

# Practical Based Learning (PBL) for Academic, Technological and Scientific Education in Engineering Courses - Case Study

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**Abstract**— *The increase in the number of students evaded has alerted different segments of society and the public sector to the need to update the guidelines of engineering courses as well as innovation in teaching engineering. In this sense, the objective is to report on the challenges of engineering education in Brazil and the methodological strategies that have been adopted for the modernization of the curricula of engineering courses and consequent reduction of the indicators of avoidance and withdrawal. In addition, involving the use of the 43 academic academics of the University of Cruz Alta (Unicruz) who studied the discipline of Research Methodology in the second semester of 2017 through the Problem Based Learning (PBL) strategy as an innovative strategy education. Finally, in addition to the production of a technical material produced throughout the course, it was observed that there were only 2 students in 1 failed exam, demonstrating that teaching by PBL has high effectiveness for academic achievement in the discipline of research methodology.*

**Keywords**— *Agronomic Engineering, Civil Engineering, Environmental and Sanitary Engineering, Production Engineering, Research Methodology.*

## I. INTRODUCTION

The quality of education at different levels of schooling has been the object of analysis and studies in different parts of Brazil and the world in the attempt to understand the dynamics, the challenges and propose technically and economically viable solutions considering the different elements that make up the relations and [1;2]. In this scenario, a series of analysts, scholars and researchers have

emerged who, considering the national policies for education in Brazil in the different spheres, seek to outline the profile and needs of the different agents of education, considering the social, economic and, more recently, as strategies to establish pedagogical practices in a more effective, economically viable, and socially acceptable way in order to form politically aware citizens and, at the same time, to form active agents of transformation in their social context in what concerns the improvement and guarantee of the quality of life of the citizen subject [3;4;5;6;7;8].

In any case, the elements of social interaction that establishes teacher-student relations in higher education have undergone profound transformations, requiring a new look at the dynamics of higher education in the face of the technological and behavioral advances that have become more pronounced since the advent of was digital [4;6;8]. In this scenario, the understanding of didactics as a resultant competence of the psycho-intellectuals-emotional attributes inherent to the teacher in the establishment of the dialogue and transmission of knowledge in the academic-teacher relationship had to be re-discussed and contextualized to the contemporary demands resulting from the profound social and technological transformations that is determining the new dynamics in higher education [1;2;4;5]. In this context, the aim of this study is to present a brief report on the challenges of engineering education in Brazil and the methodological strategies that have been adopted for the modernization of engineering curricula at the University of Cruz Alta - Rio Grande do Sul. discipline of Research Methodology for undergraduates of the engineering course for the adoption

of Problem Based Learning (PBL) as an innovative teaching strategy.

## II. METHODOLOGICAL PROCEDURE

Based on the proposed objective, this case report is characterized as a descriptive research. In order to evaluate the learning efficiency of the discipline of scientific methodology applied to engineering courses, it was considered the income throughout the discipline in face-to-face activities, distance activities, presentation of scientific technical topics in disciplinary meetings, preparation of a technical study project to the work axes of agronomic engineering courses, environmental and sanitary engineering, civil engineering and production engineering. The period of study coverage occurred between 2014 and 2017, involving 430 academics in the engineering courses of the University of Cruz Alta. For the evaluation of undergraduates' technical project presentations, professors from other applied disciplines of the engineering courses were invited at the end of each semester. In each class had enrolled around 30 to 40 undergraduates for each Professor responsible for teach class pertinent contents to the scope of the Research Methodology.

In order to guarantee only the evaluation of the pedagogical strategy based on PBL, we compared the academic performance of undergraduates submitted to this didactic methodology, were compared with the academic performance of graduating from years prior to the application of this pedagogical strategy. Evacuation indicators were also considered among the classes as a way of evaluating the acceptance of undergraduates with the pedagogical strategies characteristic of PBL.

## III. RESULTS

According to Campos and collaborators (2015), active learning using problem-based teaching methodology (PBL) is configured with a promising alternative in the development of the teaching / learning process for engineering content [9]. In this methodology it is necessary that the student must learn to solve problems of his professional area within an interdisciplinary vision, which in turn favors the ability to develop skills and abilities and teamwork. The difference of this methodology in comparison to the methodology traditionally adopted in most of the higher education institutions in Brazil is due to the fact that the student is the main responsible for his / her own knowledge, stimulating to incite to the pro-activity of the academic [9;10-14].

In this sense, the case report involved 430 engineering undergraduates from the University of Cruz Alta (Unicruz) who studied the Methodology of Research Classes among year of 2014 up to 2017. This group was submitted to the pedagogical strategy based on PBL as an innovative

strategy of teaching the from the second two-month period by the formation of 90 teams in which the academics elaborated a review of the technical literature of nine topics of interest of the professional formation of the engineer having as reference the techniques and concepts of research methodology seen in the first two months of classes and deepened in the course of group reviews. In addition, it was agreed that the manuscripts would be evaluated by teachers of the engineering courses, subjecting them to the need to prepare for the oral presentation.

In addition to the involvement of academics, it was verified through the evaluation report sent by the Permanent Evaluation Committee (CPA) that 83.87% of the academics said they were very satisfied with the methodology adopted in the discipline. In addition, academics pointed out in the report offered by the CPA that they preferred the PBL-based method adopted during the 2nd quarter, that the traditional and passive teaching-learning model adopted during the first two months. The main results of these changes should be highlighted the results obtained and the high frequency after the adoption of the PBL and, at the same time, there was a reduction of 82.5% in the number of absences between the 1st and 2nd bimester and better utilization in multiple-choice tests, in which the average between the two-month period rose from  $6.55 \pm 3.15$  to  $7.95 \pm 1.43$ , respectively. In addition, the academics prepare a presentation and manuscript that had been submitted to the I Prointec - Show of Integrative and Technological Projects of Engineering as part of the evaluation of the discipline. Finally, in addition to the production of a technical material produced throughout the course, it was observed that there were only 20 students in exam 10 failed.

When compared to indicators of avoidance and repatriation related to the classical pedagogical approach, based only on the observation of the content taught by the teacher, the writing of evasion was verified in 84.5%. While the number of disapproved in the discipline was 92.5%. In this sense, it is possible to affirm that the pedagogical strategy based on learning by previously defined projects (PBL), allowed the greater involvement of the academics and, consequently, greater use in conceptual terms and, mainly, in the reduction of academic avoidance in the discipline.

## IV. DISCUSSION

According to Thomas Tredgold (1788-1829) he defines engineering as "the art of directing the great sources of energy of nature for the use and convenience of man" [14]. In this way, engineering courses are characterized by their high content of disciplines related to physics, mathematics and chemistry that demand a high degree of abstraction, associative and correlation capacities for the understanding

of natural phenomena and reproduction in a technical and optimized way for generation of a good and understanding of the phenomena that involve a chain of production [5;13].

At the same time, there has been an increase in vacancies in engineering courses in distance and hybrid education throughout the country, as well as in the number of students who have escaped, making higher education institutions, the Ministry of Education (MEC) and National Confederation of Industries (CNI) warned about the limited number of engineering academics and the need for engineers as a strategic professional in promoting economic, industrial and social growth in the country. The Brazilian Engineering Education Association (ABENGE), in association with the Business Innovation Movement of the National Confederation of Industry (MEI / CNI) and the Federal Council of Engineering and Agronomy (CREA - Confea), presented in January 2018 to the National Council of Education (CNE), a proposal for guidelines for engineering courses containing a series of notes on engineering curricula for the twenty-first century, going through the need for constant updating and methodological innovations for engineering teaching considering the social and technological advances that have been modifying the academic-teaching relations and that guarantees the technical and leadership formation for the conduction of the Brazilian productive sector [14].

The practice in teaching in higher education requires constant updating by the teacher and the institution and patience and high motivational skills and conflict management [1;3;5;7].

Conflict management is due to the fact that new students enter full of expectations and with almost no emotional resilience to situations of frustration characterized by difficulties of following the content inherent to the teaching-learning process of more complex contents, a debatable educational base due to the structure of education received at previous levels and the lack of persistence in staying motivated and assimilating the new contents because they demand an effort and disposition for the study that is not necessary for the proper formation, and not only the information of a given content [1;3;4;11]. Consequently, the lack of maturity and difficulties commonly faced throughout university life has led academics, mainly engineering academics, to give up or abandon their courses [5;12].

In this context, the adoption of methodological strategies adapted to the demands of the engineering courses becomes indispensable for the formation and maintenance of the academic of engineering during the 5 years of academic life. In this way, the courses of continuous training, extension, lato sensu and stricto sensu are the channels for the constant updating of the teacher to meet expectations, to solve and to circumvent academic

conflicts as part of the strategy to reduce evasion, abandonment and better utilization in order to be able to use the knowledge and skills of the future engineer [11;12;13].

## V. CONCLUSION

Finally, the teaching practice as a capacity for transfer and construction of knowledge in a regulated, motivated and technically oriented way that allows the technical and scientific training appropriate to the professional contexts in which the student, future professional, will find in the day-to-day job market. As far as engineering academics are concerned, it has been verified that in addition to a good average demand for pedagogical complementation of chemistry, physics and mathematics in the initial semesters, it is also the responsibility of the teacher and institution to constantly monitor the deficiencies of academics, constant updating of management strategies people to cope with the different generations who seek and reach higher education and continuing education of the teacher in order to remedy the deficiencies of the academic ones as the technical content is ministered from techniques and pedagogical tools like the PBL in the context of the discipline of Research Methodology for Unicruz engineering academics. With regard to public policies and curricular guidelines, there is a movement to update engineering curricula in the face of technological advances and that is more adapted to current and future generations of digital native academics.

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