apparent that fewer mistakes were made by students from middle-class backgrounds than their peers from working-class backgrounds. Consider the two responses following from students when questioned further as to their incorrect responses where it was not the mathematics that was problematic, but rather the selection of the incorrect discourse within which they needed to embed the task:

Girl

R: Why did you take that shape [the square]?

G: Because it looks like the shape of my garden.

R: Is your garden at home like that?

G: Yes.

Boy

B: None of those.

R: Why aren't any of them the same?

B: My garden goes like that [draws a semi-circle in the air].

In these tasks the students have been able to offer a response in the ways desired by a testing situation; that is they have selected an answer, albeit incorrect, but the inappropriateness of the response is due to a misrecognition of the recognition rule. The students failed to recognise the context of the question – the question is not asking about their personal gardens, but rather some abstract garden that has nothing to do with them personally. Students need to recognise that mathematics education is rarely a personalised game, but something that is often abstracted from the personal. Where questions may be embedded in discourses that suggest, or even encourage, a personification of mathematics, this is not the case. Indeed, mathematics increasingly becomes depersonalised as the students move through to higher levels of content. For these students (and others), the incorrect responses indicated a misrecognition of the context of the problem rather than seeing it as mathematical task requiring shape identification.

Unlike other discourses in mathematics education where the interpretation of such incorrect responses may be based on Piagetian notions of cognitive development where the students are caught in the concrete / abstract divide, Bernstein's theory offers considerably more potential to understand the social basis to such differences. Bernstein (1996) found that middle-class students, as young as seven years, are able to privilege official pedagogic codes over local or home pedagogic codes. In his work, he uses the example of classifying foods and found that middle-

class students were more likely to classify them according to food groups (a school-based classification system) whereas working-class students were more likely to offer local classification systems, such as what would be offered as Sunday lunch. Moreover, he notes that middle-class students are able to switch between codes when asked to offer different classifications, whereas this was not the case with working-class students who tended to rely on local pedagogic codes. Within a language framework, what becomes critical when working with students is to recognise whether or not they identify realisation and recognition rules, rather than within a restrictive 'numeracy' framework. Students need to be able to recognise that the teacher is embedding mathematical tasks in particular discourses and that these discourses may or may not be relevant to the task.

In their extensive work on UK testing regimes, Cooper and Dunne (1999) have appropriated Bernstein's work to demonstrate the effects of social class on performance and report that where questions are embedded in clearly recognisable mathematical contexts, students from working-class and middle-class backgrounds are likely to respond in similar ways. That is, there is little difference in performance on such tasks – tasks that they refer to as 'esoteric'. What is concerning is that where tasks are embedded in 'realistic' contexts, differences emerge in performance. They argue that the embedding of tasks in 'realistic' contexts distracts students from the demands of the tasks whereby students from working-class backgrounds are less likely to identify the recognition rules and so fail to recognise the specificity of the mathematical tasks. In contrast, middle-class students are more likely to identify the recognition rules and so respond appropriately. That is, they are able to realise legitimate responses to the tasks posed. Whereas, once it was commonly assumed that working-class students were more likely to be concrete thinkers due to their perceived slower cognitive development, and hence more likely to perform better on concrete tasks, Cooper and Dunne challenge such assumptions. Their analysis has shown that working-class students may perform equally as well (as a group) as their middle-class peers on esoteric tasks (mathematical ones) but perform less well than their middle-class peers on realistic (or contextualised) tasks due to what Bernstein (1996) identifies as recognition and realisation rules. When students fail to identify the recognition rule – in this case the task posed was shape identification – they are unable to respond appropriately.

The work of Walkerdine (1992) has also been useful in alerting educators to the effects of the different codes used by families. She notes that within working-class families, the numeracy practices and language are somewhat restricted in comparison to their middle-class peers. For example, she notes that whereas middle-class parents use both terms in binary oppositional terms (such as more and less), working-class parents tend to use only more. This exposure to language has the potential to impact on students' capacity to make sense of teacher interactions when comparisons of number or size are being undertaken: Which is more, 2 or 5? What number is 3 less than 6?, and so on. These are common teaching strategies in the early years of schooling and integral to the development of number sense. Yet, when students are not exposed to the taken-for-granted language of instruction, there is potential for students to have greater or lesser access to the concepts as a consequence of their language.

Frequently cited studies in the Number strand have shown the effects of contexts and outcomes. For example, Ruesser (1986, cited in Schoenfeld 1992) posed nonsensical word problems to primary school students such as 'There are 125 sheep and 5 dogs in a flock. How old is the captain?' to which almost 75% gave a numerical response. Students toyed with the numbers until they were able to arrive at an answer that seemed to produce a sensible response to the question: 125+5 = 130; 125-5 = 120; 125 / 5 = 25; so that 25 seemed to be a reasonable age for a shepherd as the others were too high. While this research fell into the apolitical category of research, questions need to be asked as to whether or not some students respond differently in relation to their social and / or cultural background. It may well be that some students have greater or lesser opportunity to unpack the question for the hidden mathematics as a result of their social and / or cultural background that predisposes them to analyse the task within particular frameworks, some of which are more or less aligned with the official pedagogic discourses of school.

Conclusion

When considering students' numeracy learning, it becomes necessary to consider aspects of language as being integral to the teaching and learning process. Not only is language the vehicle through which students come to make sense of concepts via the teaching process, but also how they realise their understandings though their responses to teachers and through assessment schemes. Language is a political process through which some students have greater or lesser access depending on their language background. In cases where there are extreme differences between the language of instruction and language background, there is greater chance for error not due to some innate ability but due to differences between the formal language of school and the language of the home. It must be recognised that even in the case of English-as-a-first language, there are aspects of language that will hinder or enhance students' capacity to make sense

and to make meaningful numeracy constructions. This is particularly the case for working-class students, and some indigenous students who speak different forms of English to that of the formal school context. Bernstein and Bourdieu have been particularly useful in alerting educators to such distinctions and their potential impact on learning outcomes. What becomes clear is the need for teachers, educators and researchers to explore this gap more thoroughly and identify the disjunctions between the home language and the formal language of instruction. The impact of language on numeracy development needs to have further exploration since little is known in any systematic form.

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