SUPER-ORDINATE COMMUNITIES OF PRACTICE: CROSSING BOUNDARIES, 'TRANSFER' AND IDENTITY

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The aim of this paper is to discuss a theoretical construct – super-ordinate or overarching communities of practice – to contribute to the discussion of transfer and, more specifically, to reconceptualize what, within the school context, might be thought of in Bernstein's terms as the transfer of knowledge between two insulated vertical discourses. We describe how this theoretical construct was developed from interdisciplinary work carried out by secondary mathematics and science teachers. We tell some stories about the learning of two fifteen year-old students to ground our ideas. We conclude with some theoretical suggestions of how we might develop and make use of the concept of super-ordinate or overarching communities of practice.

INTRODUCTION

Transfer of knowledge refers in general to the use or application in one context of knowledge learned in another. It is suggested by some researchers (e.g. Lave, 1993; Greeno, 1997) that those choosing a strongly cognitive perspective on learning see knowledge as something relatively stable, generalizable to different situations and characterized by personal attributes in the sense that once acquired, the subject carries it with her from one place to another. As Boaler (2002a) points out, situated learning perspectives offer an interpretation of knowledge that is radically different: a representation of knowledge as activity, as something that is shared or distributed by persons; something that is located between persons, the environments in which they are inserted and in developing activities. From these perspectives it is not that cognitive structures are not considered, but that they cannot be detached or abstracted from learning contexts.

Here we explore how transfer has been approached by some researchers whom we judge broadly to share our theoretical perspective. We offer a theoretical construct – super-ordinate or overarching communities of practice – as a contribution to the discussion of transfer and, more specifically, to reconceptualize what, within the school context, might be thought of in Bernstein's terms as the transfer of knowledge between two insulated domains or vertical discourses. We describe how this theoretical construct was developed from interdisciplinary work carried out by secondary mathematics and science teachers. We tell some stories about the learning of two fifteen year-old students – Aline and Julia - to ground our ideas. We conclude with some theoretical discussion of how we might develop and make use of the concept of super-ordinate or overarching communities of practice.

TRANSFER OF KNOWLEDGE UNDER SOME SITUATED VIEWS

There is disagreement over transfer in the mathematics education literature relating to situated learning. For example, Greeno (1997) proposes that it is more appropriate to treat the issue in terms of generality of knowing than transfer of knowledge. Lerman (1998) refers to Bernstein's sociological perspective and that of Dowling to support his suggestion that *transfer-ability* in mathematics is a specific activity that can be learned. Such ability would be related to the potential to read texts with mathematical eyes no matter in what form they are presented. Lave (1988) treats the issue in terms of meanings within practices. Lerman points out that Lave sees 'the range of practices in which any individual engages to be overlapping, mutually constituting and related' and 'offers the possibility for conceptualizing transfer across…boundaries, where practices have family resemblances to each other' (Lerman, 1999, p.96). Boaler (2002b) uses inverted commas to say that students are able to 'transfer' mathematics under certain circumstances.

METHODOLOGICAL POSSIBILITIES

The degree of variation in the theorizing of the problem of transfer from perspectives of situated learning raises methodological difficulties for those who aim to research the issue from these perspectives. According to Greeno (1997), situated learning perspectives should focus on the consistency or inconsistency of the patterns of participative processes within situations. These patterns have contents and structures of information, which are important aspects of social practice. Methodologically speaking, empirical research from a situated perspective relating to crossing boundaries should adopt as the unit of analysis interactive systems which include individuals as participants, interacting with each other and with material and representational systems.

BOUNDARY CROSSING

Here we focus on the crossing of boundaries between school subjects, often seen as insulated, non-intersecting school practices.

Bernstein's (2004) theoretical perspective accounts for the social production of such subject boundaries and their associated pedagogies. To this perspective and that of Wenger (1998) we add two elements from Evans (2000): 1) the structural differences between the language codes used in such practices may be used to define the boundaries between them; 2) for learners to cross these boundaries they need to grasp or apprehend something of the nature of what Bernstein (1996) calls 'recontextualisation'.

Bernstein can help us to explain why it is that a major challenge for teachers and students in schools is to do what looks like transfer. Boundaries may be socially produced, but they are no less real for this in the experience of teachers and students. So, why is it that some people are so disposed to do what looks like boundary crossing that, for them, boundaries appear completely permeable? Why is it that, for others, boundaries have a solidity which makes the very thought of crossing impossible? We think that it is helpful to account for this kind of boundary crossing in terms of what we will call super-ordinate or overarching communities of practices. We will tell Aline's and Julia's stories as a basis for developing this idea.

MATHEMATICS AND SCIENCE INTERDISCIPLINARY WORK

Cristina and Selma set out to do research with a year-9 secondary school class (28 students) that they both taught that would underpin the development of mathematics and science collaborative work. Cristina had been teaching this class since year-8. The objective of the research was to investigate how and under what circumstances such collaborative work might encourage their students to cross the boundaries between these disciplines. The subject matter chosen by the teacher-researchers was proportionality in mathematics, and density in science (the same concept of course from the point of view mathematics, but probably not recognized as such by the students). Cristina and Selma spent a lot of time planning and organizing the materials and activities for their class and discussing how and when bridges could be built between their disciplines. We think it is significant that the two colleagues were very close, both in daily-life and their shared educational values.

It was agreed that proportionality lessons would be given first. Cristina made an interactive text about direct proportionality which, among other things, invited the students to discuss some 'special ratios': speed, demographic density, energy expenditure during a period of time, and Pi (3.1416…). The students were divided into small groups to work on the text/exercises. When the groups finished this work Cristina encouraged them to talk about it. The proportionality activity took 4 class-hours.

Selma gave 8 class-hours to the topic of density. Here the students worked through activities from their science textbook and carried out laboratory activities in small groups in which they calculated the density of materials and did some experiments to check the relationship between density and the buoyancy of these materials in water. During all classes on density Selma drew the students' attention to the fact that the mathematical concept 'behind' density was proportionality which had recently been studied in Cristina's class.

Before starting the data collection both teachers talked with the class about the research, its objectives and its procedures. The proportionality activities began in August 2005; the density activities began two months later (November 2005).

ALINE'S AND JULIA'S STORIES

Aline's story begins after the work on proportionality has been collectively and carefully corrected. The class had been discussing 'special ratios' and Cristina had made careful notes on the blackboard. Cristina asked the students if they knew any other special ratios. Aline said, *'density'* (and so did a number of other students). Cristina asked what they meant by density and these students said *'mass divided by* *volume'*. Cristina asked Aline to talk further about the connection between proportionality and density. Both the teacher and the students discussed the densities of water, iron, oil, and other physical materials. As Selma had done, Cristina also encouraged this 'linking' discussion, trying to adjust her mathematical language code to fit with Selma's scientific code[i].

At the end of the class Cristina asked Aline and two more students (one boy and one girl) to talk with her. Among other things, she asked them when they had first identified 'density' as a special ratio; had it been on the day they had been working on the text, or on the day when they had corrected their work together? All of the students said that they had made the connection when they had corrected their work. Aline said, *'I've already studied this in chemistry. Then I saw the ratio. Then when I compared this with the ratios that were on the blackboard yesterday, acceleration [for example], then I remembered density'* [here, the utterance seems to mark a crossing of the boundary between the two subjects. In fact, she suggests that density is a particular case of proportionality].

Later in this conversation, Cristina asked if they had worked on density before. They all had - in two different contexts: when they were 11 in a science class (taught, coincidently, by Selma); and recently in an additional private 'cramming' course they were doing for entry to high school. They all commented that Selma didn't like formulas, that she preferred to work on understanding; they voluntarily contrasted her approach with the 'straight' (procedural) methods of the cramming course: *'this is for this, that is for that and you have to use this (formula for density) in this way'*. More interestingly, these students suggested an awareness that they had learned different things, albeit with the same label, in the two settings. We suggest that this may also be evidence of students' awareness that their teachers' differing approaches reflected what we might call the inevitable result of recontextualisation.

Julia's story starts during a technical outing to a hydroelectric plant, by coincidence planned by Selma at the time the class were studying density. The objective of this visit was to observe the phases of the process of energy transformation *in real life*. The first stop the group made was at a reservoir. Their task was actually to watch how water passed through sluices designed to regulate flow into a canal. Sadly, when the students got closer to the reservoir they came across the dead body of a dog floating in the water. The body floated amidst papers, plastic bottles, pieces of wood and other rubbish. The sight of the dead body unsettled the students. Some of them began to wonder how the dog – presumably a good swimmer – had drowned. Others were disturbed by the teacher's observation that the Brazilian attitude to the environment allowed the river to become a rubbish dump. And then Julia exclaimed: *'floating and sinking!'* This surprised Selma whose agenda was no longer density, but the processes of transformation of energy. But, she used Julia's observation to revive the talk about 'floating and sinking' and new problems arose: why were all those materials floating? The students had no difficulty recalling their studies about density. Some said, *'because they were less dense than water'*. Others said: *'But,* *what about the dead body of the dog, why does it float?'* Selma and the students talked about the dead body of the dog and applied what they had learned about density in the science laboratory. Selma also extended the talk to include other scientific relationships, including that between buoyancy of bodies (including human bodies) and the structure of lungs. This talk took over a good part of the visit, and all students engaged in the conversation.

What could lead Aline and Julia to make these connections? Why did other students engage so quickly in the conversation that followed these connections?

SUPER-ORDINATE (OR OVERARCHING) COMMUNITY OF PRACTICE

In Bernstein's terms we might say that Cristina and Selma, having translated for each other their specific discipline codes and worked together to prepare and organize their collaborative work and to build bridges, had set up 'something' that enabled the crossing of the boundaries between their disciplines – seen as specialized symbolic systems within a *vertical discourse* (Bernstein, 1996). Our theoretical construct is that the 'something' these teachers had set up can be seen as a mathematics and science 'super-ordinate (or overarching) community of practice' (SCoP) which had some durability and stability. We suggest that it was in large part the activity of Cristina and Selma that led to the constitution of the SCoP. A community of practice was constituted which overarched practices that might otherwise have stayed unconnected within the two insulated subject disciplines. From this perspective, the comments and the connections that were made by Aline, Julia and others are signs of the students' participation in such a SCoP as well as evidence of ZPDs (see Vygotsky 1986) that have emerged within it. Indeed, the students' comments suggest that they have caught on to their teachers' intentions that they learn to make such connections.

Equally important in the constitution of the SCoP are the predispositions of the students, their readiness to become active participants in these practices. The students' apparent awareness of differences in teaching, of the ways in which these differences are produced and why, might be taken as evidence of their apprehension of something of the principles of recontextualisation. It may also be another facet of the students' predispositions and so important in the constitution of the SCoP.

A question that must be of continuing concern to us is what schooling might have to do with the development of such dispositions and the understanding that follows from these. Ricoeur (1981, p. 56) notes that: 'The first function of understanding is to orientate us in a situation. So understanding is not concerned with grasping a fact but with apprehending a possibility of being.' Such 'apprehension of a possibility of being' may be a central, possibly a defining feature of our developing idea of SCoP; this idea is closely linked in our minds to Vygotsky's notion of ZPD and we look forward to the joint development of both as a way of planning for the powerful learning of students.

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[i] Recordings of Cristina's classes show a change in the way she talked mathematically about proportionality; it became embedded in scientific talk. Cristina had already studied Selma's material and talked over her understanding with her. Cristina set out to talk about density in her class using the terms and expressions Selma had taught her. In the case of Selma, a similar change can be seen in the recordings of her classes.

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