TEAM BASED LEARNING IN MATHEMATICS COURSES

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INTRODUCTION

"The chronometer was invented by a mathematician, not by a watchmaker"

Chrisriane Dujet

The philosophy of mathematics provides to understand the place of mathematics in peoples' lives. For this reason, we insist on the importance of mathematics in engineering schools and its huge role on the evolution of engineering professions. This evolution is aimed to enrich the teaching, in the light of new mathematical theories, so that the engineer can face the increasing complexity of the real world and learn how to deal with professional difficulties in real life.

Indeed, the engineer is neither a scientist nor an inventor. He is a man project, who has to lead his project with greater efficiency and performance.

He will use and apply knowledge and skills in science and technology, developed on the basis of knowledge and skills acquired during his training as an engineer.

However, the engineering student prefers courses made with innovative pedagogy, which is dynamic and practical, than learning abstract lessons with traditional methods such as mathematics because he cannot see its relevance to his future professional life.

We did not remain indifferent to this lack of motivation about the abstract materials, which are necessary, but we tried to create our own innovative way, drawing mainly the experiences of our colleagues from INSAT Toulouse [1] and from the Polytechnic School of Louvain[2].

1.TBL METHODOLOGY

1.2 Collaborative learning

For two years, the problem-based learning was the main way to learn in engineering school ESPRIT. This new innovative method leaded students to a learning based on solving problems and making projects so they can face real difficulties. This new form of learning is a student-centered pedagogy where his thirst for learning and autonomy are raised. It is no longer in listening to a final evaluation but active status acquisition of knowledge, expertise that will be subject to the assessment of his work [3] .

It is the pedagogy of success and confidence, a new way to learn and train, which allows the engineer to adapt and challenge throughout his professional life. The problem may be more or less complex, more or less long concerns one or more disciplines.

Comparing to the traditional learning method, this new method increase student's participation, engagement and high level thinking instead of listening and doing exercises, it starts from a problem situation which led him to discover the concept itself and in groups.

Collaborative learning situations students must:

- Build knowledge by exploring documents or remembering concepts already known.
- Understand and explain their analysis to peers
- Compare their ideas with those of his comrades
- Defend them
- Listen to the arguments of the other group members
- Reach a consensus.

The student develops his curiosity and work strategies that prepare for training throughout life:

- The ability to search information in autonomy
- Transversal communication skills, organization of team work and time management throughout the project period.
- Self-confidence
- The ability to work on a regular basis
- Storing a longer-term
- Adaptation to new situations qualities.

1.2 Techniques of teaching mathematics with TBL

Team based learning is based on group work described above. This technique is the strongest point of our method. It is remaining between formal education and active teaching in mathematics [4] .

The key point is not to lecture, but to ensure that students work during the course in small groups of 5 to 6 students, which we call "teams". The method consists in transforming the classical course into smaller problems answering a series of questions to be addressed within the teams.

Difficulties in solving some questions lead students to discover the new acquits they need for the solution. Tutorial restructuring complete aspects of course work. Their purpose is not to present new concepts for, but articulate the notions and bounce on what has been done.

These exercises skills are direct applications of the achievements of TBL asking initiative, they are made in three stages: first a collective effort to define a method of resolution "scientific brainstorming", then working individually, self-practicing and acquire or strengthen the skills, and finally each member of the group shows his results, they compare it, they do synthesis and Comment.

The construction of TBL also follows a group work among teachers in stages:

- Define the objectives of the course.
- List the prerequisites.
- Define the steps of TBL
- Problematizing the course with questions and answers, small exercises, small problems based on the prerequisites
- Find practical situations applying the theoretical concept, where appropriate, the student will respond to various questions exercises.
- Increasing the difficulty of the questions, the student feels the need to acquire new knowledge enabling him to find the solution.
- At this stage, a summary outlining the problem and the need leads students to conclude by learning a new concept.

The student is then the actor in his class and the teacher takes the role of guardian reframes these small groups to achieve objectives.

Group work is therefore used to avoid dispersion of energy and unsuccessful searches. We are looking more to ensure that students do not lose too much time in details or points schedules compared to the goal of teaching, as well as details of layout they acquire technology in all ways of other materials.

Issues groups are welcome, and the teacher responds willingly, even when they are quite technical. However it ensures whether indeed a matter on which the group has thought and seeks his help.

The type of response (de-questioning, technical details, cons-example...) of course depends on the question and pedagogical appropriateness of the teacher.

The evaluation methods are traditional. In assessing the scientific aspect of learning, it also evaluates, in fact, the ability to learn, ability to work in a group, since it is estimated that the student has acquired using the group to be more effective.

1.3 Examples

The TBL course is distributed to the students, a reflexion time is given to them, it is a time for reading and discussing between each others, a constructive curiosity is created, this curiosity build the motivation of students, who feel themselves making a team, they search in their pre-required information, and look for missing information.

At Esprit, students are always working, even outside classrooms, they exchange ideas, and they simply discuss to improve their training.

The motivation of the students is stimulated with the choice of special examples that make them curious. The student’s group find a dynamic to share the ideas and find common solutions.

1.3.1 Example 1

A chocolate maker prepares several types of chocolate with some milk, some cocoa, some sugar and some butter. The following table gives the necessary quantities for the manufacture of every type of chocolate:

Chocolate	Cacao	Sugar	Milk	Butter
Asia Chocolate	6	4	4	0
USA Chocolate	7	5	3	2
Africa Chocolate	8	2	2	4

- ✓ Represent the data by a matrix of type $(3, 4)$.
- ✓ The chocolate maker receives an order of 5 units of chocolate Asia, 6 units of chocolate America and 9 units of chocolate Africa.
- ✓ Represent this order by a column matrix
- ✓ Using a matrix product, calculate the necessary quantities for every ingredient.
- ✓ The respective price of every ingredient is in euro, respectively $3, 5, 4$ and 6. Calculate the total price of this order.

The more the problems exposed in examples are interactive, the more the students find a pleasure to study them and to spend their time thinking about a solution. It is amazing to discover that we can use matrix to model such a problem related to chocolate. It's always difficult to translate physical notions with mathematical equations [5] , it depends on mathematical notions that student needs. The notion of real sequences, numerical sequences is introduced to the students by raising problems, which manage to draw their attention.

1.3.2 Example 2

The price of a book undergoes an increase of 100 centimes on 1st September of every year. We appoint by p_0, the book's price on the 1st September 2014 and by p_n its price on the 1st September of the year $2014 + n$.

- ✓ Express p_{n+1}in function of p_n, deduce that p_n is an arithmetical sequence which reason is r
- ✓ Express p_n in function of n, u_0 and r.

StusStStudents begin their work by finding the book's price for 2015, 2016 and then they write the corresponding formula.

The most spectacular examples are those who touch closely their life, or their families, the following example are about numerical sequences.

1.3.3 Example 3

A person affected by a disease has to take a daily dose of $20\ mg$ of a certain medicine. Every day, the body eliminates 25% of this medicine. We note q_n the quantity of medicine present in the body at the end of the day n $(n \epsilon N^*)$

1. Calculate q_1, q_2, q_3.
2. Find the expression of q_n.
3. If you know that the human body can support only $70\ mg$ of this medicine and that this ill person will take that drug the rest of her days, can you confirm if this person's life in danger?

Students discuss in every group: First of all, the students specify this type of diseases in their circle of acquaintances, the diabetics are for example concerned, second, they ask about the medicine (the insulin) and how to choose the maximal doses. A group find that this person's life is in danger; others find that it's safe, so discussion about the importance of the first term in the numerical sequences sum. The role of the professor is to offer the frame, the guidance and the harmonization of the work the student to let him progressing.

It is sometimes difficult to find examples that can satisfy the curiosity of the students. In the chapter "parameter dependent integral", it was hard to find concrete example, so the course was introduced as a problematic course, I quote.

1.3.4 Example 4

We consider the following function:

$$F(x) = \int_0^1 cos(xt)\, dt$$

- ✓ Verify that f is well defined on $\mathbb{R}$.
- ✓ Give the expression of $F(x)$ for every real variable x.
- ✓ Study the continuity of F.

So the student discover that they can study the continuity of F is they have her expression, but in a second example they discover that they can else study the continuity of F even if they don't know the expression of F explicitly.

2. STATISTICS RESULTS

In this section, we present statistical and comparative tests between the two promotions. We view the averages for classes in mathematics, two consecutive years in the same period of the year . The only variable changed is the transition from classical to innovative teaching pedagogy.
The x-axis represents the years and the y-axis represents the mathematical average of classes**.**

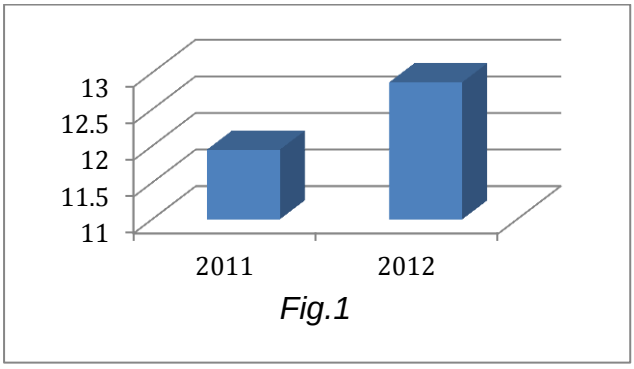

Fig.1

In *Fig.1* a comparison between both results in maths classes 1A .
In 2011 we used classical pedagogy and in 2012 active learning.

In 2012, Students in the first year computer course at ESPRIT lived the first active learning experience on Mathematics. These statistics show a comparison of the average in math made with 2011, when teaching was done with the classical method. We notice many changes in average proving the functioning of the new pedagogy.

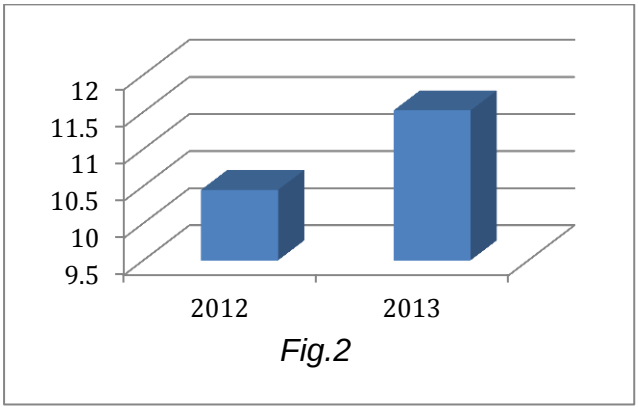

Fig.2

In *Fig.2* a comparison between both results in maths classes 2P.

In 2012 we used classical pedagogy and in 2013 active learning.

The second year P, are the student entering Esprit in the second year after spending two years in preparatory institute for engineering studies.
Theoretically, they have a solid training in math and they are very accustomed to classical teaching practices.
We have attempted this year for the first time at Esprit to put them testing active learning. Students approved the new teaching way and the results of the first semester of this year compared to the past one proves also the great progress in the mathematics assessments.

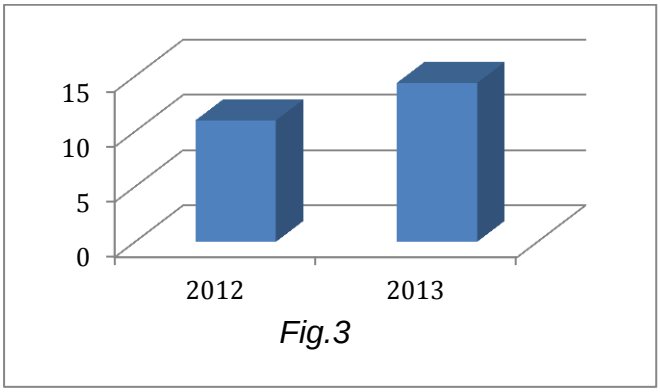

Fig.3

In *Fig.3* a comparison between both results in maths classes 2A .
In 2012 we used classical pedagogy and in 2013 active learning.

The second year IT course has already started the new pedagogical reform since the previous year still study math in TBL. The average grade in 2013 compared with 2012 still supports our choice for this new type of mathematics education.

3.TESTIMONIES

In this section, we give some students testimonies about their experiences during the courses with active learning.

« *Last year it was my first experience in Esprit with the active learning pedagogy. In the beginning it was so complicated and were not satisfied, but step by step we got used to it and it is a good method to motivate students* » **Oumayma Guedria**

« *From the start I didn't like the active learning but afterwards I got used to it and i liked it because it made us work harder and it's easier than the classic education*. **» Wassila Abidi**

« *I think that the active learning applied in mathematics courses is a successful one. It's about working in a team and try to progress not only by participating but also by creating a great atmosphere during the mathematics courses. To conclude, let me say it's the best method ever in this subject.* **» Sarah Baili**

« *At first, I through it wasn't a good idea, particularly in mathematics. But little by little, I discovered that it was a good method that encourages you to study and helps you to understand better than before. The fact that everything is given step by step instead of giving you the whole lesson from the beginning of the chapter is a good way to memorize* **» Yasmine Bhouri**

« In the beginning, the active learning was a new method of education that started in Tunisia. At first, I didn't like it because I was not used to learn from problems and projects. But, when time passed and I started getting used to active learning, it became the best method of

educating, and don't think that I will get back to using the old classic method in education »
Ines Hammouda

4.SUMMARY AND ACKNOWLEDGMENTS

We have to mention the importance and easiness of our method involved in all the abstract courses. Team based Learning which is based on working in groups motivates students and affects positively their academic results either on their good assimilation of the learning outcomes or on their ability to memorize new acquisitions.

In the future, we hope to integrate mathematics in inter-disciplinary projects covering previously fixed objectives.

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