Possibilities and Challenges of Mathematical Modeling in Teacher's Formation

Maria Salett Biembengut
Post-Graduation Program in Education, Universidade Regional de Blumenau – FURB
Blumenau, Santa Catarina, Brazil salett@furb.br

Abstract
In this article are the results of research of empirical data from two pedagogical experiences using Mathematical Modeling with two groups: one with 28 students from the last period of a course of mathematics teachers, and another with 21 teachers of a course of continuing education. The objectives of the course were: teach Mathematical Modeling, and in sequence, modeling as a method of teaching. The data about the interest for the proposal and the need of the two groups in learning modeling for use in practice was raised from interviews and issues raised and works done by them. Even though the importance of Mathematical Modeling as a method of teaching is not underestimated, some aspects exemplify the difficulties for the participants in changing the concept of teaching and learning: formation of the participants and the need for formation.
Key-words: Mathematical Modeling, possibilities and challenges.

Presentation

In the last three decades, the growing interest for mathematical modeling in Brazilian education has generated curricula reformulation, and new pedagogical proposals, research and ways of mathematical modeling. Motivated by these new reformulations and proposals, many states and cities have promoted courses of continuous education for mathematics teachers, with the proposal of improving the quality of teaching and the interaction between teachers and students. At the same time, many courses of mathematics teachers' formation have tried to insert into the curricular schedule subjects about lines of research of Mathematics Education, in particular, about mathematical modeling. For example, according to government data, there are 413 courses of mathematics teachers' formation in Brazil; from these, the author of this research identified (until March/2009) that about 30% have in the curricula schedule the subject of modeling.

In spite of the law and critics, in the greater part of the courses of mathematics teachers, the curricula is still subdivided into disciplines, without any connection with each other, composed of strict plans, teaching methodologies and evaluation in the traditional way. Except for isolated instances, the specific disciplines are treated without any connection to the matters that should be dealt with by future teachers in Basic Education; and only in the pedagogical disciplines the task of showing to the future teachers the actual tendencies of the methodological teaching proposals. (BIEMBENGUT, 2004). Generally, the classes are no more than passing content, exercises and techniques or the exposition of theorems and proper demonstrations without meaningful objectives.

The concern with the preparation of this future teacher for the field in which he/she will act belongs under the responsibility of some disciplines, such as: Mathematical Education, Tendencies of Teaching or Mathematical Modeling. However, the number of hours available for these disciplines (between 45 to 90 class /hour) is not enough to prepare a future teacher to act differently from what he/she has experienced during his/her school years. In the same way, the teachers who come to participate in a course of continuing education, of mathematical modeling for example, (between 30 to 90 class/hour), have the motivation and interest for another proposal, although there are few that are able to break with the teaching practice they have been using, (BIEMBENGUT, 2009; BASSANEZI, 2002). Thus, despite the results of research and recommendations in official documents of the Brazilian Education Department, few changes have occurred in classroom practices. For the most part, mathematics teachers in all levels are still stuck to the textbook and reproducing the same teaching they experienced since the beginning of their school life. These perceptions have initiated a search for an answer to the question: what factors make the mathematics teacher not to alter his/her practice despite the difficulties presented by many students?

To answer this question two pedagogical experiences were carried out with two groups: one with 28 students from the last period of a course of mathematics teachers and another, with 21 teachers in a course of continuing education; the objectives were: to teach the art of modeling – mathematical

modeling in research, and in sequence, the art of teaching – modeling in teaching. To reach these objectives, this researcher elaborated on material of didactic support that is organized in four phases, denominated: mathematical language; experiences based on classical models, modeling as a research method and modeling as a teaching method. The data relating to the interest for the proposal and the need of the two groups in learning modeling to use in their practice were raised from the interviews and issues raised by and works done by them. To better understand the happenings during the pedagogical experiences philosophical literature concepts and definitions were searched about interest and necessity. For Dewey (1922), interest means an internal achievement or feeling of value given that each person has; it is dynamic and pushes one to action; necessity, for Claparède (1958) is what stimulates the person to move or to act. "The interest implies a necessity, or then the interest produces a necessity" (Habermas, 1987, p.220).

Modeling and the classroom: two pedagogical experiences

The course given for each of the groups lasted 60 class/hours. For the students of the last period of the teachers' formation course these 60 class/hours were developed during the semester, four class/hours per week and for the teachers of the continuing course, in six weeks, 10 class/hours per week. For both groups the course was divided into four steps: in the first, two problem questions, not formulated for them to present the solutions; in the second, twp classical mathematical models to check their validity through experiments; in the third, to elect a theme from an area of knowledge and do mathematical modeling and in the fourth step, adapt the work of Modeling for the teaching of Mathematics in Basic Education. The participants gathered in teams of two or three members to develop the activities. It is important to mention that both groups were motivated and interested in learning modeling in the first class. In the following there is a synthesis of the common occurrences of the two groups in the four steps proposed by the course: main difficulties and possibilities.

The first two steps had four activities with the proposal to inspire in the participants the spirit of a researcher: raise data, decide the mathematical language to be used in the formulation and resolution and analyze the validity of the solution. None of the two proposals demanded mathematics besides the one of the Basic Education. In the first, when they faced the two non-formulated proposals, which data they should find and then formulate to later solve students had difficulties to read, attend the prescribed orientations and recognize in from their previous formation the mathematical knowledge demanded for the solution. In the second, they should have done simple experiments to better understand two classical mathematical models (restricted growing and cooling of a liquid). These models are part of the program of the discipline Integral Differential Calculus. Despite having a meaningful timetable of integral differential calculus, algebra, geometry, analysis, among others, they did not know how to use this knowledge. The lack of understanding showed how these participants are conducted with the way of teaching that lived along their school life.

In the following two steps, it demanded that each team (two or three members) elected a theme according to their interest and empathy, and elaborated on a mathematical model, following the orientation proposed and after such elaboration, adapted this model for the teaching of mathematics for some school level. To do modeling it is supposed to study and to interpret a theme, a topic from any area of knowledge, and after, raise issues whose answers or solutions are not explicit or without need of formulation and resolution. To use mathematical modeling in classrooms the teacher needs to know how to do modeling and moreover, how to adapt one or more mathematical models that allow him/her to develop the content, while at the same time, calls the attention of the students to do and learn mathematics. They know that they improve with experience, so this step should complement this formation (to know how to model and to know how to adapt models) for them to use in the school practice.

This condition – to do modeling to be able to teach mathematics through modeling – contributed the most to resistance in doing the proposal. In the course of continuing education, for the most part the teachers affirmed not needing to know how to create their own material of didactic support, saying that a great number of schools already have a textbook. According to Claparède (1958) to make a person act it is necessary that he/she is in good condition for the appearance of a need and that it calls his/her interest in satisfying that need. Thus, it is supposed that the need to 'learn to teach' was remote by the value that is attributed to the teacher, dismissing the initial interest of these three participants.

Modeling in the classroom: possibilities and challenges

Even though the importance of the mathematical modeling is not underestimated as a method of teaching and learning, some aspects should be verified not to underline with too much emphasis, forgetting the limitations that the educational structure produces for the teacher as well as for the students. The educational structure with the curricula broken into many disciplines, each discipline under the responsibility of a teacher, and schedules and periods to accomplish each school phase, with no doubt, is the main difficulty to turn mathematical modeling into a method of teaching and learning in the classroom. (Saeki, Ujiie and Kuroki, 2007; Biembengut, 2007). In the proposal described above, some happenings were indicators of difficulties for the participants (teachers and future teachers); happenings that were gathered in two categories: formation of the participants and need of formation.
Formation of the participants: one of the main problems of the Brazilian school formation, from the elementary to the superior, is that rarely does the student learn to do research, or is taken to be responsible for his/her own learning, except for isolated experiences. The structure used makes only the teacher responsible for the student's learning. In this scenario, many students assume their physical space, transfer the content somewhere, the questions or exercises that the teacher presents and answer these questions or exercises, if and only if, they are asked to take a test for a specific evaluation and giving a grade. Rarely, he/she is called upon to search for an answer, in a kind of 'to do to know' and 'to know to do' as suggested by Maturana and Varela (2001).

Thus, for the most part, the participants of these courses, even being teachers or students at the end of their graduation course, assumed the same position as the students: wait for the teacher to tell them what to do, how and which results he/she 'would like' to receive from them. As affirmed by Maturana and Varela (2001), between the person and the environment there is a necessary structural congruence. The interaction between the person and the environment may promote changes in the biological structure. This suggests that if the teacher wants to adopt a different position from the student he/she was, it will be necessary to be aware of the effort that is demanded from him/her in the change of structure, living another way of learning.

As all the participants from this course were promoted, worked in at least two periods, they had little time to study and do the activities involved in the course. Thus, prevented by time constraints and by their own school life, the same interest that took them to wanting to participate in this experience forced them to think again about their needs in learning. The interest is a kind of feeling that prevents the action. It comes from the vicissitude that one person faces and that incites them to find an answer; developed by the observation and is associated with concepts, to its contrasts and interconnections. HABERMAS said (1987, p. 73) "the interest only transcends the simple perception, by the fact that in it the thing observed conquers preferably the spirit and if imposes certain causality among other representations."

Need for formation: To learn depends on the interest and the need if that person and moreover, demands from the person: diligence, discipline and perseverance. According to Habermas (1987), knowledge is found at the top of climbing done during a person's life and is part of his/her process of human formation. The activities done come from his/her interests and needs. "The interest implies a need, or then the interest generates a need." (HABERMAS, 1987, p. 220). According to Claparède (1958), every human being tends to keep intact until something disturbs his/her interior balance and promotes doing necessary acts to his/her own reconstruction. It is about "a continuous readjustment of a balance perpetually broken" (…); a search to reach "an objective and not to disappear the needs that show up" (CLAPARÈDE, 1958, p.40). In the functional perspective, of overall relevance, defended by Claparède, it is the need that makes the human beings move, it is that which vibrates the interior stimulus for doing the activities.

The personal life, particularly in this virtual time, is found to be multifaceted in occupations of multiple interests and needs. The participants, when faced with the proposals of the modeling course, and that to do them demanded enough experience or understanding to be able to describe and refine this description, were required to think again about the needs of the multiple occupations with which they were involved. From one side, their difficulties in being self-taught, to know how to read and interpret different contexts of the questions of the textbooks and, on the other side, the many demands or factors coming from the educational system used.

Despite the official Brazilian documents emphasizing the importance of turning mathematics into something meaningful for the students, in promoting learning, skills and their critical senses in using it, and the research indicating how modeling contributes to that, the educational politics present certain contradictions between the propositions and actions. From one side, they prescribe a pedagogical orientation that respects the socio-cultural differences among the students; from another side, they keep the same curriculum schedule and do not value the professional enough.

The educational structure in all the levels (from Basic Education to Superior) with the curriculum ruled in many subjects, not enough time for teachers to prepare thoroughly and having each one of these subjects under the responsibility of one teacher, makes it difficult for meaningful changes to be done in the students' formation. Besides that, this teacher has little availability to gather with other teachers of similar subjects to organize a proposal that brings an academic formation efficiently. And because of that, each time more students without interest and without realizing any need in getting this academic knowledge, keep showing results that are each time worse on the exams and in the job market, when they start to act. And the teacher in this context keeps using his/her techniques and strategies, sometimes taken to make new attempts just because of his/her virtuousness.

The pattern adopted by the governmental organs that (un)shape the objectives of the education when alluding to the assistance to the student strongly, even that it is sealed. The student knows that he/she does not need to make an effort, because he/she will be asked to present a minimum understanding of a concept. Therefore demands little of themselves or what he/she produces. The teacher in this scenario hardly dares to change his/her practice, especially if this practice demands more time from the teacher to prepare and to orient the students.

Facing these conditions, the educational proposals with results that tend to improve the Mathematics Education are tenuous. In particular, if guided by these signs it is possible to move on to other educational areas: from the needs to the interests of survival and from the interests to the needs of survival, in a continuous circle, without carrying improvements in the academic formation of the people. In the attempt to give words to the problems coming from these contradictions from the public educational politics, it is prudent that there is an analysis of the objective manifestations of the students' and teachers' reality. It is not less meaningful that "to take the consciousness of your reach, of the doctrinal autonomy, and the extension of your success to a popular auditorium, it is precisely situated" nowadays. (GRANGER, 1969, p. 38).

References

BASSANEZI, R. C. (2002). *Ensino Aprendizagem com Modelagem Matemática*. São Paulo: Contexto.

BIEMBENGUT, M. S. (2004). *Modelagem Matemática & Implicações no Ensino e na Aprendizagem de Matemática*. Blumenau: Edifurb.

BIEMBENGUT, M. S. (2007) *Modelling and Applications in Primary Education*. In: Modelling and Applications in Mathematics Education. New York: Springer.

BIEMBENGUT, M. S. (2009). *Processos e Métodos de Ensino e Aprendizagem Matemática na Formação Continuada dos Professores.* Relatório de Pesquisa – Conselho Nacional de Desenvolvimento Tecnológico Científico – CNPq.

CLAPARÈDE, E. (1958). *A educação funcional*. Tradução e notas de PENHA, J. B. D. 5ª Ed. São Paulo: Cia Editora Nacional.

DEWEY. J. (1922). *Human nature and conduct*. New York: Henry Holt and Co.

GRANGER, G. (1969). *A Razão.* 2ª ed. São Paulo: Difusão Européia do Livro.

HABERMAS, J. (1987). *Conhecimento e interesse: com um novo posfácio***.** Rio de Janeiro: Guanabara.

MATURANA, H. R; VARELA, F. G. (2001) *A Árvore do Conhecimento.*Trad. de Humberto Mariotti e Lia Diskin. São Paulo: Palas Athena.

SAEKI, A.; UJIIE, A. & KUROKI, N. (2007). *Students' Analysis of the Cooling Rate of Hot Water in a Mathematical.* In: BLUM, W. et al. Modelling and Applications in Mathematics Education. Springer: New York.