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APPROPRIATION OF TECHNOLOGICAL RESOURCES THROUGH GEOGEBRA AS A SUPPORT IN THE CONSTRUCTION OF MATHEMATICAL KNOWLEDGE AND BASIC EDUCATION

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ABSTRACT

Since 2010 the Government of the Rio de Janeiro State has implemented a series of public policies to improve the teaching and learning Math system, all of them permeating the continued formation of teachers, which we emphasize a Continued Education Course, it was thought from a Basic Résumé recently implemented to all the state school from Rio de Janeiro, initially in a level of improvement, but it can lead the student to a post-graduation lato sensu and the New Education of Young Adults, it is focused in competencies and abilities, which also can be started as an improvement and conduct to a specialization according to the wish of the teachers who participate. These two moments of continued education to the teachers are permeated for the utilization of GeoGebra associated to formation and exploration situations of mathematic concepts.

Keywords: Public policies. teaching of mathematics. teacher training. GeoGebra.

INTRODUCTION

Largely verified results from exams of systemic evaluation (like IDEB[1] and the IDERJ[2]) they indicated that the students had a low performance in questions that deal with basic math abilities. Such results show the action of the educator in the classroom, conducting to a reflection about his/her function in this space. To this already overloaded professional remains the responsibility of reversing this situation in the public education – particularly worrying in the Rio de Janeiro State, which was in twenty-sixth place in the IDEB in 2009.

[1] Índice de Desenvolvimento da Educação Básica (Index Basic Education Development).
[2] Índice de Desenvolvimento Escolar do Estado do Rio de Janeiro (Indexo f School Development in Rio de Janeiro).

In a search for the reduction of this deficit, the SEEDUC-RJ[3] has started a series of investments actions for the improvement of the education quality. It has started with the résumé unification from the implementation of the résumé, it was defined as minimum and it was applied since 2011 in all the school years and to all the subjects. This document since then guides as much in relation to the content aspect as the aspect of its temporality in the school year. At the same time to that, it was started a continued formation to math teachers to the effective instructors of the network, in an association with the Foundation CECIERJ[4] to organization, implementation and education management of the Course. Posteriorly to this initiative, other ones came, like the Reinforcement Classes Project and the New Education to Young Adults.

In this work, we will show each one of these actions from an academic management and operational perspective of the projects, whose general coordination belongs to the authors of this report. The next sections will demonstrate to readers a synthesis of each of these actions, as well as how they relate to each other and their progress during the last two and a half years.

THE CONTINUED FORMATION COURSE IN THE MINIMUM RÉSUMÉ IN MATHEMATICS – SEEDUC-RJ / FOUNDATION CECIERJ

The Continued Formation Course in the Minimum Résumé was implemented around 2011, it has been offered to the mathematics teachers in the state from the education network who worked with the ninth grade of the basic education or with the first grade of the high school, initially, also reaching, since the second class (2012) either the second and third grades of the high school.

This course is fulfilled in the distance mode, it uses a Virtual Environment of Learning to interaction and discussion, besides that, it sends tasks, and it is based in three coordinate moments: planning, implementation and internal evaluations about the implemented actions. The conductor of the themes to be studied and discussed in this formation are the prescribed contents for the Minimum Résumé, and the temporality of the course also gets adapted to this

[3] Secretaria de Estado de Educação do Rio de Janeiro (Secretary of State Of Education in Rio de Janeiro).
[4] Fundação Centro de Ciências e Educação Superior a Distância do Estado do Rio de Janeiro (Foundation of Science and Higher Distance Education Centre in Rio de Janeiro).

document, it anticipates in around two weeks in a way that the teachers who participate can use in their own classes like implementation moments of activities and planned actions in collective discussions with their classmates. In order to do this, it is a necessary condition for the teachers to take the course – anticipated in the edict of the teachers' selections – they should be working during the period of the formation in at least one class which the course is intended.

In the year 1 f the course (August 2011 to July 2013) we attended about 1500 mathematics teachers from the 9th grade of the basic school and the 1st grade from the high school and in the year 2 (August 2012 to July 2013) we attended about 2000 mathematics teachers from the 9th grade of the basic school and 1st, 2nd and 3rd grades of the high school. The year 3, which has started its activities in August 2013, it counts with about 600 participating teachers who were distributed into three school years.

There are 4 courses offering one for each school year – 9th grade of the Basic School and 1st, 2nd and 3rd grades of High School – which they only can be done one by one. That means the teacher can do the course referring to the four school years, but for that, it is necessary to do and conclude each one at a time, besides, as indicated above, the teacher must be working in the same grade as he or she is taking the course. During the period of the duration of the course – one year- he must do 4 subjects of 40 hours each, connected to the two academic months from the school year in question, the menu of these subjects is coordinated to the contents to be studied in two months and the grade in question. The approval in these four subjects assures one certificate issued by the Foundation CECIERJ of Improvement in Math Teaching with a total of 160 hours of duration. The teacher who participates is given the option to proceed in a Specialization by LANTE-UFF in New Technologies in the Math Teaching. If this choice is made, he must attend one more subject by the Foundation CECIERJ – Curricular issues in Math – with 20 hours of duration, thenceforth attend more two subjects by the LANTE-UFF and write the work of the course conclusion.

The course pedagogic organization is done from the planning steps, implementation and evaluation, as mentioned above. In the planning step the teachers are invited to study the didactic material developed by a team of teachers who are master or doctors who were hired by the Foundation CECIERJ to this purpose. These materials offer the teachers a revisit to the

contents from the Minimum Résumé to the two specific months, they show innovator situations in the sense of technological exploration or the application of these contents and other knowledge areas. It is searched an approach more conceptual than procedural, it offers the teachers a reflection of the teaching goals of those contents related to the orientation of the National Curricular Parameter and the recent research in the Math Education area, which teachers and coordinators are closely related. In this moment of the course, there are questions to be discussed and commented in a thematic forum, mediated by a tutor, where the collective discussion, the sharing of doubts and the clarification among the teachers are discussed. In any moment that eventually it becomes necessary, the tutor can request the assistance from some teacher or from the coordination to reduce more complex doubts.

The didactic materials are formed by reading material itself and by a series of files named Action Guide which are activities with foreseen duration for 100 minutes in general, and they propose an action which is ready to be implemented in the classroom, it is based in the text for reading and the teacher can edit according to he or she thinks it is necessary to apply to his or her students. From this reading, the teacher elaborates his or her Work Plan, which is a planning of actions and activities to be accomplished in a period of at least 4 hours/class – which must be related with the Course somehow. We were careful about not naming of Class Plan to make it clear the necessary difference between an isolated action and to a class that contemplates the work with a determined content.

Whenever the WP is elaborated, the teacher sends it to the tutor, who accompanies in the Virtual Environment of Learning; the tutor reads it and makes some suggestions for the application. In the next step, the implementation, the teacher applies it in his or her classroom and evaluates this application according to explained goals in the Work Plan. Thenceforth, he or she improves and sends it back to the former. In the evaluation step, there is a discussion in a forum, mediated by the tutor, among the teachers who participated, their WPs and their application, where they can change ideas and analysis about their respective actions.

This structure is inspired in the ideas of design and redesign of activities (Mion & Angotti, 2005), they allow the instructor to think about the activities used in the classroom and their results considering the theoretical framework presented. This position collaborates in avoiding one of the mainly criticism normally directed to researches accomplished in the educational area, they show gaps between theory and the educational practice (di Sessa &

Cobb, 2004). More recently, this methodology – DBR (Design-based research) – has been applied also as an important role in the theory development, and not just in the evaluation (Edelson, 2002).

Part of the Action Scripts that inspire the elaboration of the Work Plan suggest the application of technological resources in the actions connected to the math teaching, with the goal of supporting in the formation of mathematical concepts. These activities are thought to be used in the classroom, with the simultaneous use of the teacher's laptop and the multimedia projector, or still in a computer lab, or even in contexts OCS (one computer per student). We understand it is important the insertion of this kind of activity in the teacher training, once the schools are directed with increasing speed to these ways, without mentioning the motivational aspects that evidently configure themselves in relation to the students when they use these resources.

At the end of the first year it was fulfilled with the teachers, in an unidentified way, one evaluation research of the Course, by the virtual form, Google Spreadsheets, it was about four topics: the course impact about its teaching practice, pedagogical mediation, didactic material and virtual environment of learning. We will only concentrate in the first topic information.

From the almost graduated teacher, 888 teachers participated of the research, and among them, 81% affirmed that they developed new exercises from what they have worked in the Course, 95% affirmed that they learned something new and 92% improved their previous knowledge in the use of computers, particularly from GeoGebra, and from internet with educational goals. Finally, 99% of the respondents affirmed that happened a significant improvement in the process of teaching and learning math in their classes, they had observed a bigger motivation in the students from the classes which they implemented the Work Plan and a consequent improvement in the intern evaluations, emphasizing that these results were potentiated; when GeoGebra was suggested.

THE GEOGEBRA

A striking characteristic of the course is that certainly one of the biggest differentials of this proposal; it is the motivation to use the GeoGebra in the classroom, assisting the

teachers to permit the visualization and the conceptual understanding from the math ideas. To facilitate this process, around the half of the action scripts proposed foresee the utilization of the GeoGebra, whether as an environment of constructions and manipulation in Geometry, whether as a function graphical plotter, whether as analysis of function graph behavior using the parameters or as an environment of manipulation by the student with the goal of doing conjectures and validate hypothesis. The scripts that the Geogebra uses with screen that the teacher will need to put together with the students are carefully explained, in a step by step which guarantees the teachers' success. In this task, the authors of the course assist if it is necessary, since all the authors have a consistent knowledge in manipulation of the Geogebra. Besides, most part of the bimonthly in person meetings that exist in this course, are offered workshops in GeoGebra. These workshops are planned in a beginner level – intermediary – advanced, in such a way that they always can be interesting to the teachers who participate.

The insertion of technological resources in classroom was inspired in Koehler & Mishra (2008), Niess et al (2009) e Palis (2010), they highlighted the need to concentrate the pedagogic knowledge and content to the technological to the Math teaching in the basic education might be realized with better results. The theoretical panorama that reflects these approaches is known as TPACK, abbreviation to Technology Pedagogical Content Knowledge – originally TPCK. The insertion on the letter A had the function to configure this set of knowledge as a whole and necessary package to the initial or continued math teachers' formation.

The use of math software configures well the theory, since it implies as much in the utilization by the teacher of the software, which depends of the teacher's previous knowledge about the software in question, as well as in the recognition by the potentialities of the software in the utilization of the pedagogical and mathematical. The possibility of generation of dynamic environments which become manipulable the abstracts objects typical of the Math; it is one of the biggest gains that can be reached with this approach. In this way it is possible to aggregate real meaning to the math contents. The comprehension of concepts is favored by the student, once these would not be only algorithmic process; repeated and memorized to become effective math objects. Sfard (1991), Dubinsky (1991) e Gray & Tall (1994) commented about the math learning by the students, affirming, each one in his own way, that the math objects only start cognitively to exist to the apprentice when they stop

being isolated processes, derived of memorization and repetition; to have an effective meaning. These objects need to be constructed over other solid cognitive structures to the apprentice which they can be general or mathematical knowledge – these also need to be math objects so they can anchor new knowledge.

The utilization of technological resources in classroom, during the math classes, configure themselves as an odd opportunity to the manipulative exploration of the math objects, allowing a double gain to the apprentice: on the one hand, he can give a reality state to the math objects eventually already consolidated in their cognitive structure, but they still need some setting, on the other hand, it allows to manipulate and operate with them, creating and developing new processes and, consequently, new math objects. Let's remember that the more advanced the mathematical studies are, the less real are the studies objects, which certainly is more difficult in the final series of the basic education in Math.

The choice made by the pedagogic team of this course was GeoGebra. The factors that motivated this choice were: the free availability, the permission of work with big diversity of mathematical contents isolated or integrated and the characteristic of being multiplatform, which allow the proposal activities be realized in free or not system, and more recently in tablets – which they will soon be distributed to the teachers and students from the basic public education in all the country.

The areas in which we proposed activities with GeoGebra were: (a) 9th grade from the basic school – circle and circumference, trigonometric function in the rectangle triangle, introduction to the studies of functions, (b) 1st grade of high school – conjuncts, introduction to the study of functions, polynomial function from the 1st degree, polynomial function from the 2nd degree, trigonometry in the circumference and trigonometric functions. (c) 2nd grade of the high school – logarithmic functions and spatial geometry, prisms and cylinders and spheres; (d) 3rd grade of the high school – analytics geometry, complex numbers and polynomial. All the activities were developed by a team of teachers hired by the Foundation CECIERJ to this purpose. As an example to situate the reader, we mentioned some approaches presented in the scrip from the 9th grade of the basic school to the 1st grade of the high school.

In the study of the subjects related to the 9th grade of the basic school, the action scripts proposed activities to (1) construction and exploration of the circumference and the study of its elements from the tools available by the GeoGebra software; (2) empiric study of the perimeters indicated by the Geogebra software to a sequence of regular polygons enrolled in the same circumference, with increasing quantity of sides and comparison with the relation C=2*pi*r; (3) the same to calculate de area, with the relation =pi*r^2; (3) study of the trigonometric reasons in rectangle triangles that are similar, guiding the student to realize that the indicated reason sine, cosine and tangent does not change when the angle is question is the same; (4) the study of graphs of functions and some attributes, as growth, concavity, extremes, etc., among other things. In the subjects of the 1st grade of the high school, the utilization of the GeoGebra in the action scripts was done by actions connected to: (1) comparison segments of different sizes in the study of numerical sets; (2) the study about the conditions that one curve should attend to represent the graph with a real function ; (3) the study of inclination of straight lines which represent related functions and their elements; (4) the study of parabolas which represent quadratic functions; (5) construction of parabolas by a geometric perspective; (6) construction and study of the trigonometric circle's properties; (7) construction and study of the properties of the trigonometric functions' graphs connected to the study of these relations in the trigonometric circle, among others. The approaches connected to the other school years follow approximately these ideas.

It is important to highlight, despite this is one of the focus of the Course, the teacher who chooses not to use any of these resources finds a receptive environment and offers of Action Scripts to base his/her Plan Work the same way as the others. The tasks with technological resources are offered and their use is just stimulated, they are not an imposition. In the annex, we put some comments made by the teachers in discussion forums.

FINAL CONSIDERATIONS

It is still early to evaluate the impact of the public policies and different practices of the teachers' formation implemented in the last two years and a half in the State of Rio de Janeiro. What is known is that about 8000 from the 12000 Math teachers of the network are

going through a continued formation and having the opportunity to be in contact with pertinent and updated discussions about the teaching and learning in math.

All the more, they are having the opportunity to bring to the team of 150 teachers who make a group of coordinators and formers of these projects, the reality they live in their classroom, and it has enabled an updating and a constant adequacy of the contents, approaches and formation practices which they are submitted. In other words, the structure DBR also adapts itself to the projects, which they are constantly evaluated, by means of bimonthly meetings with the network teachers, and remodeled in order to improve to the reality of the classrooms.

There was not an external evaluation to validate the results of these actions, accompanying in a separated way the students of the teachers, who are in the continued formation, the students of the teachers who are not participating of the projects, but we already have many reports that show a bigger interest from the students of these teachers who are in formation, they also show a better income in the internal evaluations.

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