

Empowerment of Teachers as Learners: Active Learning in the College Mathematics Classroom

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Introduction Empowerment and the Active Learning Strategy in the College Classroom

In the age we live in, the individual must absorb and adapt to an unending stream of cumulative knowledge, in order to be in harmony with others, and to be able to act to actualize his full personal potential. There is no disagreement today among shapers of political and educational policy regarding the importance of the empowerment of learners. In the PEP (Czuba & Page, 1999) option, empowerment is a process enabling or qualifying the individual to think, believe, carry out an activity, and criticize his own work and decisions autonomously. The three elements of empowerment are the basis for understanding it, and they are: a) *interdisciplinary* – occurring in the framework of various areas; b) *social* – occurs on the different levels of the individual, the group, and the community; and c) *process-oriented* – like a path or a journey that unfolds along the way. Empowerment can be seen as a goal aimed at cooperation, based on mutual respect, discovery of perspectives, development of vision, and provision of options for reaching creative solutions (Rood, 1997).

This understanding of empowerment must be clarified regarding the empowerment of teachers who, in the capacity of their professional role, must aid the social effort of the empowerment of other learners. Yet, on the other hand, since constant learning is part of what they do, ways of improving their learning and empowering them as learners must be examined.

The Active Learning strategy in the college classroom is a method that can lead the task. It can also promote the empowerment of the teacher, and change his experience; these aspects are manifested in how he deals with his learning and his work (Faust and Paulson, 2000; Silberman, 1996). This must include a move from “passive learning” to “active learning,” from being a “teacher as a passive learner” to a “teacher as an active learner.” A team established in 1995 and led by Romig (2000) proposed guidelines for using active learning in college classrooms. These guidelines concern the behavior of lecturer and students in ways of teaching and assessment, as follow: a) the lecturer “directs students”; b) students participate in defining goals; c) the class climate is collegial, supporting, spontaneous, student-driven, and problem-centered; d) assessment is continuous and offers support; and e) teaching focuses more on development than on setting a direction or presenting expectations, for more varied results. Obviously, implementing the active learning strategy demands experience, experimentation, and change in teachers’ perception of teaching in an educational and professional context.

Humanistic Nature in Learning/ Teaching Mathematics

Acknowledgement of mathematics as “a human effort,” understanding mathematics as a humanist-social activity (Hersh, 1997), seeking mathematics as humanist (Brown, 1996), and learning/teaching mathematics humanistically (White, 1987) provide a *humanist foundation in mathematics education*. The aims of the NTCM (1989, 1998) documents guide those engaging in mathematics education towards a focus on the history of mathematics in the curriculum and its interlacing in mathematics teaching. Mathematicians and mathematics educators see the combination of mathematics, history of mathematics, and humanistic mathematics education as a breakthrough – a change in the perception of mathematics education (Ellington, 1998; Fauvel and Barrow, 2000; Hersh, 1997; Brown, 1996).

I will shed some light on the focus on mathematics teachers as learners. This presentation is a part of a broader action research that examined aspects of the educational process of teachers in the “History of Mathematics and its Interlacing in Mathematics Teaching” course, as well as ways of actualizing the ideas of humanist mathematics by implementing the course’s curriculum. However, exposure and learning about interlacing mathematics with its history is by itself insufficient to bring about a change in teachers’ attitudes toward mathematics teaching. Only learning by experience that touches the emotions, along with a deep impression of mathematics, can give vision to mathematics teachers. The Active Learning strategy was implemented in the course, and the action research made it possible to expose the educational and learning processes undergone by the teachers participating in the course, and to examine how humanistic mathematics education is reflected in the processes and in the products of the learning.

The Course and the Learning Process In It

The thoughts that led to the construction of the new curriculum of the course concerned trying to change the traditional approach of teaching mathematics through the teachers’ learning why, wherefore, and how to interlace mathematics with history of mathematics when they design lesson plans. What is necessary is a

change in views regarding this interlacing – and this means changing the content and the learning atmosphere, ways of teaching/learning, intensive experience, and reflection on this experience – in other words, insisting on special training for mathematics teachers.

At the beginning of the course, the preservice and in-service teachers participating were informed that they would be working in pairs to prepare a study unit on interlacing the history of mathematics in mathematics teaching. These units were to be included in a course book – a compilation of their collective work over the year. In the first part of curriculum, participants recognized the chronological development of mathematics, read and understood texts from the history of mathematics, and attempted to make these texts more accessible to and appropriate for pupils by turning them into an integral part of the mathematics lesson. Later on, they were presented with examples of study units compiled by course students from previous years – this is the fourth year the course is being taught – and these gave rise to intense, critical discussion that helped them to handle continually presenting their products. The variety of options offered to the participants in choosing a topic for a study unit gave them a greater sense of independence; however, it also meant that they had to take responsibility and demonstrate criticism and autonomy in their decision-making.

The lecturer flows with the class, and never knows what topics will be raised by the participants during the year. This stimulates interest and curiosity. Together, the lecturer and the participants form a learning community requiring constant communication and cooperation. Friere sees such a situation as the ideal learning circumstances for liberating education, in which “teacher and pupils form a community of learners, and where both sides are essential factors in the process of obtaining knowledge” (Friere & Schor, 1990).

A novel aspect of this learning process is that teachers who participate in the course must be equipped with strategies for conveying mathematical knowledge, and must not only assimilate a concentration of logical phrases and ways of thought that underpin mathematical knowledge but must learn to do so through a process that reflects the historical ways by which humankind arrived at such knowledge (Katsap, 2002). In contrast with the usual way of handling ancient mathematical problems by bringing up the problem and then showing the solutions, the course participants investigate these problems’ historical circumstances and discuss how they developed over time. The questions they address include: a) Who were the individuals involved and what was the place from which they connected to this problem? b) Does a particular topic touch only on the specific area in mathematics, or is it linked to additional subjects or areas in mathematics, c) What is the relevance of this ancient problem in currently teaching mathematics in school? and the like.

The main points raised by the participants during the course indicate that the interlacing of mathematics with its history in mathematics teaching is a desirable method that makes it possible to enrich the lesson content with emotion. It is also evident that it contributes to transforming the lesson from what the participants termed a “traditional model” into one “arousing motivation in the pupils.” This is because in addition to the purely mathematical material the pupils will be exposed to the developmental and the affective aspects of mathematics.

The participants’ descriptions of their learning process demonstrated the effect of significant learning and of active learning on the process of the intensification of the teacher’s professional knowledge. From these self-descriptions come the portrayal of a teacher who has managed to find knowledge sources by himself, has assimilated schemas so as to create the affective knowledge he needs for teaching, has examined the knowledge while presenting the subject to his colleagues, and then has written, edited, and presented the knowledge unit. Such a teacher has undergone a process that includes motivation, curiosity, desire to succeed at the task, and experience as well as reflection on the experience. In general, with regard to reflecting on the learning/ teaching method in the course, the participants maintained that: a) learning was cooperative; b) demonstrating the implementation of the learning unit to colleagues influenced decisions to adopt the method and the topic; c) learning and preparing the unit taught, which is to be included in the course book, required that the teacher take responsibility; and d) learning in groups was characterized by organization and division of labor. In criticizing active learning in the course, the participants discussed their lack of skills they needed in the course to deal with the multiplicity of information sources, particularly with those on the Internet, which were mostly in English and difficult to cope with. Furthermore, active learning demanded that they invest a great deal of physical, mental, and emotional effort – and not all participants were willing to do this much “for a single course.”

The Learning Method: Promoting the Empowerment of the Mathematics Teacher as Learner

One of the interviewees described the learning processes she had encountered that led to her empowerment as a teacher. Her words reflect what the other course participants said:

“Among the new skills I acquired in the course were searching for material on the Internet and genuine teamwork. An important value for me was the freedom to search for and choose the topic. This was a heavy responsibility, but nevertheless it gave a sense that they trust you and appreciate your work. All this reinforces you as a teacher and develops your creativity. Writing the learning unit that is to be included in the course book makes you into a player who gives knowledge to others, not only receives. The fact that you work and investigate – even if it is not successful – makes it [different]. It’s like all those who worked on the Fermat Theorem – the investigation is important... From this course, I take with me the humanity of mathematics.”

The five statements below summarize what course participants said about the course’s way of learning that promoted the empowerment of the mathematics teacher: a) acquiring new skills through searching, choosing, classifying, and organizing knowledge, as well as developing new knowledge; b) gaining experience in teaching/learning and reflecting on this experience; c) assessing cooperation’s contribution to better production of learning and of the products of learning; d) observing changes in attitude to mathematics as a discipline, and to mathematics as a teaching profession; e) integrating humanist values into the educational process.

As stated at d), the learning process helped promote the change that became evident in the participants’ views of mathematics as a teaching profession following the course. This latter was accurately described by expressing it in actions, as follows: a) annotation of understood mathematical concepts that were previously mechanically illustrated, i.e. “You had to know them, but not necessarily actually understand them”; b) a desire to continue studying the history of mathematics; c) viewing adding knowledge from the history of mathematics to the existing mathematical knowledge as creating a complete mathematical language; d) developing new horizons for observing mathematical knowledge; e) gaining a renewed understanding of the importance of mathematical accuracy. The learning process led the participants to empowerment, which Friere (1999) sees as a social phenomenon, and which can take place only when the individual is part of society. For this reason, the individual can reach the peak of empowerment as the group to which he belongs attains collective actualization.

The Learning Products: Teacher Creativity

The book, published and distributed at the end of the course, is a collection of learning units compiled by the course participants. It presents suggestions for studying mathematics interlaced with mathematics history. The participants saw the compilation of the course book as the culmination of their learning. The course book is characterized by, *inter alia*, the following aspects: a) emerges from educational process during the course year, b) constitutes a collaborative collegial creation in which every individual takes part, c) offers a collection of the learning units, including worksheets for the teacher’s immediate use, d) sparks motivation in preparing papers and poses “a learning challenge,” and e) enhances participants’ sense of personal responsibility within the collective enterprise.

Following the Action Research carried out during the course, an ongoing discussion was conducted in the classroom that focused on the following question: What ways can the course be enriched, in addition to the course book? The search for the answer led to the idea of writing a brief mathematics narrative, about one page in length, the plot of which involved motifs taken from the history of mathematics.

The narratives reflected several genres: historical narrative, fairy tale, and short story. Common to all was discussion of a mathematical concept, theorem, or topic. In general, it can be said that for the participants the narrative was a means on the way to accomplishing a learning goal – constructing a mathematical concept in the pupils. The participants noted that writing the narratives aroused their sense of creativity – “mathematics clothed in words.” Through composing the narrative, they realized that a traditional way of teaching could be changed, from writing a mathematical solution to writing a narrative – something which gave them a “wonderful feeling.” Moreover, they saw the narrative as a bridge between the precision of mathematical work and life and the external world.

Conclusion

In order to change teachers’ traditional approaches to teaching mathematics, teachers must be led to an understanding of the necessity of change, and of incorporating it into practice, so as to show them that they are capable of changing. Among the elements of this change are *the learning atmosphere*, which can, during the educational process, inspire to change, and *the way of learning*, which can lead the learner to

acquire experience and ability to adopt critical thought through reflection on experience, as well as to produce a learning product reflecting the spirit of humanist mathematics. During the study, implementation of the purposes of teachers as learners was observed, in four categories:

A collegial class climate directed at empowering the teacher in the course;

Educational and learning activity in lessons defined or led by the lecturer and/or the course participants

Teachers' learning, guided by responsibility, a critical view, and striving for self-actualization, influenced practice in creating new knowledge;

Continuous assessment of all the steps of the activity and provision of critical/supportive feedback throughout the course helped produce more sophisticated learning products.

The intensive teacher-teacher and teacher-content interaction during the educational process of the course served as a means for empowering the mathematics teacher. With regard to the type of study – Action Research – the teachers who participated in the course were involved in the investigation, which led them to raise for discussion questions about their learning and the products of their learning. The answers from the discussion indicated that the learning process was characterized by the creation of particular knowledge for teaching mathematics. Learning as creativity was key to the empowerment of each teacher as an individual in the collective enterprise.

According to the characteristics found in the study, *a model of three clusters depicting the profile of the empowerment of the teacher as learner* was constructed, as follows:

Internal cluster - Personal: Responsible, critical, active.

Middle cluster - Social: Cooperates through reciprocity, values people with knowledge and experience in mathematics, shows solidarity, learns together with others in a group, learns through teaching, is a wise consumer of knowledge, solves problems together, creates knowledge from experience.

External cluster - Professional: Acquires knowledge in history of mathematics, reinforces understanding of the concepts in mathematics, reinforces positive attitude to the subject of mathematics, autonomous in choosing the topic in mathematics, discover various sources of information in mathematics, values interlacing mathematics with history of mathematics.

Through Active Learning in a supportive environment of humanist mathematics education, the educational process in the course helped with the empowerment of each teacher as an individual in the collective, and with the empowerment of the collective as consolidation entity. Empowerment was based on “interdisciplinary approach” – interlacing of history of mathematics with mathematics, was “social” – seeing and acceptance of individual as a part of collective, and was “process-oriented” – the process continue during course year. The main expression of mathematics teacher empowerment in the spirit of the ideas of humanist mathematics was manifested in the development of a humanist-social approach to mathematics as a discipline and to the mathematics as a teaching profession.

Thus, the balance between teachers' learning and teachers' empowerment is a concept worthwhile considering for the education of mathematics teachers.

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