Diverse Teams in the Classroom

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***Abstract*— Grouping students has always been a problem when organizing cooperative work in a classroom. Teachers typical grouping usually does not to take into consideration all diversity features, e.g. competencies and personalities. We introduce an AI-based system that improves current practices.**

I. INTRODUCTION

Seven of the educational techniques that every teacher should know (Flipped classroom, Project based work, Co-operative learning, Problem-based learning, Gamification, Design Thinking, and Thinking Based Learning) need groups of students who work well together.

This is because students learn better, keep the knowledge longer and have a more satisfactory experience when working as a team. We must involve students in an active learning that helps them learn from each other.

The problem of group creation is complex due to the large number of grouping possibilities that can be managed. Artificial intelligence can help us efficiently create well-informed and competent teams within the classroom.

II. RELEVANT THEORIES OF LEARNING

A. *Vygotsky's Constructivist Theory*

Vygotsky [1] emphasizes that mental functions and human development have their origin in social relations. He argues that the cognitive abilities of the individual depend to a large extent on the group in which they are immersed (shared views, cooperation between apprentices ...). In this sense, then, learning and intellectual development will always take place from the interaction with others.

B. *Jean Piaget's Theory of Cognitive Development*

Piaget emphasizes that the resolution of conflicts is key for learning. [2]. For him, the cooperation between different people favors the ability to disassociate something that is subjective from something that is objective, thus encouraging adjustments among people. Knowledge, according to Piagetian theory, is based on the interaction between the person and the environment. This interaction generates a conflict between the previous schemes already achieved by the individual and the new information that comes from the environment, thereby enriching his mental representations (socio-cognitive conflict). The goal of this interaction will always be to reach an agreement or a common response after starting from moderately divergent points of view.

C. *Social Learning Theory*

The Social Learning Theory [3] maintains that the success of the individuals depends on the success of the group to which they belong, which forces to create a "climate of co-operation" to work together in a new task. Their dependence on the group motivates students to strive to achieve success, since each of them will achieve their individual goals if, and only if, the team achieves success. Relationships between students have a great educational value as they allow for socialization, facilitate the acquisition of social competencies, make different points of view more meaningful and, in short, increase individual aspirations towards school work.

III. ENABLING TECHNOLOGICAL ADVANCES

Against this theoretical background, EduTeams (http://eduteams.iiia.csic.es) is a free AI-based program that helps teachers to make teams of students, so that each group presents a variety of personalities and a variety of capacities to solve complex tasks, improving both the learning process and the final product. EduTeams helps us to organize heterogeneous groups that balance inequalities, facilitate peer learning by adjusting the demands and responses to the level of student development.

After students fill in a personality test (Mayers-Briggs [4]) and a test on multiple intelligences [5], the teacher specifies in the program what he wants to be taken into account when doing the groupings: number of students per group, typically a minimum of 3 students and a maximum of 5 to be able to obtain maximum performance in the dynamics that students work (planning, discussion, responsibility, agreeing, etc.), competencies that are needed to perform the task, and what level of mastery of the competencies requested must the students grouped together have (strong mathematical, average literary, or weak artistic, for example). Based on the results of intelligence and personality tests, the program achieves a high level of congeniality by building diverse teams, as according to the theory of Wilde [6] the groups that include diversity of personalities and forms to address themselves to the world work better than non diverse groups. The program also allows the teacher to ask for new combinations of students if she or he thinks there is a sound reason not to make particular students work together (race conflict, etc). See details of the theory and algorithms implemented in [7], [8], [9].

Obviously, in education every group is required to perform well, so they can all complete the requested task and no group is left behind.

IV. Real world applications

A. Experiment 1: Final Assignment

Place of the experiment: This study took place in "Institut Torras i Bages" school.

Time of the experiment: The experiment took five days, it was performed in June 2017.

Student and team data: The experiment was performed upon 98 grade 8 students.

Task type: Students were asked to undertake the set of interdisciplinary activities ("Treball de Síntesi"), which is an obligatory exam performed at the end of each year of the secondary education curriculum in Catalonia. That year, students were asked to create a tourist brochure of their city with all details (collect the information about the city architecture, history, cuisine, main festivals, design the logo, design the brochure, translate parts of the brochure to English).

Team size: We divided each classroom into teams of size three.

Measuring Personality: Students answered the Post-Jungian Personality questionnaire using computers and/or mobile phones.

Competence measure: We measured students' intelligences using a self-evaluation test introduced by rice2013common that we slightly modified to fit the five-questions-per-intelligence format (in the original test, there is an unequal number of questions for some intelligences) and translated it into local language (Spanish) consulting the school psychologist.

Performance evaluation: Students worked in teams and at the end of every activity presented their work in front of a panel of three teachers that assessed the content, presentation and cooperation between team members using a standardized rubric on a scale between 1 and 10.

The procedure:

- We split each class into two halves of similar size using random sampling;
- We partitioned one of the halves into triplets by (16 teams in total). The other half was divided by the expert method (15 teams in total);
- All teams performed "Treball de Síntesi" and we collected the final marks of students.

B. Experiment 2: Scratch Programming

Place of the experiment: This study took place in three different schools in Catalonia, that is: "Institut Broggi", "Institut Olorda" and "Institut Torras i Bages".

Time of the experiment: This experiment took place between March and November 2017.

Student and team data: The experiment was performed upon five groups of students in ages between 14 and 15 (154 students in total). Specifically, "Institut Broggi" (55 students), "Institut Olorda" (24 students) and "Institut Torras i Bages" (75 students).

Task: The experiment was performed during 2-hour technology classes, where students had to create a game, a story or an animation using the Scratch programming language (https://scratch.mit.edu/).

Personality and Competence test: We followed the same methodology as described in the first experiment.

Team size: Teams of size two so that students were able to work on one computer together.

Performance evaluation: An independent Scratch expert that did not know the source of the team compositions evaluated the performance of each team following a standardized evaluation form.

The procedure: Same as in experiment 1.

V. Evidence of potential impact

A. The results of experiment 1:

We calculated the geometrical average of marks for the teams in each partition. We used the geometric average to penalise more the partitions that are imbalanced (i.e. the variance in team performance is high). The teams composed by obtained 8.1 in the scale between $[1, 10]$, while teams composed by the expert method achieved only 7.3. The relative improvement measured by the difference between two geometric averages and divided by the possible improvement is equal to 29.2%. Teams composed by perform better.

B. The results of experiment 2:

Same methodology as in experiment one. The geometric average for teams composed using was 5.87 while for teams composed by the expert was 4.47. The relative improvement is equal to 25.3%. The observed result is statistically significant (p-value$=0.04$). Hence, we observe that again teams composed by achieved better performance than the teams composed by teachers.

VI. Summary

In this abstract, we focused on schools that design complex tasks that require the collaboration of students within a team. The task has a set of competence requirements and associated competence levels needed to solve the task. Students are characterized by gender, personality, and by competences with competence levels. With the help of AI techniques we compose teams that are both proficient (cover the required competences) and congenial (balance gender and psychological traits). We empirically evaluated our team composition model and the quantification of the results shows that up to a 30% increase in the individual marks can be achieved by the teams so formed.

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