



An Approachment to Cooperative Learning in Higher Education: Comparative Study of Teaching Methods in Engineering

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ABSTRACT

In the way of continuous improvement in teaching methods this paper explores the effects of Cooperative Learning (CL) against Traditional Learning (TL) in academic performance of students in higher education in two groups of the first course of Computer Science Degree at the university. The empirical study was conducted through an analysis of covariance (ANCOVA) in order to assess whether teaching methods have a significant effect on academic performance. The results show that teaching methods did not have a significant effect on the academic performance of the students. However, informal interviews with students revealed that they preferred CL. The study also explores whether there was a relationship between the average scores for conceptual and problem-type questions between both groups through a t-test analysis and for both courses there was no significant difference in the exam results between the two groups. Students who were exposed to TL methods outperformed the students who were taught via CL in mid-term exam. However, the result is opposite in the final exam where students from CL obtained better scores. Finally, with CL techniques students got better global results because they acquired a deeper understanding of the materia.

Keywords: academic achievement, higher education, cooperative Learning, engineering students, traditional learning

INTRODUCTION

When we want to research about learning methods there are two main questions that have to be answer as Esmonde (2009) pose, first, what do students learn? For example, which topics and processes are important for students to learn, and second, how do they learn it? In this article, I tried to highlight the second one analyzing two teaching methods, the traditional learning (TL) based on teacher centered methods and competitive instruction and the cooperative learning (CL) based on collaborative instruction. The majority of recent research studies about teaching methods encourage teachers to use CL because they positively impact students' abilities to deal with the needs, diversity, and interpersonal demands of the twenty-first century and help them deal with science problems successfully (Ebrahim, 2012).

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State of the literature

- Cooperative learning is a valuable tool for learning in academic institutions as well as provides benefits for students and instructors. Many research studies have indicated that the use of cooperative learning strategies in the classroom can improve students' performance.
- A few studies indicate that cooperative learning can significantly increase student achievement (compared with traditional methods) when it is properly implemented; however, this does not mean that all operationalization of cooperative learning will be equally effective.
- The analysis of the academic performance of the students is a good way of comparing two different learning methodologies but it is necessary to complement it with the study of other competences such as the interpersonal and intrapersonal skills.

Contribution of this paper to the literature

- It is necessary to continue deepening into the study of new techniques of teaching such as cooperative learning in higher education in the way this study does.
- Students prefer to learn in an environment of cooperative learning than in a traditional one because they participate more and they feel more implicated in their own education.
- The study provides some interesting positive results of the use of cooperative learning techniques in engineering students.

Therefore, cooperative learning approaches may have a positive influence on conceptual achievement in addition to socioemotional factors. The benefits of cooperative learning are known for some time, it is a constructivist approach that makes possible a significant learning for the students (López-Cancelos, Comesaña & Badaoui, 2013). A lot of studies on cooperative learning exist (Decuyper, Dochy, & Van den Bossche, 2010) and most of this research confirms that there are positive effects of cooperative learning on different outcomes. Studies on cooperative learning have indicated its positive relationship with student achievement and attitudes about learning (Johnson and Johnson, 1989; Slavin, 1990; Johnson et al., 2007). Although, there are very few experiences in the university classrooms on cooperative learning, the study of this methodology begins to appear in international journals of high impact (Fernández, 2004; León del Barco, 2006; Pérez, Paz y Poveda, 2009; Alorda, Suenaga y Pons, 2011). The goal is to improve the academic results of the engineering students in line of The European Higher Education Area.

So, the aim of the present study is to know if there are differences between CL and TL in engineering courses on higher education, in the way that students learning with cooperative teaching methods obtained better academic performance scores than students learning in a traditional teaching environment in line with Hosal-Akman & Simga-Mugan (2010) and Ebrahim (2012). The following section explores both types of learning methods. The next section presents the methodology of the study and the fourth section the results of the research. Finally, I present the conclusions and future lines.

COMPARISON OF COOPERATIVE AND TRADITIONAL LEARNING APPROACHES

Cooperative learning continues today to be a valuable tool for learning in academic institutions (Johnson, Johnson & Smith, 2007), as well as provides benefits for both students and instructors (Shimazoe and Aldrich, 2010). It represents a shift in educational approach from competitive-based to collaborative-based instruction in order to address diversity in the classroom (Slavin, 1990). Cooperative learning as Johnson and Johnson (1989) define has five essential components: (a) positive interdependence searching for a common goal, (b) face-to-face interactions, (c) individual and social accountability, (d) use of interpersonal skills and (e) group-processing skills. Cooperative learning approaches create excellent opportunities for students to engage in problem solving with the help of other group members (Effandi & Zanaton, 2007). Reys, Suydam, Lindquist and Smith (1998) described how cooperative learning settings promote student-centered instruction and advance the learning environment in the classroom. However, as Onwuegbuzie, Collins & Jiao (2009, p. 272) pointed out, individual accountability is key to the success of the overall group and helps to reduced individual effort resulting from too much dependence on other group members.

Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and working cooperatively to complete academic tasks (Effandi & Zanaton, 2007). Many research studies have indicated that the use of cooperative learning strategies in the classroom can improve student performance. Slavin (1991) found over 70 high-quality studies that assessed CL over a period of at least 4 weeks at elementary and secondary school levels. All of these studies compared the effects of cooperative learning and traditional learning methods on student achievement in various content areas. In the other hand, in traditional learning it is assume that the main source of the information in a classroom is the teacher; therefore, students should deal mainly with the teacher to acquire knowledge. Learning involves a passive reception of information from the teacher by the students who then organize and store these ideas without substantive modification in long-term memory, to be retrieved when needed. The students rely on their teachers to decide what, when, and how to learn. The majority of teacher learning work involves listening to a teacher talk, using either a lecture technique or a Socratic method (simple question and answer) which demands basic recall of knowledge from the learners. Lecture-based instruction dominates classroom activities, with the teacher delivering well over 80% of the talk in most classrooms (Effandi & Zanaton, 2007). Students subjected to TL may not find opportunities to freely choose the strategies they are interested in to solve problems since the teacher decides the most appropriate problem-solving strategy. Moreover, students, especially in the primary grades, may become bored with the one-way communication found in teacher-centered instruction. Furthermore, Johnson and Johnson (1990) noted that in the last decades more than 320 studies had been conducted comparing the effects of cooperative, competitive, and traditional situations on students' achievement in different content areas. The fundamental findings of those studies indicated that students'

productivity in cooperative learning settings is higher than in traditional learning. Jones (1990) explored the influence of cooperative learning versus traditional learning in elementary schools and the results indicated that the cooperative learning approach was no more effective than the traditional approach. Currently, educators and researchers show enthusiasm regarding the application of the wide variety of approaches under the cooperative learning umbrella in schools; however, this support does not necessarily ensure that all of these methods are the most effective at improving students' cognitive abilities and social skills as Sharan (1990) or Johnson, Johnson and Stanne (2000) pointed out. They argued that cooperative learning can significantly increase student achievement (compared with traditional methods) when properly implemented; however, this does not mean that all operationalization of cooperative learning will be equally effective. They mentioned that many of the studies conducted have methodological shortcomings and, therefore, any differences found could be the result of methodological flaws rather than the instructional approach itself. The cooperative learning method can be difficult to implement effectively in the classroom. Adams and Hamm (1996) cautioned that the following elements must exist for cooperative learning methods to work effectively: positive interdependence, face-to-face interaction, individual accountability, personal responsibility for reaching group goals, frequent practice with small group interpersonal skills, and regular group processing and reflection. So, effective implementation of cooperative learning involves specifying instructional objectives, create heterogeneous groups of students, explain the task and methods to be used in achieving the group goal, to monitor progress of the groups, to intervene to provide assistance when necessary, and to evaluate student achievements (Hamby & Grant, 1997). Researchers suggest that teachers should view the cooperative learning approach as being flexible and change teaching strategies depending on students' needs and interests. In this way, it is crucial to understand the differences in approaches to enable teachers to choose the cooperative method or procedure that is best suited to their classrooms (Sharan, 2010). As Sharan (2002) presented, there are three models of CL methods: (1) Models that emphasize mastery of knowledge and motivation, such as jigsaw, (2) Models that emphasize social skills and interpersonal communication and (3) Complex Models including beyond and emphasize long term intellectual inquiry, intrinsic motivation and equal status interaction.

Taking into account that accounting is a practice with profoundly social derivations and implications (Burchell, Clubb, Hopwood, Hughes, & Nahapiet, 1980), it is very important to study the implications of teaching accounting, and to analyze different ways to do it, such as the application of cooperative learning in accounting courses. There are some experiences in cooperative learning in accounting courses, like Lindquist (1995) who conducted a case study in which students formed groups and studied various auditing reporting issues and at the main conclusions were that students prefer cooperative learning way and perceive greater achievement. There are other studies about the differences between CL and TL in accounting based on academic performance with antagonist conclusions; with no differences between both teaching methods Lancaster and Strand (2001), Ravenscroft and Buckless (1997) or Marcheggiani, Davis and Sander (1999). In other way, we can found positive results for CL in

Ravenscroft and Buckless (1995), Caldwell, Weishar and Glezen (1996), Ciccotello and D'Amico (1997) and Yamarik (2007). And finally, we can find studies such as Kunkel and Shafer (1997) with better academic results in TL group than in CL group.

Therefore, this study presents the following question:

RQ: Are there significant differences between higher education engineer's students' achievement based on using cooperative learning methodology or traditional learning methodology?

METHODOLOGY

The experiment took place in the 2013-2014 first semester in two groups of Financial Accounting first course of Computer Science Degree at the Complutense University of Madrid. The total number of students was 110 and they were divided randomly in one group of 47 students that formed the treatment group and the control group with 63 students. The course was offered using the same textbook and presentations. The instructor used PowerPoint slides that were available to the students before the lecture at the course website. The method employed for problem-solving was different for the treatment and control groups. In the control group, the instructor solved the assigned problems; in the treatment group, problems were assigned to groups of students. Assigned problems in the control group and in the treatment group were equal. In the last part of the semester, the treatment group used the jigsaw technique to learn the last theme while in the traditional group it was explain by the teacher. As Hanze and Berger (2007) reveals the jigsaw technique has the potential to satisfy the basic needs in the theory of self-determination (Deci & Ryan, 1985, 2000), and thus to enhance the probability of intrinsically motivated, deep-level learning. As a cooperative learning environment, the jigsaw classroom should support the need to experience social relatedness. In comparison with direct instruction, there will also be a better chance to feel autonomous because students have more leeway in structuring the learning process. The main characteristics of the jigsaw structure are (Johnson & Johnson, 1990): (1) positive interdependence: each member has to contribute to the group task because each student's part is essential for completion of the task; (2) individual accountability, cause all students have to make their own contribution to the group; finally, (3) cooperation in the way that students actively promote each other's learning. The jigsaw learning technique was first developed and implemented by Aronson (1978). In the jigsaw classroom, the day's lesson is divided into several segments, and each student, who is in one of several jigsaw groups (in our case of 5-6 students each), is assigned to learn about one segment of the written material. Before reporting on their topic to their jigsaw groups, students meet first with other students who have been assigned the same segment (one from each jigsaw group). Together, the experts research their segment, discuss, and clear up questions with each other. Finally, the jigsaw groups reconvene, and each student in each group acts as a tutor to the group on his or her topic. In this case, the students enrolled in the treatment group were assigned randomly to 8 groups of 5-6 members, and the instructor determined the theme presentation dates for each group.

For both the CL group and the TL group, academic performance was assessed by one mid-term exam and a final exam. The same exam questions were given to both treatment and control groups. The same exam questions were given to both treatment and control groups. Mid-term exam consisted of multiple choice questions and final exam on financial accounting problems so as to assess both the conceptual comprehension level of the students and their ability to practice what they had learned.

FINDINGS

The academic performance of students in engineering courses is dependent on various factors such as gender or previous academic performance in high school (Doran, Bouillon, & Smith, 1991). Therefore, in order to assess whether teaching methods have a significant effect on academic performance I conducted an analysis of covariance (ANCOVA) as previous research (Hosal-Akman & Simga-Mugan, 2010; Ebrahim, 2012), in which teaching method was the main effect, mid-term exam was the covariate and the dependent variable was the overall grade of the students at the end of the semester. The results of the analysis, applied at the 0.05 significance level, are presented in **Table 1**. The results of ANCOVA show that teaching methods did not have a significant effect on the academic performance of the students.

Table 1. Results of ANCOVA

Source	Mean Square	F	Sig.
Corrected Model	108.034	48.124	.000
Intercept	25.576	11.393	.001
Mid-term exam (Cov)	216.050	96.241	.000
Teaching methods	.806	.359	.550
Error	2.245		
Total			

R Squared = .474 (Adjusted R Squared = .464)

Thus, based on ANCOVA results, the null hypotheses cannot be rejected. In other words, we can say that traditional methods and cooperative learning methods did not differ significantly in their effect on the academic performance of students in opposite with the results of Tsay and Brady (2010) where there was a positive relationship between student's academic performance and cooperative learning. However, student participation was higher in the treatment group; informal interviews with students revealed that they preferred cooperative learning, indicating that they liked being a part of the lecture instead of just sitting and listening to the instructor. The academic performance of students was assessed by mid-term and final exams. Multiple-choice/essay questions were designed to measure the conceptual understanding of the topics, whereas the problems were aimed at measuring the practical aspects of accounting. Therefore, we also explored whether there was a relationship between the average scores for conceptual and problem-type questions between the treatment and control groups. The t-test results are presented in **Table 2**. As can be observed from **Table 2**, for both courses there was no significant difference in the exam results for both conceptual

Table 2. T-test on exam scores

	TREATMENT GROUP		CONTROL GROUP		Z- value	p-value
	Mean	St. Dev.	Mean	St. Dev.		
Mid-term exam	3.71	0.219	3.883	0.189	-0.374	0.708
Final exam	3.823	2.1485	3.798	1.9834	-0.677	0.499

and problem-type questions between the two groups. Though the results are statistically insignificant, there are some interesting outcomes. Students who were exposed to traditional teaching methods outperformed the students who were taught via cooperative learning in mid-term exam that consisted on a multiple-choice test. However, the result is opposite in the final exam where students from the cooperative learning teaching methods obtained better scores than the traditional ones.

CONCLUSIONS

The present paper describes a study measuring the effects of two teaching methods on the academic performance of engineering students of computer science. According to the results of a mid-term and a final exam during one semester it was observed that teaching methods had no significant effect on academic performance. The academic performance of students who actively participated in the course through cooperative learning was expected to be higher, conversely, although statistically not significant, mean mid-term exam scores of students who were exposed to traditional teaching methods were higher than the students who were taught by cooperative learning, but in the final exam the results were the opposite, and students from the cooperative learning group got better scores than the students from the traditional learning group. Students of Cooperative Learning may have lower notes in the test exam because the interpersonal skills are not reflected in this kind of exam. However, at last with cooperative learning techniques students got better results because globally they acquired a better understanding and knowledge of the material. Anyway, only analyzed CL based on academic performance is limited because effects of cooperative learning method are more extended than the academic performance ones, and they haven't been detected by this study, because CL method improves interpersonal and communication skills that aren't assessed by academic exams.

With the limitations of the present study, unfortunately I cannot conclusively state any implications for practice other than that the students prefer, and say that they learn better in a cooperative learning group, because they participate more and they feel more implicated in their own education. Furthermore, a future study could test differences between both learning methods taken not only academic achievements into account.

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