TABLE TOP FOR SCHEDULING AND CONTROLLING CONSTRUCTIONS COURSE

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ABSTRACT

This paper brings the report of using the table simulation method as a tool to reach required competences to Civil Engineering students. To obtain results in this project it was used questionnaires, pictures, movies and individual perceptions of the researchers. The theories used are directly linked to teaching by competence, the methodology of table simulation games and techniques of Scheduling and Controlling Constructions. The reached results are: a) identifying and development of competences of civil engineer specialized in Scheduling and Controlling Constructions; and b) ascertainment that learning is more effective when applied setting exercises and table simulation techniques. In the classes where this methodology was applied it was verified that the students were able to develop the required competences to the proposed course and their reaction showed their preference and approval for that kind of classes. In addition, when compared, it reaches levels of attendance and knowledge higher than lecture classes.

Keywords: table simulation, competence, construction scheduling.

1. INTRODUCTION

Many projects show the different way of using simulation in the educational environment, from finding solutions to particular problems to creating an environment that allows qualification for the activity (Larréché 1987; Wolfe 1993; Curland and Fawcett 2001; Khaled 2001; Santos 2002; Van Der Zee and Slomp 2009; Pasin and Giroux 2011).

The simulation here understood as a technique that allows studying, previewing and understanding the behavior of a system in a simplified way is the "permanently representation of reality" (Ellington et al 1981).

According to Daneshfar (2006); Salas, Wildman, and Piccolo (2009); Mahboubian (2010), learning from simulation takes the learner to construct knowledge in a safe environment where it is possible to make mistakes, understanding it and reaching correct results with no damage in the equipment or changing productive flow of the activity to be learned.

Learning through experimentation and simulation balanced with the application of theoretical classes results in a solid basis for students who needs knowledge for taking decisions in real scenarios (Latorre and Jimézes 2012).

Developing competence in courses of under graduation programs based on teaching methods that goes beyond the traditional teaching method may be the solution to achieve better results in the students' education.

According to Magee (2006) an approach to learning through the use of simulation and games in adults education has been working quite well in training paradigms, where the aim of the educational experience is the creation of a homogeneous labor force with consistent and predictable levels of competence.

The aim of this project is to prove the acquisition of the required competences to the students of Civil Engineering's "Scheduling and Controlling Constructions" course from the use of table simulation techniques (serious games) as a tool to add value to the methodology of teaching by competence.

2. SIMULATION IN UNDERGRADUATE EDUCATION

According to Larréché (1987); Thavikulwat (2004); Faria and Wellington (2004), it was in the 1950s that the first simulators were used in manager, economics and business area.

In the end of 1960s, in the USA, every business school was using some kind of games and simulation in their teaching programs.

In Brazil, the use in large scale began only the 1980s (Pantaleão, Oliveira, and Antunes 2003) based on the use of business games in undergraduate programs of business area.

Thereafter emerged games applications and simulations in undergraduate programs in other knowledge field, and some application in Engineering teaching may be emphasized, as the papers of Paxton (2003); Ross, Victor, and Stlather (2004); Costa, Bogado, and Jungles (2006).

In other knowledge areas, aligning learning and competence, from the focus of simulation and educational games, we can find some studies that bring the students' learner training in undergraduate programs.

In Thavikulwat, Chang, and Sanford (2013), it is shown to a group of 180 university students the analyses and the comprehension of the characteristics of merging and purchasing companies through a business game, simulating this experience in the academic environment.

Koops and Hoevenaar (2013) verifies the acquisition of concepts of Newtonian mechanics from the comparison of two students groups, the first one exposed to a traditional class and the second one using the simulation of learning games.

Reviewing the literature of the current status of simulation in adults' education, there is Magee's studies (2006) that go further this review reporting the main problems of the implementation of this model, the main trends of research, and the main educational issues by adopting this model of education.

The paper of Siddiqui, Khan, and Akhtar (2008); Salas, Wildman, and Piccolo (2009) discuss the benefits and effectiveness that the application of games and simulation in the context of academic education, though many cases the adoption of this teaching strategies may have a high cost, which is the main challenge to be overcome (Pasin and Giroux 2011).

Thus, the use of simulation from table games, a technique with low cost, was the one chosen to mediate the acquisition of the required competences to turn the Civil Engineer competent in the area of scheduling and controlling constructions.

The expected result was to verify how was the progress of competences development comparing to groups that were exposed to the traditional teaching and the competences methodology (Knowledge – Skills – Attitude).

3. METHODOLOGY

It is an applied research, in the view of the kind of research, once it "aims to obtain knowledge to the practical application headed to solving specific problems" (Silva and Menezes 2005) which is the qualifications of "scheduling and controlling constructions" students in Civil Engineering.

The moment built, described and analyzed in this paper is part of the Master thesis of one of the authors of this paper, exemplified below:

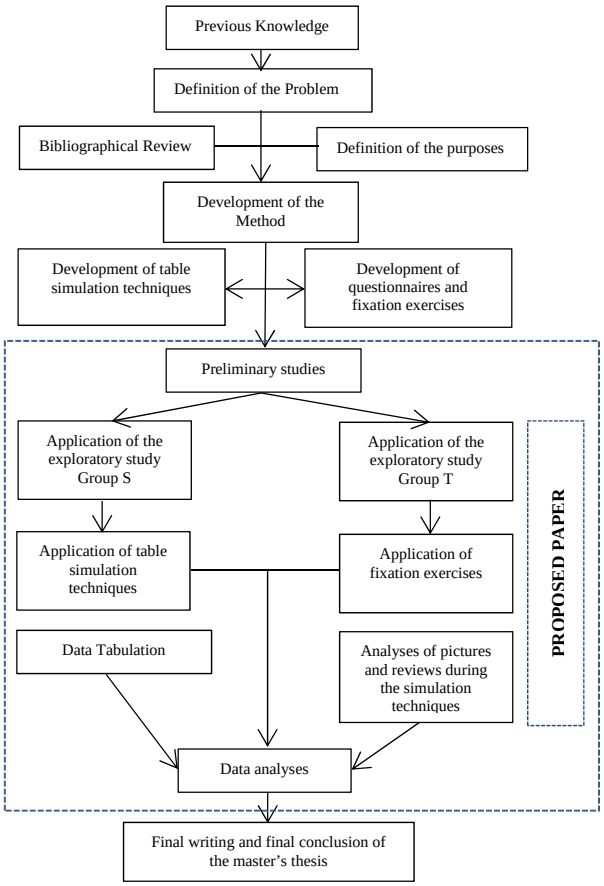

Figure 1 – Flowchart of master's thesis

For the moment of knowledge construction in classroom, it was chosen the strategy of Constructive Research, which is for Kasanen, Lukka and Siitonen (1996) a research procedure to produce "innovative constructions", to solve real problems and to supply theoretical framework to the course that it is applied.

The constructive research has as characteristics (Kasanen, Lukka, and Siitonen 1996): a) focus in real world problems to be solved functionally; b) production of an innovative construction aiming to solve the problem proposed; c) implementation to the developed construction, testing the practical applicability; d) cooperation among researchers to allow learning based on experiments; e) a powerful connection to a prior theoretical knowledge; and f) a reflection about empirical evidence based on a theory. Thus the main characteristic of constructive research is that the "constructions" are created and developed, where it is not possible to it be discovered.

Based in the Constructive Research, follows the structure of the work done which led the results presented in this paper. Figure 2 brings the logical system of this research.

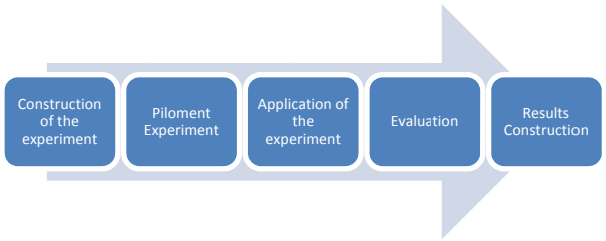

Figure 2: Logical scheme of research

The construction of this experiment came from the evaluation of the profile of the students enrolled at "scheduling and controlling constructions" course, with the sample of 64 students.

The experiment consisted in the application of the traditional teaching methodology and the methodology by competences (Knowledge – Skills – Attitudes) for both groups of Scheduling and Controlling Constructions course of University of Santa Catarina.

The experimentation was applied in two academic semesters (9 months) in two groups, with the amount of 64 students, nominated as traditional group (Group T) and group with simulation (Group S).

Group T: thirty students under lecture classes;

Group S: thirty-four students under KSA classes with simulator applications.

The application of the traditional methodology consisted in lecture classes with application of theoretical classes and practice of exercises, closing with the application of two writing tests.

The KSA methodology was built from the required competences for the academic student of Civil Engineering of the proposed course, using for it the application of table simulation.

At this point was defined the competences – KSA (knowledge, skills, abilities) (Durand 2000; Nisembaum 2000; Le Boterf 2002) required to become a Civil Engineer competent in scheduling and controlling constructions' field, achieving the following Table 01.

Table 1: Required competences for Scheduling and Controlling Constructions course

Knowledge	Skills	Attitude
- PERT/CPM Method Development of work plain; Sequencing of implementation activities; Scheduling resources. - Line of balance Repetitive tasks; Usage of Buffer in scheduling resources; Teamwork allocation. - Last Planner: Specific and long-term vision of planning; Long, medium and short term planning.	- Know how to plan; - Work as a team; - Communication; - Organization; - To delegate activities; - To solve problems; - To motivate the team; - To manage and control people; - Flexibility.	- Own-initiative; - Leadership; - Dynamism; - To take decisions; - Bargaining power.

Source: Adjusted from Odusami (2002); Moore, Cheng, and Dainty (2005); Cripe et al (2007); Dudon and Marchigto (2007); Navarro (2007).

Identified the students' profile and the required competences for the construction of learning in this course, the next step was to define the course leading using KSA technique, the instructional design.

At this point was chosen the table simulation techniques that would simulate the required practical to achieve the competences defined in Table 01, these techniques are: "*Jogo das casinhas*"; "*Miru Woli*" and "*Jogo do Carteiro*".

Figure 3: Example of the used techniques of table simulation

According to Vargas (1998), the "Jogo das casinhas" is a simulation of the execution of a set of houses using a reduced material design. Its purposes is to apply techniques of evaluation of labor force productivity and measurement of losses, showing the variety of modern project management techniques, and the gains that may come with the technological innovations adopted in the building site.

The table simulation technique "Miru Woli" works with the communication between the participants, where they have to choose, from many information, which ones fits to the purposed.

For Sugiura et al (1999) the technique of "Jogo do Carteiro" consists in walking between two P.O. Boxes, not talking to each other, communicating only through written messages. This simulation technique highlights the leaders who have the fundamental task of knowing how to express through the written communication.

These techniques of table simulation were applied during the analyzed term time, interspersed with setting exercises solved by the students which were collected and assessed statistically.

In order to validate the instructional design, of the materials prepared to the instruction and the chosen learning situation, it was made a pilot trial with 16 students for 4.5 months, where it was possible to verify mistakes, adjust time and activities, resulting the definition of the learning instruction based on KSA and supported by table simulation techniques.

The evaluation of the acquisition of the competences was made from the method of Kirkpatrick (1988), which developed the technique of evaluation and classification of training in four different levels, as showed below:

Table 2: Evaluation levels according to Kirkpatrick

EVALUATION LEVELS		
Nível 01	Reaction/Satisfaction	Evaluates the satisfaction of training after undertaking.
Nível 02	Learning	Evaluates before and after training, measuring the learning.
Nível 03	Change in behavior	Evaluates the different behavior before and after training.
Nível 04	Results	Evaluates the impact caused in the organization, from the training.

Source: Adapted from Kirkpatrick (1988)

This project was focused on levels 01, 02 and 03 in the evaluation of acquisition of competences from the use of lecture classes and the classes that used the table simulation techniques. Level 04 was observed by the researchers, assessed and reported to Analyses of Results.

4. ANALYSES OF RESULTS

During the reaction/satisfaction evaluation process (Level 01) during Scheduling and Controlling Constructions course was applied two questionnaires, developed and tested for this purpose, applied in the beginning and in the end of the course.

Table 3: Evaluation of Reaction/Satisfaction in "Scheduling and Controlling Constructions" course.

Reaction/Satisfaction Evaluation (Level 01)		
	Before	After
Group T	62.4%	70.5%
Group S	65.1%	88.7%

Table 03 shows similar results as the questionnaires applied in the beginning of the course in both groups; however the results of the end of the course are quite different, a small increase in Group T, and a substantial difference in Group S.

Observation and communication were the two points identified by the students of Group S as important to filter the knowledge taught and to use it in the working atmosphere, allowing:

- Make the relation with work and professional practice;
- Develop interaction and team work;
- Relate the developed content with other parts of the course and also with the under-graduation program.

In Group T, only with lecture classes, it was verified little perception of the importance of the course for the development of education in the undergraduate program and the integration of education and entrenchment of future working life of the student.

In the learning evaluation (Level 02) were applied eight fixing exercises, four evaluation tests and a final project in both groups, and in Group S it was interspersed with table simulation planned and scheduled for the course. It was taken for analyses, corrected and measured by the researchers group.

The following Table 04 shows the summary of results reached by the average of these activities for Group T and S, and also the average of attendance in both groups.

Table 4: Learning Evaluation of Scheduling and Controlling Constructions course

Learning Evaluation (Level 02)		
	Final Grade	Attendance
Group T	7.32	83.1%
Group S	8.06	89.5%

The difference between the average of final grades of the group who had lecture classes and the group who had KSA classes with table simulations was 0.74 points, what represents an increasing of about 10% in the final grade.

With the final result of attendance and the analyses of the course's offering records, it can be stated that there is lower truancy when it the methodology of KSA is applied in classes of Scheduling and Controlling Constructions course.

Another insight is the increasing of knowledge acquirement during this experiment (Chart 01) of Group S, since the student did not have a sufficient knowledge of constructive techniques or professional experience which could have affect in a higher final grade when faced with the use of a table simulation technique in the construction of this knowledge.

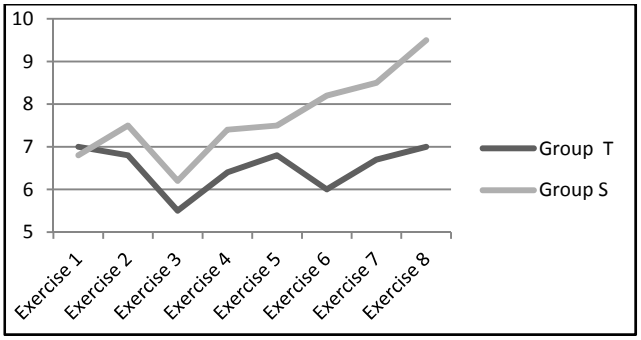

Chart 01: Average of the fixing exercises applied in Scheduling and Controlling Constructions' course.

At the moment to analyze the acquisition of skills and attitudes, it was observed the development of the skills mentioned in the study (Table 01), while the skill lower developed was team motivation, since it was not included situations that require this skill in the simulations, only during the technique of table simulation – *Jogo do Carteiro* – it was observed in some instance, when the group was delayed the leader acted to motivate.

The attitudes observed the own-initiative and dynamism were the most frequent, the leadership role, the decision-making and the observation power were also observed, however it were more frequent in table simulation of "*jogo das casinhas*".

Observing the changes of behavior was more complex, the majority of students have some of the skills mentioned, but in the study it is targeted to the professional field and since the students did not have a professional experience, these skills have never been used to scheduling and managing works.

Considering that it was the first time that they acted as Engineers and played as planners, it can be observed that there is a change of behavior between before and after the course (Level 04).

It can be stated that the Kirkpatrick (1988) training evaluation tool was successfully used in this study, proving that the students were, in the end of the course, competent in scheduling and controlling constructions from using table simulation as a tool to the construction of competences (knowledge, skills and attitudes).

5. CONCLUSION

For a student to be considered competent when finishing a program at a university, it should be given to them tools that develop their knowledge, skills and attitudes. It can be stated that the aim of this study was confirmed by the results obtained.

The skills and attitudes were identified in the national and international bibliographical researches and it is based on the Brazilian legislation, aiming to diagnose which would be necessary to turn them competent in Civil Engineering field and, consequently, in Scheduling and Controlling Constructions field.

Therefore, it can be observed that the competences, defined in the study, were constantly produced by the students during the application of table simulation techniques.

The motion of the methodology of KSA classes' proved that in the beginning of the course the students were totally lacking of competences referring to Scheduling and Controlling Constructions and in the end they had an excellent performance in knowledge, skills and attitudes.

Besides that, when applied the KSA classes' method it is noticed that the attendance to classes and the grade achieved by the students are higher than the achieved in lecture classes.

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