TEACHERS AS RESEARCHERS: PUTTING MATHEMATICS AT THE CORE

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This paper analyses the teachers-as-researchers movement, showing that teachers research mainly focus on pedagogical issues. It reports on a study where teachers were researching aspects of mathematics for teaching limits of functions where mathematical and pedagogical issues were intertwined. It shows that it is uncomfortable for a teacher to deeply challenge his own teaching.

THE TEACHERS AS RESEARCHERS MOVEMENT

According to Elliott (1991), the teachers-as-researchers movement emerged in England during the 1960s, in the context of curriculum reform. Initially it focused on the teaching of humanities subjects, teachers working together in cross-subject teams. The research was not systematic, but occurred as a response to particular questions and issues as they arose. It aimed to improve practice rather than to produce knowledge.

This movement extended in the 1980s in what is usually known as the teacher research movement, which main feature is that teachers are no longer considered as mere consumers of knowledge produced by experts, but as producers and mediators of knowledge, even if it is a local knowledge. In most of their research, teachers focussed on their own classroom practice.

In Mathematics Education, research has now become an important part of many teacher education programmes all around the world. It also has been the subject of debate within the mathematics educators’ community and of several papers presenting results of these programs or discussing certain aspects of teacher research. Most of these publications focus on teachers’ practices.

In 1988, a working group called “Teachers as Researchers” started at PME. This group met annually during nine years and published a book based on contributions from its members (Zack, Mousley & Breen, 1997), presenting different experiences of teachers’ enquiry in several countries and using several methods, which aim was basically to improve practice.

Adler (1992) reports the case study of a middle-class mathematics teacher researching his interactions with learners and their interaction with each other, during his postgraduate studies. Through this research, he realised that he dominated classroom interaction and that his mediation was gendered.

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Hatch & Shiu (1998) reports the case study of a primary school teacher researching her own practice through the analysis of class transcript and a reflective journal as part of an in-service course. They argue that she contributed not only to developing knowledge of her own practice but potentially to the accumulated knowledge of the research community.

Halai (1999) reports on action research conducted by mathematics teachers in Karachi and involving university researchers as facilitators. They also used participant observation, field notes, and reflective journals. She claims that this action research project promoted learning and professional growth not only of the teachers but also of the university researchers.

Edwards & Hensien (1999) describes action research collaboration between a middle school mathematics teacher and a mathematics teacher educator, involving observation and discussion of lessons and exchanging roles in the classroom. The analysis of the teacher’s narrative of this collaboration as well as the teacher’s regular reflections on her beliefs and practices were important to her process of change.

Jaworski (1998) describes the MTE (Mathematics Teacher Enquiry) project, which involved six secondary mathematics teachers undertaking their own research independently of an academic programme. These teachers were invited to identify a question they were interested in researching. Jaworski points out that, during this research, the teachers focused their attention on pedagogical issues, rather than on mathematical issues.

Decisions about what mathematics should be done, what classroom tasks would be appropriate, and what outcomes would be desired, were a normal part of the teaching process, hard to extract as problematically related to the research issues. (1998: 25)

She asks the question “How might mathematics issues become more overt in the research project?” (1998: 29).

In most of the papers presented above, the focus was on teachers’ classroom practices, independently of the knowledge to be taught. In all these projects, it seems that the mathematical content to be taught is taken for granted, and that teachers are not supposed to challenge it. They are only supposed to try to improve their teaching practices. A few articles mention some change, or some possible change, in teachers’ knowledge of mathematics.

Mousley (1992) reports the results of a one-year course in an off-campus mode called MATHEMATICS CURRICULA. Course participants used cycle of action research in a chosen area of their change of practice. They were required to work with colleagues. A representative sample of sixty teachers was then contacted by mail,
telephone or a personal interview about the impact of the course. It was found that there was
not only some ongoing restructuring of pedagogy, in terms of content, organisation and classroom interaction, but also growth of understanding about (1) the nature of mathematics, (2) the processes of teaching and learning of maths, (3) the power of institutional contexts of teaching and learning, and (4) the processes of pedagogical change. (Mousley, 1992: 138)

Although the aim of this project was to improve practice, it also shows that through their research teachers’ knowledge on mathematics evolved, and that they became aware of the weight of institutional constraints.

The notion of mathematics as a stable body of knowledge and skills to be transmitted and practiced became problematic. Questioning traditional classroom practices provided an incentive for teachers to confront given curriculum content. (1992: 139)

Mousley concluded that

participatory, experience-based research has the power to emancipate some teachers from taken-for-granted classroom routines which constrain and control mathematical learning. The dialectical interaction of reflection combined with social interaction allowed innovation in the nature of teaching and learning mathematics as well as in curriculum content. (1992: 143)

This experience shows that through research and interaction teachers can be led to challenge institutional relations to mathematics.

In the first edition of the *International Handbook of Mathematics Education*, Crawford & Adler suggest that:

It seems possible if teachers and student-teachers act in generative, research-like ways, they may learn about the teaching/learning process, and about mathematics, in ways that empower them to better meet the needs of their students. (1996: 1187)

These authors seem to avoid the distinction between practical inquiry and more formal research, using the term “research-like ways”. The focus is on teachers’ personal learning by researching, not only their own practice, but also mathematics. They argue that, the quality of teachers’ mathematical knowledge being strongly influenced by their own experience as students, they need to unlearn the old conceptions of mathematics derived from their schooling experience. The experiences of “teachers’ voices” in South Africa and of a program of action-research with student teachers in Australia lead Crawford & Adler (1996) to conclude that research helps teachers to challenge their practice and their conception of mathematics. Student teachers doing action research “learn a great deal about mathematics as they work with their students to define and refine mathematical ideas and use them actively as a means to inquiry” (1996: 1200).
Another research project reporting changes in teachers’ knowledge of mathematics is the PLESME project (Graven, 2005), where mathematical knowledge and mathematics pedagogical knowledge were intertwined. “PLESME focused on the development of mathematical meaning and pedagogical forms simultaneously” (2005:219). Using this two-year INSET project as an empirical field for her research, Graven investigated the nature of mathematics teachers learning within a community of practice (2005:207). She argues that most of the literature on teacher development indicates a focus on teacher change. In the South-African context, the curriculum support materials call “for radical teacher change where old practice is completely replaced by new practice”. This view of teacher change is disempowering for teachers (2005: 223). On the other hand, the PLESME programme was based on a conception of learning as a life-long process, where teachers were expected to build their own knowledge.

This non exhaustive review of papers about the teachers-as-researchers movement shows how different the experiences in this domain are, in terms of research topics and methodology. However, some common trends can be found in these reports.

In the first place, they seem to share a common conception of teacher as a producer of knowledge and not as a mere consumer of knowledge produced by other individuals, particularly academics.

Secondly, in most of these research projects, teachers worked together in groups, the research team being composed of either pre-service or in-service teachers. Interaction between teachers, or between teachers and mathematics educators, allowed them to deepen the analysis of their practices and difficulties.

Finally, in all projects discussed above, teachers chose to investigate some pedagogical issue or some problem of student learning. It seems that when asked to choose a research topic, teachers question their own teaching, or their students’ performance and difficulties, but take for granted the content usually taught within the institution.

**LEARNING MATHEMATICS THROUGH RESEARCH**

In the research project reported here, teachers were researching different aspects of limits of functions. This project is based on the one hand on the study of the institutional relation (Chevallard, 1992) of the Mozambican secondary school with this concept, and on the other hand on a study of the mathematical knowledge which would enable a teacher to extend this institutional relation (*mathematics for teaching limits of functions*).
The study of the institutional relation of Mozambican secondary school with limits shows a dichotomy between a formal part, the ε-δ definition, which students are not asked to use in practice; and an algebraic part, the determination of limits, what most of students’ tasks are based on.

*Mathematics for teaching* limits of functions includes the following aspects: (i) Scholarly mathematical knowledge on the concept; (ii) Knowledge about the social justification to teach this concept; (iii) Knowledge on how to organise the students’ first encounter with the concept; (iv) Knowledge on the practical block (tasks and techniques); (v) Knowledge about students’ conceptions and difficulties when studying this concept. In each of these components mathematical and pedagogical knowledge are intertwined.

Four teachers researched a different aspect of *mathematics for teaching* limits involving both mathematical and pedagogical issues, and shared their findings in periodic seminars. One of them was an experienced Grade 12 teacher, who had taught limits at school, while the others were teachers in lower grades. All of them used their research for their Degree dissertation. I was their supervisor and the facilitator of the seminars. The teachers were also interviewed three times during the research process. All interviews and seminars were audio-taped and transcribed.

Data analysis focused on five main aspects of *mathematics for teaching* limits: how to organise students’ first encounter with this concept, the social justification for teaching limits at school, the essential features of the limit concept (part of the scholarly mathematical knowledge), the graphical register (from the practical block), and the ε-δ definition (also from the scholarly mathematical knowledge).

**FINDINGS**

Data analysis for the five aspects mentioned above indicate that teachers’ knowledge evolved substantially for the first three aspects, but that difficulties remained for the two last aspects, the graphical register and the ε-δ definition. These difficulties were explained by a lack of deep understanding of basic mathematical concepts. For the first three aspects (which only involved general mathematical knowledge), reading books and mathematics education papers, and discussing their findings within the research group seemed to allow teachers to reflect on these issues and to make links between the limit concept and other mathematical concepts. However, when a deep understanding of basic mathematical concepts was required, such as for the use of graphs to study limits or the ε-δ definition, reading books and papers and discussing these issues within the research group did not allow teachers to overcome their difficulties.

Furthermore, the Grade 12 experienced teacher faced more difficulties during the whole process. In fact, this teacher was in a less comfortable position than his
colleagues. While the other three teachers were researching and challenging the institutional relation of Mozambican secondary school to limits of functions, he was also researching and challenging his own practice. For example, at some point he realised that he had taught L’Hôpital’s Rule before teaching derivatives and that students could not understand it.

I remember that, well I gave tasks about limits, er … mainly, they were polynomial functions I think, well, for me, the practical way was, you know, use what we usually call L’Hôpital’s Rule, because it was practical and [sighing] but … after all, now I get to know that, well, how could I use that L’Hôpital’s Rule if the students did not learn derivatives? And limits come before derivatives … But … I saw that after all I was doing a mistake by that time … (Abel, 3rd interview)

He then explained how he introduced limits to his students.

I gave the definition, ok, I gave the rules, we go to the tasks. (…) Well, I was myself reduced to … to that knowledge, thus, it’s how I learnt and it’s also what the textbook shows, and I’m going to pass it on [to students]. (Abel, 3rd interview)

According to his discourse, it is clear that this teacher’s mathematical knowledge did not allow him to teach in a different way. It is now very hard for him to realise that he taught in a way students could not understand. This possibly explains why teachers researching their own practice seem to prefer to look at pedagogical issues or students’ difficulties. In that way they do not need to challenge their own personal relation to mathematics as much. This result highlights a limitation of teachers learning through research.

CONCLUSION

This paper reviews papers on teachers as researchers, showing that they mainly focus on pedagogical issues. It then reports a study where teachers researched aspects of mathematics for teaching limits of functions involving both mathematical and pedagogical aspects. This study puts into evidence that the teachers’ mathematical knowledge could not be taken for granted. For those aspects of mathematics for teaching which required a deep understanding of some basic mathematical concepts, the evolution of teachers’ knowledge through the research process was limited. Furthermore, the research process was more challenging for the experienced Grade 12 teacher, whose research also challenged his own practice.

I suggest that teachers be involved in research putting mathematics at the core: research on mathematics for teaching, based in both mathematical and pedagogical issues. In that way they will produce knowledge that helps them evolve their personal relation to mathematics and its teaching and learning, as well as hopefully improve their practice. Obviously I do not claim that they would necessarily teach in a
different way, as they would be exposed to institutional constraints, but that their personal relation to mathematics would enable them to teach differently.

References


