Humanistic Mathematics Network Journal

Issue 5 Article 6

5-1-1990

Preparing Teachers to Teach Mathematics Within a Humanistic Perspective

Beatriz S. D'Ambrosio
University of Delaware

Preparing Teachers to Teach Mathematics within a Humanistic Perspective

Beatriz S. D'Ambrosio
College of Education
University of Delaware

Introduction

As a newly hired faculty member of the Mathematics Department of the University of Campinas Brazil, I was assigned the course Finite Mathematics, for the 1988 academic year. It was a one year long course in the program for future secondary mathematics teachers[1]. This course was embedded in a new program that was implemented as of March 1988. It was the very first night-time program to be offered by that University.

About the program

The new program was intended to be different from that offered during the day, in an attempt to make change occur in secondary teacher education. It was designed to prepare secondary mathematics teachers within an approach that had several "humanistic" characteristics. For example, throughout the program mathematics courses and education courses would be integrated. The different mathematics courses would exemplify different methodologies proposed in education courses.

It was expected that the students choosing a night program would be quite distinct from their daytime colleagues, with differing personal characteristics such as age, maturity, responsibilities and experiences, as well as having quite different career goals and professional aims. The program was designed to cater to the needs of this different population.

Another characteristic of the program was that it was designed specifically for future secondary mathematics teachers. Traditionally the pre-service program was very similar to the pure mathematics programs, except that the students were required to take a few less mathematics courses that were substituted by courses offered by the School of Education. All mathematics courses were those designed for any field of mathematics, with no relationship at all to the students future professional goals. The criticism voiced by Morris Kline (1977), that many American universities do not prepare future mathematicians for their role as teachers can equally be made of the mathematics programs of most Brazilian institutions of higher education. Therefore, the intention of this new program was to deal with this problem raised on many occasions, especially by students of previous programs who pursued teaching careers.

Other characteristics of the program that allow us to categorize it as a program educating future teachers within a humanistic perspective are the following:

a) Each instructor deals with the students as future teachers. All students in the classes are pursuing the same degree.

b) From the beginning of the students' involvement in the program they are pursuing their professional development. All work done in the courses is related to their future professional endeavors. Whatever the discipline being taught, some reference is made to the teaching and learning of mathematics.

c) Whenever possible, relationships are drawn between the theoretical aspects dealt with in the education core of the curriculum and the practical aspects of mathematics learning, dealt with in the content core of the curriculum.

d) A special emphasis is given to practical experiences, students' contact with children occurs much earlier than in traditional programs. This rests on the belief that these students construct their understanding of mathematics learning and teaching based on their experiences in the teaching-learning process.

About the students

The population of students enrolled in the program is unique to the institution. The individuals in this group were working full-time with very little time out of the classroom to invest in studying. With daily classes from 7 pm to 11 pm and an 8 am to 5 pm workday, one could not expect much work during the scarce hours that are left in their days.

There was something special about the group with respect to their feelings towards mathematics. Unlike other groups of students with career goals that are not the teaching of mathematics, these students did not appear, at first, to feel anxious about

their mathematical ability. This proved to be a false assessment when they began preparing for their calculus examinations. Somehow, due to attitudes of the calculus instructor, they never felt comfortable with their expertise in problem solving to deal with calculus problems. Due to the nature of their calculus examinations, it was clear to them that they were safer by memorizing as many formal solution processes as possible. Unfortunately, within the perspective adopted in the course, this did not generate legitimate mathematical thinking, instigating reproductive thinking rather than productive thinking by the students.

About the Finite mathematics course

The intent of this report is to discuss the teaching perspectives assumed throughout the 1988 academic year in the Finite mathematics course and relate the successes and difficulties of educating teachers for work within a humanistic approach.

The basic principles of the course, in line with the program, were the following:

a) These students were being prepared to be future mathematics teachers for grades 5 through 12.

b) They had had a school lifetime's experience with mathematics and consequently had developed their own beliefs and attitudes about mathematics, its learning and its teaching.

Several studies have documented attitudes and beliefs of individuals with respect to mathematics teaching and learning (see Schoenfeld, 1985; Thompson, 1985; Robinet, 1989). Many of these results were confirmed with the pre-service group being discussed.

c) The dichotomy between mathematical content and mathematical teaching methods had to be broken. This could only happen through a joint effort of the content core and the educational core. We know that the education core alone has traditionally had very little success in breaking this dichotomy. Thompson (1985) states that:

> There is research evidence that teachers' conceptions and practices, particularly those of beginning teachers, are largely influenced by their schooling experiences prior to entering methods of teaching courses. ... We need to explore ways in which to articulate mathematical content courses that teachers are required to take with methods courses, so that the learning experiences are consistent with those advocated in the latter. (pg. 292)

With these three aspects as guiding forces for the work of the year, the curriculum was designed for the course.

Basically the approach would be a problem-solving approach involving small group work and occasional large group discussions.

Instruction was designed within a constructivist paradigm. Experiences are believed to be essential for the construction of ones' concepts, hence the learning experiences about the teaching of mathematics and legitimate involvement with mathematical thinking should be an integral part of the experience of future teachers. According to Kline (1977) mathematics courses fail for never involving students in the creative act of doing mathematics which would include "the fumbling, the guessing, the blundering, the mental struggles, the testing of hypotheses, the frustrations, the false proofs, the insights, and other acts of the creative process" (pg. 129). These aspects of mathematical thinking are rarely present in the students' mathematics experiences, unless of course they pursue graduate work in this field, when they will, all of a sudden, be expected to understand this as being legitimate mathematics (experiences which are reserved exclusively for research mathematicians).

With these concerns in mind, looking towards providing experiences that would involve students in legitimate mathematical thinking, a problem-solving approach was the main mode of instruction selected for the course. Every class period began with a list of problems to be solved. This list occasionally took more than a class period to be completed, but each group was given as much time as they required for the solution. Groups finishing earlier were given additional problems, which never generated any complaints. During the solution process the instructor went around the classroom observing students at work and groups interacting and often modeling metacognitive behavior, serving as external monitors to students during problem-solving activities. Students were constantly reminded that the group work did not consist of finding a solution, but that each and every member of the group reach a solution upon which the group agreed. Furthermore, every member of the group should be sufficiently convinced of the solution to be able to explain it in the end.

Group work consisted of the normal interactions of a group of individuals pursuing a similar goal. However, when a member was satisfied with his/her

solution they should assume the role of "teacher" in the sense of trying to help colleagues with their own solutions. As was to be expected solution processes differed greatly and it was the role of the acting "teacher" to try to understand the colleagues' solution, and ask appropriate questions that would focus on misinterpretations in the understanding of the problem or in execution errors.

At the end of a problem set a large group discussion took place. The intent was to formalize any concepts that had arisen, to clear any doubts about any of the problems through intra-group discussions. Basically, this was the moment to discuss both mathematical concepts and dynamics of group interaction. The discussion of students' beliefs and preconceived notions about the nature of mathematics, the nature of learning and teaching mathematics were often part of the large group debate. In general these were issues raised as a consequence of conflicts between the activities in which students were involved and their previous experiences in learning mathematics.

Tensions and Conflicts

There were several difficulties in the implementation of a problem-solving methodology with this group. Some of these were felt as tensions between the students and the instructor. At other times conflicts were observed in the students, between their previous experiences and consequent expectations and the new experiences they were having. Examples of these tensions and conflicts are described here.

a) Students were quite resistant to change and resentful that they were not told exactly how to solve the problems before being given the problem. They considered the sequence of activities to "inhibit" their ability to solve the problems given. Comments were often heard of the type: "I think this pattern is probably a geometric sequence, or an arithmetic sequence..." Revealing that students would first attempt to categorize problems as being of a type for which they had a pre-established solution sequence. In doing this students soon became aware of their lack of thorough understanding of several concepts which they were throwing around for consideration.

b) Students commented that the instructor "did nothing during classes". They were unhappy by the fact that they had such few notes from classes.

c) Students did not know how to work in small groups. They would work independently and then often reveal their beliefs about effective mathematics teaching by telling colleagues who were struggling with a problem exactly how to solve it. Colleagues would readily say "Oh, now I understand," revealing their beliefs about the process of learning mathematics. The instructor would respond to the situation by asking questions about the solution process used or giving a modified version of the problem or an isomorphic version of the problem. This often led to a discussion with the students about the meaning of "understanding".

d) In the beginning of the semester students would constantly ask: is this right? is the answer "x"? To which there would be a response with a question about the solution process or another problem. Very often the students would say: "Oh, I guess its wrong, or you would just have said yes or smiled." They were usually expecting the positive reinforcement that had always cued correct answers throughout their learning experience.

e) Students were not accustomed to having an active role in mathematics classes.

f) Evaluation: assessment of this type of instruction has many difficulties. First it is not possible to use a traditional form of individual work to evaluate student progress. Second, evaluation is not a static process that can be pinned down to a certain moment, it is a continuous process, possible by the fact that the instructor is in continuous observation of the class members and their activities. Students resist any type of evaluation procedure with which they are unfamiliar and consequently do not trust. Since evaluation is a delicate issue and often put aside in pre-service education programs, in fact one might venture to say that it is avoided in most cases, this became a major discussion point in the large group work. The evaluation procedures used during the course were proposed by the students. Immediately after which we discussed the pros and cons of each procedure, both from the students perspective and from the instructor's perspective. An example of such a procedure was the following: a three step evaluation process in which students would solve, individually, a problem: this would be handed in, then they would discuss the problem in a group and rewrite the solution, incorporating the new aspects gained from group discussion. This process generated much discussion and many pros and cons were raised, but probably the most important consequence was a definite change of attitude toward the group work. Students decided that the period of individual work was essential for the success of group interactions. During the individual work period students thought on their own and were able to each contribute to the group discussions.

Observations

Of course, final results will only be noted on a long term basis, by analyzing students' mathematical thinking skills in other classes or their teaching skills when they actually assume mathematics classes. It is the observation of these individuals in their teaching practice that will permit an analysis of the validity of the procedures with respect to their teaching practice, the program's ultimate goal.

However towards the end of the year observations were made of changes in students' behavior and attitudes about teaching and learning mathematics. The observations discussed here are primarily interpretations of students' comments in small and large group discussions as well as observations of small group interactions.

Students attempted non-routine solutions with more ease even in other mathematics classes, apparently they were no longer stuck to one solution procedure.

Through the group work it became clear that knowing how to solve a problem was not enough to teach an individual the solution, in fact students claimed that it was quite easy to find a solution to a problem without really knowing what they were doing.

Students claimed that "showing someone how to solve a problem defeats the purpose of education, you spoil the positive feelings and attitudes that are consequent of the efforts of solution and being able to come to a result and being convinced that you have found a solution".

Students, at first, were quite surprised at the number of different solutions possible to a problem. Furthermore, they were also surprised, when put in the "teacher" role in the group activities how difficult it is to ignore your own solution and attempt to understand your colleague's solution ("student" role), trying to look for possible errors in the understanding of the problem or in the solution process itself. The "teacher" role assumed on occasion by every student helped develop their questioning skills. It was "difficult to hold your tongue" when all you really wanted to do was say: do this. This was a statement made by a few of the students and was confirmed by the reduction in the number of occasions in which students were observed simply telling colleagues how to find a solution.

There is a form of intrinsic motivation in a problem-solving environment, this conclusion can be drawn from the following fact: classes were held from 9 pm to 10:30 pm. Unlike previous teaching experiences, rarely did students involuntarily signal the end of class (by closing notebooks, or becoming fidgety and looking at their watches). On almost all nature: "already?! It feels like we had just begun. I was just starting to warm up." Students were busy and active to the very end of classes. On rare occasions did the instructor have to draw students' attention back to the problems at hand.

In trying to assess the nature of this motivation students commented on the challenge of each problem situation. And that group work made them feel comfortable in taking risks at solutions. Normally, in the privacy of their own work the negative feelings of failure would soon overwhelm their desire to continue working on the problem.

Conclusion

In order for teachers to feel confident that there are alternative ways of teaching mathematics that are more effective than the traditional methods, they must experience different learning situations themselves. The knowledge they have acquired through rote must be challenged. In other words there must be some conflict created in their beliefs about effective learning and teaching of mathematics.

It is not through simply discussing the importance of a humanistic approach to the teaching of mathematics that we will effectively create conflicting situations that challenge their beliefs. It is from these challenges and their resolutions that learning will occur, and in fact learning about the teaching and learning of mathematics can be the focus of these challenges and should be the focus for future teachers.

The experience revealed the urgent need for reform in teacher education programs especially with respect to the content courses and the dissolution of the dichotomy between the content and education cores of teacher preparation programs. It became clear that beliefs about effective mathematics teaching overpower any learning that may occur in methods classes, and maybe explain how the traditional teaching of mathematics has perpetuated throughout the years in spite of all attempts to reform and change mathematics instruction in schools.

References

Kline, M. (1977). Why the professor can't teach: mathematics and the dilemma of university education. New York: St. Martin's Press.

Robinet, R.J. (1989). Representations des enseignants de mathematiques sur les mathematiques et leur ensignement, Cahier de

Didirem- Didatiques des Mathematiques. Paris, France: Universite-Paris VII. March.

Schoenfeld, A.H. (1985). Mathematical problem solving. Florida:Academic Press.

Thompson, A. G. (1985). Teacher's conceptions of mathematics and the teaching of problem-solving. in Silver, E.A. (ed.). Teaching and learning mathematical problem solving: Multiple research perspectives. New Jersey: Lawrence Erlbaum Associates, pg. 281-294.

[1] In Brazil the University pre-service mathematics program certifies teachers for grades 5 - 12. In some cases university graduates pursue teaching careers in small private colleges.