

# How An Educational Program Can Improve Learning for An Engineering Student

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**Abstract:** The evasion in Higher Education, especially in science courses, is a reality faced by Universities not only in Brazil, but also in several other countries around the world. The number of students who drop out of university is very expressive, resulting in academic, economic and social losses. To try to minimize this problem, the Universidade Federal do Pará (UFPA) together with the Instituto de Tecnologia (ITEC) created in 2011 the Levelling Courses Program in Basic Sciences for Engineering (LCPBSE), whose main area of action is to teach basic Mathematics, Physics and Chemistry for the newly enrolled students in Engineering Courses. These classes happen before the students have contact with the first subjects of the basic cycle, especially the discipline of Calculus 1, common to all Engineering Courses. Recent statistical studies have demonstrated that LCPBSE has a relevant role to reduce educational gaps in conceptual and operational fields in the basic sciences to Engineering, in addition to working essential topics to the basic courses of undergraduate. Recognizing the importance of LCPBSE as fundamental tool against evasion rate, the research is aiming to better understand its functionality and how it was able to increase the approval ratings. Thus, this paper has as objective to explain how the LCPBSE supports students and it tries to understand what epistemolog-

ical learning mechanism under the factors contributing to students academic performance increasing. The methodology was based on the bibliographical research of several authors who study the cognitive learning. Among them, we studied those who had a philosophical cognitive/constructivist stance: Piaget, Vygotsky, Kelly, Ausubel and Vergnaud. As a result of this studies, we focus on David Ausubel's work, who proposes the Meaningful Learning Theory, a thesis that may be able to explain how LCPBSE is helping students to learn more efficiently. According to Ausubel, for learning to be meaningful, it is necessary for the new information to relate to a relevant aspect already existing in the learner's cognitive structure. These relevant aspects are called subsumers, which serve as an anchor for the new knowledge to be acquired. Based on this, the LCPBSE classes may be serving as an organizer of the students' subsumers, so that they can attend the Calculus classes already with the necessary prior knowledge. Finally, we concluded that the organization of subsumers can be a critical strategy used to improve learning and to decrease the evasion rates. Such strategy can be applied not only in the LCPBSE, but also in other programs of other Universities.

**Keywords:** Meaningful Learning, David Ausubel, Engineering, Evasion, Subsumers.

## 33.1 Background

According to estimates made by INEP (National Institute of Educational Studies and Research AnísioTeixeira), the average annual dropout rate in Brazilian higher education in the period between 2001 and 2005 was 22%<sup>1</sup>. Analyzing this percentage, and considering that the number of enrollments made in 2008 was 5.080.056 students<sup>2</sup>, it is possible to verify that 22% of 5.080.056 equals 1.117.612. That is, it is possible that more than 1 million academics have given up on pursuing higher education in the year 2008.

In order to try to minimize this problem, the Institute of Technology (ITEC) of the Federal University of Pará (UFPA) created in 2011 the Levelling Courses Program in Basic Sciences for Engineering (LCPBSE), whose work consists in alleviating the basic difficulties of a newcomer in higher education. Among the various factors that influence evasion, the Program works on that related to the poor quality of basic education.

The main action front of the program is to teach expository classes in elementary mathematics, physics and chemistry. So, the students who do not have an efficient educational base can alleviate their difficulties and level their knowledge. These classes are taught before the academics have contact with the first undergraduate subjects. They will serve as a basis for learning content from Calculus 1, for example.

## 33.2 Purpose/Hypothesis

Statistical studies have shown that the LCPBSE is playing an important role in assisting students' performance in the university's early disciplines. The approval percentage of those who took the leveling course is higher than those who did not. However, the success of the Program is still unknown. It is not yet known what epistemological mechanism is being used to achieve such results.

Then, recognizing the importance of LCPBSE as a fundamental tool against evasion rate, the research seeks to better understand the functionality of the program and how it was able to increase approval rates. Thus, this paper aims to explain how the LCPBSE supports students and seeks to understand the mechanism of epistemological learning under the factors that contribute to the increase of students' performance.

## 33.3 Design/Method

In order to find some theory that explains how the LCPBSE can help the student's performance in the subjects of Calculus, a bibliographical research was carried out between thinkers who study the teaching-learning process and human cognition. In this field of knowledge, three philosophical positions predominate: Behaviorism, Cognitivism and Humanism.

The present work does not seek to emphasize the behavioral question nor

the human question, but it seeks to understand the mental processes of the students. Therefore, it was decided to study the theoreticians who have a philosophical cognitivist position, that is, it was made a bibliographical survey of the ideas of Jean Piaget, Lev Vygotsky, George Kelly, Gerard Vergnaud and David Ausubel, since these authors develop theories of the Learning with a focus on cognition. Some of these thinkers, in developing their theory, do not have learning as a central concept, as in the case of Piaget, which focuses on cognitive development. However, its principles have great implications for the understanding of the teaching-learning process.

## 33.4 Results

Among the theories and authors studied, it was verified that the Meaningful Learning Theory of David Ausubel has aspects that can be related to what the LCPBSE has been doing. The classes taught by the program may be developing the prior knowledge necessary to learn meaningfully the contents of Calculus. The classes could be, according to Ausubel's words, differentiating the students' subsumers.

The Meaningful Learning is the process by which the new information interacts substantively and non-arbitrarily with what the student already knows. It is the process by which ideas expressed symbolically relate to a specifically

and relevant aspect of the individual's cognitive structure, that is, this process involves the interaction of new information with an already existing specific knowledge structure<sup>3</sup>.

When it is said that the interaction is substantive, it is meant that it is non-literal. And when it is said that it is non-arbitrary means that the interaction is not with any previous idea, but with some specific and relevant knowledge that already exists in the cognitive structure. To this knowledge, David Ausubel calls subsumer, which can be a concept, a proposition, a mental model, an image or an already significant symbol, for example<sup>4</sup>.

The subsumers serve as an anchor for the new knowledge. In this process, in addition to assigning meanings to new information, the subsumers also acquire new meanings, and end up undergoing a stage of growth and modification. In doing so, it becomes richer, more elaborate, and more stable. The concept of force, for example, can be expanded. The student who comes in contact with the new knowledge about gravitational force now understands that force can be attractive in nature and applied over long distances. Thus, the subsumer "force" became clearer, more differentiated and broader.

The classes taught by the program play the role of developing the subsumers that will be needed to learn meaningfully. Many academics enter the university without possessing the basic skills and competencies required in a college degree. Without these fundamentals, it is difficult to understand and relate new

knowledge, although some pedagogical strategies are used to promote learning. So the LCPBSE has the function of differentiating the subsumers, making them more elaborate, broader, more stable, more inclusive and richer in meanings. In this way, the cognitive structure will be better able to give meaning to the new information.

The program accomplishes this objective through 3 procedures: identification of the relevant prerequisites, identification of students' previous knowledge and consolidation of the less elaborated subsumers.

Some statistical studies have shown the effectiveness of the program in students' income in Calculus 1. During the years 2013, 2014 and 2015, the percentage of students who took LCPBSE and those who did not take LCPBSE were measured. The data is separated by Engineering course and shown in the Figure 33.1.

## 33.5 Conclusions

The work sought to explain what epistemological learning mechanism the LCPBSE uses to improve the approval rates. Based on the Meaningful Learning Theory, it was verified that LCPBSE fulfills the function of developing the subsumers, making them more differentiated, elaborated and inclusive, so that they are able to serve as an anchorage for the new information. Without

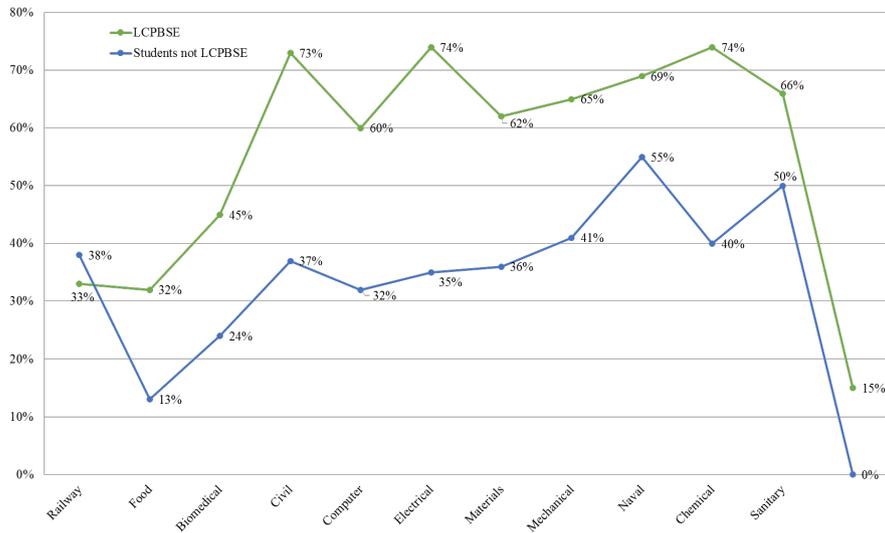


Figure 33.1 – Percentage of Engineering approval.

these stable and available subsumers in the cognitive structure, the student is not able to learn meaningfully.

In the midst of the great social losses that evasion represents, it is important to join efforts to guarantee the permanence of the academic in higher education. In this sense, it was verified that the development of the subsumers is a strategy used by the LCPBSE that is working well, and this strategy can also be applied in other programs of other universities.

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