

EDU WORLD 2018
The 8th International Conference

**ON THE PEDAGOGICAL MATHEMATICS PRACTICE AND THE
MATHEMATICS EDUCATION**

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Abstract

It is possible to teach mathematics without to have training in the teaching practice in the real classroom? This is a quite rhetorical question, but its importance must be judged by the way in which university training programs are designed for any kind of teacher education. In our paper we present some aspects related to the real problems of the debutant mathematics professors from the pre-university education system concerning to how they teach the mathematics for the students in the classroom. There are some issues of the mathematics education which are not approaching at the university level, but these issues are very important for the mathematics teachers within their didactical activities in the classroom. In our work we have tried to analyse the “position” and “status” of the pedagogical practice in the mathematics teacher's training plan both in the context of national university education and, by comparison, in the context of the universities of some European states. Some of the directions of this analysis have been highlighted some new concepts in the mathematics teachers' training for the 21st century, such as “learning the mathematics teaching” and “teaching how to teach mathematics.” If these concepts can be assumed to be common in the conceptual fields of the educational science, then it is surely that these are strictly related to the pedagogical practice, which has to be thought as an opportunity for the undergrad of mathematics learn how to teach mathematics in the classroom contexts.

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Keywords: Mathematics education, pedagogical practice, teaching mathematics, learning mathematics, learning math teach.



1. Introduction

Education is one of the fundamental human activities and the history of its emergence and development is linked to the history of human society evolution. For this reason, the social-cultural perspective must be taken into account when we want to analyse education, from a theoretical point of view, as a conceptual field where the teaching and learning activities play a central role. In this context, “learning to teach” has a context and an experience that we cannot identify in the remote history of humankind. We can see that each species of animals, birds, cats, pachyderms, primate, etc. have probably inserted in their genetic code the way “parents” teach their own babies to survive in “their jungle” in order to ensure the preservation and continuity of their species. Instead, man has learnt to teach children to become “grown-ups”, trained to take the responsibilities of the society they will live in. In case of people, at a certain historical moment, which we cannot determine with scientific certitude, emerged the need of a specialized profession dealing with the children’s education, that is the teacher, the person telling about knowing the world where we live in. This is how the schools/universities for training teachers appeared, and there they could acquire the knowledge to be taught and the methods, ways, modalities, techniques, etc. useful in teaching to the young generation. So, at a certain moment, the science of learning how to teach appeared, under the large umbrella of didactics or/and pedagogy. Are the last two concepts related or do they refer to the same thing? This is an issue linked to the culture and traditions of Western or Eastern Europe! But, this is another major issue that we do not want to approach in this study nor we want to start sterile polemics about it. Last but not least, we must see that, due to the “expansion” of human knowledge, because this is a process that cannot be stopped, the science of “learning to teach” has been detailed, specialized, diversified according to the research directions of sciences (physics, chemistry, mathematics, biology, economics, etc.) or to the socio-economic interests.

In short, once the human society felt the need to set up schools, as state institutions, the activities of teaching, learning and evaluation appeared, based on a curriculum, and, at the same time, institutions to evaluate the “products” of schools. The story is quite long and the theories, more or less useful, related on education, abound and even suffocate. This is another issue that should be considered seriously. It is certain that, in the society based on knowledge of the 21st century, with advanced technologies of communication and processing of data, ICT, investigation technologies of Universe and of “nano-univers”, Mathematics becomes a necessity of scientific knowledge and communication and also for their development. Besides, Acad. Grigore Moisil, even in the 60s, said that mathematics would become “a Latin language of the future”. It is not the case to develop the idea of the need to learn mathematics since, its reasons are clearly all the international programs related to mathematics and science, STEM, those linked to education, PISA, TISSA, etc., also forums, international congresses dedicated to mathematics as a science of teaching mathematics.

Last but not the least, there are international debates on the way the programs for training mathematics teachers are designed. In this sense, we are wondering how we can reconceptualise and reinforce the professional teacher training programs so that we can provide a different and differentiated type of training which gives a type of knowledge that simultaneously differentiates and identifies teachers professionally. Thus, it appears a new concept: the professional knowledge of the teacher (Sá-Chaves & Alarcão, 1998). Among these we note two of them: the didactics of the discipline and the teaching practice.

Regarding the last skill of the teacher, we try to analyse some aspects from the current Romanian mathematics university education system which provides the maths teachers for the secondary schools.

2. Problem Statement

The training of future teachers implies both theoretical and practical training. The theoretical training aims at acquiring general knowledge, specialty and pedagogical knowledge, found in psychology, pedagogy, sociology but also within didactics of various school subjects, frequent information used in class activity.

The practical training of future teachers is done through pedagogical practice, an essential aspect in student training. Through pedagogical practice, the future teacher makes use of and develops abilities.

All the acquisitions gained through the study of the specialized, socio-psycho-pedagogical and didactic disciplines, are better understood and become sustainable through the *direct knowledge of school environment* (educational process) and *extracurricular* activities. More, through practice, all knowledge and skills acquired are combined and adjusted to specific situations and contexts (ex. teaching the same lesson to different classes).

Pedagogical practice is the activity through which, in the 3rd year of study, the two sides of professional training (didactics and specialty) truly interact. The importance of pedagogical practice also derives from the fact that it is the only method of forming *pedagogical aptitude* and the basis of a didactic personal style are laid.

Pedagogical aptitude is a special aptitude, "a complex psychological formation that, based on a certain level of organization and functionality of psychic processes – shaped as a system of inner actions and operations, genetically constituted according to the outer pattern of educational activity - facilitates an efficient behaviour of the teacher through the adaptive operationalizing of the whole personality" (Mitrofan, 1988, p. 56). It enters the structure of the teacher's personality through performing and developing didactic activity. This activity starts with being a student trainee, through practical pedagogical activities, and it will be finalized during the first years of teaching in class. Based on this fact, there are mentioned objectives and not competences when analysing the finalities of pedagogical practice of students.

We underline the fact that *pedagogical aptitudes are formed* and developed through the *introversion* and *generalization* of pedagogical action patterns offered by activities specific to the training of a teacher. Hence the need for optimal organization of this activity; underestimation or defective organization have long-term repercussions on forming pedagogical aptitude, on learning the didactic profession.

The specialized knowledge of students-trainee blends with the elements of *psycho-pedagogical competence*. The *psycho-pedagogical competence* is conferred by the synthesis of the pedagogical skills ensuring the efficiency and effectiveness of the didactic process. Current recommendations for the training of new teachers focus on forming high abilities including *motivation for learning, creativity and cooperation* (Ausubel & Floyd, 1981).

The Romanian educational system acquires new characteristics under the new European reform. In the contemporary society, dynamic and always changing, with quick changes and immediate effects, education and the educational system must constantly be renewed, completed, adapted and the concept of education re-thought and updated. Given the contents that contribute to the training of future teachers, the

pedagogical practice is the central dimension engaging all the other theoretical concepts but also all psychic availability of the student. All the acquisitions gained through the study of specialized disciplines, of socio-psycho-pedagogical and didactic disciplines, are better understood and become sustainable through the direct knowledge of school environment (education process) and extracurricular activities (retraining, refreshing, visits to museums, trips, clubs, scientific clubs, films etc.). Moreover, through practice, all knowledge and skills acquired are activated, combined and adapted to specific situations and circumstances (ex. teaching the same lesson at different classes). The current and the future society have higher and higher expectations from the teachers, aiming at performance and professionalism. That is why, training in specialty coincides with training for a didactic career implying a double responsibility.

Making researches on the reform of high education in several countries adhering to Bologna process, we can notice that new approaches and taxonomies are being promoted. In each country, a specific pattern, variable proportions, of psycho-pedagogical training, specialized and pedagogical practice has been set up. To this purpose, we would like to emphasize and discuss how pedagogical practice is carried out for initial professional training in a few countries, in order to discover, by comparison, similarities and differences. Searching in the specialized literature, we can see that, regarding the requirements of pedagogical practice in initial professional training of the teacher in Europe (Bernat, Chiş, Albulescu, & Berce, 2002, p. 16) the indexes revealed are between 100 and 200 hours, indicating the fact that pedagogical practice has a special statute. It is certain that „the success of pedagogical practice depends on the specialized theoretical training at disciplines within the pedagogical module (Voiculescu, 2010, p. 506). In Belgium and Spain, the initial training is performed at the Pedagogic High Institute, providing academic, pedagogical studies and pedagogical practice. The pedagogical practice has lower proportions in the first year of study, it increases in the 2nd and the 3rd years (more than half of the time allocated to professional development). Denmark and Norway train the future teachers for university studies for 4 years. For those working in preschool education, the theoretical training is completed by 28 weeks of pedagogical practice. In France, the training is carried out throughout 5 years of study, 3 years at university and 2 in IUFM, (Instituts Universitaires de Formation des Maitres) where the future teachers achieve pedagogical practice.

In Italy, the initial training takes place in 4-year study universities, Institute Magistrale, where there are professional studies of psycho-pedagogy and internships, while in Germany, - there are 2 distinct stages: scientific training, the methodology of teaching given subjects, psycho-pedagogical training and the practice stage of 2 years, all ending with a bachelor's exam. Each student has a coordinating teacher with psycho-pedagogical training analysing the educational issues observed during the activities performed and helping the student when needed. There are also teachers in schools monitoring the professional practical training of each student. In some states, such as England, there is a tendency to transfer the greatest part of teachers' training into schools and classrooms (school/ classroom based teacher training) and to significantly reduce classroom hours in amphitheatres. In Portugal, the high education system is regulated by the state constitution and it guarantees the right of teachers and students to take part in the democratic administration of institutions. The scientific education in Portugal is completed by pedagogical trainings making the initial professional training more efficient (Bernat, Chiş, Albulescu, & Berce, 2002, p. 83).

In Romania, the period of theoretical training coincides with that of pedagogical practice. According to the regulation of pedagogical practice, this is:” the basic discipline (...) of initial training, it is carried out by combining two dimensions, one focused on training and takes the shape of observation practice and

the other of exercise, of practical applicability, occupying the greatest amount of time of pedagogical practice representing operational practice. There are also scheduled a number of hours of individual study that can be done outside the school institution” (extract from the Regulation of pedagogical practice). Given the importance of this discipline mandatory in the curriculum of psycho-pedagogical training, we consider that the number of hours scheduled (3 hours each semester starting with the 3rd year) is insufficient. The time allocated to the pedagogical practice in the pre-university school institutions is not enough for the students in order to form and develop their ability to identify in concrete educational situations the behaviours correlated to the information they got during the theoretical-didactic training from previous years. We consider that allocating a larger number of hours would allow the students to familiarize with the school and with the educational process, to study the curriculum, the school syllabus and the alternative textbook, to update their previously acquired knowledge on the methodical organization of the lesson and of school documents, to assist to several demonstrative lessons conducted by mentors, to take part in the analysis of demonstrative lessons, to prepare didactic projects taking into account the requirements, to self-evaluate their lessons, to provide didactic projects of lessons that they are going to conduct to the tutors and practice coordinators in order to be corrected, to take part in the evaluation of the lessons conducted by other colleagues. But, are these activities enough in order to become a good mathematics teacher? What does it mean to be a good mathematics teacher in the 21st century?

3. Research Questions

We can say that the didactics of mathematics is a relatively new science. According to Brousseau (1994), the didactics of mathematics was born in the middle of the 60s in the context of the improvement of mathematics education. The didactics of mathematics is defined, first of all, naturally, as a science of specific conditions leading to the acquisition of mathematics knowledge by the students during the educational interactions at institutional level. In other words, in the didactic act, seen as a communication activity between teacher and student, the didactics of mathematics is considered the science of specific conditions to transmit knowledge of mathematics. Transmitting knowledge involves and implies transformations of the knowing process corresponding to the functions of cognitive activity specific to this interaction system, but mostly to students. So, the didactics of mathematics is placed among cognitive sciences, transmitting knowledge of mathematics useful for the general functioning of human institutions (Vâlcan, 2005). Nowadays, the knowledge of mathematics transmitted must use to the student to integrate himself/herself in the social-economic society as an actively participant citizen, contributing to building the „fortress” (Cucuș, 1999).

The didactics of mathematics is a scientific discipline. In order to demonstrate and promote this statement, a major contribution was brought by Hans-Georg Steiner (1987), who stated that the didactics of mathematics must be approached from the perspective of inter and trans disciplinarity, integrated through:

- Philosophy and history and mathematics,
- Didactic analysis specific to mathematics,
- Research of mathematics curriculum design,
- Research from the perspective of cognitive psychology of mathematics,
- And the theories of learning and teaching mathematics.

The principle of the didactics of mathematics should take into account, as Hans Freudenthal said, the fact that the most abstract mathematics, in an objective sense, is also very flexible and that, due to its applicability to the problems of human activities, it must be *useful, ... belong to everybody* (Gravemeijer & Terwel, 2000). In other words, Freudenthal pleaded for applied mathematics that could be useful, productive and constructive for human activities, both in terms of knowledge and especially current activities. In his opinion, traditionally, the didactics of mathematics takes as a starting point the results (outputs) of the mathematics activities obtained, by comparison, by others, who, then, theorize them and state them generally valid for the entire educational system. This way is considered by Freudenthal *anti-didactic*. We share Freudenthal's point of view, and, besides, we think that the meaning of the expression *mathematics as a human activity* must include the entire set of didactic activities necessary to train a student throughout the mathematics curriculum, designed unitarily, from pre-school level up to highschool, integrated and subsumed to the educational objectives and to the competences that the student should acquire to become a citizen responsible and useful for the future community where he or she will integrate and live.

“So, the didactics of mathematics should be the science that studies and substantiates the processes of teaching-learning-evaluation for mathematics both in the context of formal and informal education, and its research interest should cover almost all aspects of human life. Considering the complexity of educational sciences, it is difficult to admit that they can assume this responsibility. In fact, sciences of education, in a metaphoric sense, can be considered as a „philosophy” (in the good sense of general science of things, principles and causes) for all the disciplines, whether scientific, humanist, social, political etc. which are included, in one way or another in the curriculum or initial training plans, master, doctoral or continuous training. Are the role and importance of mathematics as a discipline well-defined in all training plans or curriculum? Is the way of selecting the mathematical notions, concepts and problems that we should approach with the students in the mathematics activities well-understood, so that they acquire them in order to form competences of applying them in current life situations, others than those belonging to the field of mathematics? Last but not least, can we scientifically explain, from the perspective of the didactics of mathematics, which is the effective contribution to the formation of a future mathematician with exceptional results in this field but also as a maths teacher? Surely, at the previous rhetorical questions, as to many others that we haven't taken into account yet, we cannot answer now, remaining for future studies. Of course, given this question, a major question arises: What is the relationship between didactics of mathematics and pedagogical practice? (Nicolescu & Petrescu, 2013)

4. Purpose of the Study

In the pedagogy framework, very often it is possible to meet the idea that —the current teaching practices tend to view mathematics in terms of subject matter such as definitions, theorems, proofs, problems and their solutions, not in terms of the conceptual tools that are necessary to construct such mathematical objects. It is a point of view of those pedagogues which do not understand that the mathematics there is by a hand, in implicit way, in everything we do day by day, and by the other hand it is a science in its own right, which is interconnected with any field of knowledge. So, via transdisciplinary philosophy, appeared the innovative educational approach called integrated method (Nicolescu & Petrescu,

2016). Also, still within the holistic paradigm of education, it is not understood or it is meant not to be understood that training the teachers, of mathematics, in our case, is a transdisciplinary action in the conceptual field of mathematics. Thus, since the didactics of mathematics cannot be separated from mathematics, the pedagogical practice of a mathematics teacher cannot be “cut” from the didactics of mathematics, in conclusion from mathematics. The purpose of this article is to draw attention, with all due respect and consideration for the “current education sciences”, that mathematics is one of the oldest sciences of education and this reality is from the very beginning of humankind, no lack of modesty. In short, the holistic of mathematics tells us that mathematics is also its didactics, which has as an application field the didactic practice, be it at the beginning of learning, as a student, or every day, as it is for the mathematics teacher. The teacher, generally, learns every day from the interaction with the students in classroom. For the student who learns to teach mathematics, it is very important to relate his or her teaching experience to what he or she studied in terms of didactics of mathematics. So, let’s “give” to mathematics everything that is rightfully its!

5. Research Methods

From the perspective of the second author, as the teacher of the other two authors, at Mathematics Faculty, this article is an opportunity to draw the attention of the academic and politic environment that designs/implements/manages etc. the plans for training teachers, from any level of the pre-university educational system in Romania. For example, there is no bachelor-level training plan for the “mathematics teacher”. In Romania, until 1990, there was a high educational system formed of “3-year Pedagogical Institute”, training teachers of mathematics, physics, chemistry, biology, art, music, P.E. etc. for the secondary school. During the same period, in order to become a mathematics teacher for highschool level, you had to have graduated from the Mathematics Faculty of a University in Romania, because, the training program implicitly contained a minimum number of courses of pedagogy, school psychology, didactics of mathematics and pedagogical practice, giving the skills of mathematics teacher. How did someone become a mathematics teacher after 1990? Just as before 1990, except that the training program for a “mathematician skills” is distinct from that of DPPD. The didactics of mathematics, as a discipline and pedagogical practice are in the training plan governed by DPPD, but the teachers teaching these disciplines are university teachers from Mathematics Faculty. Is this right? Is it wrong? Is it enough? To these questions, tried to answer our former students of the Mathematics Faculty, currently Mathematics teachers, for example, the first author of this article is a mathematics teacher at secondary school level, and so is the third author. For this article, it was insisted on the question linked to the pedagogical practice. How we describe it in terms of activity, objectives and what should be relevant and applied from the didactics of mathematics in the pedagogical practice.

6. Findings

If mathematics education has as a subject of study to apply the scientific contents of mathematics, specified in the national curriculum, in case of national formal education, in the classroom, then the pedagogical practice should be an activity teaching students to apply what they have learned in theory about how to teach mathematics in the classroom, so they should directly interact through didactic communication

with the “real” students of another “experienced” mathematics teacher. In other words, if the mathematics education defines the optimal knowledge for the training of the future mathematics teacher, so that he or she could be able to perform his or her tasks as a trainer for the future pupils or students, the pedagogical practice should be considered as the opportunity of the students to verify and improve everything they have learned during the mathematics education course, so that they can teach mathematics. So, the pedagogical practice is, first of all, a direct application in a classroom of the theories of mathematics education. Does it truly happen like this? The answer is unfortunately, negative. Both mathematics education and pedagogical practice of students from faculties of mathematics remain at the level of theories or/and good classical practices. None of these disciplines adapted to the new expectations of the new generations of pupils who have a different “start” of knowledge of the real world, due, especially, to ICT, Internet, access to “free borders” etc.

The endless reforms from the Romanian education system, in general, the requirements of the new mathematics school curriculum, designed in accordance with the European competences and requirements, especially, led to a “gap” not only of mathematics students, but also of the mathematics teachers from the national education system. The continuous training programs for the mathematics teachers do not take into account their real needs to adapt, adjust, understand the new school curricula etc. It is a sad reality! Regarding the didactics (methods) of mathematics for secondary school and highschool, the structure of their contents is dedicated to the methods and algorithms of solving mathematics exercises and problems, usually with a high degree of difficulty, from mathematics competitions and olympics, etc. on average of approx. 70-80%. The issues related to :

- Difficulties in teaching notions, concepts and mathematics properties,
- Difficulties of students in understanding them,
- Applying them in fields other than mathematics,
- Training errors that we „commit” without any intention, etc.

are almost ignored. Aspects of mathematics education are not approached for vocational and humanist branches. From our point of view, this approach is totally unproductive for the national education.

So, who addresses mathematics to? Of course, to the teacher, to the educator, to the trainer. To what purpose? In our opinion, in order to get examples and good practices from the science of mathematics education. Where does the student apply all these? Of course in pedagogical practice. But can a student “apply” through a starting professional experience in the class of a mentor teacher? Can he be free to experiment, to prove he or she has “true skills” of mathematics teacher? The answer is definitely “NO”. Why? For many objective and subjective reasons. One of these is the fact that the mentors agreeing to have a group of students (10 students) at his or her classes, for attendance and those classes when the students will take the mentor’s place in order to teach during one class as they have learned, are no longer considered teachers associated to the training program. In short, the teachers mentors from pre-university system are no longer paid. They do voluntary work based on contracts conducted between faculties and school inspectorates. We will not give any other reasons because we would extent the “pedagogical practice” to other issues linked to a good training of the teachers. Sadly, we could say that pedagogical practice has the part of “Cinderella” in the plan of pedagogical competences training of the maths teacher.

7. Conclusion

We are sure that we are not the only ones asking these questions that we could consider “vital” in training teachers, in our case, mathematics teachers. We also think that it is not easy to answer to these ones perhaps to many others, but, basically, this is what research in education sciences is about. On the other side, paraphrasing Claude Adrien Helvétius, we believe that the mathematics teacher is the result of the education received” and we surely know that there are very good maths teachers in the national education system. We did not want to point out that the pedagogical practice as a natural extension of mathematics didactics should be part of the training plan governed by the maths department instead of DPPD. Let’s not forget that the didactics of mathematics is actually a branch of mathematics!

Last but not least, we are convinced that, sooner or later, we should approach the issue of educational technologies at university level to „produce” mathematics professions for secondary school, highschool and university. In other words, we support the idea that within the faculties of education sciences, there should be elaborated plans of training at bachelor, master, doctorate for the teachers of basic disciplines from the national curriculum for secondary school and highschool.

Being a mathematician is one thing, being a mathematics teacher is another one. We believe that the truth of this statement is well known by everybody. So, which is the right “way” to correct to “produce” a good mathematics teacher? We can be, for one moment, those responsible for teachers’ training at university level and those who elaborate educational policies, professional ethics? If yes, we must do what it is expected from us the best we can! Have we understood what the math teacher's professional development means for the 21st century? (Joubert, Back, De Geest, Hirst, & Sutherland, 2010)

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