Communicative Competence in School Mathematics: On Being Able to Do School Mathematics

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School mathematics has two sets of criteria for judging competence¾one that is mathematical, explicit, and founded in psychology. The other, the focus of this paper, is concerned with the hidden criteria for competence in school mathematics. Using the theoretical tools developed by Basil Bernstein, it is proposed that aspects of school mathematics are socially biased and enhance or hinder the potential for success for some students. Two aspects of school mathematics are considered¾written texts and classroom interactions.

One of the perennial problems faced by mathematics educators is why students appear to fail mathematics. This is particularly evident in these new times when economic rationalism is entrenched in the educational reforms nationally and internationally. In a these new times, numeracy is a feature of the reforms and hence serious considerations are made of what it is to be numerate, but with little consideration of the social context within which judgements about levels of numeracy are being made. Most of the literature tends to examine the problem from an individualistic level, particularly from a psychological base and seeing mathematics as central to the problem. From such perspectives, the 'blame" for failure is often placed with the victims and engenders a deficit model of thinking. In contrast, we examine critically the social context within which mathematics learning is occurring in order to identify and understand aspects of the classroom milieu and how they impact on students' performance. Central to our work is the theoretical work undertaken by the English sociologist, Basil Bernstein. His work is extensive in examining the sociolinguistic aspects of schooling in order to unpack the ways in which social advantage and disadvantage are realised insidiously through the practices of schooling. It is our intention in this paper to identify practices in the classroom and how they constitute a particular way of working and being. As a consequence of being able or not to participate in these practices, students are more or less likely to be constructed as learners of mathematics in ways which remain invisible to teachers and educators and have little to do with the mathematics or cognition but intrinsically related to the social context of mathematics classrooms. The ways in which this occurs have been identified as being related to the structuring practices of school mathematics – that is, it is bound to the social and political context of learning. It is our thesis that the practices of mathematics classrooms are cultural representations that are more or less accessible to students based on their cultural and social backgrounds. By being able, or not, to participate in the social milieu of the classroom demands particular knowledge of the unspoken (and untaught) rules of classroom culture. Those students who are able to identify and participate within the dominant, yet invisible, practices of school mathematics are more likely to be constituted as effective learners of mathematics than those who are not.

There is little work in mathematics education that specifically addresses this issue. Lubienski (2000) and Zevenbergen (1998; 2000a; 2000b) have addressed aspects of the social context of mathematics classrooms, while others such as Cooper and Dunne (1999) have appraised examinations and Dowling (1998) has examined text-based curriculum packages. These authors have indicated ways in which practices in mathematics are biased towards the middle-classes. The latter two have been particularly strong in using the theoretical tools offered by Bernstein and this is particularly useful for understanding classroom practice in a way that was not undertaken by the former.

In terms of this paper, we will use a number of examples and draw on students' responses to the question in order to highlight aspects of Bernstein's work that we find most useful for analysing social aspects of mathematics education. As such, the theoretical model offered by Bernstein provides a grounding for understanding aspects classroom talk. A Bernsteinian perspective has as central the notion that the practices within schooling "work selectively on how the student is controlled in the classroom" (Davies, 1995, p.147) particularly in relation to social class, gender, ability and ethnicity.

Bernstein (1981) uses the notions of "classification" to refer to the underlying principle of the social division of labour and "framing" to refer to the interrelationships of its own discipline. Strong classification occurs where there is a clear division of labour between the students and the teacher with the teacher assuming a dominant position. As a discipline, mathematics is strongly framed – that is; there are clear demarcations between mathematics and other disciplines. Traditionally, school mathematics is seen to be strongly classified and framed as it is often a taught as a discipline quite distinct from others and taught in a way where there is an emphasis on specialised skills; the teacher taking a dominant position in the class.

Bernstein (1996) is explicit with his pedagogic theory and proposes that students need to be conversant in the unspoken, or invisible, aspects of pedagogy. Two important considerations need to be made – one is how tasks are framed for students (recontextualisation), the second is how they are answered by the students (recognition and realisation rules).

Contextualisation and Recontextualisation

Mathematics problems have been investigated by Dowling (1998) through the UK SMP series of textbooks, and through UK examinations (Cooper & Dunne, 1999). These authors, using Bernstein's theoretical model, have argued that mathematics has esoteric knowledge that is then recontextualised into problem form. Following on from Bernstein's fundamental thesis that students from working class backgrounds generally do not move from one discourse to another when asked to reclassify objects into different systems of classification, this work suggests that some students have difficulty in identifying mathematics problems as essentially mathematical when they are posed in everyday contexts. This thesis raises questions about the posing of tasks into everyday contexts as serving as distractions from the main mathematical underpinnings of the task. For example, "Steve has bought 4 planks of 2.5m each. How many planks of 1m can he saw out of these planks?" (Verschaffel, De Corte, & Lasure, 1994, p. 275) . In this problem, there is an expectation that students will treat the task as a school mathematics task and identify the assumptions built into such a task. In contrast, if students see the task as a "real" one, they can translate the problem according to the demands of the everyday context. Such an interpretation may involve consideration of waste material and decide that minimal waste is desirable and cut lengths of greater than one metre to ensure limited waste, lengths slightly under one metre so that 3 planks can be sawn from each larger plank (making 12 in total) or assume that there is some mechanism for gluing the leftover pieces together to form 2 extra planks (to make 10 in total). From a mathematical standpoint, there is only one correct response, that of eight 1m planks. However, if the student fails to reinterpret the task as a mathematical one rather than an everyone one, there is considerable scope for considering the everyday demands of such a task and make due consideration to these demands, and thus potentially producing and incorrect response.

In tasks such as the above cited plank task, or similar tasks (such as buses or how many cans of paint are needed to paint a room) students need to conduct the arithmetic of the tasks and then to round the answer to the next highest number. Students who round up remainders are constructed as knowing the mathematics of the task. In contrast, other students may construct responses that draw on their practical knowledge (of carpentry, bus hire or painting) so that their responses are invalid in the mathematics context. In a mathematical sense such responses are deemed incorrect as the mathematical discourse invalidates the practical discourse. Students do not recognise that the tenets of the task are mathematical rather than practical – that is, they fail to recontextualise the everyday task into a mathematical task, instead offering an (incorrect) response to the question.

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 recognizable mathematical contexts, students from working-class and middle-class backgrounds are likely to respond in similarly ways. That is, there is little difference in performance on such tasks – tasks that they refer to as "esoteric". Such tasks are what would traditionally be described as "pure mathematics". What is concerning is that where tasks are embedding 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 recognize the specificity of the mathematical tasks. In contrast, middle-class students are more likely to identify the mathematical discourse and so respond appropriately. That is, they are able to realize 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 (1998) 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 contextualized) tasks due to what Bernstein (1996) identifies as recognition and realization rules. Cooper and Dunne conclude that working class students have been socialised within non-school practices that predispose them to see and respond to the world in different ways from their middle-class whose experiences aid in the appropriation of school practices. When students fail to identify the recognition rule, they are unable to respond appropriately.

Recognition and Realisation Rules

One aspect of pedagogy is the rules through which students come to participate in interactions – with the teachers, texts and peers. Bernstein (1996) refers to such rules as recognition and realization rules. Recognition and realization rules occur at the level of the individual – recognition rules are the means by "which individuals are able to recognize the specialty of the context that they are in" (Bernstein, 1996, p. 31) whereas realization rules allow the student to make what are seen as legitimate responses within a particular context. If students are not able to recognize the "power relations in which they are involved and their position in them, but they if they do not possess the realization rule, they cannot speak the legitimate text" (Bernstein, 1996, p. 32). For example, with the context of the classroom and an interview situation, students recognize 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. For example, in the mathematics classroom, students must be able to recognise that when a teacher asks a question, there is an expectation of a response. Furthermore, when a mathematics question is posed, that there are particular responses that are desired. Common tasks used in mathematics often relate to contextualised questions – such as: There are 289 students at the school sports. If a bus carries 45 students, how many buses are needed to transport the students back to school? This task requires the students to recognise that this is a mathematics task, and not a task about hiring buses. By knowing this, students are able to identify that the response required is one that rounds the answer up to the nearest whole number. By undertaking this deconstruction of the task, students are able to recognise the task as mathematical and realise their correct response.

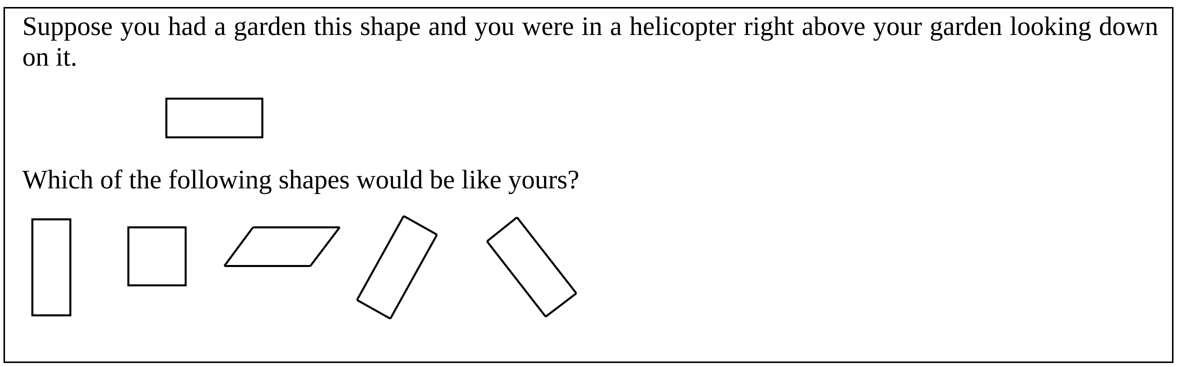

Figure 1. Spatial task from Zevenbergen (1991).

Consider the task shown in Figure 1. While many of the students were able to respond to the task correctly, particularly when the task was given to older students, it was more likely that when incorrect responses were offered, they were from students from working-class backgrounds (Zevenbergen, 1991). Typically, incorrect responses involved answering the question as if it were a task involving identification of the shape of their gardens at home. For example:

R: Why did you take that shape [the square]?
Girl: Because is looks like the shape of my garden.
R: Is your garden at home like that?
Girl: Yes.

Boy: None of those.
R: Why aren't any of them the same?
Boy: My garden goes like that [draws a semi-circle in the air].

These two quotes indicate that the students selected different shapes from the correct ones based on their home knowledge. Walkerdine (1982) argued that students often select the 'wrong' discourse for the selection of responses, based on the use of key words. In this task, the use of "your" can work as a distracter for the students. However, Bernstein's theoretical position offers a richer interpretation of these types of responses where the notion of recontextualisation in concert with recognition and realisation rules need to be considered, particularly in relation to the responses offered by students and even more so when considering backgrounds of students.

In the first instance, the task is a shape recognition task that has been recontextualised into a realistic context, although questions need to be asked about how “real” the context is given that many students would not have flown in a helicopter. If the task were to be posed as an esoteric mathematical one where the problem posed referred explicitly to the mathematical demands – such as “which of the following shapes is the same as this one?” – then the work of Cooper and Dunne (1999) would suggest that students may be solve the task as the mathematics was apparent, the demands of the task apparent. Instead, the recontexualising of the task into a realistic context serves as a distracter for some students due to the recontextualising process. In her study of students in the classroom, Lubienski (2000) reported similar findings where her students from working-class backgrounds preferred esoteric tasks and the middle-class students were happy with problem-based tasks where they needed to unpack the tasks to find the mathematics.

In the second instance, the students have offered a response in the ways required for a testing situation, that is they have selected an answer, albeit incorrect, but the inappropriateness of the response is due to a mis-recognition of the recognition rule. The students failed to recognize 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 recognize that mathematics education is rarely a personalized 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 may not be the case. Indeed, mathematics increasingly becomes depersonalized as the students move through to higher levels of content. For these students (and others), the incorrect responses indicated a mis-recognition of the context of the problem rather than seeing it as mathematical and a task requiring shape identification.

Social Context of Classroom Interactions

Students bring to school very different discursive rules (Heath, 1983) that influence how they act and how actions are interpreted. Lubienski (2000) indicates clear preferences for styles of working and mathematics in her study of a mathematics classroom. In concert with the different backgrounds and discourses that are brought to school, students experience very different classrooms, often based on the teacher’s perceptions about the styles of learning of the students. Research suggests that students from lower classes are often exposed to imperative control (Davies, 1995); rote instruction and low-level exercises with low levels of expectations from teachers (Means & Knapp, 1991) and were more likely to receive rote instruction whereas middle-class peers experienced problem solving (Anyon, 1981). In considering the different discursive backgrounds of students; teachers’ perceptions of their students’ learning styles (that frequently correlate with the social background of the students); and the ways in which classrooms and curriculum are organised for students depending on their backgrounds, consideration also must be made of the interactions within a classroom.

Questioning is an integral part of classroom practice. Sullivan and Clarke (1991) have been strong advocates of the use of good questions in mathematics classrooms, arguing that some forms of questions are better than others. Posing questions that encourage deep and analytical thinking is seen as preferable for developing desirable dispositions towards mathematics than questions that are shallow and rely on rote learning. Yet, the literature on social class and questioning indicate that there are particular forms of questioning dominant in different classrooms. While some of this is due to teacher preference, Lubienski (2000) poses that students (in her study) cite preferences for different forms of questions – working-class students preferring the more traditional forms of questions whereas middle-class students are happy with both traditional and problem-orientated questions. Zevenbergen (2000b) has raised similar issues in relation to the ways in which questioning influences how students are able to access knowledge and interact in mathematics classrooms. When this literature is coupled with the research of Heath (Heath, 1983; Heath, 1982) where there are clear differences in the ways in which questions are posed in the home from those at school, it becomes essential to consider how interactions and questions in the school differentially impact on learners and learning in mathematics.

The mathematics classroom is a cultural representation of the values of the dominant culture – in terms of mathematical knowledge but also with the social values. Mathematics is taught through interactions that are embedded with the social practices of a western middle-class value system. It is this second aspect that will be discussed here. The following extract is taken from a Year 7 classroom (final year in primary school):

T: We are going to work in small groups on this problem. Would someone like to read it out for me please?

B: [reads the problem from the chalkboard] A length of rope is cut in half, and one half is used. The one third of the other half is cut off and used. If the remaining piece of the rope is 10 metres, how long was the original rope [students interject]

T: Please be quiet as Steven reads it

B: [finishes reading problem]

T: OK…. So you've got work out how long the original rope was by following all those instructions. No, you don't tell me now. You can do this in groups. You can talk about it, you can write little notes down on your maths book if you like, or a piece of paper, on your note pad, and well try, but some people think they know the answer straight away, but talk about it with the people and see if they agree with you that that's the length. Alright, now can you see if you can find at least one other person to work with, put your hand up if you can't. [Students begin working in small groups]

When interacting with students, teachers are more likely take on the value system of the middle-class¾posing pseudo-questions in terms of the regulative discourse where behaviour is controlled e.g. "Would someone like to read it out for me please?" or "You can do this in small groups". Ethnographic studies (Heath, 1983, Zevenbergen, 1995) have shown that students from working-class backgrounds often appear to "misbehave" in classrooms but argue that this may not be due to "bad behaviour" from the students but a misrecognition of the implicit rules for interacting with the pedagogic discourse. In our observations of classrooms posing the question "would someone like to read it out for me?" is often seen as not a good question but it does not meet with the same reaction from different classrooms clientele. Bernstein's theoretical position allows us to theorise that posing questions in this way is likely to survive with middle-class students who are able to recognise the implicit assumptions in the question, whereas working-class students are potentially likely to interpret the question literally.

Within the regulative discourse, Bernstein (1996) proposes that through the discourse, behaviours are sought to be controlled. In the example cited here, students from middle-class backgrounds have experience with this form of command and are able to negotiate its implicit meaning (i.e. read out the instructions). In contrast students from working-class backgrounds are at risk of not interpreting the cultural demands embedded in the direction-posed-as-a-question and may see that there is an option. It is not uncommon is such cases for the student to be interpreted as a "behavioural problem" and asked to leave the room when they respond in the negative. In our work with teachers, they often report that even the inclusion of “please” can be interpreted as conveying an option to participate in the interaction. Many teachers in disadvantaged students have indicated that they are reluctant to include “please” within their pedagogic discourse for fear of the potential consequences. Many of these teachers also report that they feel uncomfortable with this deletion from their speech as it is incongruent with their ways of being – a well-mannered (middle-class) teacher.

In contrast, the pedagogic discourse seeks to control the content of the mathematics lesson. In this example, the teacher states “So you’ve got work out how long the original rope was by following all those instructions”. Here, the problem is stated (find the length of the rope) and how to solve it (follow the instructions). However, the instructions are not clearly evident and from the mathematical standpoint need to be extrapolated from the given information. In this case, the teacher is hinting at a “working backwards” strategy, although not clearly stating this. The students need to unpack this interpretation of the teacher’s discourse. In similar examples, often the mathematics is embedded in a context and students need to recognise the contextual or language cues from the mathematical cues. This was evident in the earlier section on written texts.

Conclusion

Unlike other discourses in mathematics education where the interpretation of incorrect responses may be based on psychological models of learning, such as 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 is 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 recognize whether or not they able to undertake the recontextualisation of tasks from a mathematical context into another ‘realistic” context, and to identify realization and recognition rules, rather than within a restrictive ‘numeracy’ framework. The examples provided here give some insight into how the discursive practices in school mathematics can be restrictive for students – depending on their social background.

Students need to be able to recognize that the teacher is embedding mathematical tasks in particular discourses and that these discourses may or may not be relevant to the task. Whereas this is often undertaken under the guise of making mathematics more meaningful and relevant to the life experiences of the students, it often creates another (invisible) layer of disadvantage to some groups of students.

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