

ANALYSIS ON EDUCATIONAL RESULTS USING COLLABORATIVE AND COMPETITIVE APPROACHES

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ABSTRACT

As long as courses exist, there will also be a way of applying the notions learned from them. They come in various forms, such as laboratories, workshops, and homework. There is a long discussion involving different strategies that a professor can use to boost the results of their students. The purpose of this paper is to outline, assess and present the best strategies to follow to maximize students' growth while also taking into consideration the personal experiences of the above-mentioned authors.

KEYWORDS: *collaborative approach, competitive approach, learning skills*

1. INTRODUCTION

The concept of grading has existed for a very long time in the education system. The first recorded grading comes from the then President of Yale University, Ezra Stiles, in 1785 when he said that “*after examining 58 Seniors, recorded in his diary that there were 'Twenty Optimi, sixteen second Optimi, twelve Inferiores(Boni), ten Pejores.*” [1].

Every student knows that in order to promote the course they need good grades. Grades decide whether or not students have accumulated and processed the knowledge taught during a course, and approximate, with a given degree, the growth of the student. However, grades do not always reflect the knowledge of a student. This has contributed to the feeling that teaching methods need to be innovated and improved. The teaching methods that are chosen have a great impact on students.

“Collaborative learning is a reacculturative process that helps students become members of the knowledge communities whose common property of knowledge is different from the common property knowledge communities they already belong to.”, according to

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Bruffe[2]. By collaborating, students can learn to work as a team, to share ideas with one another, to contradict one another and present their points of view. They also come in contact with different mindsets and learn about the hardships that come with working in a group. Ultimately, the goal is to raise a sentiment of accomplishment at the sight of the end results of their work.

In the competitive approach, students are often given a task and they are put to compete against one another. Achieving the goal of one of the student means the failure of the rest of the students. This way, they feel like they want to do better than their peers and they struggle to obtain the best result. Often a reward is set for the best result, thus rewarding the efforts of the students.

The authors of this article follow to ascertain if and how collaborative and competitive approaches changed and will change students’ growth and turn them into fully fledged engineers.

2. PREVIOUS WORK

Up until now, various studies have shown that both approaches have positive effects on students’ growth.

As presented in “*Effects of Competitive E-Learning Tools on Higher Education Students*” [3], where The Quest System was tested out and students were graded by their fast response to challenges that came from both teachers and students, the growth rate increased drastically. This experiment shows that a competitive environment can lead to unexpected results, such as the ones presented in Table 1 and Figure 1. The T-Test shows whether the means of two groups are statistically different from each other. When the scaling factor of T-Test is under 0.001, the results are significantly different.

Table 1: GROUP COMPARISON—STUDENTS’ ACADEMIC OUTCOMES AND PARTICIPATION IN QUEST. Taken from [3]

	QUEST group 126 students		Control group 74 students		T-Test
	M	SD	M	SD	P
Final grade	2.7	1.9968	1.58	0.7343	<0.001*
* Results are significantly different at $p < 0.001$ (T-Test) * M = mean (the average) * SD = standard deviation * P = scaling factor of T-Test					

The results shown in Figure 1 emphasize the fact that the students that took high scores in the Quest System, did not score as well in the final examination. Thus, the second hypothesis of the study did not hold.

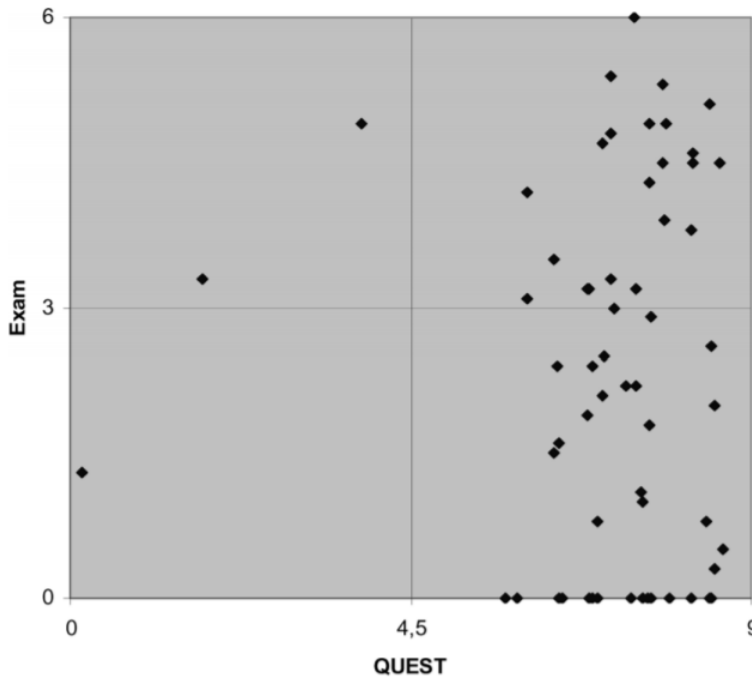


Figure 1. Grid of exam-QUEST scores. Taken from [3]

Two other studies, “*Active Learning: Cooperation in the College Classroom*” [7], and “*Cooperative Learning Returns to College: What Evidence is There That it Works?*” [8] compare the efficiency of the collaborative and competitive approaches on different plans.

The authors looked at 168 studies between 1924 and 1997 and compiled a table of improvements by learning outcome. Table 2 suggests that by using collaborative teaching instead of a competitive one, each category presented sees an improvement rate between 6% and 83%.

Table 2. Collaborative vs. competitive learning: Reported effect size of the improvement in different learning outcomes. Taken from [9]

Reference	Learning Outcome	Effect Size (%)
Johnson, Johnson and Smith [7]	Improved academic achievement	67
	Improved quality of interpersonal interactions	82
	Improved self-esteem	83
	Improved perceptions of greater social support	67

Reference	Learning Outcome	Effect Size (%)
Johnson, Johnson and Smith [8]	Improved academic achievement	49
	Improved liking among students	68
	Improved perceptions of greater social support	6
	Improved self-esteem	47

Both of the studies presented above show how competitive and collaborative approaches can affect students' growth and the way they have been used.

3. PROPOSED APPROACH

The aim is to analyze how these approaches had an impact on the grades of the students while outlining the differences between them. This study is based on data from the generation of students who started the Faculty of Computer Science and Automatic Control at the POLITEHNICA University of Bucharest in the year of 2015 and who are expected to finish their bachelor's degree in the year of 2019. The study regards the following courses in different years of study: "Algorithms Design" that took place in 2016 – 2017, during the second year of university, "Microprocessors Design" between 2017 - 2018 during the third year and "Software Project Management" that started in 2018 and finished in early 2019, as part of the fourth and final year of university. In regards to the consistency of the examined students, the batch of 500 students for the "Algorithms Design" course is reduced to 400 for the "Microprocessors Design" and then to 130 because of the structure of the faculty and the students that left.

It should be noted that there are many types of students and there is also a formed hierarchy based on the level of academic preparation. Taking this into consideration, these aspects will be observed using the proposed approaches.

On the one hand, there is the collaborative approach where students were to work with others in teams in order to achieve a goal. On the other hand, there is the competitive approach where students were to compete against one another using their ingenuity. Lastly, there is the mixed approach where the combination of the aforementioned two will be considered. This approach involved students working in teams in a competitive manner.

Regarding the collaborative approach, it was started from the premise that the students would embrace the idea, considering that it would mean sharing the work, the planning and the grade without any consequence. Forming teams would also reduce the pressure of working alone that some might be affected by when working on a task at hand. In the end, this premise turned out to be true and it will be analyzed why.

Considering the competitive approach, most situations that involved this approach implied students learning extra information regarding a subject in order to be able to compete at the highest level of knowledge against their peers. The initial premise was that in these cases, most students might feel discouraged to compete, being aware of the fact that the number of potential winners was very low compared to the total number of students (out of the 400 participating students, only the first 15 places were winners). That implies that some students would believe that their supplementary work would lead to nothing and, because of that, they would feel intimidated by other students whom they perceived as being too competitive. However, that did not happen, making it interesting to analyze the reasons why.

Being aware of the two approaches that we mentioned, it was believed that by combining them the negative aspects would even out while the positive ones would additively stack, creating a new mixed approach. Having that in mind, for the mixed part we tried to outline how this approach stood out compared to the other two.

As with any project, during its lifetime, teachers could point out some advantages and disadvantages regarding the growth of the students. It is important to take these into account when considering which approach to adopt.

The results of the study will be presented after the description in detail of every part.

4. COLLABORATIVE PART

In 2018, during the “Software Project Management” course, students were organized into teams of 6 persons and were given a project, that being to create a 2D card game. The teams were formed randomly so it was mandatory for the students to collaborate in order to obtain a good grade in the assignment. Their goal was not only to finish the project but to also go through every step of the development cycle that happens in the industry, inside a team. Firstly, the students had to establish the specifications and the design for their software, then they would choose the most fitting technology, plan the development and assign tasks to each member of the team. In order to help the students with project monitoring and planning, they were encouraged to use the Git version control. At the end of the assignment, the teams presented a demo of the game in front of the other students and the teaching assistant and received questions and feedback.

The main advantage of the collaborative approach was that the students could learn from each other and improve their technical skills. In order to implement the game, teams had to choose different software products even if they were aware of the fact that not all members of the team were familiar with them. These students had the chance to learn something new and improve their skills while being guided by their colleagues. This experience also enhanced the team working skills of the students. When a team member submitted a component of the project they were working on to the version control repository, they would receive feedback about the readability of the code, its performance or even unnoticed bugs from their team, proving that communication and listening are crucial in a team. This aspect led to the development of a cleaner and more refined final product. Finally, the project was able to put the students in a position where they had to deal with different opinions and reach a common ground in order to obtain a good grade.

Another advantage of this approach is that the students had the chance to simulate the project management and development that happen in the IT industry today. They could experience what happens in each individual team that belongs to a company, from debating ideas and technology, planning and assigning tasks to testing and presenting their product. This undoubtedly gave the students a better understanding of the importance of teamwork in software development and prepared them for a future career.

One disadvantage is that one does not get to try to work on each part of the project. The authors of this paper believe that it is important to get to work, at least once, on each part, mainly because of the fact that if one knows how others want to approach a subject, they can more easily adapt to the styles of others.

5. COMPETITIVE PART

In 2017, during the “Microprocessors Design” course, the teachers decided that in order to stimulate the students to improve, they need to promote the competitive spirit. Those who would follow the idea would be rewarded for their effort with something that should motivate them, such as bonus points to the final grade. Having that in mind, they created a competitive science fair named “PM Fair”, in which students would present their projects created during the semester.

The projects aimed to allow the students to learn not only about embedded programming but also about hardware management. Each student had to choose what they were going to build for their project and had to implement the most attractive one. The 5 most interesting ones received special bonuses as well as a significant increase to their final grade. Despite the fact that the competition was very tense and challenging, most of the students still tried to push their limits in order to win the competition. This is exactly the opposite of what was believed in the beginning. This is due to the fact that the teachers made the “PM fair” and working on the projects to be interesting and the fact that the promised awards were consistent enough.

One main advantage was that every student tried their best, each to a different degree, to innovate as much as they could. While the best students saw it as an opportunity to learn more about what they like, the ones that clearly had a passion for hardware outdone themselves. This aspect encouraged some students to keep trying and build something everyone would be amazed of.

On the other hand, a clear disadvantage of this approach is that it hinders any development of team spirit and social friendliness. As it is important to be on a high level of education, it is also important to aspire to grow as a human being. Students stopped sharing interesting knowledge between them in order to prevent the competition from benefiting from the information they worked hard to obtain.

Even if the expectations were set since before the launch of the project, there were some unexpected results that brought good news. The grading teachers were fascinated by the work of their students.

6. MIXED PART

When considering both the collaborative approach and the competitive approach, it is important to be aware of both their advantages and disadvantages. The “Algorithms design” course tried to combine them during the year 2017. The organizers of the course proposed a whole semester project that involved working in teams to create a bot for the game “Halite”. The game features a board of locations with production values that create pieces and each bot controls 1 location at the start. The purpose of the bots is to win the game as fast as they are able to. The first stage of the project evaluated the bots created by students against a set of predefined bots created by the course team which were not very efficient. The purpose of this part was to give the students an example of the competition to start with and to encourage them to participate. The second stage of the project had a ranking system and ranked the students by evaluating the performance of their bots against each other. The teams of students would then receive points based on the rank of their bot.

The mixed approach taken in this course brought advantages from both the collaborative and competitive approaches.

Firstly, just like in the “PM Fair” competition described above, every student participated. While the best-graded students wanted to stay at the top and get the most points, the lower graded ones wanted to get more points in order to raise their grades. This desire not only motivated the students to participate but also showed them that teamwork was entirely necessary since they could not get many points if they would not collaborate with their team. Thus, the students had no choice but to use and improve their team working skills to create synergy with the other members.

Secondly, the competition was a great way of making the students understand the notions presented in the course. This is true because the bots had to use the most efficient algorithms possible in order to yield the best winning time, and the most suitable environment to understand them are obviously the course and laboratory activities. Furthermore, the students would then deepen their knowledge by comparing the alternatives and trying to reach a common point of view inside the team.

Unfortunately, because of the early stages of students’ knowledge and the difficulty of their project, the results were not the ones that were expected.

7. STUDY RESULTS

The results of the students in the above-mentioned projects were analyzed by the score they obtained on a 1 to 10 scale. The grades were given by different professors and laboratory assistants and they can be affected by subjectivism.

The results were surprising. With a high grade of 8.56 in the collaborative approach project and 8.49 in the competitive project, the mixed part only provided a grade of 6.33. The causes of this low average grade could be the difficulty of the assignment, the first experience of working in a group and competing at the same time, and the inexperience of the students that took part in the study at that time.

Other indicators such as standard deviation show how well distributed were the results of the study. It should be noted that the mixed part has the highest standard deviation which means the evaluation was done more correctly than in the other approaches. Details about each approach are presented in Table 3.

Skewness shows the asymmetry of a Gaussian distribution. 0 skew means normally distributed, thus the negative values show that more high grades were given than low grades.

Kurtosis shows if the peak of the Gaussian distribution is sharp or round. In the competitive part, we can observe a sharp spike at the grade of 10.

Table 3. Results category”; * SPM = Software Project Management; * MD = Microprocessors Design; * AD = Algorithms Design

	Collaborative (SPM*) 130 students	Competitive (MD*) 400 students	Mixed (AD*) 500 students
Average grade	8.56	8.49	6.33
Standard deviation	1.087	1.842	2.078
Kurtosis	-0.888	1.497	-0.703
Skewness	-0.098	-1.342	-0.390

Figure 2 presents the distribution of grades among students and how they were influenced by the 3 methods presented above. The figure does not present the number of students per grade, but the distribution of them.

In the collaborative part, there were many grades higher than 6 with a maximum of 40 students obtaining a grade of 9. The notes are well distributed in the array of 6 to 10, thus showing stability and suggesting that everyone has deepened their knowledge on the subject of the course.

With the competitive approach, there was a spike of students who earned maximum grade of 10, but there were many that scored low. The talented students that were passionate about the competition obtained the maximum grade, while the ones that were neglectful of it had low grades.

Regarding the mixed approach, many students scored 8 but fewer scored higher than that. In fact, most of the students scored lower than 8 and a spike around grade 3 is visible. This shows that not everyone was prepared for this kind of approach.

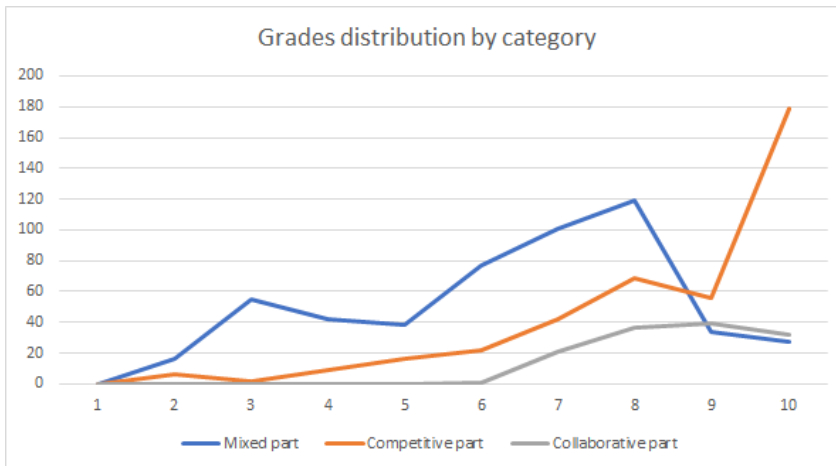


Figure 2. Distribution of grades by category

8. CONCLUSION

In this article, an analysis of the competitive, collaborative and mixed approaches was conducted, by considering the courses which the authors attended. The advantages of collaborative and competitive approaches were illustrated by using the projects from the “Software Project Management”, “Microprocessors Design” and “Algorithms Design” courses that took place during the authors’ four years of college.

In conclusion, the use of competitive and collaborative approaches benefits both professors and students. The students had the opportunity to experience new methods and to learn more than only one way to approach a project, while professors had the chance to study how their approach had results on this particular batch of students in order to improve their expertise as educators.

While each one of the proposed methods has its own particularities, one could not say which is superior. Diversity is what we should try to achieve, as this study shows, when there is more than one way of approaching the students’ response to challenges, unexpected results appear.

9. FUTURE WORK

Internships and University group projects

With internship programs, companies give students a role in the team and evaluate them based on their performance. Generally, companies adopt a collaborative strategy, each member having a very specific role in the team (developer, tester, manager, designer, etc.).

We believe that universities should use group projects to give students an understanding regarding why such a strategy is important, why people have these different roles and to prepare them for real life situations by making them experience something similar.

A group project managed by a real company might also give students insight into the life of an actual engineer.

Introducing these methodologies in laboratories and courses

Courses are mostly activities where the theoretical work is presented, and the dialogue should be between the teacher and their students. During laboratories, on the other hand, students must use the principles and methods they acquired in order to find solutions to problems. We believe that this is the best environment to teach them how to work in a team and how to find a common solution and prepare them for real-life experiences.

The competitive approach could also be applied here to make students work harder to obtain the most points, but we believe that it would also be very stressful.

Remove studies' causes for non-relevant data

Remaking this study by using the same batch, in the same year and course. This should eliminate all the causes that have affected the mixed part of this study.

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