Effect of the group size on student learning using an active learning methodology in a science class

Arturo PAZMINO, Esther GUTIÉRREZ, Eduardo MONTERO

Escuela Superior Politécnica del Litoral, ESPOL, Facultad de Ciencias Naturales y Matemáticas, Guayaquil, Ecuador

Abstract. Peer-project learning is an active methodology applied to one university in Ecuador, and it has improved students' learning process in Physics. The main goal of this research is to provide a first analysis of the effect of the team members' number, working on a real-life project, on the understanding of electromagnetism. An introductory electromagnetism course for engineering students was taken. The grades of an electromagnetism test were taken to quantify the students' understanding. As a result, the number of team members doesn't influence the acquired knowledge if every member works on the project with a medium effect size.

Introduction

Project and problem-based learning (PBL) are active learning methodologies that have become more significant in recent years due to the active role that students have in their learning process. PBL promotes academic motivation inside the classroom [1] by performing a project design or solving a complex problem. PBL seeks group interaction among students through analysing and solving a real-life project or challenging problem [2]. In addition, students can develop several soft skills, such as written and oral communication, critical thinking, and problem-solving ability [3].

Peer Project Learning (PPL) is an active learning methodology that has been applied in one university in Ecuador since 2016 [4]. It combines interactive teaching models such as peer instruction, flipped classroom, and project-based learning. PPL is implemented in a course with two components: a theoretical component using peer instructions and flipped classroom approaches and an experimental component employing project-based learning. This study is focused on the latter component of this methodology, involving the experimental design of a prototype.

The main objective of this research is to provide an initial quantitative analysis of how the team member number affects the teams' meaningful learning on a specific topic in science through an experimental prototype based on a playful game that will allow to propose a constructivist didactic of learning in electromagnetism. The research question is: Does the meaningful learning for each student on the electromagnetism topic depend on how small or big the collaborative team is?

Method

In a town county fair, there is a typical game called "High Striker," which is a tower with a bell on top and a spinning top on the bottom, and the idea is to hit a target with a mallet to raise the spinning top and hit the bell. This project is based on that game, and the objective is to build an electromagnetic propulsion system that allows a sphere to move along a track, showing physical concepts such as electromagnetism and energy conservation. For detailed information about this project and a representative solution, please refer to [5].

An introductory electromagnetism and optics course was taken for engineering degree students at a university in Ecuador. The course was taught using PPL as an active learning methodology. The total number of students who dedicated enough time and effort to finish the project is 83, from different engineering majors. They were placed into sixteen teams, made up of two up to seven

members. The county fair game project was developed under a collaborative teamwork modality over twelve weeks, with five review stages to follow up on the progress, as detailed in [5].

An electromagnetism problem-solving test is used to quantify the students' meaningful learning; the same test was applied to every student simultaneously and individually. This test was based on three questions that evaluated electromagnetism concepts only. For analysis, the teams were divided into two distinct groups: group 1 comprised five to seven team members and group 2 comprised two to three team members.

Results

Group 1 is arranged with teams with five and up to seven members, given a total of eleven teams with 70 students, and group 2 has teams with two or three members, given a total of five teams with 13 students. The average score of the electromagnetism test is 11.9 for group 1, and 10.5 for group 2. The normal distribution of the data for each group and the equality of variances were confirmed using the Shapiro-Wilk coefficient and Levene's test, respectively. Therefore, t-test two-sample assuming equal variances statistical analysis is used to check if the means of the two groups are statistically different, given p-values of 0.14 and 0.29 for one-tail and two-tail. Based on these results, there is no statistical difference between the means of both groups because both p-values are larger than 0.05, with a significance level of 0.05. Finally, to analyse the effect size of this research, the statistical Cohen's d value is obtained, given a medium effect size of 0.60.

Conclusion

Both groups received the same instruction in the theoretical component, where students studied electromagnetism physics concepts and worked with problem-solving questions that involved mathematical elaboration. Additionally, on the practical component, both groups work on the same game project; however, from the t-test, the p-values are larger than 0.05, for a significance of 0.05, meaning that there is no statistical evidence to conclude that the mean between both groups is different. Therefore, working on a large team has the same effect as working on a small team on the mean score on a problem-solving test for the entire team. Furthermore, the given medium effect size for the problem-solving test, 0.60, shows that the upper half of group 1(the larger collaborative teams) exceeds more than 66% of the population of group 2 (probability of superiority). The effect size suggests a moderate difference between the two groups' performance compared to the problem-solving test. However, the statistical methods used to test the hypothesis, show no statistical difference between the means of these two groups.

References

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