Active learning methodologies to develop cognitive skills in Engineering Courses

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Introduction

The development of cognitive and non-cognitive skills (socioemotional) is a necessity in the area of engineering both for the understanding of fundamental concepts, which is the basis of intellectual and academic formation, and for problem solving, which is intrinsic to the performance of the engineer in its different specialties, as emphasized in the National Curricular Guidelines of the CNE / CES Engineering - Resolution Undergraduate Program [1].

In this sense, this work proposes the use of active and collaborative teaching-learning methodologies and techniques in curricular components of the civil engineering and production engineering courses in order to improve students' academic performance, reduce the rate of avoidance of courses and qualify the graduates to meet the expectations of the labor market.

Active Learning Methodologies

In the 21st century, the search for education with a more social, political and ideological approach has promoted research and the use of active and collaborative teaching-learning methodologies [2]. The methods of active involvement of students in courses in science, technology, engineering and mathematics have been shown to be more efficient in the academic performance of higher education students, who increasingly demand a collaborative profile. Among the main active teaching-learning methodologies, which are shown as alternatives to the formal model of merely expository classes, we can mention:

- The *Inverted Learning* or Inverted Classroom method that proposes a reversal in the logic of the teaching-learning process, making students become active agents of their learning process [4,5].
- The *Just in Time Teaching* method, which is based on interactive teaching with the help of information technology to perform previous tasks of the activities to be carried out in the classroom [6].
- The *Peer Instruction* method, which proposes to actively engage students in the learning process [7].

The dynamics of the method of Instruction by the Colleagues is presented in Figure 01.

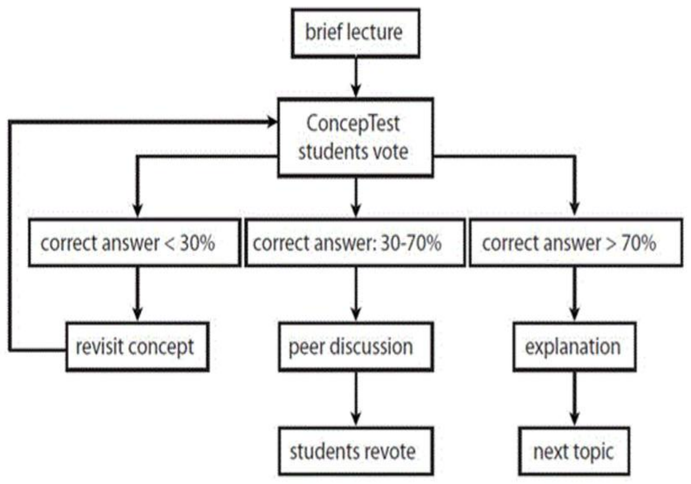

Figure 01 –Classroom dynamics using the method of Instruction by Colleagues [10].

- The *Project Based Learning* method that is characterized by applying projects with an interdisciplinary and collaborative approach. In this way, it is possible to develop the skills and competences of working in groups and building knowledge through research to seek the response to a real situation [8,9].
- *The Design Thinking* method that according to Tim Brown can be understood as a methodology that drives innovation activities through a human-centered design culture [8,9]. Figure 02 presents an illustration of *Design Thinking*, highlighting the moments of generating new ideas, refinement of information and development, and applicable design techniques such as the *bodystorm*.

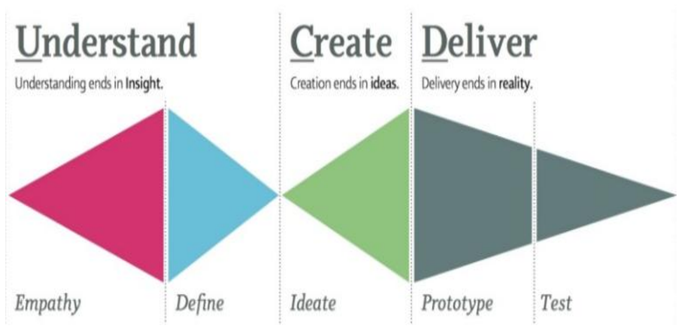

Figure 02 – Illustrative scheme of the Thinking Design method storm

Methodology

The implementation of the methodology and active teaching-learning techniques are being carried out in the Civil Engineering and Production Engineering courses at the Science and Technology Center of Mackenzie Presbyterian University. The pilot project is being carried out in the following curricular components: Differential and Integral Calculus I, General and Experimental Physics II, Product Development and Innovation, Technical Drawing and CAD and Architectural and Urban Design. In order to carry out the project, two classes of each discipline were selected, where one group is the experimental group, the active learning methodology is applied and the other is the control group, in which the traditional methodology of expository classes is being used.

Preliminary Results

Below we can see, for example, the result of the application of the questionnaire, called Force Concept Inventory (FCI), for the students of the course of Experimental Physics II (Figure 03) [10].

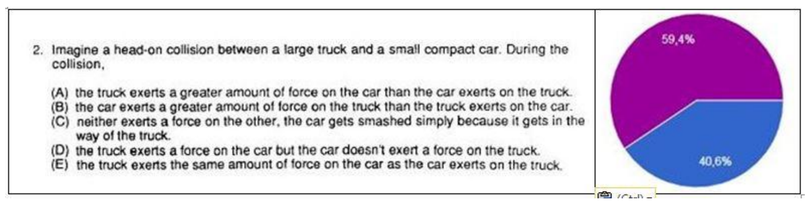

Figure 03 – Response of a question from the FCI questionnaire

It can be seen that 40,6% of the students selected item C and still think that the interaction forces between the two bodies are different contradicting the Newtons´ Trird Law showing the necessity of increase the conpect discussions in class.

Preliminary Conclusions

Several active and collaborative methodologies of teaching and learning have been applied in curricular components of the engineering courses and the perception of the methods as well as the academic performance of the students have been evaluated where the results will be presented in future publications.

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