Negotiation of Meaning in Outside of the Classroom Group Assignments: Accounting for the How to Understand the What of Future Mathematics Teachers' Learning

Pedro Gómez[1], Vilma Mesa[2] and María J. González[3]
[1]Universidad de Granada, [2]University of Michigan, [3]Universidad de Cantabria

Abstract. *In this paper we illustrate how Wenger's theory of social learning can be used to account for phenomena of future teachers change in settings that are not usually studied, namely group work that future teachers do as they work on class assignments outside of class. We describe how we adapted Wenger's theory to the exploration of future mathematics teachers' learning and illustrate how the analysis of the audio taped interaction of a group of future teachers working outside the classroom generated conjectures that help to explain their didactic knowledge development.*

1. Future Teachers' Learning

In order to understand why a training model or a training process is effective, it is important to explore how future teachers develop the competencies expected from them. When the teacher education program hinges on group work and learning is supposed to emerge as a consequence of future teachers' interaction, then exploring learning requires to take into account the negotiation of meaning processes that take place among future teachers and emphasize the different elements of the learning context that might influence such negotiation of meaning. That is why several researchers have suggested studying future teachers' learning from a sociocultural perspective (e.g., Borko, 2004; Lerman, 2001; Llinares & Krainer, 2006). We have chosen Wenger's theory (1998) for this purpose.

2. Context

The study took place in a methods course for last year mathematics students who expected to become secondary mathematics teachers in Spain. The purpose of the course is to provide opportunities for the future teachers to develop their lesson planning competency. This is done by using a sequence of conceptual and methodological tools (e.g., representation systems, analysis of errors and difficulties, etc.) that allow the future teachers to identify, describe and organize the multiple

meanings of a school mathematics topic (e.g., sphere, quadratic functions). Future teachers work in groups and they are expected to analyze their topic with the tools provided and use the information emerging from such analysis to design a series of lessons for a curriculum unit and to justify their decisions. Through out the course, groups present their work regularly to the class. At the end of the course they submit a document and present their planning of their lessons (at most six) to the class. They have to justify their proposal with information that emerges from the use of the conceptual and methodological tools mentioned previously. Most of this group work is done outside the classroom. The study reported here is part of a larger research project that sought to explore de didactic knowledge development of future teachers participating in such a program.

3. Method

In this paper we concentrate on the analysis of the audio taped interactions of one group of future teachers who worked on the quadratic function. We used Wenger's (1998) notion of *community of practice* as representing the smallest unit of analysis in which one can include the negotiation of meaning as a mechanism of learning. It is configured on three notions: mutual engagement, joint enterprise, and shared repertoire (pp. 772-73). Learning as a social practice can be characterized by these three notions because *learning in practice implies a mutual engagement in the search of a joint enterprise with a shared repertoire*. That is, learning as a social practice implies evolving forms of mutual engagement, understanding and tuning the enterprise, and developing the shared repertoire.

The operationalization of the three processes—mutual engagement, joint enterprise, and shared repertoire—gave rise to a set of nine categories (e.g., "relationships among members", "meaning", "working routines") and 94 codes (e.g., "a member makes a reference to his previous experience as teacher", "the responsibilities within the group are defined and configured") with which we coded over 16 hours of transcriptions of the group meetings recordings, producing 7,412 episode-code pairs corresponding to 2,606 episodes—more than one code could be assigned to a given episode. Through processes of *coding synthesis and analysis* (Gómez, 2007, pp. 340-348) we identified 30 *issues* that characterized the learning of the group, established the main characteristics of each issue and identified the episodes that were more representative of each characteristic. Examples of these issues are the emergence of a leader in the group, the role of the members' previous teaching experience, the processes and mechanisms through which the group resolved their meaning conflicts, the role of the educators' commentaries, the working routines that the group established, and the difficulties that the group had with the analysis of their topic. For instance, the coded information showed

that the educator's written commentaries to the group's presentations configured how the group, towards the end of course, was able to solve some of their difficulties (e.g., connecting the different representations of the concepts and procedures of their topic). The transcriptions showed that the group did not read the teacher educators' commentaries when they received them. Nevertheless, when producing the final document, the group went back to those commentaries and was able to interpret those commentaries on the basis of the information they had gathered on the topic. Different interpretations appeared, giving rise to events of meaning confusion and conflict, that were gradually resolved into a new group's meaning for the idea of connections among representations. This meaning was adopted (as part of the shared repertoire) enabling them to produce new analysis of their topic. Hence, the educators' commentaries influence on the group's learning processes was established as one of the issues of those processes. The structuring of these issues (in terms of the three processes implied by learning as a social practice) and the evidence supporting them enabled us to produce an account of the working of the group as a community of practice (i.e., the fact that there was interdependent learning in the group).

4. Findings

By looking at negotiation of meaning as a central mechanism of learning (Wenger, 1998, p. 96), we found that the group engaged in a permanent search of meaning that generated multiple events of confusion, conflict, and discovery that gave rise to the formulation, rejection and adoption of meaning proposals. Simultaneously, we were able to characterize the mechanisms used for these events (e.g., in some occasions, the leader used his influence on the group, for solving some of the conflicts of meaning). Given that the group had to solve a task in each meeting, these processes of negotiation of meaning always ended in the adoption of some proposals (e.g., the group's meaning at a given point in time of the notion of representation system) that were reified and registered in the transparencies they would use to present their work to the class. This type of participation promoted a mutual engagement with *interdependent learning*, one of the most important features of a community of practice. The emergence of a leader, the teaching experience of the members, the way tasks were defined and the written commentaries that the trainers made to their work were the most significant factors affecting the working of the group as a community of practice.

The information gathered on the group processes of negotiation of meaning suggests conjectures for explaining some aspects of the didactic knowledge development of the group that were established in the other three studies. In particular, the group's interpretation of the teacher educator's written commentaries

played a relevant role in two aspects of their didactic knowledge development: (a) how they solved problems they had concerning the phenomenological analysis of the topic, and (b) how they established connections among the multiple representations of the topic. For instance, the group understood the notion of phenomenological analysis towards the end of the course when, through a process of meaning confusion and conflict, they were able to interpret the educator's written commentaries and establish a new meaning for this notion. This new meaning enabled them to further analyze their topic and produce new information about it. This new information proved to be useful for analyzing, selecting and supporting the tasks they proposed in their final work. In addition, the community of practice analysis suggests conjectures for explaining the role of future teachers' previous teaching experiences on their cognitive analysis of the topic. Their experience as private tutors seems to have given them knowledge about students' difficulties with the topic. They were able to put this knowledge into play for analyzing the topic and for selecting the tasks they proposed in their final work.

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