Mathematics student teachers as participants in a research project: the emergence of critical thinking

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Introduction

Becoming a mathematics teacher is often referred as to engage into a learning process. A way of conceptualizing this process is to assume that the student teachers' knowledge acquired before entering a course influences what they learn and how they learn it (Richardson, 1996). Studies of that type aims to describe and explain the importance and influence of student teachers' beliefs and knowledge on their learning. Thereby, the identification of changes in their beliefs and knowledge are presented as evidence for a learning process (Furinghetti & Pehkonen, 2003). Increasingly, research reveals the complexity of mathematical knowledge and recent research indicates a shift from considering mathematical knowledge as an entity independent of context to considering mathematical knowledge as situated within the practice of teaching. Rowland et al. (2004) elaborated a theoretical framework to address and describe student teacher's mathematical subject matter and pedagogical knowledge as evidenced from their teaching. In an attempt to learn in and from practice, Nicol & Crespo (2003) introduced analysis and reflection on teaching practice as a means to integrate theory and practice. Along the same lines, a new initiative at Agder University College (AUC) is offered to mathematics student teachers through the opportunity to participate into a research project in mathematics education and to become research assistants (Grevholm, Berg & Johnsen, 2006).

Central features of the new course at Agder University College

Our aim is to design and implement a different kind of practice, where the student teachers, through their active participation both in a new designed course and in a research project which is running at AUC, the Learning Communities in Mathematics (LCM) project, are offered opportunities to develop their awareness of the complexity of the teaching practice. This new practice was tried out for the first time in autumn 2005 and, based on the student teachers' evaluations, it has been developed further and redesigned. I have been responsible for running this course since it started and, in collaboration with Barbro Grevholm, we selected relevant articles from the research literature in mathematics education and designed the student teachers' school-based practice which consisted of classroom observations and interviews with pupils. The assessment for the course included an essay in which the student teachers were asked to show how central ideas from the research literature in mathematics education were exemplified in chosen excerpts from pupils' interviews. I considered as a crucial aspect of the course to invite student teachers to discuss in a critical way both the content and the structure of the articles. Furthermore, my aim was to underline the link between the different theoretical ideas, as presented in the research articles, and the various aspects the student teachers met in this new school-based practice.

Research question and theoretical considerations

The research question which I propose to address in this paper is the following: What is the nature of the student teachers' thinking, as emerging from their participation in this new course? In order to address these research questions, I work from a sociocultural position where learning is addressed in terms of increasing participation in socially organized activities where the dimensions of negotiation of meaning and inquiry are central (Jaworski, 2005, 2006; Lave & Wenger, 1991; Wells, 1999; Wenger, 1998). Following this perspective, knowledge is located in particular forms of situated experience, and "has to be understood relationally, between people and settings; it is about competence in life settings" (Lerman, 2000, p.26). I argue that these different theoretical elements were present in the course: during our critical discussions of the research articles, the student teachers were gradually involved into the experience of negotiating the meaning of the theoretical ideas presented in these articles; during the preparation of their school-based practice, the student teachers gradually developed an awareness of the links between theoretical constructs and elements of the teaching practice; and during the writing of the essay, the student teachers were asked to articulate and make visible those links. These characteristics of the course were introduced using inquiry as indicating "a stance towards experiences and ideas – a willingness to wonder, to ask questions, and to seek to understand by collaborating with others in the attempt to make answers to them" (Wells's, 1999, p.121). In that sense, I consider inquiry as a fundamental means inviting the student teachers to become legitimate peripheral participants in the research project LCM at Agder University College. Furthermore, I argue that these elements are characteristic of the development of 'critical thinking' where my understanding of the idea of 'critical thinking' is based on and rooted in Jaworski's (2006) 'metacognitive awareness' and Wells' 'metaknowing' in relation to community of inquiry.

Methodology

The methodology adopted in this research follows the design-based approach. According to Kelly (2003), this methodology might be described as an emerging research dialect whose operative grammar is both generative and transformative. It is both generative by creating new thinking and ideas, and transformative by influencing practice. This new research approach addresses problems of practice and leads to the development of usable knowledge (The Design-Based Research Collective, 2003). Wood and Berry (2003) offer a characterization of design research as consisting of five steps: First, the creation of a physical or theoretical artefact, then the product is tested implemented, reflected upon and revised. Third, the design and revision of the products are rooted in multiple models and theories. Fourth, even though, by nature, design research is deeply situated within the contextual setting of the practice of teaching, results should be sharable and generalizeable to the wider scientific community. Finally, the importance of the role of the teacher educator/research has to be recognized and is described in terms of interventionist rather than as a participant observer. I recognize the relevance of these aspects for my research, however, I want to comment on the first step concerning the creation of a physical or theoretical artefact. As underlined by Jaworski (2005), it might be hard, in teaching development context, to identify the product of the developmental process. Therefore, it is sometimes better to talk about developmental research, where "the tools of development form the basis of what is studied and the outcomes of the research process constitute a combination of development and of better understandings of the developmental process and its use of tools" (p.360-361). In the research reported in this article, I consider the tools of development as consisting of inquiry, in the sense of a stance towards experiences and ideas, and the outcomes of the research

process as consisting of the student teachers' critical thinking as gradually emerging from our course. The data consists of the student teachers' evaluation forms of the course, both from autumn 2005 and 2006. Evidences of the development of critical thinking are presented in the next section.

Analysis and results

The evaluation forms show that a large majority of the students are positive to the new design of their practice, and consider this course in mathematics didactics as the most valuable and relevant part of their education. It is also possible to find similar reflections in their essays, but because of space restriction, I will only present examples from the student teachers' evaluation forms.

Evidences found in the student teachers' evaluation from 2005 (my translation)
Student teachers' answer to the following questions:

1) Do you consider this course as relevant for your future work as a teacher? why?

Yes! fine to reflect together on different things connected to the teaching of mathematics. I could notice that I became engaged and it makes me want to become a teacher who is conscious of what she is doing in a teaching situation and why … (S1)

Most of the articles we have been through have been really relevant in relation to my role as a teacher: how I can/will teach, how I can understand and meet the pupils etc. (S2)

Yes, I can see that I can also engage in research as a teacher: research on questions that I could meet as a future teacher. The interviews showed me how important it is to talk with the pupils, to try to understand how they think and like this. (S3)

Yes, mathematics didactics will always be relevant for teacher education! I wish I become a teacher how promote <u>understanding</u> in mathematics, and I believe that good knowledge in mathematics didactics will increase that to happen. (S4)

2) How was it to interview pupils?

Exciting, and demanding! I think it was interesting to be part of the pupils' thinking processes. This might help me to understand other pupils later, now as I became more conscious of how they think. (S2)

Evidences found in the student teachers' evaluation from 2006 (my translation)
1) Do you consider this course as relevant for your future work as a teacher? why?

I think it absolutely has been relevant. Many new ideas and thoughts have emerged, and old thoughts, ideas and BELIEFS have been rejected. It has been especially useful to learn how important it is, for a teacher, to have knowledge about how pupils think and calculate. (S1)

yes, I got advice and useful experiences both through discussions, reading articles and writing the essay. I can see things that I both will and won't do as a teacher. (S2)

2) How was it to interview pupils?

It felt as if it was going very good, but during the transcription we saw many mistakes. We could have interviewed several, and compare them afterwards in an essay. (S2)

I see the interviews as especially relevant in relation to my future work, because I became aware of the fact that pupils think very different from each other. (S3).

I consider that these quotations provide examples of the fact that the student teachers have experienced learning situations in relation to the discussions during the course, and to the interviews during their school-based practice. Especially, several student teachers underline the emergence of new kind of ideas, a process which provoke a critical examination of previous thoughts. It seems that this course enable the student teachers to act critically in several sociocultural settings (AUC, schools) and, thereby, to question their future practice, as mathematics teachers.

Conclusion

The answer to my research question is that through becoming legitimate peripheral participants in the research project, the student teachers are engaged in critical discussions and negotiation of meaning concerning theoretical ideas from the research literature, in interviews where they search to follow the pupils' thinking, and in writing an essay aiming to link theory and practice. I argue that these activities act synergistically and promote critical thinking, as exemplified in the student teachers' evaluation forms. The excerpts from these reveal evidences of the development of awareness in relation to their future teaching practice, to their own ideas, thoughts, and beliefs, and in relation to the pupils' thinking. Furthermore, some student teachers mentioned the possibility to develop a research perspective on teaching activities. Almost all student teachers underlined the importance of the course for their future work, as mathematics teachers, and these considerations, in addition to other suggestions help us to modify and improve the design of the new practice. Even though I do not have the possibility to address issues related to our own learning, as teacher educators/didacticians, I recognize the importance of the processes related to the conceptualization and development of a new practice, and of the challenges we met while realizing it. I consider that mathematics didactics aiming to develop critical thinking might play a crucial role in the professional development of mathematics student teachers.

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