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ACTIVE LEARNING AND BOARD GAMES TO TEACH ENGINEERS

Héctor Fuentes Castillo[1], Ph. D. & Prof. Sra. María Díaz Campillay[2]

[1]*Assistant Professor, Department of Industry and Business. University of Atacama.*

[2]*Instructor Professor, Department of Industry and Business. University of Atacama.*

Abstract

This document shows how active learning can be transformed in a practical teaching experience of continuous improvement, through a fun activity. This activity is dedicated to encouraging and motivating the student, contributing to gaining new knowledge and improving the interaction between peers, all elements which are necessary to obtain better academic results. The experience was applied to students taking the Accounting subject, in the Civil Engineering in Computer Science program at the University of Atacama, in Chile. The educational and fun tool incorporated into the course was a board game. The field analysis, dedicated to directly observing and recording all kinds of behavior presented by the students, was maintained throughout the period of time that the subject lasted. The results obtained were compared with a second group of students, used as a control group, who also took the Accounting subject at the University of Atacama, but, from the Industrial Civil Engineering programme and with the traditional methodology of teaching. The conclusions and final results showed that by using a non-traditional methodology, the average students' grades increase.

Keywords: *active learning, accounting, teaching approach, table games.*

Introduction

Chilean Universities, and among them the University of Atacama, continuously seek to improve the quality of their educational processesin order to increase the benefits of their students and society. At the end of the 20th century, international financial organizations pointed to quality as the central problem of education in Latin American countries. This is why, as the end of the second millennium approaches, a process of transformation begins in Latin America in the area of education, including reforms in the organization, financingand management of systems, as well as in the pedagogical processes and curricular content(Vázquez, 2015). From the beginning of the 21st century, Chile has been facing numerous reforms to its educational system, several of them associated with quality. As a consequence, at the end of the second decade, a series of laws were enacted that cite quality as a governing entity which should be present in all study plans and programs. State Universities mustguide their institutional work in accordance with the criteria and quality standards of the higher educational system, oriented to the specific characteristics of each

institution, the mission established in its statutes and the strategic objectives stated in their respective Plans of Institutional development.(Law 21.094, 2018). Latin American educational systems have been organized around four axes, one of them being in charge of relating and articulating quality with competitiveness and citizenship. (Boom, 1999 revised in Guzmán, 2009). All this demandsHigher Education Institutions (HEI) to develop effective skills in their students, associated with increased productivity and competitiveness for their economies. Achieving high quality standards implies intentional processes of continuous improvement aimed at achieving university excellence.(Pilozo, Tejeda, & Daysi, 2015).

It is in this context, where the need to start a redesign of the plans and programs of all the programmes at the Faculty of Engineering of the University of Atacama arises, with the purpose of giving the country future professionals,highly qualified, competent and competitive. In this process of continuous improvement, students must play an active role and contribute to their learning with their teachers, which implies a great challenge. In addition, during academic sessions it is necessary to assessthe impact that the experience has on the student(Dyson, 2008). Achieving these objectives often involves using various methodologiesthat promote active learning from students, implying, in many cases, using completely innovative techniquesfor their teachers. Despite the sacrifice that this may involve, the vast majority of academics who have usedsome active methodology, express their satisfaction and pleasure with the attained achievements.(Marin-Garcia & Conchado-Peiró, 2012). In light of these new and important benefits discovered, it is important to note that from the theoretical perspective of teacher thinking, the study of teaching is not reduced to the didactic aspect, or to what is done in the classroom, but on the contrary, the teacher must reflect, analyze and interpret intellectual and affective aspects, both their own and their students.(Cañedo & Figueroa, 2013).

The present work is presented in two parts, the first briefly shows the theoretical support that highlights the importance of active learning, and the second shows a practical example of its importance.

Concept of active learning

When trying to explain, and at the same time understand the concept of active learning, specialized literature provides different definitions.Although it is true, and there is no one correct meaning, it is possible to synthesize them as quality learning, where the student is at the center of the training process and commits himself thoughtfully and closely to his professional future. All the activities that the students carry out in their learning must be

accompanied by reflection on the actions they are performing(Bonwell & Eison, 1991). Students learn when they are truly involved with what they are studying,thusunderstanding the amount of physical and psychological energy they devote to each academic experience (Astin, 1985).It is important to get the student understandthat boththe process and the product that are experienced must be the result of the synergisticinteraction between motivation and active learning(Barkley, 2009).

In this sense, the active learning methodology needs to involve the student with its training process.It is necessary that the teacher, through innovativemethodologies, involves the students in constructivist environments, and for this, the contents of the study subjects must have a configurationthat includes professional endeavor, the class taught and the level of prior knowledge that the students possess. It is necessary for students to have competences that allow them to relate the concepts that have been designed or selected by the educator in a logical way.Why is this done? The answeris obvious: for learning to be meaningful, as meaningful as possible(Escobar, Ramirez-vazquez, Gonzalez-rubio, Arribas, & Augusto, 2017). This new approach also implies more dynamic teachers, as it is necessary to avoid classes taught in a conventional way, where the academic is the center of knowledge and his classes are classified as master lectures. It is essential to design situations that allow students to interact with their classmates, moving to different parts in the classroom, and using tools, such as technological instruments or games, that allow them to strengthen learning. This new formative training process suggests that students learn by doing and not by sitting passively in a classroom.

Despite the great benefits that this new approach brings, most of the teaching in universities has always been very conventional, where the teacher conducts classes in a classical way, and students passively attend to listen, write and memorize content. All of this definitely provides very few opportunities for a more active learning(Prieto, 2006). It is therefore necessary to move to more participatory processes, where students commit to the development of their knowledgein order to increase the quality of education, and at the same time, the attributes of future professionals, who in the future will be the engine of development and economic growth of their regions. The obstacles that are present in the implementation of an active learning process, according to literature, can have various sources; highlighting, in most of them, the following difficulties: (Prieto, 2006):

- Fear of wasting time on activities that take teachers away from their fundamental task.This fear is based on the perception that most of the students have regardingthe work delivered to them; they do not see the actions carried out by teachers in the classroom as part of the teaching-learning process, they consider them activities that are far from helping them in the process.A way to solve thishas to do with the design of the tasks given, which must be completely aligned with the learning objectives and the achievement of the contents of the unit.
- The risk of losing control of the classroom, giving greater prominence and responsibilityto students.Active learning means that students have greater responsibility in the training process and, consequently, greater control, which often exceeds the teachers.On the contrary, greater preparation and organization of all the activities carried out in the classroom will help the teacher maintain control of the learning, only not in a direct way.
- Little trust in the students' prior knowledge.Active learning needs highly prepared students in a series of subjects and skills. This methodology assumes that they possess all the necessary skills to be responsible for their own training process. However, many teachers underestimate the knowledge and skills of their students, which leads them not to use active learning strategies. However, these deficiencies can be remedied through the use of didactic learning strategiesguiding students in the appropriate ways of learning, depending on their needs and abilities.

Although it is true that difficulties can discourage the use of active learning methodologies, it is no less true that their implementation brings great benefits, as well as a greater challenge in the preparation of classes and study programs. It is therefore necessary to train teachers in the application of new active learning techniques, as well as in the creationof new dynamics and activities that involve all students, and make them participate in new challenges and common objectives.Following in this article, is the presentation of an active learning methodology based on a table game used to teach the accounting subject in a course inComputer Civil Engineering at the University of Atacama, in Chile.

Problem to address

The Faculty of Engineering at the University of Atacama, is in a process of continuous improvementaimed at improving the syllabus and study plans in all their programs. In this need to improve what already exists, academics in charge of different subjects have been

encouraged to improve their teaching and learning processes. It is in this quest, where the interest to implement active learning techniques in the subject of accounting arises, this subject is taught in the third year and is a transversal subject,which means that, without being a specialty course, it must be taken by all future civil engineers.

The accounting subject has very specific purposes, which are sometimes far from the objectives of a civil engineering student, which is why teaching accounting to this group of students is not an easy task. Teaching accounting to future engineers, who are not from the accounting area is difficult, since the students show a very distinctive professional identity. (Damián, 2018). All this makes them more reluctant to accept subjects that are not part of their professional profile, since they mistakenly believe that these do not give them any benefits or utility to their future work as engineers, and ultimately, it is contradictory for students to study them.The reasons that cause poor performance, or lack of interest in learning a subject, are mainly based on motivation, be it intrinsic or extrinsic. It is intrinsic when the motivation is self-regulated, there is a degree of reflection and self-determination for the actions that are carried out; on the other hand, when it is extrinsicis based on external incentives given by the consequences, such as the rewards or punishments that the student has or is exposed to. (Furnham, 2001)(Vargas, Rodríguez, & Hernández, 2012). Likewise, if this lack of motivation is combined with the little awareness of usefulness that the student perceives of a specific subject, it results in a null or low interest in studying it, and this originates in them an apathetic or indifferent attitude towards these courses. Although it is true that this problem is transversal to other subjects taught in civil engineering careers at the University of Atacama, the problem studied focuses on the lack or little enthusiasm for learning accounting.

Consequently, active learning methodologies emerge as an excellent alternative to didactic strategies, aimed at raising the students' motivation and actively managing their learning, thus helping to provide a solution to the problem referred to in the previous paragraph.

The selected didactic strategy is a game, which is a fundamental strategy for the development of people,considering that it is not an exclusive activity of childhood. That is why many teachers, psychologists and educators claim the game as an educational tool to use in classrooms, and encourage not to leave it only to infants or preschoolers. It is necessary to emphasize that the didactics of the game is a tool that fosters knowledge in an entertaining, satisfying way.(Torres, 2002). In educational terms, games are described as an environment that facilitates and improves the acquisition of knowledge and skills; besides they help to

create, understand and retain knowledgein a fun and interesting way(Waiyakoon, Khlaisang, & Koraneekij, 2015). Games also require the players to develop certain skills that improve communication among the members of the group; in addition, it asks them to have a brief knowledge aboutthe subject, read the instructions well, work as a team and keep a logical order of all the activities to be able to associate and connect the information in a better way, considerably improving analysis skills.(Vélez, Palacio, Hernández, Ortiz, & Gaviria, 2019). Ultimately, the use of didactic games as a teaching strategy provides clear positive repercussions, when its approach, focus and execution is the right one.The game is an innovative recreational strategy, which should not only allow relationships between previous and new knowledge to be established, but also between the concepts necessary to describe and explain a phenomenon. It is important to take advantageof the potential of the game and open spaces to learn through this activity, because when playing, not only the body moves but also themental structures (Melo & Hernández, 2014).Metacognitive strategies, information processing, and context control become the fundamental aspectswhen students are learning.(Alarcón, Alcas, Alarcón, Natividad, & Rodríguez, 2019).

The experience written below corresponds to an intervention in the accounting subject altering the traditional teaching methodology for the career of civil engineering in computing and informatics. The sole purpose ofthis is to be able to assess students' learning through the use of active learning tools, and analyzethe existence of any increases or decreases in the academic results of the course. The results are compared with a traditional teaching approach, also from the accounting subject, but for the industrial civil engineering degree both from the University of Atacama in Chile.

Experience

The objective of this experience is to establish a methodology that fosters theconstruction of knowledge among students. As this is an early stage practice, the use of the active learning didactic was applied only to the first unit of the accounting subject. The tool used for this is the use of a board game. The research was experimental,descriptive andhas a cross- sectional design.The selected population were students from the civil engineering computer science course, who were the test unit, and students from industrial civil engineering, who acted as a control group.Both groups belong to the Faculty of Engineering of the University of Atacama, are in their third academic year and are enrolled in the accounting subject. As this is a test and analysis practice, the use of didactics is carried out only in the first learning unit, which aims at the following topics:

- Know the technical and practical elements of accounting
- Understand the role of accounting in the company and the importance of accounting financial reports.

The variable to analyze is the behavior that the students have in relation to different teaching methods.For this, two groups are considered; in the first groupwhich is called Group A, a methodology based on traditional classes, called master lecture, is used as a teaching tool, andthe practical accounting exercise is done through the use of a board game as a didactic resource. In the second group, called Group B, the same teaching structure used in Group A is used, so it is also based on master lectures, but is only supported by theoretical accounting exercises. In this last group, the role of the student in their learning process is much more passive when compared to Group A. It is necessary to mention that Group B will function as a control group.The tools used to measure students' behavior in both groups are direct observation and summative assessments. The board game, usedas an active learning tool, is based on the exchange and sale of real estate, the students – players move their respective tokens in turns, around a board that shows all the properties that can be bought. The teacher interacts with the students - players through the bank; he is in charge of the money and the propertiesthat have not yet been sold and still belong to the bank.In addition, he also fulfills the role of moderator, facing conflicts that may appear among the student-players.It is necessary to indicate that each transaction that is carried out in the game must be recorded in an accounting way, and at the end, the students must prepare their balance.The student who obtains the greatest profit will be the winner of the game.

This experiment is carried out in 2 stages:

a) The first stage, called theoretical,is carried out on both groups equally. It is usedto transfer the theoretical accounting concepts,and the methodologyto be used is the master lecture.
b) The second phase, called practice, is in charge of exercising the theoretical concepts taught in the previous stage, which must be recorded in the JournalandLedger, and must end with the presentation of the balances, the income statements and the balance sheets. A presentation of the graphic representation of accounting equality is expected, which should be simplified as it can be an additional contribution to its understanding.

It is necessary to emphasize that the only difference between Groups A and B, is the practical way in which what students learned is exercised. Group A uses a board game and Group B uses only theoretical exercises given by the teacher.

In Group A, the teacher acts as the class leader, coordinates and moderates the board game and the players. Each student is a player who must follow the rules of the game, the teacher is the bank while the game lasts. At the beginning, an amount of money is given to each student - player, which represents their initial capital, all participants must start with the same amount of money. Players take turns moving their respective tokens clockwise around a board, based on the score of the dice, each turn on the board equals one month, so 12 turns represent a business year. The game is based on the exchange and sale of real estate, the ultimate goal is to form a monopoly of supply, owning all the real estate that appears in the game.The player with the highest profit will be the winner of the game.

With Group B, the teacher acts as the class leader, he previously designs and provides students with all the theoretical exercise.In addition, during the development, he must accompany and guide students in solving them.

When the activities finish in both groups, a summative evaluation is carried out for all the students, with the purpose of determining the level of knowledge obtained in the subject, in a given period.Assessments are one of the pillars of any teaching-learning process. Particularly, in the university higher education system, itis relevant for making decisions about possible epistemological and even methodological changes(Alarcón et al., 2019)

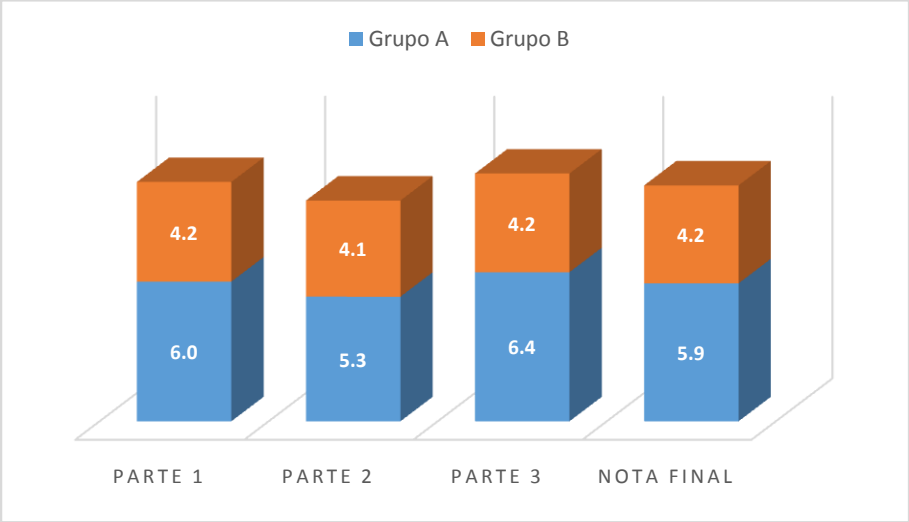
Discussion

To analyze the results, a quantitative study is carried out, which allows determining and quantifyingifthrough the application of the game, it was possible to increase the academic performance of the students. The level of exigency, for both groups, is evaluated with a grading scale, which begins with a minimum value of 1.0 and ends with a maximum of 7.0. At the time of measurement, the two groups of students are considered. It is necessary to remember that the first group, Group A, corresponds to those students where the game was applied, while the second group, Group B, belongs to those students who used the traditional methodology of theoretical exercises.Toevaluate performance in both groups, the same structured, written,objective and impartial instrument test is used. The document is built in three parts; being the first multiple choice, where different questions or statements are presented with several possible answers, some of which may be credible or partially correct, but only one represents the optimal answer. This type of test is used to measure learning

results, both simpleand complex; in the second stage, the student must record the accounting facts; and finally, in the third part, a statement of financial position and income statement is prepared in a very simplified way, using the graphic representation of accounting in it.

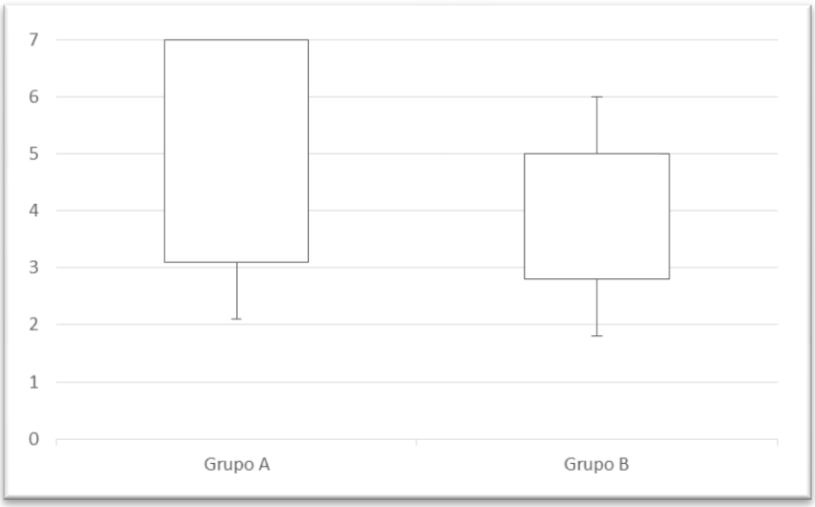
In relation to the analysis of the averages of grades in each group, it indicates that the students evaluated in Group A obtained better results than the students in Group B, see figure Nº1.

Figure N° 1.- Average of grades between Group A and Group B.



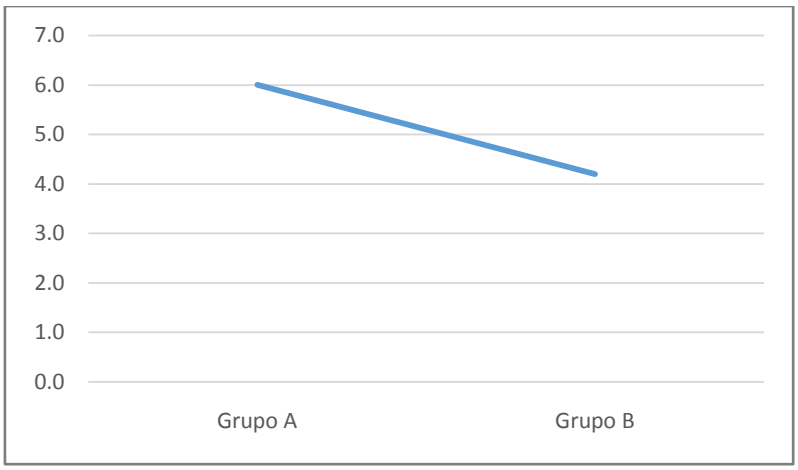
When analyzing the descriptive exploration of the grades, it can be seen that Group A obtained better results than Group B. In other words, students who applied active learning tools obtained better results than those students who used the traditional methodology. See figure 2.

Figure N° 2.- Descriptive statistics of the grades between Group A and Group B.



Group A obtained an average grade of 6.0 versus Group B, where their average grade obtained is 4.2. Figure Nº 3 shows
a clear difference in the results.

FigureNº 3.- Average values of the grades between Group A and Group B.



To analyze whether there is a significant difference between the mean scores of the grades, the t student testwith 95% confidence is used.

Hypothesis:

Ho: The means are the same

H1: The means are different

Table 1. - t Student Test.

	Grupo A	**Grupo B**
Mean	5,825	4,1875
Variance	1,530714286	0,63839286
Observations	8	8
Pearson's correlation coefficient	0,157881894	
Hypothetical difference of the means	0	
Degrees of freedom	7	
t statistic	3,398791524	
P(T<=t) una cola	0,005730665	
Critical valueof t (una cola)	1,894578605	
P(T<=t) dos colas	0,011461331	
Critical value of t (dos colas)	2,364624252	

The t value 0.01146 is less than the probability of 0.025, so it is assumed that statistically, there are differences between the means of the Groups.

In short, it can be affirmed that, when teaching groups of students with similar characteristics, the same content, but using different learning methodologies, different results are obtained in the grades of the students who were evaluated with the same scale and instrument. In this way, a greater increase in the mean of the grades is observed among thosestudents who are involved in an active learning process, compared to those who use a traditional learning methodology.

In relation to the direct observation of students, it is important to highlight that class attendance during the application of the methodologywas the following; the students belonging to GroupA achieved 100% attendance, versus Group B, who obtained 88%. Both variables were controlled in the same period of time. Students from Group A, acted more committed to their teaching process, their level of attention was concentrated mainly in thelearning processand the board game. In addition,they showed greater respect for the rules of the game, improved team work, and in the search foralternatives to win, some students showed more appetite to takefinancial risks when playing.

Conclusions

The implementation of active learning methodologies requires greater preparation by the teacher; he must be trained in the management of new teaching techniques, in the creation of

new dynamics and activities that involve all the students, and makes them participants in new challenges and common goals.

Supported in the analysis of the results obtained, it is inferred that the active learning can be motivated, using new strategies and didactic resources that generate in the student a greater interest in the subject, contributing to the comprehension and understanding of accounting, thus improving academic results. Active learning methodologies, such as a board game, can be a strategy that generates greater opportunities to learn actively, where all interested parties build and intervene, contributing to the assimilationof knowledge and interacting with peers; because in the game, conflicts and difficulties are overcome, teamwork is built, and attitudes and aptitudes are discovered.

When incorporating the game in the classroom, the professor must be aware that learning will be more integrated for students, since variables related to students' behavior and personality are also regulated. The rules of the games teach how to share, to work as a team, to receive guidance and suggestions from others. The game can also favor autonomy in decision making.

Active learning methodologies arise as an excellent alternative to didactic strategies, aimed at raising students' motivation and actively driving their learning, thus helping to create common goals and raising the useful awareness that the student perceives in a specific subject. In other words, it increases the student's interest in studying subjects considered irrelevant for them.

Additionally, it is necessary to indicate that accounting historically arises to satisfy a man's need, as a discipline reflects the economic facts that surround us, a discipline that has evolved over time and together with men. Based on this, it can be indicated that accounting as a discipline requires creativity, and this is why it should be possible to have a teaching-learning process with the same characteristics.Given that future professionals will work in changing environments, and will face uncertainty, it is recommended to continue investigating about the teaching processes and didactics that are used when teaching accounting, since we as teachers must be committed in promoting an optimal environment for the development of attitudes and skills, which will help them to face their professional life in a better way.

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