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METHOD OF GROUP WORK AND MATHEMATICS TEACHING: THE CASE OF A GRAPHICAL REPRESENTATION OF A DIGITAL FUNCTION

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ABSTRACT

Students have difficulty drawing a curve of a digital function and geometrically interpret the limits and derivatives. The purpose of this study is to identify the possible causes of these problems and propose an effective teaching strategy for a proper understanding of this part of the lesson to students in 1st year baccalaureate experimental sciences option, and we worked with the technique of groups while incorporating activities on geometric interpretations of the limits and the derivative to find the lost meaning of these concepts.

This method is very motivating and after the experience in the classroom, the results were encouraging and students who followed propose that it be used for all lessons and all subjects studied (Mathematics or another. ...).

Keywords: *Graphical representation of a function, geometric interpretation, meaning, group work, active learning.*

INTRODUCTION

In active learning, active students' character is often associated with how they acquire new knowledge. For example, problem-based learning, it is the students who organize knowledge starting from a broad and complex situation by the teacher (Barron *et al. 1998*). Several aspects of the subject are then visited by the students during the search for solutions to the problem. Students are also asked to reflect on their learning strategies and techniques of their work in order to continually adjust them. Finally, the active character is brought by methods such as project-based learning where students must perform experiments and deliver a product. We say that learning occurs in the action or "learning by doing" (Barron *et al*, 1998).

Students inherit a greater responsibility in the rhythm and how knowledge is acquired. In other words, learning is student-centered. The traditional role of the teacher diffuser of knowledge has evolved in active learning. In fact, doesn’t diffuse information directly and instead focuses on supporting students in learning. The teacher is active: he circulates in rows and asks questions to students in order to guide the formulation of hypotheses or proposes to them strategies for organizing knowledge. The teacher is patient rather than giving information quickly, he provides resources and promotes interest to find the answer. This role change is not easy, but the absence of direct traditional teaching is needed in several ways so as not to adversely affect the learning process of students. According to several authors, problem-based learning and productive failure are particularly sensitive to these interventions of the teacher (Cohen, 1994). Finally, the support for learning is not to be overlooked because experiments indicate that strategies to control student learning represent one of the factors that has the greatest impact on student performance in the context of active learning (Yukselturk & Bulut, 2007).

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In conclusion, active learning occurs in practice by teaching methods centered on the student were learning is done by goup work and where teachers play an important role in supporting learning, by limiting and sometimes completely eliminating, the role of content diffuser. In addition, they bring a complexity of the planning process underway.

Active learning is, in short, any learning activity engaged in by students in a classroom other than listening passively to an instructor’s lecture. As we will show below, this includes everything from listening practices that help students absorb what they hear, to short writing exercises in which students react to lecture material, to complex group exercises in which students apply course material to “real life” situations and/or new problems. The term cooperative learning covers the subset of active-learning activities that students do in groups of three or more, rather than alone or in pairs. Cooperativel earning techniques generally employ formally structured groups of students assigned to complex tasks, such as multiple step exercises, research projects, or presentations. Cooperative learning is to be distinguished from the more general term collaborative learning, which refers simply to any situation in which groups work together. Cooperative learning uses groups to work toward a common goal with positive interdependence, individual accountability, and heterogeneous groupings (Cooper & Mueck, 1990). Active-learning techniques, then, are those activities that an instructor incorporates into the classroom to foster active learning. The underlying premise for collaborative and cooperative learning is founded in constructivist epistemology. (Johnson, Johnson & Smith 1991) have summarized these principles in their definition of a new paradigm of teaching" First, knowledge is constructed, discovered, and transformed by students. Faculty create the conditions within which students can construct meaning from the material studied by processing it through existing cognitive structures and then retaining it in long-term memory where it remains open to further processing and possible reconstruction. Second, students actively construct their own knowledge. Learning is conceived of as something a learner does, not something that is done to the learner. Students do not passively accept knowledge from the teacher or curriculum. Students activate their existing cognitive structures or construct new ones to subsume the new input.

Third, faculty effort is aimed at developing students' competencies and talents. Fourth, education is a personal transaction among students and between the faculty and students as they work together. Fifth, all of the above can only take place within a cooperative context.

Sixth, teaching is assumed to be a complex application of theory and research that requires considerable teacher training and continuous refinement of skills and procedures" (p16).

For Abrami *et al.* (1996), one of the main reasons for the success of this approach comes from the will and the need for mutual support among peers in the perspective of collective success and individual learning. This form of interaction between students, which means that the success of one helps the other and vice versa, and that drives to accountability of each one towards the group.

Working in cooperative small groups provides an opportunity for students to exchange ideas and challenge their own knowledge (Johnson, Johnson & Smith 1991) and small group work has been shown to improve student academic achievement, critical thinking abilities, social skills, and self-esteem,(Johnson, and Johnson 1994) though peer assessment components are not necessarily valued by students(Munk and George 2003). According to Vygotsky (1978) small group work is particularly effective when instruction is offered at or slightly above a student’s own level or “zone of proximal development.”

The growing use of cooperation in classroom practice to develop cognitive skills (arguing, categorize, check ...) and social (respecting others, wait your turn...) of students raised the question of its didactic efficiency. According to Pelgrims Ducrey (1996), different areas of research have focused in recent years on this question. Thus, in the context of experimental pedagogy, a series of focused researches "on a study of the efficiency of the processes and methods of teaching" has shown that group work also produced significant effects on the acquisition of specific academic learning.

The new methodology of mathematics provides many activities that encourage interactions between students. Sometimes focused on competitive mode through some games, these activities often resort to the virtues of cooperation to promote learning and cognitive progress of students. In addition, students are expected to perform their task without the direct supervision of teacher.

Group work in learning continues to produce proof of its efficiency in many ways in the field of mathematics. Not only does it get good results for many students of various levels and of different types (Slavin, 1991), but it also helps to develop students' skills in the field of communication and interpersonal relationships, as students work in groups (Greenes, Schulman and Spungin, 1992; AAAS, 1989, 1993). Working in small groups, students are more interested in the subject and their class-mates than would have been the case if the lesson of mathematics was taught to the whole class (Mulryan, 1992).

Group work promotes values such as clarification, comparison, and defense of ideas and social virtues of listening, compromise and consensus (Rees, 1990; Yackel, Cobb & Wood, 1991). Group work offers diverse opportunities in promoting fruitful interaction between students (NCTM, 1889, 1991). It contributes to the promotion of a mathematical community, as recommended in the book "Everybody Counts", published by the National Research Council in 1990.

1. DIFFICULTIES IN MATHEMATICS TEACHING

The teaching of mathematics in basic education is according to the European Commission, 2007):
• designed as a formal teaching, focusing on learning of techniques and memorizing of rules;
• the link with the real world is low;
• experimental practices and modeling activities are rare;
• appropriate use of technology is still relatively limited.

Important knowledge in mathematics is designed as abstract structures which are in the form of relations between concepts and fundamental principles. How these superstructures have to be acquired? Under their symbolic forms only? or first under concrete form?

Mathematics is a form of thought rich of sense, but that relies on formal sequences and combinations of symbols it is possible (and sometimes desirable) to handle regardless of meaning. Mathematicians and mathematics teachers are wondering more and more about the meaning of mathematics they produce. This return to meaning is very important to give life to a subject which causes a problem in learning and teaching.

These difficulties lead to "failures and dropouts, with low self-esteem, an inability to take charge and unsuccessful attempts to understand the real reasons for failure" (Lafortune, 1997, p.4). Most students approach mathematics reluctantly and with obligation and without feeling any pleasure (ibid., p13).

A quality mathematical education must see mathematics as a living science, engaged with the real world, open to relationships with other disciplines. It should in particular enable students to understand the power of mathematics as a modeling tool to understand and act on the world[1].

2. LOSS OF MEANING IN MATHEMATICS EDUCATION

The teaching of mathematics is facing a lot of difficulties and challenges. Mathematicians and Didacticians consider that these difficulties are related to the problems of teaching the meaning. Each concept in mathematics has a meaning and a form, so how should the education system handle this dichotomy "meaning/form"? And how important is this dichotomy in teaching mathematics? And what is the role of group work in the realization of this dichotomy?

In his article "Mathematics and mathematics of always", Thom (1974) stated that the real problem of teaching mathematics is being the construction of meaning. But, how to build the meaning of mathematical objects? And with what kind of means?

Lemoyne (1993) agrees that the question of meaning in didactic research of mathematics is always addressed when it comes to interpreting student's errors.

There is loss of meaning at every link in the didactic transposition, "the mathematician does not communicate its results in the form in which they were found. He reorganizes; he gives them a form as generalizable as possible. He [tries] to put the knowledge in a communicable form, decontextualized. The teacher made the opposite work (...). He performs a recontextualization of knowledge. He looks for situations that will make meaning of knowledge to teach. "(Briand, p. 53)

In the founding text of the theory of conceptual fields, Vergnaud (1996) defines the meaning as a relation of the subject to situations and signifiers. The meaning for the student "will be built from different semiotic objects that have been handled in its practices" (Lemoyne, 1993, p270).

Brousseau says that dialectic 'meaning / form "is fundamental to the teaching and learning of mathematics:

[1] One can refer to works of ICTMA (International Community of Teachers of Mathematical Modelling and Applications – http://www.ictma.net) and to the study ICMI focused on this theme (Blum et al., 2007).

"The old position was to separate the learning of skills and meaning. The new offers hope to merge the two because it provides the teacher that the meaning of the structure that is ultimately learned and algorithms that are attached to this structure [...]. But in fact the "structure" will be replaced by skills expertise and learning of meaning is going to be even more neglected. We even witness the disappearance of problems "(Brousseau, 1994, p195).

Teaching methods should seek to reject the idea that mathematics is a difficult subject, abstract and detached from reality. For example, the organization of lessons around interdisciplinary themes helps build relationships with everyday life and with other subjects. Group work can help give meaning to many
concepts in mathematics.

3. LEARNING & TEACHING OF THE CONCEPT 'FUNCTION

The notion of function as an object of analysis can intervene with many frames (Douady, 1986) and it is related to other objects (real numbers, numerical sequences ...).

This concept also requires the use of multiple registers (Duval,1991), that are, algebraic Register (representation by formulas); numerical register (table of values), graphical register (curves); symbolic register (table of variations); formal register (notation *f, f (x), fog ...)* and geometrical register (geometrical variables).In addition, Balacheff and Garden (2002)have founded two types of image conception among pairs of students at high school, that are, conception curve-algebraic, i.e., functions are seen as particular cases of curves, and a conception algebraic-curve, i.e., functions are first algebraic formulas and will be translated into a curve. The authors Coppe et al (1990) showed that students had more difficulties to translate the table of variations from one function to a graphical representation which shows that students have difficulties to adopt a global point of view about the functions. They have also shown that the algebraic register is predominant in textbooks of the final year at high school. They also noted that the study of functions is based on the algebraic calculat ion at the final year in high school (limits, derivatives, study of variations...). According to Raftopoulos and Portides(2010), the graphical representations make use of point of global and punctual point of view of functions; on the contrary, the properties of the functions are not directly visible from the algebraic formulas. Bloch (2003) highlighted that students rarely consider the power of the graphics at the global level and propose teaching sequences supported by a global point of view of the graphical register. The students do not know how to manipulate the functions that are not given by their algebraic representations. And they do not have the opportunity to manipulate the families of functions depending on a parameter.

In this paper we attempted to develop the apprentice of graphic representation of digital function to students of 1st year baccalaureate experimental sciences option, integrating group working activities.

4. METHODOLOGY STUDY

We have chosen a mixed approach, we have done first a scrutiny with a group of 10 teachers of mathematics of secondary cycle who answered three open questions and an enclosed one based on the difficulties encountered by students when representing a function. The causes and solutions proposed to surmount their problems.

The teacher's answers have improved the study of a function integrating activities related to geometrical interpretations of "limits" and "derivation" through applying the method of group working in a class of 34 students (1st year baccalaureate option experimental science) divided in 6 groups of 5 students and a group of 4 students and a group of 4 students, the course length is 35h/7 weeks.

By the end of this experience, students are divided into 3 classes (the 1st is experienced, the second and the third are witnessing except that the 2nd class students followed the same activities as the 1st class, but these activities were done individually. The 3rd class followed the course through a transmitting method who have undergone the same evaluating test.

A questionnaire has been addressed to students who assisted this experience just before handing in the evaluating test to assess the appreciation of group working method.

5. SURVEY WITH TEACHERS

The teachers confirm that all students have difficulties to draw graphic representation of digital function.
These difficulties are:

- geometrical interpretation of "limits" and "derivatives";
- graphic representation of parts of a curve within the domain of definition and the apprentice draw the curve one in a unique continued part though it is constituted from two parts or more;

- impreciseness of graphics representation of the curve (the disrespect of the concavity of the curve and the absence of tangents especially in the extremum.).

Students perform the activities of the calculation, but they fail to give a geometric interpretation of these calculations (Nachit Namir, Bahra, Kasour & Talbi, 2012).

The causes of these problems:

- the formal study is dense in the practices of math's teaching (Nachit, 2014);
- fear from mathematics to the apprentice is caused by the absence of requisites; he does not make any effort;
- the abstract aspect of the subject does not allow students to feel the ability of functions;
- the apprentice is not able enough :
  - to make the liaison between different questions of the exercise. In other words, he does not understand the exercise as a whole;
  - to read correctly the horizontal chart of variation. The elements which do not belong to the domain of definition, the points where the function is not derivative;
  - to make the geometrical interpretation of limits, the derived number and the second derived;
  - to understand the notion of the infinite;
- The apprentice had some deficiencies in:
  - working with the indefinite x, y, t…;
  - working with a right line as a geometrical figure and analytical notion which constitutes hence a basis to draw the curves.
- concerning the precision of one representation of a curve, it may be possible that the apprentice is adopted to draw geometrical figures and lines using geometrical tools (for example: a ruler…) not to forget that the curves to them are represented always in a form of segments;
- the predominance of the abstract aspect of the courts without a practical application renders the student incited towards what he is learning, we note that the graphic representation of a curve is everywhere in our daily life.

In conclusion, we note that students succeed the activities around the "form" and unable to do the activities around the "meaning." They are able to make the study of functions (domain of definition, limits the terminals, change direction ...), but they are unable to assign a spatial place of the elements involved in this study, particularly to interpret geometrically the limits or derivatives. So school textbooks and teachers' practices are far from the pedagogical guidelines around the "meaning."
Proposed solutions to solve these problems to the apprentice:

- diversify the situation of acquisition during the representation of limits concentrating more on the geometrical interpretations of limits, derived numbers and extremums of a function;
- adopt the apprentice to read the data beginning with a curve of limits, tangents, asymptotes, the image of a number … introducing situations and convenient activities;
- concentrate more on the linear functions, and affine functions as they are analytical notions and geometrical, and the counting of an image of a real number through a function; therefore, the apprentice understands well the notion of a real variable;
- integrate the TIC within the course "graphic representation of a curve";
- reduce the number in each class to 24 students;
- reinforcing students with difficulties to maintain certain learning.

Accordingly, we tried to develop our course by integrating some activities on limits and derivations; we are inspired by activities proposed in Maths handbook "FI-RIHAB" 1st year baccalaureate, option experimental sciences.
Activities of limits are:
Activity 1: the finite limit of a function around the endless.
Activity 2: the infinite limit of a function around the endless
Activity 3: the finite limit near to a real number.
Activity 4: the infinite limit of a function around a number (right and left limit).
Activity 5: limits of trigonometric functions.

Activities of derivatives are:
Activity 1: instantaneous speed and the derived number.
Activity 2: tangent of the curve of a function in one point.
Activity 3: derivability of function on the right and the left.
Activity 4: monotony of a function and the sign of a derived number.

Activities of graphic representation of a function
Activity 1: asymptote parallel to the axis of abscises.
Activity 2: asymptote parallel to vertical axis
Activity 3: oblique asymptote.

Activity 4: parabolic branches.
Activity 5: concavity of a curve and the point of inflexion
Activity 6: axis of symmetry and center of symmetry of a curve.

6. EXPERIMENTATION OF GROUP WORKING METHOD WITHIN STUDY ACTIVITIES OF A FUNCTION FOR SECONDARY CYCLE

6-1 Application of group working method in a lesson:

We have subdivided the class in 6 groups of 5 students and a group of 4 students, each group is composed of a good student, two have a middle level and two others are weak. We have avoided that the members of each group are acquainted; each group has a reporter and an animator. The animators have the right to ask for help from other groups and if all the groups do not have the right answer, the teacher intervenes to guide them without giving any answer only after many attempts so as they auto-correct the exercise.
The teacher tries to involve all members to participate during the activity.

6-2 Evaluation test

By the end of the experimentation all students of 3 groups (Experimental and the two witnesses.) have undergone the same test of acquisition on a graphic representation of a function. This test aims essentially to know the students degree of mastery of their level of knowledge mentioned in Bloom's taxonomy namely:

- acquisition of knowledge (Memorisation);
- comprehension of a knowledge acquired;
- application of this knowledge in practice;
- analysis of this acquired knowledge;
- synthesis of acquired knowledge and the evaluation;
- the decision making with regard to acquired knowledge.

In our case, we did not evaluate students according to the last level of knowledge who correspond to the decision making.

6-3- Questions type given in the evaluation test:

The subject of evaluation is composed of four 4 questions exercises:

Exercise 1: questions of the course in the form of definitions.

Exercise 2: questions of the course in the form of a sentence to complete; we have given graphic representation and we asked students to fill in the blanks with appropriate limits. In the other questions we have given students the curve and we asked them to draw a chart of variation.

Exercise 3: we have given the chart of variation of a function f and the chart of signals and its secondary derived function f''(x), we asked students to draw the graphic representation of the curve of the function f.

Exercise 4: we have given a function f and we asked students to study it.

6-4 compared results of the test of knowledge:

We present what follows the compared outcomes of the test of knowledge .Then the declarations of students who assisted to the method of working group so as to proclaim their appreciation concerning the working group method.

Cognitive activity demanded	The average mark of the experimental group	The average mark of the group witness 1 (activities applied individual)	The average mark of the group witness 2 (without activity or working group)
Acquisition of knowledge (Memorisation)	11.89/20	11.1/20	11.16/20
Comprehension of knowledge acquired	11.60/20	09.29/20	05.85/20

Application of this knowledge in practice.	10.48/20	04.81/20	02.84/20
Analysis of this acquired knowledge.	08.86/20	03.89/20	01.75/20
Synthesis of acquired knowledge	08.86/20	03.89/20	01.75/20
The general average	10.34/20	06.6/20	04.67/20

- the obtained results by students in evaluation test showed clear supremacy of students who have worked in group (experimental group) on students of two groups witnesses;
- group working helps to achieve the complex objectives of the application of Bloom's taxonomy, analysis and information synthesis;
- more than that, we witnessed a great motivation of all students who followed group working method even those who have low level at the beginning, they could have average marks, in their memorization of knowledge and application, whereas, students of average level experimental group, obtained probably the same marks as the best ones of group witness who followed activities in an individual manner.

An analysis of the results shows that teaching has a character more syntactic than semantic; more based on the understanding of rules and algorithms than on the construction of meaning involved in solving problems.

Group work promotes socio-cognitive conflict: the student by confronting others improves his learning in the interactions within the group.

7. ANALYSIS OF RESULTS AND DISCUSSION OF THE QUESTIONNAIRE ADDRESSED TO STUDENTS

The answers assembled by students allowed us to raise the following results:

- 20,59% of students judge that mathematics are easy, 52,94% confirm that they are moderately easy and 26,47% find it difficult;
- Nearly 67% of students see that difficulties of mathematics is due to the lack of practical application and of teaching method whereas 97,06% judge that it results from the lack of acquired things;
- 76,07% of students confirm that the use of group working method in studying a function facilitates the understanding of this part of the course and 88,23% of students confirm that it helps in the resolution of the exercises;
- 90,7% of students see that the use of group working method will be efficacious in all the courses of mathematics and 88,24% see it utile within the courses studied;
- More than 90% of student judge group working method helps working more in communicating with others, exchanging ideas with them, making research by themselves and their representation in confrontation with socio-cognitive, learning how to collaborate with others and developing autonomy and initiative to them.

The analysis of the responses we found that students have very well-liked method of group work and find it very motivating and want to use it for other courses and other subjects.

CONCLUSION

In this study, we have identified the difficulties that students have to build a graphical representation of the curve of a digital function, we have also detected the causes of these problems and finally we have proposed solutions to overcome them.

Also note that the results allowed us to conclude that the integration of this type of activities is useful for good understanding the graphic representation of a function, but this can only be effective by applying active didactic method such as the method of group work.

We believe that the use of the method of group work is useful to find the lost sense of abstract concepts (limits, derivatives ...) and overcome as much as possible the challenges of teaching and learning of mathematical concepts.

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