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Challenging paradigms in the continuous training of teachers from curricular area Mathematics and Science

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Abstract

Continuous training of teachers has proved a cornerstone for changing teaching from a mere activity to a profession. The teaching career is regulated by a special methodology which implies the three stages: definitive, second grade and first grade. These are supported by continuous training of teachers educational policy and activities. The various levels of change that emerged from the educational reform processes after 1989 did not leave the continuous training of teachers untouched. This paper refers to the continuous training of Mathematics and Science teachers through the project *"Continuous training network for teachers to use multimedia, virtual instruments web 2.0 in the curricular area of Mathematics and natural sciences (Proweb)*". This paper discusses the activities and results of the counties (Gorj, Dolj, Olt, Caraş-Severin and Mehedinţi) for which the "Constantin Brâncuşi" University of Târgu Jiu, România had the responsibility for continuous training(project POSDRU/157/1.3/S/141587).

Keywords: continuous training of teachers, competencies, values, attitudes;

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1. The merging paradigms: Training and continuous training

Pedagogy, Mathematics, and Science: what can be more challenging and intriguing? The Romanian National Curriculum is organized in seven curricular areas in a way a reminiscent for the digital era of the medieval *septem artes liberals*. Mathematics and Science is one of these particular curricular areas and is comprised of the following subjects: Mathematics, Physics, Chemistry, Biology, and other related including various types of optional subjects, which are circumscribed to these, or are designed based on interdisciplinary and trans-disciplinary principles. The principles that govern the core

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curriculum and optional curriculum apply to each area and its subjects. On the vertical and progressive timeline, curriculum is divided into curricular cycles that are more related to individual and particularities generated by the development stages. The common ground for these is the fact that subjects are grouped into particular curricular areas because, at the end of a curricular cycle, these lead to the same set of competencies, values, and attitudes. The syllabus for each subject integrates and takes into account these general principles. These lead our attention to the place a subject is situated and the way it becomes part of the educational experience of students in compulsory education, after that in high school and post high school educational programs. These prepare the way for the curriculum in higher education. These general remarks are necessary in order to understand the general framework of the educational system in which our discussed project in set in order to ground its further actions and results. Before that, it is necessary to add a few more areas of interest that would expand the complexity of this paper's aim and will widen the understanding of such large scale problems with which continuous training has to deal and has to address at one moment of time or another. First of all, it will be a pedagogical question as to what the profile of teachers is and the aim of these continuous trainings. The second question is what kind of scientific approach should be emphasized. The third question is concerned with the educational, social, and cultural impact for the present day and for the future of both students and of teachers. The pedagogical concern as to what model for training teachers has to be adopted is not a recent one. It is generally accepted that one field is different from another and that would determine the means, methods, and strategies used in the initial training of these type of subjects. However, subjects are not parallel lines, neither is one subject more important than another. Therefore, the balance is tilted due to a variety of factors. Some of these factors, which might seem very distant, could have a great influence. Bias and subjectivity go hand in hand. It is not only the balance between pedagogical factors and psychological factors, but it is also the balance between pedagogy and one or more sciences, such as the science of Mathematics in this case, or Physics, Chemistry, and others. What is the main concern of a teacher in an educational curriculum? More and more research and debates show the multitude of attitudes: some teachers are subject to syllabus, some to the particular science in which they are specialized and which they set first. Some are subject to the concept of performance and excellence, some point to cognitive factors, while others try to find the solution by invoking the emotional factor regarded as a forgotten and unwarranted solution. Therefore, a synthesis between models on the horizontal and vertical is difficult to impose and be accomplished unless one is sufficiently aware of the exiting diversity. The second question brings science to the frontline. Science has been, for a long time, a subject of boasting and praise; the teachers have made a paragon out of their statements that support their activity as true science. This type of practice has led to many inconsistent practices. Not only among the teachers of Mathematics, but also among the teachers of other subjects. The changes in the structure of the syllabus and in the educational curriculum of one particular subject have been seen as an attack upon the science they teach *ex cathedra*. As in the case of the dialectic of models, here we have the same type of dichotomy: unity or diversity? On the other hand, in many situations the refuge taken in the idea that they teach pure science (i.e.: Mathematics) seems ridiculous and makes no service to science. Once again, motivation, aptitude, and the choice of other subject on the part of the student could bestow on his educational fate more harm. He may possess a different type of talent, which does not fall within the competences, values, and attitudes that can be developed through the intensive care administered by pure Mathematicians or other pure science teachers. It is not an irony but one has to think that the intelligence approach that brought linguistic and logical mathematical intelligence to the forefront of education and pedagogy since Alfred Binet and Théodore Simon is also a victim of misapprehension and bad instructional practices. Educational and instructional policies that diversify the intellectual dimension have to be strengthened; it would seem too much to say

enforced, but it is difficult for many educators to think in the first places outside letters and numbers. Letters and numbers should allow other competencies, values, and attitudes to bloom out of education. It is not a poetic or romantic pleading, but it makes reference to peculiar practices that are still present in many areas of education. The third question brings attention to the desired list of benefits of education and science for society. This is not simply another area where unity and diversity are called to shake hands in a union of peace. Social benefits were very often mistaken and taken for what they are not. The global society, the global village, has to pass through various stages before it matures and leaves place to a new form of utopia, realism, or a new concept of social and cultural welfare. Until then, the settling process of values takes its time. This is a reality, which has to be accepted and learned to be lived with professionally, socially, and culturally.

1. The Curricular reform since 1989 and the training of teachers: towards teaching as a profession

Educational reforms are long, time-demanding processes. Studies come to support the necessity for reform and when the strategy and the strategic plan come into action, change within change may accompany thorough and well-planned actions, aims, and ideals. The educational reform was supported and sustained by many such studies and documents that emerged from various educational, social, and cultural policies, as well as important national and international agencies (many programs with UNESCO, World Bank, and other organizations*)* as we read*:*

Progressive approach has been embraced by decision makers throughout European education; and obviously from the Romanian (Neacşu, Stanciu, Ştefan, Mirilă, 1997, p. 12).

These have established the link with past reforms and with similar contemporary reforms, which are in fact not isolated facts. Beyond strategic planning lay the day-to-day educational and instructional activity. A remarkable practice was the general implementation of an instructional system based on B.S. Bloom's taxonomy, introduced from higher grades down to the beginning of first grades and kindergarten levels. Although the theory of B.S. Bloom has been known for a long time, transferring the objective model (goal setting, general, specific from a long-term perspective) and the pyramidal taxonomy was more than a challenge. This was in strict correlation with various changes in the educational policies at the European level. The five-objective model, rather than the eight-objective model paved the way for the model based on a set of eight key competencies. When the model based on objectives became general, the implementation of models based on competencies started to be introduced from the top to the lower levels of the educational system and the educational curriculum. It was during these periods that the keyword competence has become a landmark in planning and practice. Once the key competence model was established, it asked for action in all directions. The description of professional qualifications and occupational standards was touched on by them and from here they became implemented in the curriculum from higher education, to compulsory and comprehensive education, to tertiary education, non-formal education and, in fact, it has become part of the references to everything that has to do with education, instruction, and practice from training to profession. The derivation of educational objectives, as proposed by Gilbert L. de Landsheere(1975), might find its siblings in the new ramifications of the types of competencies, values, and attitudes such as the new version of Bloom taxonomy presented by L.W. Anderson and David R. Krathwohl and others(2001) and other types of taxonomies as such. The training of teachers has been redesigned to resemble the academic structure of undergraduate and post-graduate studies. From the situation where the subjects specific to the teaching profession were inter-spread among other subjects in the pre-Bologna programs and, in many situations, were taken on an optional basis, the first stage was to take them out and set them in a modular program and, then, to expand the

syllabus to two levels (level one: parallel to undergraduate courses and level two: parallel to post-graduate courses) that would implement a professional status to the didactic career. Sets of competencies were drawn up, not only for initial training of teachers, but also for continuous training; the continuous training of teachers has become an integral part of the teaching career. Universities became interested not only in providing the training for teachers through the Department for Teachers Training, but also became concerned with the aspects regarding didactics and methodology at all levels and the program to train specialists in didactics for the university level. After a period of so many formulations and re-formulations, of experimenting with new things and accommodating, so many experiencing new challenges did not avoid the newly reformed system. A dramatic drop in birth rate, the brain drain, and the mobility of students between various educational systems only added new dimensions to the experience and practice that educators have to deal with. Whether looking from inside or from outside, the educational system is so complex that in order to deal with all the issues preparation is always necessary. Therefore, continuous training is not only a necessity and an improvement, it is also a preparation for what comes as another POSDRU/55/1.1/S/25088 project has made evident through its six set volumes of quantitative and qualitative analysis of educational and social realities issued in 2012 by Centrul National de Evaluare şi Examinare, Bucureşti, Romania(National Centre for Evaluation and Examination, Bucharest, Romania).

2. Continuous training of teachers from curricular area Mathematics and Science

Continuous training of teachers has become a part of the on-going activities that address educational needs in recent years. Similar projects are addressed to teachers of History and Geography, and Chemistry, which had as beneficiaries and partners University Valahia of Târgovişte and "Constantin Brâncuşi" University of Târgu Jiu, Romania, as well as other partner institutions**.** These projects covered subjects form the curricular areas of Man and Society (History and Geography) and Mathematics and Science (Chemistry); these covered a large target group of several thousand teachers from various parts of the country. These projects, in a way, unveiled the need to have a coverage for all curricular area and all subjects. The reasons for such an approach was to extend the new pedagogical and educational approach to all levels of the curriculum and to all categories of teachers involved in education. On the other hand, it opened a new level for an interdisciplinary and trans-disciplinary approach. This project marks an advance from the managerial point of view in the sense that it has a digital platform, a better design for hosting a large number of applications, online and forum activities, on-line evaluation, the possibility of feedback for the activities, and evaluation reports compared for example to the project POSDRU/87/1.3/S/62651 dedicated to History and Geography teachers. Similar projects addressed subjects from the curricular area of Language and communication (Romanian Language and literature, foreign languages) and other curricular areas.
The project, *"Network of training teachers to use multimedia, virtual instrumentation and web 2.0 in the curriculum area of Mathematics and Natural Sciences (ProWeb)*", was co-financed through the European Social Fund Operational: Program for Human Resources Development 2007-2013, the priority axis: "Education and training in support of growth and development of a knowledge based society", area of intervention 1.3 "Human resources development in education and training". The partner institutions were University Valahia of Târgovişte, University "Ovidius" from Constanţa, "Constantin Brâncuşi" University of Târgu Jiu, "Lucian Blaga" University of Sibiu, and "Ştefan cel Mare" Univesity of Suceava, Romania (Proweb, 2014-2015). The project had a modular structure from a curriculum point of view. The general objectives of the project were: (A1) Development and accreditation of two programs of continuous training: (1.1) Curriculum development training programs, on-going support and applied activities and (1.2) Edit and submit specific documentation

for validation of continuous training programs. (A2) To create, implement, and maintain an innovative digital portal dedicated to the project. (A.3) Teacher training: (3.1) Selection and Management of the target group, (3.2) Organize and conduct training activities. (A4) Monitoring the use of innovative teaching tools created by the project. (A5) Making an impact study on the use of innovative technology of information and computer tools, developed and applied by project. (A6) Exchange of best practices on the topic of training: (6.1) Organizing and participating in exchanges of best practice, (6.2.) Create and connect to virtual networks on specific subjects for teachers from the curriculum area of Mathematics and Science. (A.7) Ensuring project visibility. (A8) Project management. The project covered 28 counties from eight different development regions of Romania, two groups of teachers for each county (22 counties), three groups for six counties and four groups for one county. The target group consisted of 850 teachers of various professional grades (definitive, second grade, first grade) and categories (primary school teachers, secondary and high school teachers). The structure of the target group was 250 teachers from primary education, 50 teachers form technical education, 350 teachers from secondary education and 200 teachers from upper level secondary education. The structure of the target group is shown in Table 1 and the structure for Gorj County is shown in Table 2**.**

Table 1. Target group and participants trained by "Constantin Brâncuşi" University of Târgu Jiu

County	Number of groups	Number of participants
Gorj (GJ)	2	50
Dolj (DJ)	2	50
Olt (OT)	2	50
Mehedinti (MH)	2	50
Caras Severin (CS)	3	70

The modular structure of the curriculum is shown in Table 3. The general activities involved lectures (applied face-to-face and on-line), forum activity, evaluation online, and evaluation face-to-face, based on individual portfolios**.**

Table 2. The Groups Structure of Gorj county: Group GJ 11 and Group GJ 12

Qualification and Speciality*/Teachers	GJ 11	GJ22
Teacher primary school	11	17
Teachers	14	8
GJ 11	1*	-
GJ 12	-	2*

1*: 5-Kindergarden , 9-Primary school , 7- Mathematics, 4- Biology, Natural Sciences, Chemistry, Physics
2*: 2-Kindergarten, 16-Primary school, 3-Mathematics, 4- Biology, Natural Sciences, Chemistry, Physics

The subjects of each module integrated subjects relevant for the scientific domain, coupled with elements and applications that integrated the use of computers and the use of various applications (Algodoo, Geogebra, Virtual Laboratory, multimedia applications, reading and understanding technical data of various types and categories). The pedagogical approach was based on the integration of aspects of behaviourism, constructivism, and cognitivism (and their social variants). The individual and differentiated approach was another integrated part of the course.

Table 3. The modular structure of the program

Title of program	Module 1	Module 2
"Continuous training network for teachers to use multimedia, virtual instruments web 2.0 in the Curricular area of Mathematics and natural sciences (Proweb)" POSDRU/157/1.3/S/141587).	D1.1 Pedagogical Fundamentals for using the technology of information and computers in continuous training of teachers from the curricular area of Mathematics and Natural sciences.	D2.1 Web 2.0 Educational applications in curricular area Mathematics and Sciences
	D 1.2 Technologies and multimedia and hypermedia application in modern education	D 2.2 Virtual Instrumentation and educational software

The number of applications was diverse and challenging. For Module 1, the first subject: *Pedagogical Fundamentals for using the technology of information and computers in continuous training of teachers from the curricular area of Mathematics and Natural sciences* was comprised of five applied activities. The tasks have been uploaded on the digital platform for evaluation and also online forum activities were a part of it. The tasks covered applied activities such as: a cognitive map (1), writing an argument to support the digital competence a teacher may use during his class (2), a constructivist approach to a learning activity (3), a lesson project (plan) based on the course approach (4), and a comparison approach upon using a traditional or a modern method in teaching a particular theme pertaining to the teacher's speciality (subject) (5). Themes and online participation had to keep to a recommended schedule. The participation in lecturers and activities prove a challenging experience. Although one may be confused by the diverse aspects of the project, there was no particular barrier that had to be overcome for most of the participants of the target group that belonged to the counties and the target allotted to "Constantin Brâncuşi" University of Târgu Jiu (Gorj, Dolj, Olt, Mehedinţi, Caraş Severin; target group 275 teachers) and were determined to complete the objectives of the project. In a way, the target group could be viewed from the perspective of the motivation theory of Carol Dweck, a category of teachers that were determined to master the course because it enriched their experience and professional life, and a category that did not consider it a major contribution to their practice. It was an inexplicable situation why, for example, the educational board of Mehedinţi County manifested no interest for this project, despite a large category of teachers, which have been part of the target group. The projects are part of a market nowadays and sometimes concurrence between projects and a multitude of educational offers affect the right path to follow.

The evaluation of activities made several aspects besides the quantitative data. The interest in working in a new frame and structure, and the extension and enrichment of forms and ways of doing things, was absorbent for many participants. Using digital applications in a kind of role-play, then applying these in a real context and sharing with colleagues was another practice that was exercised and implemented. Mathematics' teachers, working alongside primary teachers on algebra or geometry applications in digital way, this time was not only "intellectual activity" but also fun. Collaboration was at home, especially on the activities in Olt County and Caraş Severin County that I supervised. The collaborative aspect of work was visible in the elaboration of tasks. These have also shown other things, not only good and less good influences from the varied sources that the Internet offers. The necessity of using adequate scientific pedagogical language was reiterated. Many

elaborated tasks have shown that the teachers efficiently use Internet sources but the quality of the information and data they use is sometimes spurious and despite the nice aspect of images and figures, they do not serve the real purpose of the lesson. Therefore, more attention was drawn to these aspects of the data quality used and the relevance for specific educational objectives. Another "old sin" was the extensive dimensions of lesson plans and projects for the sake of proving that a teacher works. This oversized feature reflects a social fear and anguish for the necessity for the teacher to prove his work rather than design and do it according to the state of facts. This may just be a way that reflects how certain pressure society puts on its members gets manifested. The educational experience and expertise of participants were overwhelming. Teachers that have prepared and trained students for local, national, and Olympic competitions, teachers who elaborated all tasks of both modules in a manner and a quality that prompted the project team to propose them, for example, of good practices to be implemented, teachers from rural areas and urban areas, together with teachers from primary and high school levels, or areas where due to low numbers of students they teach in a stimulant system.

In Module 2, the subject *Virtual Instrumentation and educational software* brought the virtual reality closer, although some teachers of Physics and Chemistry asserted that students prefer real things to the virtual experiments. This subject had a rich set of applications: the use of Geogebra and Algodoo; Virtual Chemistry Laboratory; Applications based on the web for Biology; Mobile educational applications; Designing a lesson based on a virtual experiment. These categories of tasks have prompted the digital competencies of participants. Lessons in a virtual laboratory, and the complementary applications used, had a great effect and they raised a great interest, especially on the side of teachers from smaller educational institutions, which do not posses large numbers of laboratories or an extended material base. At this point, the speed of applying and working with these may present a disadvantage unless one controls the speed and rhythm of work in the classroom and makes sure learning takes place in spite of the speed such applications open the way for. Besides a long list of contributions to the forum and applications to be uploaded, the project created a community online and established a network that draws the global village closer, virtual but real too.

Table 4. Final results for groups GJ 1 and GJ2

Evaluation	Grade final evaluation GJ11/GJ12	Grade completion the program GJ11/GJ12
Excellent	18/3	15/7
Very good	6/13	9/9
Good	0/0	0/0
Sufficient	0/0	0/0
Insufficient	0/0	0/0
Rejected for final evaluation	0/0	0/2
Absent	1/9	1/7

3. What teachers do for the future

Time and space has been a dear theme, not only for science and the philosophy of science, but also for philosophy and theology, for music and arts. Mathematics and pedagogy, mathematics and

psychology, and pedagogy and cybernetics are only a few of the areas of knowledge and practice that collide, come across, intersect, join, unite and separate, generate new challenges. This project has integrated most of these issues. From various models of instruction, learning, teaching, and evaluation to the integration of digital applications and software, it opened the way to a new level of practice. The new framework of the project set for the target group was a new synthesis and a new beginning in a triple Hegelian formula for a level of training, which is part of professional life and of a new level of postmodern culture and civilized life.

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