A collaborative Mathematics Learning Using Differentiated Pedagogy

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Abstract

Our contribution represents a new method of learning mathematics by group through the differentiated pedagogy whose goal is to reduce the heterogeneity between learners in the classroom by using their knowledge, skills, and social profile. Indeed, there are different ways to implement a differentiated pedagogy. These methods must be considered by the teacher in order for his rehabilitation to be effective in student learning. Our approach specifically concerns differentiation by situation, it allows students to self-assess, and this to situate their knowledge and skills. In case of difficulty when assessing the learner, the approach uses group learning so that learners interact with each other without using the teacher. In the next works, we wish to integrate into our exerciser platform a module for the interaction of the students in order to discuss the difficulties and share the information between them.

Keywords: Differentiated pedagogy; Mathematical learning; Exercise.

1. Introduction

The question of heterogeneity is essential in the world of education because every teacher has a mission to make these students achieve the same goals, whereas they are all different in terms of their skills and knowledge and their social profils to learning. So the teachers, throughout their careers, are brought to adopt compatible teaching methods, adapted to the students, for the personal and professional development of each one of them. We are then asked if there were methods to manage this heterogeneity. The approach of "differentiated pedagogy" seems to be a solution because it has the particularity of taking into account each child for his learning according to Przesmycki (Przesmycki, 2004) and Zakhartchouk (Zakhartchouk, 2001).

Differentiated pedagogy is a way to reduce the heterogeneity between learners in the class which manifests itself by a fairly large gap between students in terms of interest in the subject, knowledge and skills required, in the acquisition of new knowledge, or even behavior in the classroom. Hassouni (Hassouni, 2014) and Jacquet-Francillon (Jacquet-Francillon, 2014) stated that these differences were felt on their grades and their progress.

Differentiation and self-assessment are essential. For an effective differentiated pedagogy, the teacher must carry out a diagnostic evaluation to assess the level of his students and know what their knowledge and difficulties are. Following this, the teacher proposes different routes, which bring the students to a common objective. This is the role of differentiation modalities. Forestier (Forestier, 2012) stated that there are different ways to implement a differentiated pedagogy. Hese modalities must be reflected by the teacher so that their remediation is effective on student learning. Indeed, the teacher can:

Differentiate by learning content: The teacher can give a different amount of exercises to do for students in his class according to their needs and abilities. He can also organize the session by proposing a common phase followed by individual work. For example, students complete a first common task and then work individually on different activities. This educational organization makes it possible not to impose an average rhythm which would be too slow for the fastest, but which shake up students in difficulty. Several works have exploited pedagogy differentiated by learning content according to Brandan (Brandan, 2015) and Donckèle (Donckèle, 2003).

Differentiate by learning and teaching methods: It can be at the same time “the word, the gesture, the blackboard, the individual worksheet, the book or the document, the slide, the film…. »: even if necessary, the lecture phase is not the main teaching method. It is important to realize the capacities of each student: his working methods, his way of understanding the teacher's words, the time necessary to solve problems, adapt to the needs of the student. And with the evolution of IT tools, several works according to TYRVÄINEN Tyrvainen (TYRVÄINEN, 2013) and MILOSEVIC (MILOSEVIC, 2015), have used other methods such as web applications for assessment and learning whose purpose is to differentiate.

Differentiate by learning situations: Learning situations are the conditions, the circumstances allowing students to build their knowledge. The teacher must therefore implement the optimal conditions so that each student can learn. Meirieu (Meirieu, 1995) characterized three types of learning situations: the collective imperative situation, the individualized situation and the interactive situation.

« The collective situation "appears to be the most common situation: that in which the teacher presents to the "class" group knowledge that each pupil will have to appropriate individually by independent intellectual work.

« The individualized situation ", Individual work appears to be fundamental, it is a moment during which the child learns for himself.

"The interactive situation" appears to be the least common. To set up a real interactive situation, the teacher must master it, that is to say that he must be sure that the students can really communicate before the group setting.

For the collective tax situation, we find Khaled Attrassi (Attrassi et al., 2015) who used the heterogeneity of the learners to promote the success of all students through differentiated pedagogy based on the work of the group. For this, the strategy implemented will be to assess the habits of students by: work alone, in pairs or with others, position in a group (speaking, listening to others, helping others), student interest (manipulating, reading, computers), all this in order to be able to create groups of job. According to Jean-Pierre Astolfi (Astolfi et al., 1992), there are several types of groups that we will present in table form:

Table 1. Types of groups within the framework of differentiated pedagogy

Groups	Discovery / Research	Confrontation	Assimilation	Inter-assessment	Needs
Goals for the student	Deepen a questioning on the basis of a problematic situation posed in a class group	Oppose and compare their points of view to (provoke their overtaking)	Reformulation of concepts presented	Show the weaknesses of a work and facilitate readjustment	Constitute homogeneous groups bringing together students with the same difficulties in order to work with them and meet the needs of each through a differentiated pedagogy

Philippe Meirieu (Meirieu, 1996) likes the idea of need groups and indeed emphasizes that the students work the same skill and therefore, can more easily and easily overcome their difficulties than if they worked alone, or in a group with students who would already have acquired these skills.

Despite the need to organize group work situations due to the great diversity of students, teachers always encounter difficulties in setting up this type of learning situation given the heterogeneity of the learners which depends on several criteria. Our article comes to overcome this problem, it is essentially based on pedagogy differentiated by learning situations or by group. The methodology represents an improvement of the method of automatic creation of needs groups with the possibility of forming homogeneous groups bringing together students with the same difficulties in order to work with them and also the stronger groups. This new strategy makes it possible to reduce the heterogeneity between learners in the class by taking into account their acquired knowledge, skills and social profile.

We hope in the next works to combine three methods of differentiated pedagogy at the same time and using digital tools for education by applying our exerciser (LMATI, 2017) in order to differentiate by the content of assessment using simple self-assessment exercises or problem type. In addition to the online assessment, the exerciser allows the publication of lectures and also course reminders based on the educational concept (theorem, definition ...), and this is part of differentiation by learning methods.

2. Approach

So that information I is shared by all learners with heterogeneous levels, learners must first know the prerequisites of I. Therefore, students should be partitioned into group categories according to the level of achievement of each prerequisite of I. Afterwards, each group must reinforce these skills with the help of feedback generated between the groups without resorting to the teacher.

Thereafter, we will develop the procedure of decomposing information applied in the context of mathematics, the creation of groups and the evolution of groups in difficulty.

2.1 Breakdown of educational information

In order for the information to be acquired and understood by all the students in the class, we must divide information I (Educational object) into small educational entities to facilitate its acquisition. And to be able to be found and reused, an educational object must be described by a set of metadata. These metadata allow a semantic description of educational resources to be able to better manipulate them, to find them, to reuse them to compose them with other resources or to distribute them in a personalized way to learners. This semantics is structured in three parts: the prerequisites (the input of the resource), the content and the results (Outputs) according to LMATI (LMATI, 2014) and BOUZEGHOUB (BOUZEGHOUB, 2005).

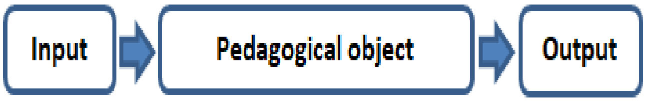

Figure 1. The inputs and the output of an educational object

2.2 Define group categories

So that information I is shared by all learners with heterogeneous levels, learners must first know the prerequisites of I.

Therefore, students should be divided into group categories according to their level of achievement of each prerequisite.

We take for example a pedagogical object OP below composed of n Inputs (E1, E2, E3,…En) and output (see Figure 1).

To communicate educational information I to a population of learners with different degrees of knowledge, This population must have prior knowledge concerning the inputs E1, E2, etc. of this information in order to teach its result. The types of population that we can have are:

E1 (Low in E2, E3…)

E2 (Low in E1, E3)

E3 (Low in E1, E2)

….

E1E2 (Low in E3…)

E1E3 (Low in E2…)

E2E3 ((Low in E1…)

…..

E1E2E3(Low in E4…)

…..

In the same group, for example E1, we can find two other subpopulations such:

E1(S) : Strong in E1

E1(M) : Medium in E1

The figure below makes it possible to model the set of possible combinations of the groups which come together to arrive at the final goal which is

E1E2…Ei…En.

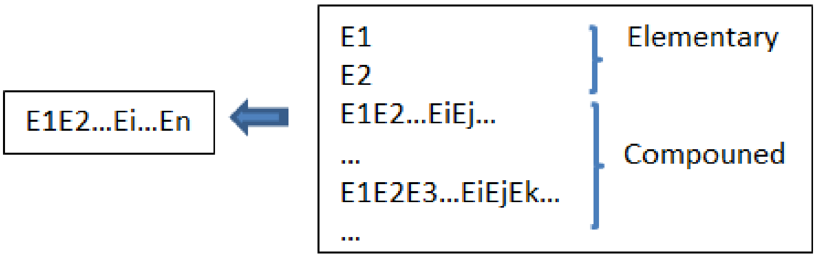

Figure 2. Group categories

Once the groups are created, you have to calculate the percentage of internal friendship and external groups for information sharing and also so that everyone learns the prerequisites and the result of information I.

3. Evolution of groups in difficulty: case of mathematics

To validate our approach, we tried to apply it to a population of students in the SVT life science sector. This population is less oriented towards mathematics and requires more supervision. For this, I chose an example of a mathematical proposition to demonstrate, and in this context, students are expected to first demonstrate their prerequisites. In this case, we will have several categories of group who know how to demonstrate some or all of the prerequisites.

We will see later how we can automatically create student groups, and how the groups in difficulty evolve as they interact.

3.1 Creation of groups

In mathematics, especially in textbooks, didactic concepts (Theorem, definition, etc.) are generally characterized by the declaration of constraints (Prerequisites) in the form of conditions (textual or logical) and the result (LMATI, 2014).

From this observation, we can use as information I a mathematical proposition like the following:

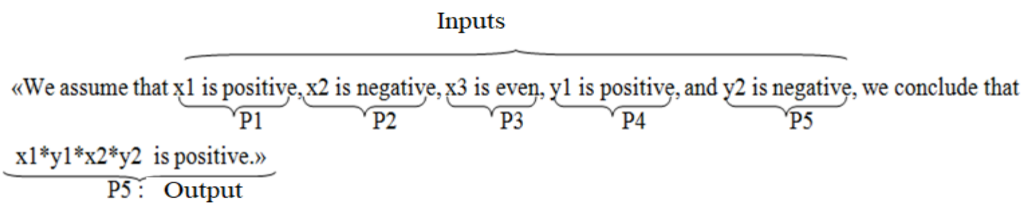

Figure 3. Example of mathematical proposition

To define the members of a group, we use non-repeated prerequisites. We obtain:

E1=P1=x1 is positive

E2=P2=x2 is negative

E3=p3=x3 is even

This gives 6 groups:

E1E2 (low in E3)

E2E3 (low in E1)
E1 (low in E3, E2)
E2 (low in E3 et E1)
E3 (low in E1, E2)

3.2 Evolution of groups in difficulty

The interaction between the different categories of the group is carried out according to the two criteria:

-Knowledge: this criterion is the first criterion to be taken into account, such that the student of low level communicates with the student of medium level, and the intermediate student communicates with the advanced student.

- Interaction: once we verify the students' membership in one of the groups created from the prerequisites of information I to teach, we pass to checking the possibility of interaction between the students by calculating the similarity rate of their profiles: their cognitive characteristics, their socio-cultural characteristics, their psychological differences, their ages, etc.

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Two types of table are used to carry out this evaluation:

The first table (Table 2) defines the percentage of learning (high or medium level) of information I according to each group.

Table 2. Example of percentage learning of information I by each group.

Prérequi / Group	Prerequisites 1		Prerequisites 2		Prerequisites 3	
	Medium	Strong	Medium	Strong	Medium	Strong
E1	60%	40%				
E2			40%	60%		
E3					70%	30%
E1E2	80%	20%	50%	50%		
E2E3			50%	50%	80%	20%
E1 E3	50%	50%			80%	20%

The second table (Table 3) is a table of possible interactions, it allows us to find all of the relations that may exist between students in the same group or in different groups, and this based on the intersections of their cognitive characters, their socio-cultural characters, their psychological differences, their ages…

Table 3. An example of interaction for a group of students.

Relation	Student x1	Student x2	Student x3	Student x4	-
Student y1	X		X		-
Student y2		X			-
Student y3	X		X		-
Student y4		X		X	-
-	-	-	-	-	-

The question is, how to evolve all the members of a given group from medium to high level. To do this, we calculate the similarity rate of the profiles for two populations. (Medium M and strong S) from the same groups and also from different groups.

We consider the application:
FR: G→N, with G group, FR is a relation function and N is an integer that represents the similarity rate.
We take as an example the group E1(M) with M is the mean level and S is strong level.

- If FR(E1(S) ∩ E1(M)) ≥ 50%, then we can have an interaction between the members of group E1 who can make the group E1 (M) evolve to a high level (E1(M) →E1(S)) ;

- If not FR((E1(S)E2(M) ∩ E1(M)) ≥ 50%, then one can have an interaction between the members of the group which can make evolve the group E1 (M) on the strong level. E1 (S) and also a sharing of a new prerequisite not acquired before which is E2. : E1(M) → E1(S)E2(M).

- If not FR(E1(S)E2(S) ∩ E1(M)) ≥ 50%, then one can have an interaction between the members of the group which can make evolve the group E1 (M) on the strong level E1(S) and also a sharing of a new prerequisite not acquired before which is E2 : E1(M) → E1(S)E2(S).

- If not FR(E1(S)E3(M)) ∩ E1(M)) ≥ 50%, then one can have an interaction between the members of the group which can make evolve the group E1 (M) on the strong level. E1 (S) and also a sharing of a new prerequisite not acquired before which is E3: E1(M) → E1(S)E3(M).

- If not FR(E1(F)E3(S)) ∩ E1(M)) ≥ 50%, then one can have an interaction between the members of the group which can make evolve the group E1 (M) on the strong level. E1 (S) and also a sharing of a new prerequisite not acquired before which is E3: E1(M) → E1(S)E3(S).
- If not E1(M)) uses the teacher.

We repeat the process for the other groups with both high and medium levels: E2, E3, E1E2, E1E3, E2E3.

The methodology we used above represents an improvement in the method of creating needs groups. with the possibility of forming homogeneous groups bringing together students with the same difficulties in order to work with each other and also with stronger groups.

4. Evaluation of the approach

In order to have an idea on students' perception toward group work, i decided to submit a questionnaire to them concerning their impressions of their progress as well as any facilities and difficulties encountered. And following the students' responses, I therefore established pie charts grouping the response data in the form of percentages.

My question therefore dealt with the feelings of the students when they worked in the same group or in a different group. My goal is to know if this method allowed them to better understand, be more successful, be more comfortable and not feel blocked by the skills of others or on the contrary.

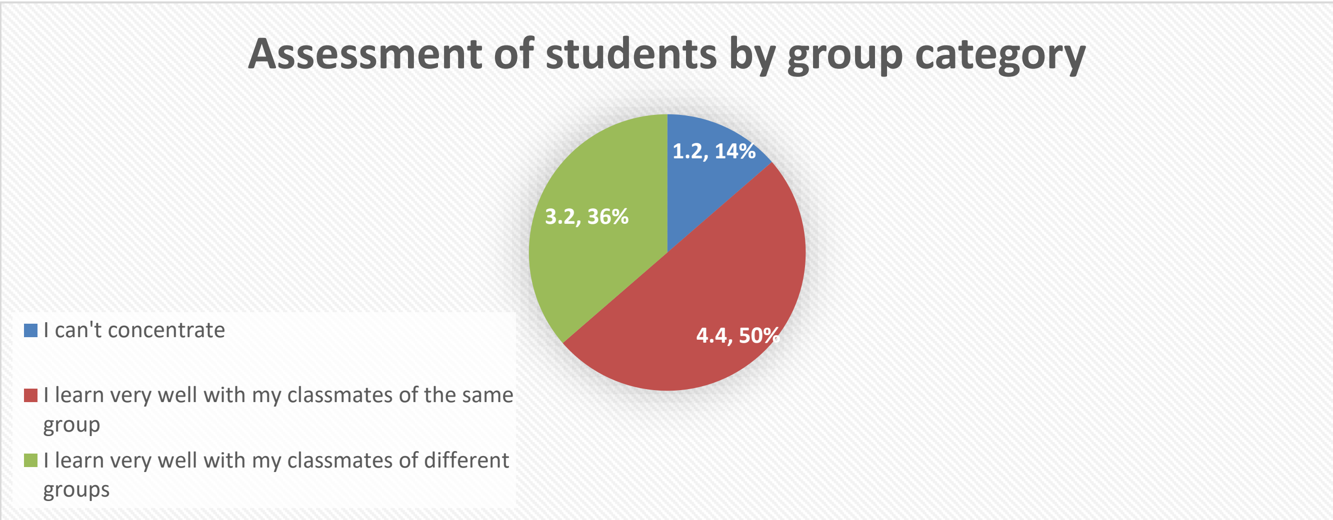

Figure 4: Assessment of students by group category

As a result, we can see that more than half would understand and succeed better in a group.

Indeed, 50% of students find it better to succeed with peers from the same groups, this student category having almost the same skills with little difference. For students who work in different groups finds only 36%.

This population of students does not have the same skills, and it is completely normal to have a percentage less the first since it will have an acquisition of new knowledge (E1(M) → E1(S)E2(M)). On the other hand, we find that 14% of students who find that group work prevents them from concentrating and therefore from working.

5. Conclusion

The proposed method has several advantages, among which is the interaction of learners in the search for information during their school career without resorting to the teacher. In addition, the group is a learning facilitator, it leads to better autonomy and self-worth.

In the case of mathematics, we tried to create groups according to the prerequisites of the educational objects and the social relations between the students. With this method, low level learners interact with medium level students to reduce heterogeneity between learners in the classroom.

We really hope in future work to combine the three differentiated pedagogy methods mentioned in the state of the art section, and this by applying our exerciser (LMATI, 2017) in order to differentiate by assessment content and learning methods using simple self-assessment exercises, problem-type exercises, the publication of a lecture, and also the publication of course reminders based on educational concepts (theorem, definition, etc.). As a perspective, we hope to develop soon:

-A prototype for the automatic creation of groups;

-A module for interaction and communication between groups within our exerciser;

-A module that calculates the percentage of friendship between group members.

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