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ACTIVE LEARNING UNDER THE INDUSTRIAL ENGINEERING PERSPECTIVE OF THE SECOND YEAR STUDENTS

Kelslene Carvalho Correa, kelslenec@gmail.com
Mayara Silva Mantovani, mayaramantovani@yahoo.com.br
Lucio Garcia Veraldo Junior, lucioveraldo@gmail.com

Centro Universitário Salesiano de São Paulo

***Abstract**: It is expected of the learning process of an engineering student the development of skills that are professionally required by the labor market. This need increases the interest to move forward and implement new teaching methodologies, which in this context was used the application of active learning methodology, peer instruction and project development in the Salesian University Center of Sao Paulo, unit of Lorena, applied in the fourth semester of Industrial Engineering. The new teaching methods imply a change in behavior both on teachers, who act as facilitators and collaborators, as students, who learn to act collaboratively through teamwork, in which they learn how to manage, to communicate effectively, to set goals and stick to them and how to understand the impact of their decisions. This article aims to present the assessment made by the students about the new methodologies through a quantitative questionnaire.*

***Keywords**: Active Learning, Higher Education, Industrial Engineering, Student's Perceptions*

1. INTRODUCTION

Engineering has always been linked to multidisciplinary; combining physics, chemistry and mathematics to design, invention and innovation, but the context is changing. Engineers, increasingly, have to be aware of social and environmental impacts caused by technology and, in addition, have to work with complex teams, interacting and cooperating with society (UNESCO, 2010).

Today's organizations require competitiveness, flexibility and efficiency to meet the needs of its customers. By contrast, customers are in faster switching process than usual and the life cycle of products is shrinking, in other words, the engineer in their daily work must deal with a liquid modernity, which is constantly changing. (Dias *et al*., 2013).

Engineers must know how to deal with the challenges in what are widely considered as a discussion center of activities related to engineering (Simon, 1996). The coaching of these engineers involves new models targeting the proximity of learning in the study of engineering with practices, particularly those related to interdisciplinary and teamwork (Adams *et al*., 2003).

The new models of learning and teaching include coordination of teams of students and that they develop necessary skills. The coordination of teams in this new model is based on design, projects or problems to be solved demanding new performances for teachers and students. (Fernandes Lima & Flores, 2003).

Through the project, students have to be able to lead, decide, manage, plan and adapt to such actions used to solve problems. PBL (Project Based-Learning) operates when students have the opportunity to link theory with practice and develop technical and soft skills (Aquere *et al.*, 2012). Sole and Schrader confirm that the PBL learning is a pedagogy that prepares students for the real world through activities that teach the critical thinking, negotiation skills, consensus building and responsibility for their own learning process (Sole & Schrader, 2007).

Thus, the purpose of this article is to study, analyze and present an overview of the perspective of the students of the 4th semester of Industrial Engineering about the active methodology applied in a specific context. We will seek to understand how the process of interdisciplinary projects is done in UNISAL (Salesian University Centre of Sao Paulo), Lorena unit, and through the results of questions addressed on the questionnaire, to understand the positives and critics that deserve attention in the search for improvement to the possible application to future projects.

2. THEORETICAL BENCHMARK

The engineer must be prepared properly to work with new technologies, products and processes in a multidisciplinary environment. For this, new ways and engineering education methodologies should be adopted (Manrique et al., 2010). Currently, the training of an engineer is demanding of the engineering schools a model more

dynamic of education, and this transformation involves an academic review, through training, schooling and assessment of teachers involved in this new paradigm change needed (Campos *et al.*, 2012).

According to Simon Veiga (2002), problem solving should be emphasized, creating conduction in the environment to develop techniques and soft skills. The ability to communicate effectively and work in multidisciplinary teams are some examples of soft skills.

Project-Based Learning (PBL) is an activity that addresses the knowledge and is aligned with the main topics of the daily life of engineering education, and also, is not a recent phenomenon.

The PBL-based learning is aligned with the trends of the most dominant engineering education (National Academy of Engineering, 2005) and the initial proposals of this methodology can be identified in the progressive ideas of John Dewey (1916) and they were further developed by Kilpatrick (1918) in his book "The Project Method". Its application in higher education gained dimension and visibility through the experiences developed since the 1970s in northern Europe, in the engineering courses at the University of Aalborg, Denmark (Graaff & Kolmos, 2007; Kolmos *et al.*, 2009).

The PBL process is done by a coordinating team that integrates the teachers of courses, tutors and researchers of educational institutions and involves five phases: organization, preparation, initiation, execution and completion (Lima *et al.*,2011).

The PBL requires an approach that goes beyond a project in form of exercise (Helle et al., 2003) in which a single course includes some work on projects, and specific courses are designed for the application of what has been learned in a context more practical. A more extensive approach of the project follows a model in which the project means the construction of knowledge by students through experiences that the project itself provided to them. However, there is not a widespread agreement of a single definition of PBL, mainly due to different contexts and interpretations in various educational institutions, but a sum of common elements can be cited. First, the projects are based on realistic and interdisciplinary problems that help students deal with specific concepts of disciplinary and interdisciplinary areas (Alves *et al.*, 2012).

Moreover, being the context not invented by the teachers, but, having a relationship with the practice of a future professional engineering and usually projects are maintained by teams of students and the responsibility is also the obligation of students. The project is not a short period of experience, it takes weeks or even months to finalize. Another common element is the result of the project: the teams have the goal of produce a real product, which may become a prototype, for example. However, all common elements such as duration, number of students per team, connection with professional practice and the construction of the product, may have a high rate of variation in different projects (Alves *et al.*, 2012).

PBL offers a range of activities related to the process of planning and management that it shows receptive when in group (Cinar & Bilgin, 2011). The activities require an intense and extensive interaction between the group members during the time that the project is maintained. According to Powell & Weenk (2003), teamwork is used about 40-50% of the activity.

Peer Instruction, is a cooperative and simple activity of active methodology created by Mazur in which it is used on a large scale (Carbone, 1998), and consists in the application of a particular issue or problem that lasts about two or three minutes to apply it, the students spend about a minute or two to think individually about the issue and its solution, then, is allowed, for about a minute, that the students try to convince his partners about his reply. After students discuss the problem, they check the solution and, again, mark your new answer (Koman, 1998).

In project management, it is a temporary endeavor that is carried out to create a product, service or result. In addition, the project has to be developed over a predefined period for the product be delivered with unique characteristics (PMBOK Guide, 2008). Problems related to project development are noticed by students as a real-life problem, requiring quick solutions therefore have the potential to engage and encourage teams to the action, executing the development of perspective on the problem of each student to build the best solution to this challenge (Alves *et al.*, 2012).

The students present new performances in which they demand autonomy, interdisciplinary integration and teamwork. And the new performances by teachers has as focus the learning process for student activities and participation in explanatory and instructional activities with a closer relationship with students (Aquere *et al.*, 2012).

3. METHODOLOGY

Fink & Kosecoff (1985) define survey, English term usually translated as data collection, as a method to collect information from people about their ideas, feelings, plans, beliefs, and social, educational and financial background. The instrument used in the survey, the questionnaire, it can be defined as a set of questions on a specific topic that does not test the ability of the one who responds, but rather the view, interests, aspects related to your personality and biographical information (Yaremko *et al.*, 1986).

The model of the quantitative questionnaire seeks to formulate preliminary hypotheses and specific verification methods, subjecting the phenomenon to experimentation (or systematic consideration), trying to control variables and eliminate factors that may cause confusion or obliquity in the search for causal explanation of phenomena. It is concerned with the reliability and validity so that they produce explanatory generalizations (Chizzotti, 1991). Steckler and contributors (1992) define as the purpose of qualitative to generate reliable measures, widespread and unbiased.

Dichotomous questions have two options, i.e., bipolar character of yes / no, agree / disagree, support / not support, usually a third option is offered, indicating insufficient knowledge or lack of opinion.

Chart 1. Advantages and disadvantages of using dichotomous matters according to Mattar (2008).

Advantages	Disadvantages
Quickness and facility of application, process and analysis. Facility and fastness in the act of responding. Lower risk of partiality of the interviewer. It presents lower possibility of errors. It is highly objective.	The respondents may be influenced by other alternatives. It can lead to measurement errors if the subject is treated in a dichotomous fashion, when in fact presents various alternatives. Depending on how the question is asked, questions with dichotomous answers are strongly subject to systematic errors.

This article is based on the use of a quantitative questionnaire with 18 questions, including 6 questions concerning the opinion of the students about the active methodology itself, 6 questions addressing the use of the clicker in the methodology peer instruction and other questions about the projects implemented by teachers, either as an interdisciplinary project or as projects used as evaluation method by certain teachers. The questions have dichotomous character whose possibilities are YES or NO getting the student's choice, and were applied to students of fourth semester of production engineering of the Salesian University Centre of São Paulo, Lorena unit.

Maassen (1997) points out that responses measured on a dichotomous scale, has the qualifying character, offering a clear selection of the interviewee's response. Raaijmakers (1999) says that a "yes" or "no," for example, which can be chosen as answer depends on how the other answers, to numerous other environmental factors. This shows that regardless of the respondent's strategy, the situation may not improve or worsen your situation by interview.

4. RESULTS

4.1. Results related to the Active Methodology

Chart 2. Questions about Active Methodology.

1º Question	In your opinion, the active method is more effective than the old method of learning?
2º Question	The teaching in the active methodology can annul all your questions?
3º Question	Do you work?
4º Question	Can you engage in the personal study required by active methodology?
5º Question	The theory was pervasive in a necessary way for the formation of technical knowledge?
6º Question	The teachers convey concepts clearly when using this methodology?

Analyzing the profile of the students, the vast majority are coming from public schools whose teaching methodology still is based in the old way, in which the teacher is dedicated to transmit the contents in a expository way and without real interaction with the students. Relating to this, the results obtained are equivalent to 19 negative ratings in the first question, it can be concluded that students are accustomed to the old method of learning, not occurring a process of adaptation.

Whereas one of the focuses of the active methodology is the particular study, the self-taught attitude, and therefore, we related two of the questions relevant to methodology, one of which related to the fact that students work, with 22

students answered YES to this question, however, of these 22 students, 20 answered NO to the question related to the commitment that each can apply to private studies. It was concluded that students fail to engage effectively to private studies, since they do not have enough time for it.

Another point to be considered is related to the doubts of the students on the theoretical concepts, in which the relevant question received 100% of negative results, which shows that students are not able to follow the lessons in a effective way, compromising learning. And this question also relates to the sixth question, which was the second more negative assessment, proving the difficulty of students to follow the explanations of teachers.

Note: A student did not respond the third and fifth questions.

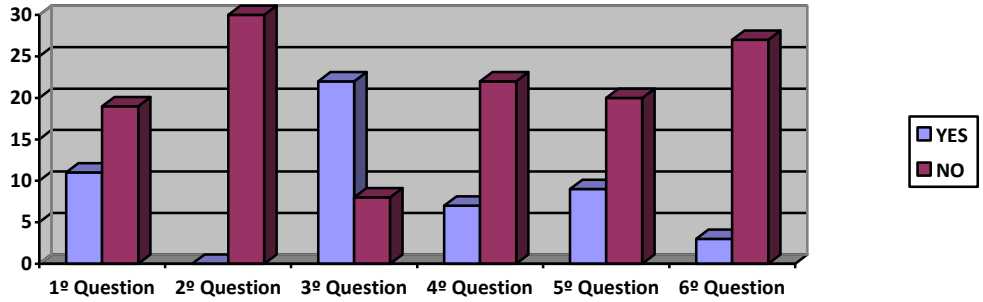

Figure 1. Comparison of the results of the quantitative questionnaire on active methodology.

4.2. Results relating the Methodology Peer Instruction

Chart 3. Questions about the Peer Instruction.

1º Question	You follow the steps correctly when using the clicker?
2º Question	Do you think it is important to use the clicker to your academic life?
3º Question	The purpose of the Peer Instruction is clarified?
4º Question	Can the teachers reach all students in their explanations?
5º Question	The theoretical concepts are passed clearly by teachers?
6º Question	The learning method by using the clicker is substantial and meets your doubts about the exercises?

From the results it can be seen that the purpose of using the clicker was not understood by the students, with a score of 21 students whose response was NOT to the question involved. Moreover, it can be seen that students do not feel comfortable when using this methodology, once they do not understand the purpose of it and they can not participate effectively, counteracting some of the principles of the Peer Instruction, which is the evaluation of student in a particular way and then as a group.

The two questions with major negative assessments are related to the learning process, one of which is related to the scope of the explanation made by the teachers involved in this methodology, showing dissatisfaction among students, the other question is directly linked to learning, demonstrating that the doubts are not clarified substantially, which causes that students do not follow the teachers, considering that both the students and teachers have important roles in the learning process (Powell & Weenk, 2003), teachers should take the facilitator or collaborator role in this process so that students can be able to engage and act actively in their own learning.

Note: A student did not answer the sixth question.

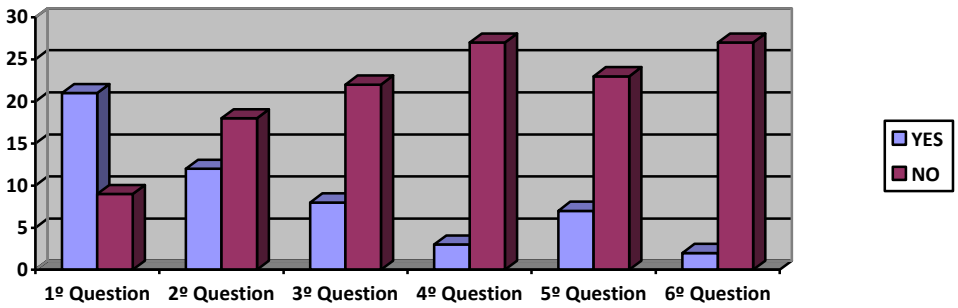

Figure 2. Comparison of the results of the quantitative questionnaire on Peer Instruction.

4.3. Results Related to Projects

Chart 4. Questions about projects.

1º Question	The theme of the projects has relevance to the professional future?
2º Question	Is it well defined the correlation between the theme of the project and the disciplines involved?
3º Question	Do you agree that it is of utmost importance the division of tasks within the group?
4º Question	The teachers are always available to offer help for the project?
5º Question	Can you obtain theoretical knowledge for the project through the teachers?
6º Question	The groups usually receive feedback from teachers about the project?

The conclusion of studies by students is a motivational and important factor, according to Moreira et al. (2011) due to the challenging effect that impacts on project success. The design theme and its relation to the professional future of the students is of crucial importance both for students and for teachers.

And the questions relating to the projects were the ones that, in total, obtained positive results, and the question related to the division of tasks it was the one that acquired the best ratings by students, followed by the question which the main topic was about the relevance of the projects in the professional future, which also received good results.

The association between the project themes with the involved subjects received both negative and positive evaluations, leaving a tied comparison.

The two questions whose results were negative was compared to theoretical knowledge transfer of teachers to students, where students end up having to look for concepts alone, therefore the students expect technical support from the teachers, not just monitoring and giving assistance in the project development. The other issue involves feedback on the projects done, where 18 students said they did not get it from teachers, making it difficult to manage errors and successes for personal evaluation of each team so that on each new project improvements can be made.

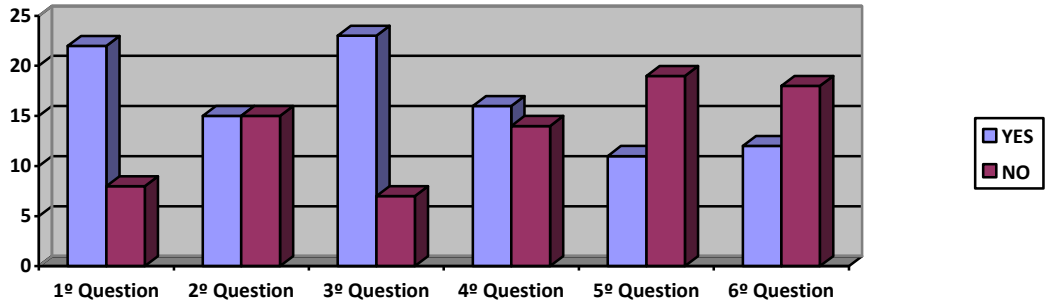

Figure 3. Comparison of the results of the quantitative survey on the projects.

4.4. General Result

Through a comprehensive analysis of the results, it was obtained a comparison between the positive and negative reviews of the active methodology, the methodology Peer Instruction and the projects.

Thus, it can be seen that both the Active Methodology as The Peer Instruction received negative evaluations, a total of 127 to 53 in both cases. About the projects, the evaluations were in general positive in a total of 99 to 81.

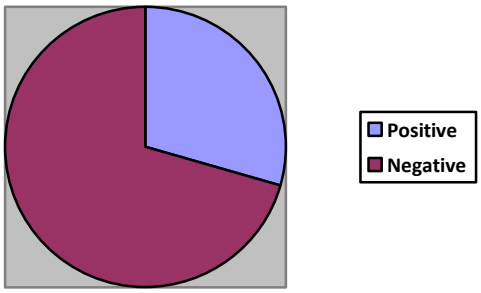

Figure 4. Comparison of the results on the active methodology.

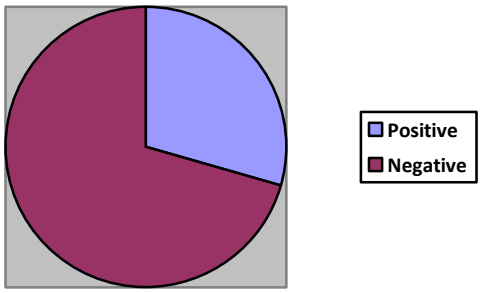

Figure 5. Comparison of the results on the Peer Instruction.

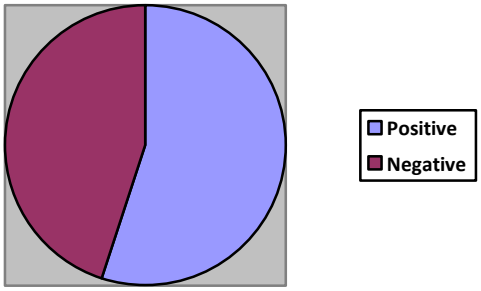

Figure 6. Comparison of the results on the projects.

5. CONCLUSION

The implementation of new teaching methodologies has been growing and spreading around the world, as there is a consensus on the need for changes in education directed to the area of engineering.

This paper presents an evaluation of the implementation of these new methodologies in the fourth semester of Industrial Engineering, and the assessment was based on analysis of results of a quantitative questionnaire that includes questions on active methodology, peer instruction and project development.

The analysis in this paper demonstrated critical and reflexive results from students that will help in maintaining and planning actions to continually improve the application of these methodologies. This is essential for the improvement not only of the learning process, but also for the continuous development of teachers.

Both the Active Methodology as Peer Instruction teaching methodology should be analyzed more deeply to make them more accepted by students, who must understand and believe in these models, which can be done through the interference of the teachers themselves, focusing not only on applying these methodologies, but rather on how students feel about them, making teachers important elements for the development and adaptation of the students.

As future work, the questioning could be applied direct to teachers. As for the development of interdisciplinary projects, how the active methodology has a strong presence. It could be implemented evaluation procedures both for the skills of engineers, as the necessary knowledge.

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