Using video-case and on-line discussion to learn to “notice” mathematics teaching

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Abstract

This research report presents part of the findings of a research project whose goal was to characterize how prospective secondary mathematics teachers learn to notice mathematics teaching through the analysis of video-cases and the participation in online discussions. In this context, we understand to learn to “notice” when prospective secondary mathematics teacher link empirical evidence to theoretical information as a process of identifying relevant aspects in mathematics teaching and interpreting them. The findings show that the specific structural aspects of a web-learning environment might explain some relationships between the different topics in on-line discussions and the characteristics of learning to notice mathematics teaching.

In this research project we assume that “notice” teaching mathematics can be learned (Lin, 2005; Mousley & Sullivan, 1996; Van Es & Sherin, 2002; Sullivan & Mousley, 1996;) understood as linking the events in a mathematics lesson with theoretical ideas originating in the didactics of mathematics as a process of identifying and interpreting different aspects of a mathematics lesson (Morris, 2006; Lin, 2005). This process of interpretation is generated by relating the particular to the general, and thus forms a starting-point for the development of professional knowledge in prospective teachers.

Nowadays, recently developed technologies can be used to support interaction among prospective teachers. Online discussions make it possible to extend the boundaries of the class and to provide opportunities for written interactions with peers and expanded discussion spaces by allowing students to reflect and to develop skills that facilitate learning from practice (Derry et al., 2000). In these social interaction spaces, questions are generated on the cognitive effects of interactions that involve explanation and justification, in particular the question of how the different modes of participation operate to mediate meanings about mathematics teaching (Llinares & Oliveros, in preparation). Here, the activity of analysing a video-clip and partcipating in virtual debates are therefore semiotically directed and enables us to analyse the “products generated” by the prospective teachers as particular examples of knowledge-building; on the other hand, as the prospective secondary mathematics teachers (PSMT) are able to integrate what they consider to be relevant information in the analysis of mathematics teaching, we can observe how they construct this knowledge (Wells, 2002).
From these two viewpoints (analysing the mathematics teaching through video-cips and the participation in virtual debates), we designed several virtual learning environments for prospective secondary mathematics teachers during their final year of their mathematics degree. The goal of this research was to characterize how prospective secondary mathematics teachers conceptualize mathematics teaching through analysing video-cases and participating in online discussions.

**Design of interactive learning environments**

For the last four years, we have been carrying out a research project using a design experiment approach (Cobb et al., 2003) about how prospective mathematics teachers endow mathematics teaching and learning with meaning through analysis of video-cases of mathematics lessons and through participating in online discussions (Llinares & Valls, 2007).

The multimedia learning environments we designed included the following: a video-clips of part of a mathematics lesson, a virtual debate, theoretical informative documents relating to the teaching of mathematics and documents containing information on the actual classroom context, which included the teacher’s lesson plan, previous activities and classroom organisation. The PSMT were expected to exchange views with their colleagues on the analysis and interpretation of the videoed episode, and to come to an agreement on the text of a written report which was to be prepared in groups of four or five and handed in as a final assignment.

The documents with theoretical information described critical classroom features that promote mathematical understanding (tasks, tools, norms, structuring and applying knowledge, reflection and articulation), and one characterization of mathematical competence as a multidimensional construct (conceptual understanding; development of skills; communication; posing, representing and solving problems; positive attitudes; mathematical confidence in oneself) (Fennema & Romberg, 1999).

The following two questions were offered to guide PSMT in their analysis of the video-clip (Pea, 2006):

- **Q1.** What features of mathematical competence are improved by Sara’s (the teacher) interaction with her pupils?

- **Q2.** What aspects of teaching (the mathematical task proposed, methodology, management of the teaching process ...) influence the development of different features of mathematical competence in this situation?

The video-clip shows the interaction between a teacher (Sara) and a group of pupils (14-15 years of age) while attempting to solve a problem consisting in drawing graphs to show the relationship between the quantities of water poured into jars of different shapes and with different surface levels. The teacher’s role consisted in helping them in the process of drawing the graph corresponding to each of the vessels and establishing the significance of the differences between the graphs in order to lend meaning to the underlying concept of slope of a linear function.
Data used in this paper come from one of these learning environments which was operative during 2005-2006. The participants were 23 PSMT. We analysed the 109 PSMT' postings in the online-discussion in the 17 days during which the web-learning environment was activated. These PSMT had experience in face-to-face and e-learning activities before participating in this learning environment. The e-learning activities formed 40% of this subject of mathematics education. That is to say, the course has the structure of b-learning.

**Analysis**

During the debate some of the contributions were organised as conversational chains through dialogical interactions. A conversational chain is a set of interactions all relating to the same topic. The characterisation of these chains enabled us to identify the topics and the ways in which the PSMT interacted. The PSMT’ contributions to the debate were analysed on three dimensions: participation, interaction and cognition (Schrire, 2006).

On the **participation** dimension we paid attention to who contributed and when. In the present paper we shall present the global participation features of the group and we shall not take the time factor into consideration.

Ways of interacting were analysed by considering 6 categories: **Supplies information** (SI), **Clarifies** (Cl), **Agrees** (A), **Agrees and amplifies** (A+A), **Disagrees** (D) and **Disagrees and amplifies** (D+A).

As regards the analysis of cognition we have established four distinct levels considering the content of participations, based on the sources used, the way in which the ideas were expressed in the contribution and the way in which were interrelated. We also considered whether relationships were established between ideas from a general point of view or whether the student examined the actual mathematical content shown in the video-clip. The four levels (L) were as follows:

- **L1. Descriptive:** The PSMT responds by describing in a “natural” manner what he/she has seen, but does not make use of the theoretical ideas which might be relevant to the analysis of the situation.
- **L2. Rhetorical:** The PSMT uses the theoretical ideas contained in the documents in order to construct a response, but without establishing relationships between the ideas and the situation. The discourse may be said to lack cohesion.
- **L3. Identification and initial instrumental use of the information provided:** The PSMT identifies one or more relevant aspects of the situation and links them to one or more of the theoretical ideas, thus generating an interpretation of the situation.
- **L4. Theorising and conceptualising: relational integration:** The discourse generated shows a process of integration of different ideas to explain different aspects of mathematics teaching.

**Procedure**
We considered the different theoretical bases of level of knowledge building, ways of participating and perspective-taking, in order to make a first draft of the category system reflecting the different analytical dimensions. The category system was revised after the researchers became familiar with the postings of PSMT in the online discussion. Next, we independently codified the different participations considering ways of participating, level of knowledge building and the perspective-taking stages. Finally, the discrepancies were discussed until a unitary evaluation was reached. We present here the findings of the first phase of analysis.

Results

We identified two conversational chains whose content is related to each of the questions posed at the start of the debate.

Chain 1 (C1): This chain deals with the meaning of the idea of mathematical competence as the interrelation between: (a) conceptual comprehension, (b) development of procedural skills, (c) communicating, explaining and arguing mathematically, (d) the capacity to formulate, represent and solve problems (strategic thought), (e) the development of positive attitudes towards mathematics, and (f) achieving mathematical confidence in oneself.

Chain 2 (C2): This chain deals with the teacher’s handling of the situation in order to develop the pupils’ mathematical competence. Following the initial response to the starter-question, five new areas of debate were opened up: (i) the rigorous use of language and the role the teacher should play, (ii) group work, (iii) characteristics of teacher-pupil interaction, (iv) ways in which the teacher can encourage pupils’ participation, and (v) the appropriateness of the mathematical task proposed.

The number of contributions and the centre of interest of the discourse were different in the two chains. Of the 109 contributions to the debate, 16 referred to the Chain 1 and 93 referred to the Chain 2.

Our analysis of the ways in which students participated revealed that although there was less participation in Chain 1, the type of interaction was similar to that in Chain 2. 75% of the contributions in both conversational chains corresponded to a reply to someone else or a clarification of something expressed previously in an attempt to make oneself understood (see Table 1). The PSMT were in greater disagreement, however, on which aspects of the lesson seemed to promote the development of mathematical competence (33.31% in Chain 2), than in their indication of evidence of mathematical competence in the pupils (25% in Chain 1).

The cognitive levels reached in both chains also showed differences (Table 2). In Chain 1, 75% of the contributions (12 out of 16) were considered to be at level 3 (L3). Of all the contributions at this level, 9 referred explicitly to the mathematical content of the videoed lesson. The PSMT concentrated on assessing the potential of the mathematical activity generated by the problem proposed by the teacher in the video-clips.
Interaction with others

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<tr>
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<th>SI</th>
<th>CL</th>
<th>A</th>
<th>A+A</th>
<th>D</th>
<th>D+A</th>
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<td>Chain 2</td>
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<td>15</td>
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<td>8</td>
<td>14</td>
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<td>(20.43%)</td>
<td>75%</td>
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<td>9</td>
<td>14</td>
<td>21</td>
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<td>109</td>
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Table 1. Modes of participation in each chain

In contrast, only 39.78% (37 out of 93) of the contributions in Chain 2 were considered to be at level 3, and of those only 6 alluded directly to the mathematical content; the majority concentrated on more general aspects such as the rigorous use of mathematical language in class, features of group work, the role of the interaction between the pupils and the teacher, the nature of the task, the way in which the teacher handled the relationship between achieving the objective of the lesson and dealing with the pupils’ answers, and a description of the context exemplified in the video-clips. None of the contributions was identified as being at level 4 (L4).

Discussion

The two questions given to initiate the debate referred to learning and teaching, or more specifically to the dimensions of mathematical competence which can be enlarged by teacher-pupil interaction, and the role of the teacher in the enlargement of those dimensions. These two aspects are interrelated: What do we want the pupils to learn? How should we modify the instruction process to achieve this end?

The two chains, however, showed different characteristics. In the first place, the first chain concentrated on a single point of interest, while in the second the discourse was more destructured and there were several different points of interest. Secondly, the students participated and disagreed with each other on the characteristics of the teaching process considerably more in Chain 2 than in Chain 1. And thirdly, the contributions to Chain 1 referring to evidence of the dimensions of the pupils’ mathematical competence were of much better quality. These differences may be explained by the nature of the topics under discussion and by the type of information

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1 The number in brackets indicates those contributions which referred explicitly to specific mathematical topic in the video-clip
The interpretation process. The difference between aspects of teaching and the identification of mathematical competence.

The documents containing theoretical information with which the PSMTs were provided referred both to the characterisation of mathematical competence and to certain aspects of the teaching process. The information provided mentioned neither the specific mathematical content of the videoed lesson nor the specific aspects of teaching involved. The information was handled in different ways by different PSMTs, which indicated how they related it to the empirical evidence observed in the video-clip. They found it more difficult to relate the characteristics of mathematical competence to the behaviour of the pupils than to do the same with aspects of the teaching process, which they found relatively easy.

For instance, one of the documents on teaching stated that “in order to create a classroom atmosphere conducive to investigation and mutual respect, the teacher should encourage the generation of arguments by asking the pupils to clarify and justify their ideas.” Recommendations of this type helped the PSMTs to identify in
the video-clip some features of the teacher’s performance which could be associated with this characterisation. This fact may have caused the PSMTs to focus their discourse more on matters relating to the teaching process (Q2). In such cases the PSMTs could simply describe what they saw and identify it with a characteristic given in the document. They could then disagree on the degree to which they thought that what the teacher was doing was, for example, relevant to the encouragement of argument-generation among the pupils. But when the information was of a more general nature, such as “one dimension of mathematical competence is conceptual comprehension of mathematical topics, by which we mean the way in which secondary-school pupils are able to link different mathematical ideas together and explain their meanings”, the PSMTs were obliged to focus their attention on the mathematical cognitive processes of the pupils while they were interacting to solve the problem, and then to interpret what they did as manifestations of mathematical competence. It appears that this kind of activity required a much greater effort on the part of the PSMTs.

This difference between interpreting the characteristic of the teaching process (Q2) and identifying manifestations of the pupils’ mathematical competence (Q1) could explain the nature of the debate generated (differences in the quality of the discourse, and differences in modes of participation). These results are similar to those obtained by Lin (2005) via videoed case studies shown to student teachers, where the students tended to focus their attention on the teaching process and had difficulty in “noticing” the development of the pupils’ mathematical competence.

Our results, however, like those of Sullivan & Mousley (1996), show that the use of videoed material is a powerful tool in relating theory to practice and in enabling PSMT to develop a high cognitive capacity in their analysis of teaching. At the same time, our research reveals that the design of the learning environments may facilitate to a greater or lesser degree the construction of knowledge about the teaching of mathematics. The fact that contributions to the debate refer separately to learning and teaching without explicitly interrelating them reveals that the PSMTs approached the analysis and interpretation of teaching through an analytical thought-process which examined each aspect of the situation in turn, instead of looking at it globally and holistically. This fact might be explained by the actual structure of the online debate and the presentation of two initial questions, though the students were never asked to answer them separately. The directions in which the debate developed could have been corrected by a chairperson (tutor), who could have suggested to the students that they try to establish more connections between different ideas and thus construct cognitive knowledge of a higher quality.

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