Alive Engineering Education

Innovating Engineering Education beyond Borders

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We dedicate this work to all those people that, directly or indirectly, have contributed to make this book come true.

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Preface

The National Curriculum Guidelines of the Engineering Undergraduate Course (Engineering DCNs), approved on 23 April 2019 in Brazil, point to continuous improvement in the training of Engineers as one of the critical factors for economic and social development. Indeed, this improvement is an important element due to differences in productivity and dispute between countries. This is the big challenge!

Certainly, the use of Active Methodologies should be encouraged as a way of promoting student-centered education. In fact, it is hoped that the new Engineer can learn autonomously by dealing with complex situations and contexts. In addition, it is expected that it will be able to assume an investigative and autonomous attitude, with a view to continuous learning, the production of new knowledge and the improvement of new technologies, as well as “learning to learn”.

As the papers in this book shows, many professors are already using Active Methodologies and initiatives in Engineering Education also come from papers submitted by undergraduate and graduate students. As a matter of fact, the papers in this book come from five different countries, namely: Brazil, Israel, the Netherlands, Taiwan (R.O.C.) and Portugal. As follows, the name of the book was appropriately chosen: "Alive Engineering Education: Innovating Engineering Education beyond Borders". I wish you all a good reading!

Getúlio Antero de Deus Júnior

CHAPTER 1

Board Game and Active Methodology: Innovation Has Not Increased with More Time

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Abstract: The gamification was used as a pedagogical instrument in the discipline of Logistics Planning offered in the category of Free Nucleus in the semester 2018 2 by the Electrical Engineering course. The methodology of game's evaluation was presented with prominence, the first occurring in the 6th week (near the beginning of the semester) and the second in the 15th week (near the end of the semester). The major difference was the liberty of material (format, size, durability and etc.) to be used in the first evaluation and the mandatory (aesthetic) standardization of all materials in the second evaluation. The results of the first evaluation were sent to all students before the second evaluation, a fact that could suggest a hypothesis: the more time the better innovation. The research revealed that the systemic view in the 1st evaluation was a total of 69% and of 77% in the second evaluation, the innovation in the 1st evaluation was a total of 65% and 73% in the second evaluation; the element‘s harmony in the 1st evaluation were a total of 68% and of 67% in the second evaluation; the theoretical foundations in the 1st evaluation were a total of 50% and of 47% in the second evaluation. But in the five other topics evaluated there was no significant improvement in the second evaluation. Even with more time used, the results remained the same. It should be highlighted among the different aspects and circumstances that surround the students of the engineering day-to-day the anxiousness caused by the tests at the end of the semester, wich suggests a hypothesis: more time, more pressure and less innovation.

Keywords: Gamification, Board Game, Logistics, Active Methodology, Research.

1.1 Background

There are several teaching methodologies that can make the class more attractive to the student. In this study two methodologies are used: gamification and pbl (project-based learning). None of the audiovisual resources are used during class hours, but students are encouraged to develop solutions that cater to a specific audience with the support of the internet. The beauty of the internet lies in the democratization of the means of invention and production. Anyone with a service idea can market it with a few lines of software (nowadays, you don't even need a lot of programming skills, and the bare minimum can be learned online) - without patents[1]. Identifying a problem and seeking solutions that can add value is a challenging task that allows students to experience situations that may awaken their entrepreneurial spirit. The entrepreneur sees change as the norm and as healthy. Generally, it does not bring about change by itself. But, and this defines the entrepreneur and the entrepreneur, the entrepreneur is always seeking change, reacting to it, and exploiting it as an opportunity[2]. Any situation can be considered an opportunity if the entrepreneur - in this case each student - has a critical view of the current reality and future scenario (changes). The first step would be to decompose the great vision into its parts. The two most important assumptions entrepreneurs make are what I call the value hypothesis and the growth hypothesis. First answer four questions: 1) Do consumers recognize that they have the problem we are trying to solve? 2) If there was a solution, would they buy it? 3) Would they buy it from us? 4) Can we develop a solution to this problem?[3].

1.2 Purpose/Hypothesis

The project-based methodology has time as one of its resources and must be used within the goal set on the first day of class. Time is the unsurpassed frontier of human endeavor, affecting everything from the way we work to the moment when things lead us to decide whether we are successful or not[4]. In the world of innovation, any result - even failure - can be considered as a step in the search for current project improvements or targeting another previously unidentified consumer audience.

1.3 Design/Method

Students receive the teaching plan on the first day of school, highlighting the teaching schedule and methodology based on a board game project. The goal of the students is to develop the design of a board game and create a prototype (that can't be digital). The subject of the game may be freely chosen by the students as long as it portrays the theoretical foundations of the course in which they are enrolled at the University or of the discipline they are currently taking and they may work in groups up to three students. The process is divided into phases: ideation; project; base prototype; validation of the base prototype; improvement of the base project; final prototype and validation of the final prototype. Validation is performed into the classroom using a standard form with seven topics: (1) systemic view of the game; (2) the game's practicality; (3) the game's utility; (4) game innovation; (5) harmony of the elements presented in the game; (6) theoretical foundations present in the game; (7) unprecedentedness of the game. Research exploratory type, quantitative and documentary means[5-6].

1.4 Results

The evaluation instrument with 7 questions was the same in the first and second evaluations. The research revealed that the systemic view in the 1st evaluation was a total of 69% and of 77% in the second evaluation; the practicality in the 1st evaluation was a total of 41% and of 70% in the second evaluation; the presentation of the idea in the 1st evaluation was a total of 40% and of 40% in the second evaluation; the innovation in the 1st evaluation was a total of 65% and 73% in the second evaluation; the element's harmony in the 1st evaluation were a total of 68% and of 67% in the second evaluation; the theoretical foundations in the 1st evaluation were a total of 50% and of 47% in the second evaluation; the novelty in the 1st evaluation was a total of 49% and of 83% in the second evaluation, as showed in Figure 1.1.

1.5 Conclusions

As seen, in the other five topics evaluated there was no significant improvement in the second evaluation. Even with more time used, the results remained the same. It should be highlighted among the different aspects and

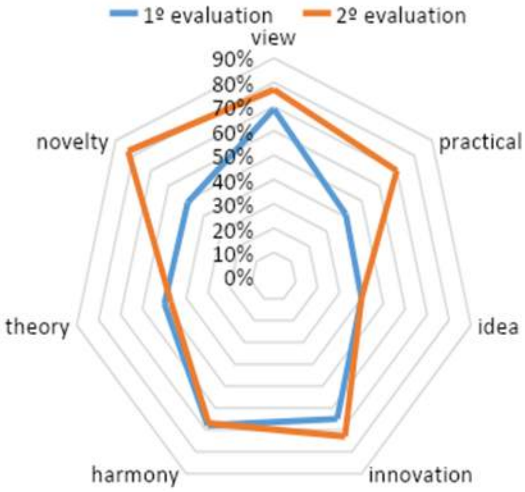

Figure 1.1 – Game Evaluation.

circumstances that surround the students of the engineering day-to-day the anxiousness caused by the tests at the end of the semester, wich suggests a hypothesis: more time, more pressure and less innovation. All innovation efforts are inherently uncertain[7]. Students developing their projects were encouraged to experience an environment of little or no certainty, with their academic grades higher than the grades given to their projects. Games have always been a part of our culture as a social practice[8]. The classroom is a particular portrait of the social environment and gamification is fully assimilated in the daily lives of students. Many companies around the world have built offices that resemble the facilities of a kindergarten, hoping to rekindle that rich and vibrant flame of our young days[9]. The Universities' challenge is to create spaces that can rescue the creativity experienced by students at the beginning of their school life.

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CHAPTER 2

Integrative Learning: Interdisciplinary Methodological Innovation

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Abstract: The paper discusses the concept of Integrative Learning (IL) as a methodological strategy for the construction of interdisciplinarity and how the academic environment promotes interdisciplinarity in the attempt to produce meaningful knowledge for the complex context in which we live. IL is a strategy that has been used mainly by American Universities since the 2000s. Since then, economic globalization - as a result of advances in communication and transport technology - combined with a free market ideology have led to an increase in free trade between countries. This scenario of great and profound technological, economic and social changes requires improvement in product quality, increasing competitiveness and the need for more and better professional qualification. Institutions of higher education in the most diverse areas have felt the need to improve and diversify the skills of their graduates. The proposal of IL methodology can provide students with opportunities through which they can reflect on experiences and on great problems of society in which they are inserted. Institutions have realized that it is not enough to provide only specific knowledge of an area, but also a systemic vision, with the integration of knowledge from several areas in order to prepare students for a labor market that is more demanding and competitive every day. The text discusses the concept of IL and the results of a bibliometric study of the term. The papers were selected from Web of Science, Emerald, Scopus, Scielo, Spell and Ebsco. The criterion for choosing these bases took into account the fact

that they are recognized by the quality of the publications stored and because they allow a better comprehensiveness of the research. The initial research featured numerous works by American researcher Julie Thompson Klein, a professor of human sciences in interdisciplinary studies at Wayne State University. Her article “Integrative Learning and Interdisciplinary studies”, drew attention to the IL movement that was gaining momentum in American Universities. As a result of the application of the IL concept, a research group on Sustainable Engineering was created at Escola de Engenharia de Minas Gerais-EMGE, School of Engineering located in Belo Horizonte, MG, Brazil. This group integrates Engineering and computer Sciences students with professors and researchers from different areas and institutions of higher education (EMGE, SKEMA, LATACI and Seattle University). At SKEMA Business School, Brazil, also located in Belo Horizonte, another IL project is being developed. Students and professors are developing their own price index, integrating disciplines from different areas of knowledge. The SKEMA Professors aim to multiply this project to other SKEMA campuses outside Brazil.

Keywords: Integrative Learning, Interdisciplinarity, Knowledge Management, Management of Higher Education, Transdisciplinary.

2.1 Background

This work is a result of research undertaken on the development of skills of undergraduate students of higher education institutions (HEIs) through the interaction of learning different specialized areas. It presents the results of an investigation of a theoretical and conceptual nature that seeks to develop a comprehensive and current view on IL. In 2005 Julie Thompson Klein defined the term Integrative Learning as an umbrella term for structures, strategies and activities involving numerous school levels, such as high school and college, general education and basic, introductory and advanced levels, experiences inside and outside the classroom, theory and practice and discipline and fields.

2.2 Purpose/Hypothesis

The World Economic Forum (WEF) recognizes that a global transformation is underway, characterized by the convergence of digital, physical and biological technologies, changing both the world around us as well as our own idea of what it means to be human. The changes are historic in terms of size, speed and range[1].

Sharon Derry, educational psychologist at the University of North Carolina at Chapel Hill, who studies interdisciplinarity, said in an interview granted to Heidi Ledford of Nature, that "The problems in the world are not problems within the discipline", further suggesting that "we must bring people with different types of skills and knowledge to work together. No one has all that is necessary to deal with the issues we are facing"[2].

During the 20th century there was an unprecedented fragmentation of academic disciplines. Disciplines were fragmented into multiple sub-disciplines, giving rise to new technologies such as biomedicine, neuroscience, nanotechnology, artificial intelligence, bioinformatics, and synthetic biology, among others.

HEIs realize this transformation and seek to follow this process, recognizing that their students will face more complex issues in their professional lives and in society in general. Aiming to better prepare students for the labor market, HEIs have sought different ways to integrate knowledge from different specialized areas. Thus, this paper presents an overview of IL, a form of education that has been used in several US HEIs.

2.3 Design/Method

Initially, the research aimed to address the concepts of IL and how it was applied to the HEIs. From this definition began the systematic search for articles in the Web of Science databases, Scielo, Emerald, Spell, EBSCO and Scopus. The descriptor applied was "Integrative learning" in the TITLE-ABS-KEY. Results showed 75 documents published included therein until November 2017. Later analysis was performed in order to check the duplication of articles in different bases, which reduced the number of articles to 70.

2.4 Results

To seek more effective ways to educate and develop skills, Hollister[3] used the term IL, defining it as an opportunity of the "put it all together" type when the experiential learning and teaching are combined, creating new and more effective personal performance skills. The author reports a five-year research with professors and trainees in a real cooperative work environment. The process has proven effective in helping trainees to obtain a better assimilation of learning and has led them to new personal skills. Hollister then found that it was an important and effective methodological innovation worthy to be taught, replicated and tested elsewhere. Subsequently, Bretz and Thompsett[4] conducted a study which sought to compare the effects of IL based training with traditional training. The authors found that, even with less experienced instructors, students who passed the IL process had similar learning outcomes, but with significantly more positive reactions, suggesting further research with different samples in different types of training.

Dinmore[5] makes a comparison between the terms IL and interdisciplinarity. According to the author, the traditional definitions of interdisciplinarity mainly focus on the relationships between disciplines; IL already presents a new approach, a process that weaves together knowledge derived from formal and informal settings. Disciplinary studies have an important and continuing role, but an increasingly complex world demands that ways be found to match ways of learning to the needs and styles of the learning. Also, according to the author, interdisciplinarity and IL do not need to work separately. Interdisciplinarity takes place in the macro field between disciplines, because even its etymology has been restricted to formal education. IL can do it too, but without so many restrictions, opening up greater opportunities for experiential learning.

According to Humphreys , at the end of the 1990's American civil society already criticized the teaching of isolated scientific principles and demanded thematic approaches and approaches to teach students to apply academic concepts to real-world contexts.

In July 2003, the Association of American Colleges & Universities (AAC&U) and the Carnegie Foundation for the Advancement of Teaching promoted the participation of HEIs in a new national project (USA) to investigate and encourage IL, seeking to help students connect intentionally ideas and insights from various disciplines and experiences. According to The Statement of Integrative Learning AAC & U, IL shows students the skills to integrate learning - between courses, over time and between the campus and community life - which is one of the objectives and most important challenges of higher education. The emphasis on IL can help students join the parts and develop mental habits that prepare them to make connections between the knowledge of various areas in the conduct of personal, professional and civic life.

In October 2005, two years after the project began, the journal Peer Review, published by AAC & U, published a special issue on IL. 10 years later the magazine returned to the subject with the title with the title “Facility leadership for liberal learning integrative”. It highlights on its homepage that the integrative skills are among the most important goals of a liberal education of the XXI century. All articles published in this 2005 edition were part of this research and explore how IL promotes connections between subjects and extracurricular experiences, transcending the academic limits. Three factors are described by Klein[7] as catalysts for promoting IL. The first is that “knowledge explosion” a marked increase of specialties and fields is exacerbating the problem of fragmentation, accelerating the need to make connections; the second is the increased focus on the problem, as Humphreys[8] also notes, “Complex problems in our working lives and society force us to resort to various areas of knowledge”; the third is the “educational reform”, which links the two concepts with a family of complementary pedagogies.

Shi[9] warns that IL should not be an isolated event or an exceptional curricular activity, but a regular part of the intellectual life - and IL access portals must be readily accessible, day and night. HEIs cannot settle for individual initiatives such as learning communities of the first year or course completion courses. Colleges need to help students make connections between learning experiences and obtained over time.

Lopez-Chavez and Shepherd[10] indicate some aspects that were key to the success of the IL program at the University of New Mexico such as the incorporation of exercises on the reflections of learning; clarity regarding the types of connections that students should make; providing feedback to the participants keeping them engaged and the professors motivated.

According to Ferren and Anderson[11], no matter the discipline or class size, all teachers can begin to expose their students to the IL through practical and interdisciplinary classes. More important than the content, structure or teaching method, IES should provide the tools, inspiration and support space for students to develop the necessary skills to act responsibly in a complex and interconnected world. For this a culture of research is needed to address important issues facing students and that eventually may even make them uncomfortable. The research should address controversial topics, problems with no easy solutions and issues of lasting importance. In this context, students can reflect on why you're in college and consider issues such as: if education is only for personal benefit or to prepare citizens for a responsible and democratic life? How global challenges such as poverty, climate change and terrorism can be addressed? What are the possibilities of technological advances helping and/or getting in the way of humanity? These are the typical questions that, according to the authors, encourage students to join higher education, and those are the typical issues involving transformation and preparation for professional and community life.

IL also has an emotional appeal as Huber and Hutchings say: "In fact, emotion can be a catalyst for IL. When students become passionate about their learning, when a topic arouses enthusiasm, it is more likely that integration happens"[12].

Recognized as an empowering process, as Ferren and Anderson[13] claimed, IL students synthesize knowledge through curricular and extracurricular experiences. By strengthening the connections between learning experiences, the process creates opportunities for developing new concepts, improving values and perspectives on problem-solving, mastering transferable skills and improving self-understanding. The authors affirm that this set of factors encourages students to reflect on their goals in order to make choices, tracing their own progress and understanding the "why" - and not just the "what" - of their University years.

Studies by Kilgo et al. [14] suggest that active and collaborative learning such as IL, as well as the practice of research, provide immense benefit to students. This discovery has significant practical implications for higher education institutions. The institutions should strive to provide students with opportunities to engage in high-impact practices, particularly practices such as undergraduate research and active and collaborative learning, generating a relevant positive impact on learning and student development.

2.5 Conclusions

Sustainability is based on a triple foundation, economic, environmental and social, which integrates several items of knowledge. The need for renewal of educational methods that integrate different knowledge is receiving more attention in different institutions all over the world. There are many reasons for this, but it essentially comes down to a fundamental need to prepare the students to be a part of a renewed and more sustainable world. So, it is important to improve the way of preparing the Engineers of tomorrow to think and build more sustainable Engineering. The authors of this paper are engaged in research and development on this topic in close collaboration within the institutions where they are members of the faculty and know that many researchers and companies are involved in similar activities in other institutions. To support our knowledge community, this work has produced an overview of IL.

Motivated by this research a group of scientific inceptions at the Escola de Engenharia de Minas Gerais- EMGE, School of Engineering located in Belo Horizonte, MG, Brazil was created that researches Sustainable Cities with the participation of Engineering and computer Sciences students, professors from different institutions (EMGE, SKEMA, LATACI and Seattle University) and professionals from different fields such as economics, information sciences, business, journalism and Engineering. It is also important to emphasize that the four institutions involved share a common vision and understanding that integrative learning and interdisciplinary innovation are essential components of education in the context of the present and the future world.

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CHAPTER 3

Analysis of The Influence of The Basic Mathematics Course, of The Escola Politécnica de Pernambuco, In The Disapproval Rate of The Discipline of Integral and Differential Calculus 1 with Emphasis on The Teaching Variables and Students Who

Came from Public Schools

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Abstract: It is well known that the transition “High School - University” is not so simple, but in Engineering this change causes extreme difficulty. There are several factors that influence this, being the mainly ones: different professors for the same discipline, the arrival at the University of students coming from public schools and the absence of basic knowledge of the Mathematics discipline. Through this situation, the Escola Politécnica de Pernambuco, in order to reduce the initial difficulties, created the Basic Mathematics Course. In order to understand the indices of failure in the course of Differential and Integral Calculus 1, the data referring to the first test scores of Calculus 1 of all students were collected to study, since it is similar to all the contents given in the Course , since 2017.1, the different types of professors per class, the grades in the assessments of the Basic Mathematics Course and which students are of “wide competition” and those who came from public school. Out of the information collected, it is analyzed which professors scored the highest failure rate and if they are - or not - part of the Basic Mathematics Course, as well as the failure rate of students who came from public schools and the importance of the Course for them in the first period, comparing both factors with the grades taken by those students in the tests of Basic Mathematics Course. In that perspective, we will have data about the importance of the Course for students and the degree of teacher professor interference. Finally, from the analysis performed on the classes and professor who had the highest percentage of failure from students, and the quantitative of those who came from public schools with big difficulties, new methodologies are in progress objectifying that the Basic Mathematics Course decreases the rate of disapproval in the mentioned subjects, and increase their Mathematical knowledge, covering, therefore, all the people involved in the process of teaching and learning, facilitating the

student's life in the first periods of the University.

Keywords: Basic Math, Curricular Gap, Obstacles, Professor, Satisfactory Performance.

3.1 Background

When it comes to entry into public Universities, depicts the dream of young people in achieving this vacancy, despite the high level of difficulty. Among the difficulties, we present the basic education factor, as may, which itself already makes a selection between candidates. In an attempt to reduce this gap between public and private school students, there is a quota system, well observed by Peixoto (2016) reporting that the difference between the performance of a student from public and private school, only reinforces the gap of teaching, being it a lower quality in public teachings. But, the University professors, especially the Engineering course, cannot modify the content that needs to be taught, there are students with lag in math discipline at the basic level[1].

In addition to the difficulty by having a lower level of education, the quota students suffer from other factors. According to Belletati (2011) in Rosa (2014) the difficulties students go beyond teaching, with other factors, such as: economic pressure, harmonization of the degree course with a paid job and learning failures due to Deficit of basic contents on account of a low quality high school. Making the student's life extremely difficult , having to balance the University life with his/her personal life[2].

Finally, besides being difficult to develop with low levels of education in the disciplines required for the Course, the factor of the professor's approach contributes to the difficulty. According to Bariani e Pavani (2008, p. 75): "What draws the attention of the students by the school are teaching techniques, the caring and encouraging learning"[3]. With that, in seeking to reduce the difficulty of students in initial basic disciplines in Engineering, Polytechnic School of Pernambuco, promotes a Mathematical leveling Course, co-written with some teachers, in an attempt to flush these students and provide a better future learning[4].

3.2 Purpose/Hypothesis

With the purpose to level the basic knowledge of the discipline of Mathematics, to face the disciplines of Differential and Integral Calculus 1 and Analytical Geometry the Polytechnic School of Pernambuco created the Basic Mathematics Course, facilitating the language and leveling the student. But, the Course does not occur without the help of the professors of the discipline, who will lead the way forward so that the approach taken by the Course monitors, resemble his in the classroom. This work shows the importance of the course and the professor's partnership for a good final result.

3.3 Design/Method

The course takes place for 8 days, with 3 hours per day, and on the first and last day an assessment is applied, to know the leveling and then the learning. At the end of the course with the evaluation data in hands, a comparative study is carried out between the grades obtained in the first evaluation of Calculus 1, whose subjects are similar to the course notes, and the notes of the second evaluation of the Basic Mathematics Course, which are similar to the subject of Calculus 1 and between the influence of the professor's participation during the Course.

It is known that not all professors are partners of the Course, being developed the study for analysis of teachers and their interference in the discipline and the Course. A, B, C, D, E, F, and G professors were analyzed during the 4 semesters, being only Professor B, C and E not influential and partners of the Course. With this, data were collected, being: the students by classes of students from the periods 2017.1 to 2018.2 and their notes in the first evaluation of the discipline of Calculus 1, which the class professor and which students from a public school. Based on the data collected, a screening process is carried out to identify the participants who participated in the Basic Mathematics assessments, based on Silva et al (2018), which is divided into four categories, they are: Approved in Basic Mathematics and in Calculus 1, approved in Basic Mathematics and rejected in Calculus 1, rejected in Basic Mathematics and approved in Calculus 1 and Disapproved in Basic Mathematics and Calculus 1. Relating the interference of the Course and the teacher in the approval of the quota students.

3.4 Results

From Figures 3.1 and 3.2, corresponding to the first and second semester of 2017, the professors were the same in the two semesters. Being, as already said, Professor B and C not a supporter of the Course. The importance of the professor's support is clearly visible for which the Course has the greatest satisfaction, because even though professor A has the majority of students who did not do well, the stimulus of the professor about the importance of the Course made them seek after the Course the help of their monitors, improve their subjects and succeed in the tests, with the him/her having a 69% approval rate, the same is not true for professors B and C, who 48% of their students in both semesters failed in both the course and the discipline.

From Figures 3.3 and 3.4, analysis performed between the semesters 2018.1 and 2018.2. In Figure 3.3 Professor D, who is a partner and influencer of the Course, had an approval rate of 57%, and Professor E, who does not support the Course, had an approval rate of 36%, only emphasizing that the partner professor of the Course helps the monitors to use the didactic and the subjects in partnership with him/her, increasing, consequently, the approval index.

In Figure 3.4, two teachers are partners of the Course and two are not, the results of this partnership are clear. Professor F and G had the feedback from the course monitors on their performance, the professors encouraged the students the importance of the Course, who sought the monitors and were successful in the discipline. The professor F and G approval index was of: 50% and 83%, respectively. However, professors B and C who did not support the course, obtained approval rates of: 0% and 36%, respectively.

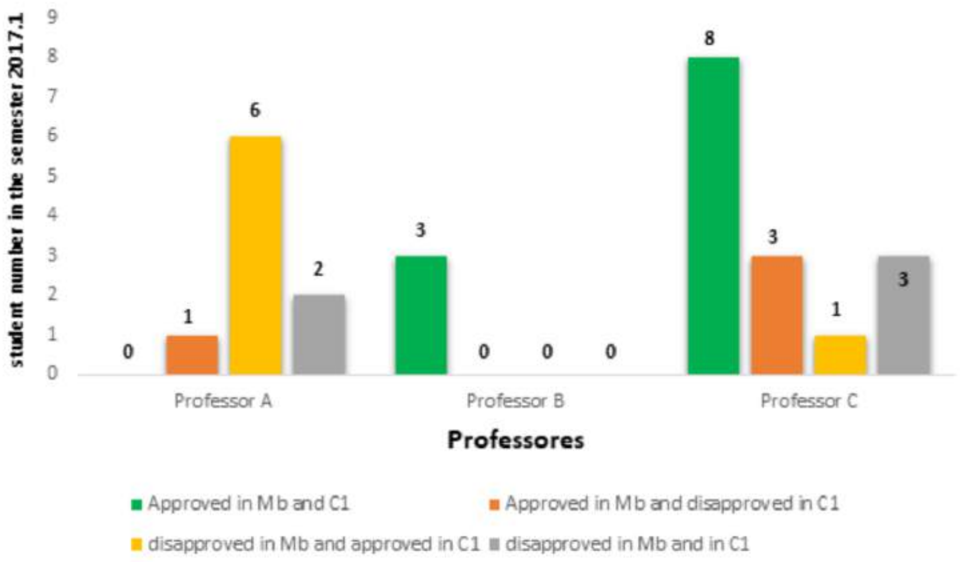

Figure 3.1 – Analysis of the influence of the teacher and the Course, in the semesters of 2017.1

3.5 Conclusions

With the analysis of the data collected, it can be seen that students from public schools enter the University, with a lag in the basic subjects of Mathematics, requiring a Course of leveling and support of the professor, because the Course without the help and influence of the professor, as seen, cannot achieve its purpose.

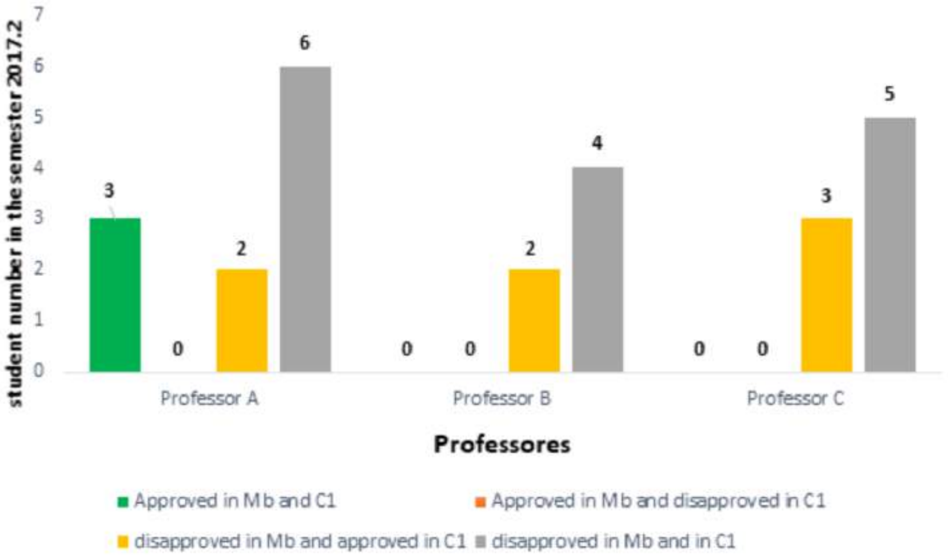

Figure 3.2 – Analysis of the influence of the teacher and the Course, in the semesters of 2017.2.

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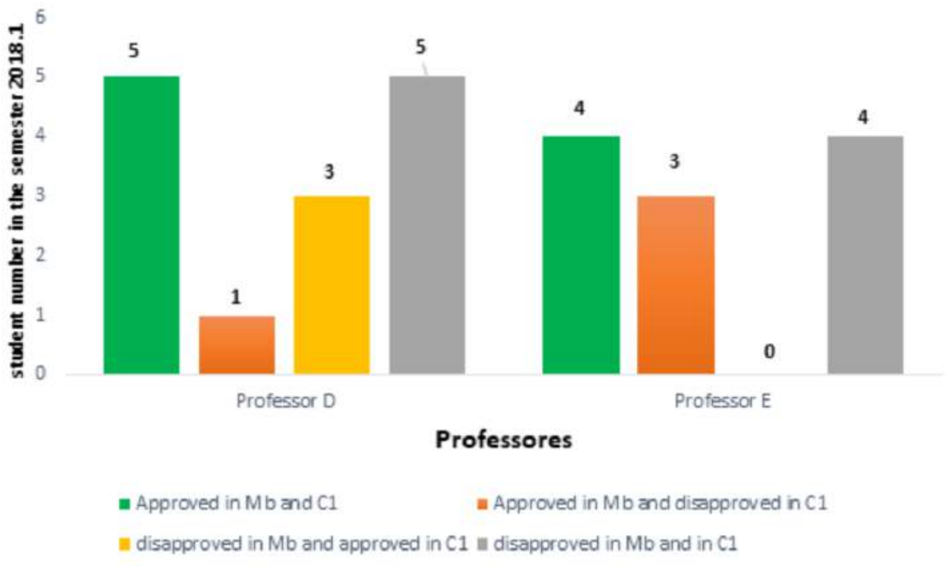

Figure 3.3 – Analysis of the influence of the teacher and the Course, in the semesters of 2018.1.

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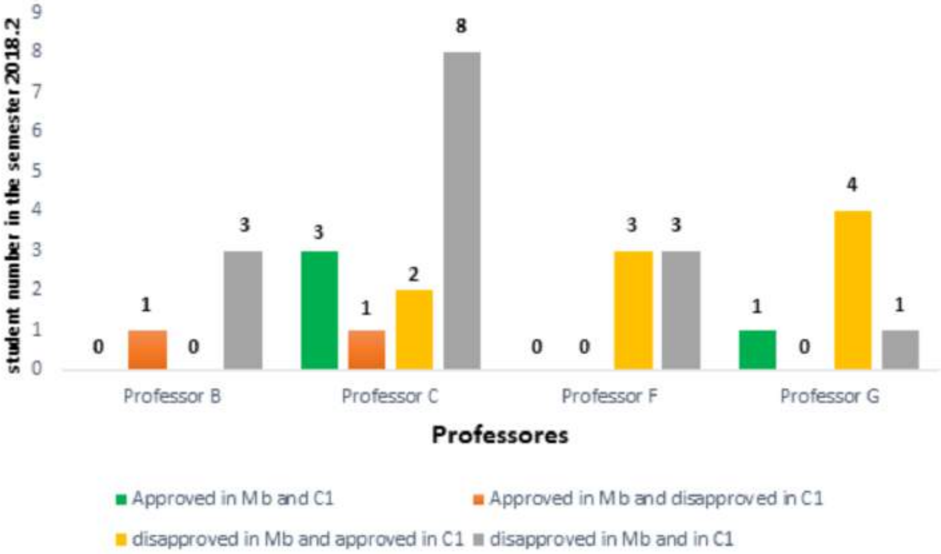

Figure 3.4 – Analysis of the influence of the teacher and the Course, in the semesters of 2018.2.

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CHAPTER 4

Teaching of Railway Signaling Concepts Using PBL as Active Methodology

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Abstract: New teaching tools are emerging in order to encourage students to understand that the concepts, phenomena and theories presented in the classroom should be employed in the daily professional life. With the use of new teaching techniques, professors should also adapt the syllabus of the disciplines more and more to current issues in the professional field. In this way, the application of the Problem Based Learning (PBL) methodology, used in the discipline of Railway Signaling (since 2017), is part of the syllabus of Terrestrial Transportation undergraduate course of the Faculdade de Tecnologia de Barueri, located in the state of São Paulo (Brazil). The student who seeks this course aims to improve in the field of transportation (road and rail) and aims to expand technical knowledge inherent to the field. Many of our students already work in the field of transport and, in search of a solution; end up bringing some situations experienced in their professional life. This participation helps in the administration of classes and in the development of projects. Most of the cases presented involve case studies related to the construction of a railway. There-

fore, it was proposed during the Railway Signaling classes the construction of a physical model, in scale 1/87, in which it should be capable of portraying the various situations of the infrastructure of the Brazilian railway network involving the fixed and mobile railway signals. This tool assisted visually in the issues of abstraction, in which regards, the identification and implantation of the railway network and its signaling. The use of this methodology allowed the student to understand the importance of railway signaling, as well as its application. It helped to emphasize the importance of good infrastructure when it comes to railroads. The students were very open to new knowledge and new teaching techniques. It is important to stress that students have learned to work in teams and managed their time very efficiently.

Keywords: Physical Model, Active Methodology, PBL Methodology, Railway Signaling, Teaching Technique.

4.1 Background

The use of new didactic techniques by programs applied in the field of Engineering or technology arose to assist the teacher in the teaching/learning process. Thus, professors should develop new methodologies to teach concepts and should create new methods for use in didactic laboratories. In order to help teachers, we have a problem-based teaching methodology (PBL). This is a powerful tool that will allow students to not only obtain results, understand phenomena, apply theories, but also examine, research, create audiovisual content and simulate real-life situations, representing problems that will occur in the professional environment[1]. This teaching methodology will allow the student to have a systemic view of the object of study and this is very important for teaching in the field related to railway signaling. The use of physical, volumetric, realistic or electronic models in teaching is an important didactic resource: "playful" and visual. It helps to understand subjects with a high degree of difficulty and abstraction[2].

For the proper development of this project, specific knowledge focused on the area of railway signaling is required. It is not an easy task to construct a physical model[3] which portrays the various situations of railroad infrastructure, involving fixed and mobile railway signals. Therefore, it was the objective of this article to verify if the concepts which could be applied in a didactic laboratory aimed at the terrestrial transport course using the PBL methodology.

4.2 Purpose/Hypothesis

The PBL methodology provides analyses and discussions of the main potentialities and disabilities as a strategy of collaborative learning, starting from the perspectives of the students and the teachers who participate in it. Why not implant the use of models in new Engineering courses, technology and/or post-graduate courses, especially in those, which focus on ground transportation? Much information is transmitted to the students, which at the first moment seem to be abstract, however they can be seen in 3D with the use of mockups. An incoming student may have a basic and visual understanding of the railway facilities after an initial interaction with the model. For senior students, the model will have the purpose, for example, to assist in the development of project involving railroad terminals, subway rail, supply or supply of products executed by a strategically placed distribution center among others. The syllabus of the course includes all railway signaling. For the content to be well understood, the students suggested the construction of a physical model representing a railway network with all the signs. Then, the construction of the physical model became part of the evaluation criterium. The students defined that they would compose a single group for the construction of the model; group formed by all the students of the discipline. Each student would be responsible for part of the construction of the model (drawing of the floor plan in AutoCAD®, identification of vertical and horizontal signs, construction of the pieces, assembly and related items). The participation of each student provides the good progress of the construction of the model.

4.3 Design/Method

The project proposed by the students contemplated the construction of a physical model, in scale 1/87, for the representation of the existing railway signals. For the development of the proposal one has the application of the basic concepts of technical drawing using the software AutoCAD®. The technical standards for railway signaling[4] were used for the installation of warning signs, labels, safety markers, mileage, traffic lights and related items.

Figure 4.1 shows the layout of the model and Figure 4.2 shows the physical model. All vertical and horizontal rail signs are in accordance with DNIT (2015) standards and located in order to facilitate student understanding[4].

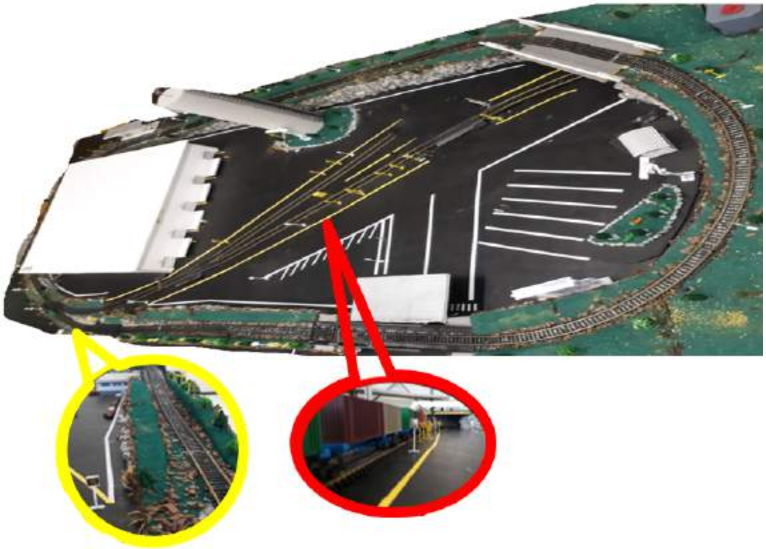

Figure 4.1 – Railway model: layout of the model. Source: Project developed by the students: Valdenizio Gonçalves Soares, Leandro Fernandes de Andrade, Júlio Augusto Michalkow, Luana Aparecida da Silva Duarte and Wênio Ferreira dos Santos (2017).

4.4 Results

The idea of this project was the construction of a physical model for the representation of the railway signals. It was observed that the students were able to work as a team, engaged and committed; thus, great commitment and participation in the development of the project was noticed. The project helped in visualizing the positioning of the plates, as well as helped to show the importance of signaling boards.

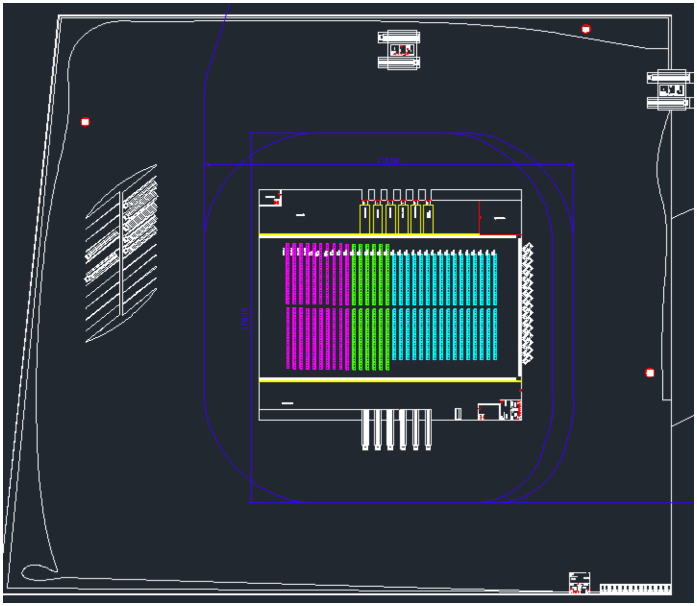

Figure 4.2 – Railway model: picture of the model. Source: Project developed by the students: Valdenizio Gonçalves Soares, Leandro Fernandes de Andrade, Júlio Augusto Michalkow, Luana Aparecida da Silva Duarte and Wênio Ferreira dos Santos (2017).

4.5 Conclusions

The application of the PBL method helped to show, in a playful way, by the physical model, the railway signals, as well as their importance. The development of the project helped to awaken in the students the interest in wanting to learn more and more; helped the student to see how it will be possible to apply the acquired knowledge in college in the professional life. Thus, this model served as an aid in the three-dimensional and interactive observation of the application of terms learned during the lessons in the Ground Transportation course. The model will help to make the Land Transport Laboratory an interdisciplinary space for multidisciplinary coexistence, providing a differentiated use of the learning/teaching process, the integration of activities aiming at the study, observation, discussion and practice of various situations which occur in the field of land transport.

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CHAPTER 5

Concept Teaching Involving Urban Mobility and Accessibility Using PLE as Active Methodology

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Abstract: The purpose of this article was to apply the Project Led Education (PLE) teaching methodology. The implementation of this tool has been observed year after year and every new form of employability, always aiming at understanding the importance of phenomena, concepts and techniques related to the development of projects in the classroom. During the classes of the Mobility Discipline of the Terrestrial Transportation under graduation course of Faculdade de Tecnologia de Barueri, located in the state of São Paulo, Brazil it was proposed for the students the elaboration of a project of a road terminal, with classification D. Thus, in this article a case study of the application of the PLE Teaching Methodology was approached using as goal the implementation of this bus terminal. The project was developed by students who considered the needs of the Brazilian urban region in relation to public and collective transportation. In the case study in question, the mobility and the internal and external accessibility of a road terminal, the location of the terrain (topography, local vegetation, economic investments, the capacity of

the highways around the terminal, impact on the service of the surrounding highways , impact on the surrounding air quality, water use, energy use, population well-being) and also the creation of an area for vehicular parking and the circulation of buses inside and outside the bus terminal. This proposal of methodology of study contemplated the implantation of ecologically correct items in the daily operation of a terminal, such as, solar energy use, reuse of rainwater, green walls among others. The students' studies to understand the current norms and legislation were intense and helped in the elaboration of the project. Participating students were very keen to learn, observed that it is possible to apply the concepts learned in the classroom in their professional life and they also developed the ability to work in teams respecting divergent opinions.

Keywords: Accessibility, Active Methodology, PLE Methodology, Urban Mobility, Bus Terminal.

5.1 Background

At present, we think of teaching in an integrated way, aiming at work beyond the realms of classical knowledge. Everyone stands out according to their knowledge, skills and abilities to solve contemporary issues involving the environment, economy, society and technological innovation as expressed in the National Curriculum Parameters[1].

5.2 Purpose/Hypothesis

The institution of higher education is the bridge that directs the individual to a better placement in the work market. However, there is a need to renew teaching techniques to support the development of reasoning. The inclusion of collaborative learning strategies, such as Project Led Education (PLE), in the syllabus of the subjects, provides students the possibility of visualizing how the concepts taught can be applied to the solution of projects or situations experienced in everyday life[2]. This methodology provides analyses and discussions of the main potentialities and disabilities of the PLE as a strategy of collaborative learning, starting from the perspectives of the students and the teachers who participate in it. Teaching techniques are innovative when they are associated with the pleasure of discoveries, solutions, stimulations of our senses and perception of the world in a creative, critical, reflective and enterprising way. Thus, this article focuses on the degree of knowledge that students can acquire with the use of the PLE tool during the mobility discipline.

5.3 Design/Method

The methodology adopted in the discipline of mobility of the Terrestrial Transportation under graduation course of Faculdade de Tecnologia de Barueri, located in the state of São Paulo (Brazil) is based on the case study suggested by the teacher (PLE). In this case, the teacher proposed the students the elaboration of a project of a bus terminal, with classification D.

5.4 Results

The teacher proposed the construction of a model representing a D-level bus terminal which aimed to unlock and bring greater accessibility (internal and external to the bus terminal), being efficient in its services, meeting the offers and demands of the place with an ecologically correct differential (following the principles of sustainability). The construction of the D-level bus terminal was done in AutoCAD® (3D plant) and it was applied the standard norms ABNT NBR 9050 (2004), ABNT NBR 14022 (2009), ABNT NBR 15527 (2007), ABNT NBR 15570 (2009), ABNT NBR 15646 (2016); NR 6 (1978), NR 18 (2018), and laws under the National Policy of Urban Brazilian Mobility, Law12.587 (BRASIL, 2012), Law 13.146 (BRASIL, 2015), Resolution nº 535 (BRASIL, 2015), Manual for signaling works and emergencies (2010), Manual for the implementation of road passenger terminals (BRASIL, 1986), Road Passenger Signalling Manual of the State of São Paulo (SÃO PAULO, 2006), an environmental certification LEED (Leadership in Energy and Environmental Design). Among the projects proposed by the students carried out by Abner Paiola, Laryssa Ferreira, Natalia Azevedo, who presented all the necessary characteristics for the terminal facilities level D (Figures 5.1 and 5.2).

The project proposed by the students can be easily implemented. The enthusiasm with the development of the project arouses the desire in the students to work in teams. This takes the students to share their ideas and, therefore, listen to their colleagues' opinions; making the students experience possible situations that will happen in their future workplace. They observed the importance of being updated intellectually to express opinions about new technologies, materials, equipment, simulators, among others; an opportunity

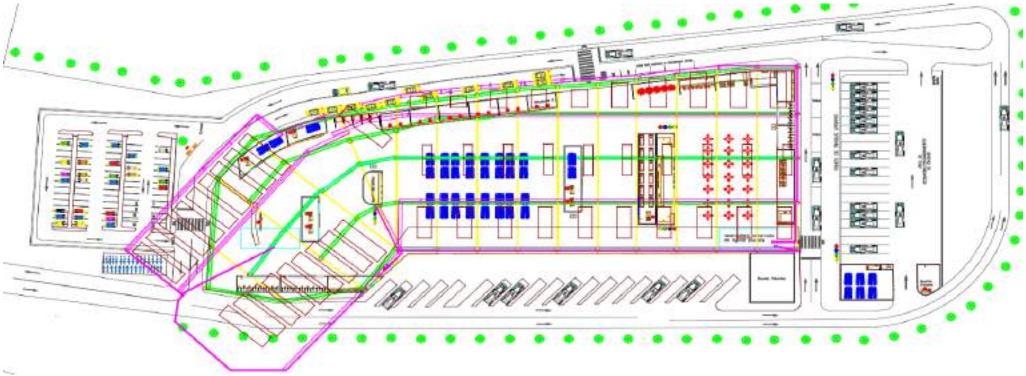

Figure 5.1 – Terminal Scenery: plant 2D. Source: Project developed by students: Abner Paiola, Laryssa Ferreira and Natalia Azevedo.

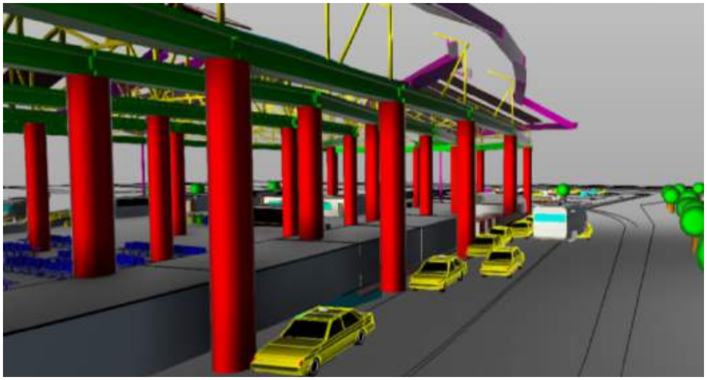

Figure 5.2 – Terminal Scenery: side view 3D. Source: Project developed by students: Abner Paiola, Laryssa Ferreira and Natalia Azevedo.

that also encourages students to research, to have logical reasoning and to work in a systemic way.

5.5 Conclusions

The application of the PLE method helped answer a common question to students: “What is the purpose of what I am studying?”. Answering this question helped awaken in students an interest in aiming to learn more and it also helped them to see how it will be possible to apply knowledge acquired in college in the professional life. The accomplishment of this case study indicates that the use of (PLE) favored the development of the reasoning in the future professionals, being important to mention that the students were determined to look for new cases to try to solve them or even to create new projects as alternatives for existing cases. Participating students were very keen to learn, observed that it is possible to apply the concepts acquired in the classroom in their professional life and developed the ability to work in teams respecting divergent opinions.

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CHAPTER 6

Automatic Correction of Discursive Question: An Approach to Contexts with Limited Language

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Abstract: Distance learning platforms usually apply objective assessments to students, proposing and automatically correcting questions. A bank of issues enables this process. Although with recognized didactic value, this process is not ideal. Essay questions are too important because, in addition to testing students' knowledge, they develop their ability to produce textual content. The automatic correction of discursive issues is an unresolved problem by the Natural Language Processing (NLP) area, but there are several approaches with partial solutions. The language offers us several words and syntactic constructions. Thus, there are several ways to express an answer. This fact is the main obstacle to the automatic correction of subjective questions. This work starts from the hypotheses that a human being invests decades in the process of refinement of his communication capacity, giving him large capacity of text production. Thus, it is likely that in adolescence their capacity for textual expression is still limited. Proposing models to construct an answer can limit still more the variations of the textual expression. This work proposes an essay question corrector that acts in a restricted language context. The main restrictions applied in the context were the application aimed at adolescents with a mean age of 15 years, the limitation of the programmatic content that

involves the issues and a template to structure the answers. These facts already reduce significantly the possibilities of textual expression. Other constraints imposed were (a) the creation of questions “what is”, “when it arose”, “what is the purpose of”; (b) establish the beginning of each answer; (c) the treatment of nominated entities; (d) the elimination of words without semantic value in the sentence and (e) the standardization of more frequent vocabularies used by the group of students. The correction process has the following steps: (a) the determination of the grammatical class of all words in the text; (b) the separation of sentences into clauses or noun phrase and (c) the creation of logical predicates representing the semantics contained in the analyzed phrase. It was observed that for each model of the phrase syntactic structure, one can derive a set of logical predicates that express the idea contained therein. With eighteen syntactic rules it was possible to map the knowledge contained in sixteen responses of the class. Some semantic problems were found inspiring the research continuity. The measure of similarity between the logical propositions that represent the answer given by the student and the propositions that represent the feedback of the question defines the student grade. The initial results demonstrate that the proposed algorithm can correct the discursive issues of a second-year high school class. In some cases, it is necessary to know the semantic of words to mapping the logical predicates, however, in the most of them, the phrase structure is enough for such mapping. The small number of necessary rules for interpretation of the studied questions shows the viability of the proposed approach.

Keywords: Automatic Correction, Discursive Question, Delimitation of Language Context, NLP.

6.1 Background

The automated process of learning assessment is performed by systems that use a bank of objective questions. The system presents to the evaluated some questions and make the automatic correction by the direct comparison with the feedback. The use of objective questions is not characterized as a problem[1], but its exclusive use in an evaluation process is rather a problem[2]. It is important that automatic assessment also contain discursive question. This kind of questions are important because, in addition to testing students' knowledge, they develop their ability to produce textual content. However, in a discursive answer the student has several possibilities of using the natural language to present the answer.

This freedom to write the answer is the main problem that Natural Language Processing area[3] faces to make the automatic correcting of discursive questions. It is a complex problem which complete solution is not yet available, although some approaches present good results in the content interpretations task.

The correction of a discursive questions is a problem of automatic interpretation of textual content[4] and of representation of interpreted knowledge. In addition, the proposed approach here involves the comparison of knowledge bases to measure how much a discursive question is correct.

This work argues that with insertion of some constraints in the natural language context, the possible ways to write an answer will be reduced. With this reducing, the system can automatically correct the answer possibilities remain.

6.2 Purpose/Hypothesis

The purpose of this work is to develop an algorithm able to correct a discursive answer. The correction process occurs through the mapping of the knowledge contained in an answer, generating a knowledge base, followed by the comparison of this base mapped with the knowledge base obtained from the feedback of the question.

It is expected that the reduction of the use context of the natural language will reduce the writing possibilities of answers, making it possible to map the knowledge of answers with fewer syntactic rules.

6.3 Design/Method

The work considers that as smaller the context of language in which the application acts, as less rules will be necessary for the process of interpretation of the text. Thus, the following natural language domain constraints are proposed: (1) to direct the use of the application to adolescents because they do not have complete mastery of the language; (2) standardize the questions in the style: “what is it?”, “What is the origin?”, “What is the purpose?”; (3) to predefine the beginning of each response, for example, to the question “What is social security?” The following response model is proposed: “Social security is __.”; and (4) limit forty words to the answer.

The proposed algorithm has the following steps of preprocessing the response: (1) the determination of the grammatical class of the text words; (2) treatment of named entities by replacing the expression with words of type “Ent001”; (3) the separation of sentences into clauses or nominal phrases; (4)

the elimination of words without semantic value in the sentence; and (5) the standardization of commonly used terms in the context.

After the pre-processing, the rule base was constructed to be able to interpret the syntactic structures written by the students. Ten syntactic rules were manually created from the analysis of eighteen questions answered. Another set of six answers were used to test the acceptance of the rules. The ten rules created were able to interpret the answers test set.

For the representation of knowledge, this work has adopted logical predicates[5], where each created syntactic rule has a set of logical predicates that represents the knowledge existing in the excerpt validated by the rule. The comparison between knowledge bases is made by the analysis of similarity between the predicates existing in each base, as well as the arguments that make up these predicates. The proposed algorithm compares the knowledge base extracted from the student answer with the knowledge basis of the feedback. In some cases, it is necessary to know the semantic of words to mapping the logical predicates, however, in the most of them, the phrase structure is enough for such mapping. The small number of rules for interpretation of the studied answers shows the viability of the proposed approach

6.4 Results

Ten syntactic rules interpreted all answers of students. But, to system interpret the feedback it was necessary to insert two new rules. The experiment used the question “O que é Direito Previdenciário?”. The Figure 6.1 shows the result of executing the algorithm for feedback of the question.

Feedback answer	Knowledge base
O Direito previdenciário é um ramo do Direito Público surgido da conquista de direitos sociais. Originou-se no fim do século IXX e início do século XX. Seu objetivo é o estudo e a regulamentação do instituto seguridade social, para ajudar o cidadão e também o profissional do Direito	Compoe(direito previdenciário, direito público) surgir(direito previdenciário, conquistar, direitos sociais) origem(direito previdenciário, no fim do século ixx e início do século xx) objetivo(direito previdenciário, estudo, instituto seguridade social) objetivo(direito previdenciário, regulamentação, instituto seguridade social) ajudar(direito previdenciário, cidadão) ajudar(direito previdenciário, profissional do direito)

Figure 6.1 – Feedback answer and the knowledge representation obtained from feedback.

Figure 6.2 shows the result of executing the algorithm for a question answered by a student. Note that the student's response generated a knowledge base with clear differences from the basis of feedback.

Answer	Knowledge base
O Direito previdenciário é um órgão que cuida do direito público, seu objetivo é o estudo e a regulamentação da seguridade social	Éum(direito previdenciário, órgão) cuidar(direito previdenciário, direito público) objetivo(direito previdenciário, estudo, seguridade social) objetivo(direito previdenciário, regulamentação, seguridade social)

Figure 6.2 – Student answer and the knowledge representation obtained from answer.

The comparison algorithm of the two knowledge bases identified that the answer knowledge base contains two predicates almost like existing predicates in the feedback knowledge base, two predicates that are not in the feedback base and, finally, five predicates in the feedback base that are not present in the answer base. The algorithm calculated 27,5% of similarity between the two knowledge base.

6.5 Conclusions

The experiments done show that the particularization of context really help to obtain a solution to the problem of textual content interpretation. The quantitative of syntactic rules generated to contemplate all the analyzed answers was surprising small.

Further studies should be done with the same class to see if the writing bias of the group remains on assessments dealing with different subjects. Aiming to make the system more robust, more assessment with other group of students also should be done to improve the syntactic rules base.

The teacher can intervene and insert more syntactic rules in the base whenever the system cannot interpret a sentence. This process should be done until the system behaves satisfactorily. The proposed approach suggest it is possible measure the writing capacity of a group, as well evaluate the its evolution along the time, this being a suggestion of future works.

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CHAPTER 7

Proposal for Updating The Civil Engineering Program of The Universities Near The Pólo Gesseiro do Araripe: A Critical Analysis of Current Curriculum Profiles

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Abstract: The Pólo Gesseiro do Araripe (PGA) accounts for about 97% of Brazil's plaster production. Thus, it becomes an important Local Productive Arrangement (LPA) of the Brazilian Northeast, since, in addition, it includes three states of this region: Pernambuco, Ceará and Piauí. Despite this importance, the region still suffers from numerous socioeconomic problems, with skilled labor and high rates of informality. These adversities result in a place of low technological development, so that the equipment used for calcination is developed in an empirical way, based on the great experience and creativity of local metallurgists, who have adapted the models that were imported by fo-

reign companies, such as Grelbex Technologies. Simultaneously, the curricular profiles of Brazilian Universities still do not follow the new curricular guidelines, launched in 2019, that seek to align theoretical content with local market reality. In this way, this work seeks to perform a critical analysis of twelve curricular profiles of the Civil Engineering courses of the main Universities of the states that make up the aforementioned LPA, in order to highlight which Higher Education Institutions form qualified Engineers to work in this sector. So, it was sought to quantify the curriculum profiles that present specific formation in the plaster area. In addition, two references were prepared: the first as a complement to the discipline of Construction Materials, contemplating the basic knowledge about the ore; and the second being more specific for the application of gypsum technology and its derivations. Finally, a reference map of the relationship between the researched Universities and their distance from the Pólo was also elaborated. Among the Universities analyzed in this production, in Pernambuco, only the Escola Politécnica da Universidade de Pernambuco (POLI/UPE) presented a discipline exclusively directed to the teaching of gypsum and its applications, which is titled “Gypsum Technology Applied to Civil Construction”. The Universidade Federal do Vale do São Francisco (UNIVASF), being the University of Pernambuco closer to the PGA, only demonstrated something related to gypsum in a complementary bibliography. As for the other Universities, including those in Ceará and Piauí, no information was found on the teaching of the respective material, only “Construction Materials” subjects, which may mention it during the course, even though the specificity is not clear in the program. The Universidade Federal Rural de Pernambuco still presented, in a generalized way, walls made of gypsum board, present in the program of the discipline of “Technology of Civil Construction 1”.

Keywords: Civil Engineering, Curriculum Profiles, Education, Gypsum, Outreach.

7.1 Background

The Brazilian production of gypsum and plaster is concentrated geographically in the PGA, which accounts for 97% of the total production[1-3] and is located in the extreme west of the state of Pernambuco, on the border with the states of Ceará and Piauí[1]. In a region with a Human Development Index (HDI) of 0.622[2], poverty levels are extremely high.

7.2 Purpose/Hypothesis

Having a vital importance in the economic activity in the hinterland of Pernambuco, the main deficiencies observed are related to the low technological level of the plaster producing companies. A somewhat incoherent paradigm, considering the number of Universities, mainly public, that are in the territory of the state of Pernambuco. At the same time, the Brazilian Ministry of Education issued in 2019 a new opinion highlighting the importance of updating the Engineering programs, including regarding the meeting of local technological needs. Having the Pólo as an important LPA, this work proposes to: (i) analyse the current programs in the Universities near the PGA, and (ii) propose a new curriculum profile to meet the demands of the LPA of plaster.

7.3 Design/Method

First the 8 Universities (12 programs in total) that participated in the research were defined. Shortly afterwards, the search and analysis of the curricular profiles found was started to ascertain which of them offered a general or specific formation for the sector of plaster. The institutions were: Universidade Federal de Pernambuco (Campus CTG e CAA); UNIVASF; Universidade Católica de Pernambuco (Late and Night Shifts); POLI/UPE; Universidade Federal Rural de Pernambuco; Universidade Federal do Piauí; Universidade Estadual do Piauí e Universidade Federal do Ceará (Campus Crateús, Russas e Pici). The keywords used were: Gipsita and Gesso. After that, the relation of the Universities vs distance to the Pólo Gesseiro was performed with the assistance of Google Maps™ and LibreOffice™. Finally, based on the programs of Michigan State University, Hanley Wood University and the POLI/UPE, the proposals for curricular profiles were elaborated.

7.4 Results

Of all the 12 teaching programs analysed, only POLI/UPE presented a specific course focused on the application of gypsum and its technologies. UNIVASF, the University closest to Araripe, has, in its entire biography, an explanation of plaques of plaster board. The others did not present any direct mention. The University vs distance relationship can be seen in the Figure 7.1.

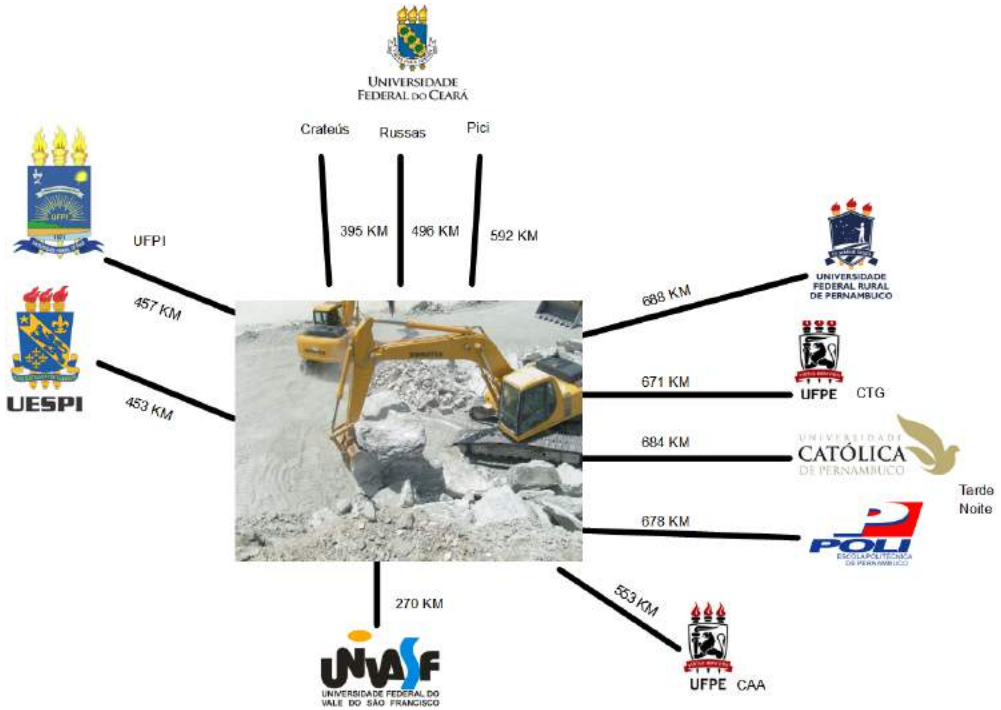

Figure 7.1 – Universities versus Distance.

7.5 Conclusions

The additional to the disciplines of Construction Materials may contain the following topics: Manufacturing process; Characteristics and properties of gypsum and plaster; Gypsum products and systems. This additional one mainly serves so that the students have knowledge about the difference between gypsum and plaster. In addition, they can understand, globally, the importance of such material and where it is applied. The main points to be addressed in a comprehensive gypsum teaching program, which can be titled “Gypsum, Plaster and Its Applications in Construction”, are: Gypsum production process; Process of comminution, crushing and preliminary treatments in ore; Types of calcination kilns; Characteristics and properties of gypsum and plaster; Process for the manufacture of plaster products; Plaster construction systems; Description of attributes and limitations of the five types of specialized performance gypsum panels; Explanation about how specialized performance gypsum panels can increase the efficiency of construction in commercial structures. Thus, students will be able to understand not only what the material is, but also the entire process from the raw material to the final product, as well as its applications and specializations in civil construction.

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CHAPTER 8

Proposal for Integration between Computational Fluids Dynamics and Project Led Education: Updating of Mechanical Engineering Curriculum Profiles in Pernambuco - Brazil

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Abstract: The vision that will guide the professional life of undergraduates is built during their academic education, and the way in which it is treated in the classroom is of short importance for student's future. The classical formation is given through the transmission of knowledge, formulas, definitions and precepts, among others. Such paradigm often makes difficult to student sees the application of those learnings in real life. So, Project Led Education (PLE) emerges as a response to this need and teaches the student through practical projects, being applicable mainly in the scope of Engineering. At the same time, it has Computational Fluids Dynamics (CFD), which is a computational tool that encompasses the disciplines of Numerical Calculus, Fluid Mechanics and Heat Transfer, as well as other associated phenomena. Its use grows more and more in the industry, as it is crucial in the execution and testing of new projects, with great reduction of cost and time. Despite this, few professionals in Brazil are qualified to work in this sector, since the access to this methodology is more restricted to postgraduate courses. This work aimed to develop a proposal of a didactic sequence for the integration of CFD and PLE in Fluid Mechanics discipline, present in the curriculum of almost every Engineering courses in Brazil. Initially, will be worked the previous knowledge necessary to understand the physics present in this software, and then, afterwards, the proposal presentation of the projects that students should prepare. For its more didactic packages, and for being a long time in the market, the software available free of charge by ANSYS ™ for fluid dynamics, becomes a great ally. The proposal was based mainly on the Mechanical Engineering courses of the Centro de Tecnologia e Geociências of the Universidade Federal de Pernambuco (CTG/UFPE) and the Escola Politécnica da Universidade de Pernambuco (POLI/UPE).

Keywords: ANSYS, Computational Fluids Dynamics, Mechanical Engineering, Project Led Education.

8.1 Background

From the 1960s onwards, the Computational Fluid Dynamics (CFD) techniques were integrated into the aerospace industry, a systems analysis that emerges from the union of Fluid Mechanics, Heat Transfer and Numerical Methods disciplines. This methodology is used worldwide in the design, research, development and manufacture of new products. Thanks to its versatility, it also reduces the time and cost of new projects, as well as allowing to predict the behaviour of systems subject to extreme operating conditions that exceed normal safety and performance limits[1].

At the same time, the Project-Led Education (PLE) approach is focused on giving students great challenges, with increasing difficulties and challenging questions, with the aim of creating and optimizing products, applying theories in their development[2]. With a long duration for the development of the proposal, the PLE starts from a project suggested by the teachers, aiming the development of a product through the participative work developed by a team of students, leading them to collect data and information, generate ideas and to identify their learning needs. Thus, it demystifies the tradition of lectures, very present in Brazilian Universities[2].

8.2 Purpose/Hypothesis

The current form of education, especially in Brazil, is focused on the exposition of knowledge, having a direct participation of the teacher and very small of the student. Thus, this work aims to propose an integration between the CFD techniques and the PLE approach, which can guarantee to the students' new knowledge in the areas of Engineering and an expertise in an increasingly present software in the industry, the ANSYS. So, this interaction will guarantee a much more agile methodology, which in addition to favouring teamwork, can also reduce avoidance in Engineering courses, since the learning process will be much more dynamic.

8.3 Design/Method

The process of elaborating a project in CFD basically follows the same steps: it starts with the generation of a geometry in Computer-Aided Design (CAD); it generates a mesh, that is, there is a discretization of the computational domain; pre-processing is performed, where the contour models and conditions are chosen; the processing of the iterative numerical calculations is monitored; and, finally, the results are analysed in post-processing.

It is important to emphasize that this process is cyclical, and it is always necessary to return to the initial phases in order to improve the project, expanding or simplifying the model, in order to achieve the best possible cost and benefit.

Thus, this work sought to cross the Mechanical Engineering programs, of the Universidade Federal de Pernambuco and the Escola Politécnica de Pernambuco, with this integration of the CFD and PLE, based mainly on the discipline of Fluid Mechanics.

8.4 Results

The first unit of the discipline will serve to expose the necessary knowledge on Fluid Mechanics and Heat Transfer. In the Universities studied in this paper, Numerical Calculus credits have already been fulfilled in the previous semester, only a brief review. In parallel, it is suggested that the teacher advise the students to be divided into teams and to distribute the themes of the projects, so that students become familiar with the problem and understand their possible models and their boundary conditions.

The second unit will be totally focused on the elaboration of the computer simulation project, in which the teacher will access the student, helping him, at first, with suggestions of simplification of geometry and discretization of the mesh. As for pre-processing, it is suggested that the teacher encourages students to seek more knowledge about Fluid Dynamics in order to better understand the models that can be chosen.

Finally, the post-processing step can be done qualitatively and quantitatively, and it can be used also from the literature. It is recommended that the evaluation is not done by the final project result, but by the student's progress and how he solved the problems during the process. A monitoring worksheet can be applied for weekly monitoring.

8.5 Conclusions

The CFD is an important computational tool that has been growing more and more in the industry over the years. Encouraging the integration of this technique together with the PLE approach can serve as a differential in the professional life of students. In addition, it can also act as an incentive to student protagonism, teamwork and the reduction of the avoidance of Mechanical Engineering courses in the state of Pernambuco in Brazil.

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CHAPTER 9

Virtual 3D Learning Environment: Development of Virtual Objects and Curricular Units for CNC

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Abstract: The model of traditional teaching, where students sit down, listen to their teacher, take notes and do tests, has been changing gradually according to technological advances. The present project deal with the development of a virtual model of a Computer Numeric Control (CNC) machine and curricular units to extend and support the traditional teaching-learning process by means of gamification and reinforcement learning. The motivation for the development of this virtual environment was the need of new methods and techniques to teach and learn at the new digital era. This project is part of a thematic project of distance learning in a remote access lab. The objective was create a 3D immersive virtual environment with high realism which the user has a dynamic learning experience, making the teaching-learning process more attractive, since technologies are increasingly present in people's lives. The project consists in using a real CNC created at CEFET-MG as model and free licenses software to virtualize and control the virtual object. For this, using Blender to create the virtual modeling. Through the Unity 3D, using a C-Sharp programming, the g-code be compiled and reproduced, creating movements and functions like the CNC used as reference. The lab was added

to Moodle using the Unity-SCORM Integration Kit, enabling the remote user access to the simulator, direct interaction with the real CNC through activities implemented via SCORM and all the content available. The analysis of the results was carried out by testing at CEFET-MG lab on February 2019, where the g-code was executed in the real CNC and right after in the virtual environment. After comparing the obtained results, it was concluded that the virtual environment present results without deviations. The virtual environment optimizes lab resources, primarily by enabling remote access. The expected impacts of this project are the use of this remote lab methodology at Engineering and vocational training levels. It is also expected to add functions like drilling calculations, tools change and tool break simulation, as well new virtual objects that has been tested, like a five-degree of freedom robot arm and a three-degree of freedom delta robot coupled with a computer vision system. We would like to thank CEFET-MG, FAPEMIG and PET/SESu/FNDE for their support in this project.

Keywords: 3D, Distance Learning, Remote Lab, Teaching and Learning, Computer Numeric Control.

9.1 Background

The use of games as learning tools is not new and is common approach to provide variety in teaching and learn approaches[1]. Therefore, as technology must guide the directions of education in the next few years, computers, tablets, smartphones, virtual reality, virtual environments and other equipment will be increasingly present at the reality and routine of the classroom.

A virtual learning environment becomes an interesting approach to contribute to new experiences and enables students to learn from their mistakes[2]. The virtual environment architecture have an attractive language for the users, making the learning process dynamic, fast and pleasurable by the use of virtual objects similar to a real machine.

These virtual objects and activities enhance learning by providing immediate and specialized feedback to student input. Moreover, students will be able to interact with these objects independently or in a group, at any time of the day or night without an instructor[3].

This project, together with other virtual objects, is part of a thematic project of distance learning in a remote access lab.

9.2 Purpose/Hypothesis

The present project deal with the development of a virtual model of a Computer Numeric Control (CNC) machine and curricular units to extend and support the traditional teaching-learning process.

By accessing the virtual object, the student can develop his laboratory activities through theoretical approach, simulation and remote access provided by the Moodle platform, as shown in the Figure 9.1.

Contributes to the overall objective of this project, bench tests for comparison of simulation results whit the actual object response.

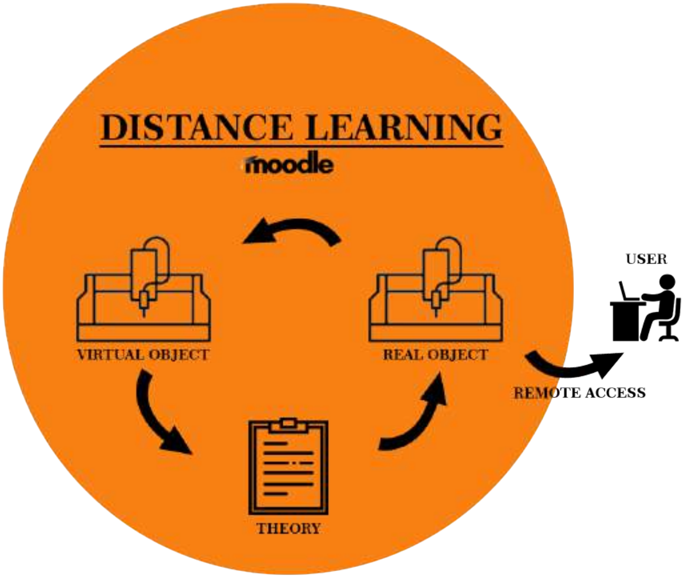

Figure 9.1 – Virtual Teaching Environment Scheme.

9.3 Design/Method

Seeking to develop a high realism environment was used a CNC created at CEFET-MG as model (see Figure 9.2). The modeling was done using Blender software. The prototype developed is shown in Figure 9.3 along with the CNC model.

The model was exported to Unity 3D software where its parts were separated by independents axes to perform the movements according to defined functions.

Basic motion functions, G0 and G1, and a method of reading and interpreting the g-code line by line were implemented to obtain the same result when

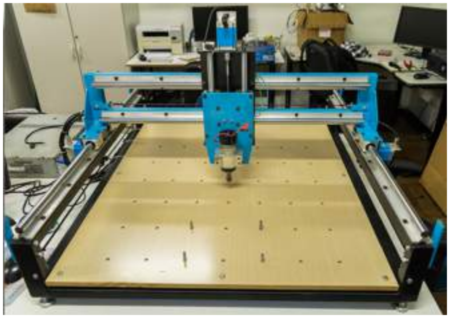

Figure 9.2 – Real CNC Machine.

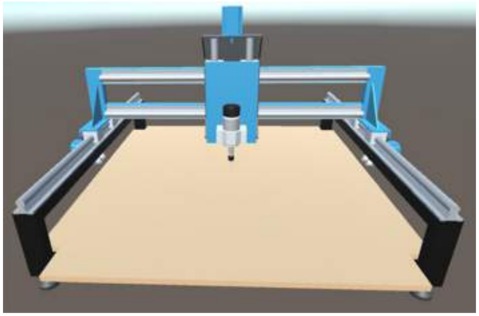

Figure 9.3 – Virtual Model.

the same g-code was used in real and virtual CNC machine (see Figure 9.4).

9.4 Results

The results were obtained through bench tests using the same g-code in real and virtual CNC machine. The simulator works in real scale, using same values as the real, allowing comparison of the outputs and obtaining the same

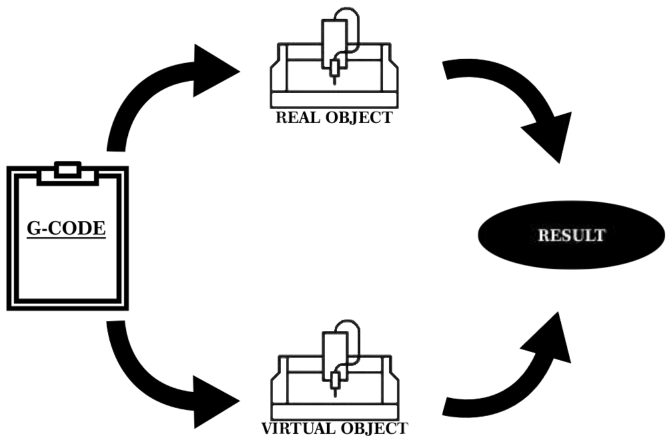

Figure 9.4 – Result Comparison Scheme.

results.

The results of the simulator are theoretical, so they may show deviations from the real object. The maximum error of the real CNC machine in relation to the positioning is six thousandths of millimeter. For this reason, it was assumed that the results did not have considerable deviations.

9.5 Conclusions

The use of the virtual object within the distance-learning tool with remote access will enhance the teaching of computerized numerical control. The student can experience various situations and build new knowledge from this immersion.

The model still does not consider some drilling parameters, for example the breaking of a tool.

Other 3D objects are being developed within the same proposal of CNC machine for use integrated to Moodle.

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CHAPTER 10

"Engenheiros da Infância" Takes Action in Early Childhood Education Centers: An UFG's Engineering School Extension Project Brings Improvements to Childhood Education

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Abstract: "Engenheiros da Infância" is a group formed by Mechanical Engineering students participating in a project, created by the University to interact the academic community and population. The main objective of this group is to make undergraduate students use their knowledge to propose improvements in infrastructure and helping developing pedagogical products together with the children's teachers in Municipal Center for Early Childhood Education (known as CMEI), situated in the city of Goiânia, capital of the state of Goiás in Brazil. Resources such as machines of metal cutting, non-traditional machining processes and theoretical knowledge is used in this project. Public centers of education usually suffer from bureaucratic processes and lack of resources, such as didactic equipment and general maintenances, affecting the quality of the education offered in basic education for children. In the attempt to collaborate with child education teachers, the program came to life thinking of ways to solve problems using Engineering knowledge acquired in the University. The first institution the group Engenheiros da Infância took part was the CMEI Cecília Meireles and its main requests were the lack of didactic toys that encourage the development of motor coordination. The results were satisfactory, generating great fulfillment in those who benefited from the actions, such as the children's teachers, parents and the children themselves, also, in those involved in the students team responsible for the project.

Keywords: Early Childhood Education, Engenheiros da Infância, Engineer, Engineering Education.

10.1 Background

One of the University main social responsibilities is to contribute with research solutions to severe social problems faced by the population, formulating participatory and emancipatory public policies[1]. It is known that public initiatives suffer in general from bureaucracy and lack of resources. In the attempt to collaborate with child education teachers, the program "Engenheiros da Infância" came to life thinking of ways to solve problems using knowledge acquired in Engineering graduation course. The initiative allows University students to use their theoretical knowledge, contact with the experience of teachers and technicians, and access to University laboratories, as well as the involvement of the community in general, to propose improvements and practical solutions to problems that affect the quality of teaching in Municipal Child Education Center (CMEI) in Goiânia, Brazil.

10.2 Purpose/Hypothesis

The main objective of this group is to make undergraduate students use their knowledge to propose improvements in infrastructure and helping developing pedagogical products together with the children's teachers in Municipal Center for Early Childhood Education (known as CMEI), situated in the city of Goiânia, capital of the state of Goiás in Brazil.

10.3 Design/Method

The first institution the group Engenheiros da Infância took part was the CMEI Cecília Meireles during the second semester of 2018 and its main requests were about some structural problems and the lack of didactic toys that encourage the children's development. Such needs were raised during an interview with pedagogical team, who explained that the classes were divided by age and there were attended children from 1 to 5 years. Among all requests, the group chose some to work with and then suggested solutions for the occurrence of high temperatures in part of the external environment and acoustic problems characterized by disturbing noise between classrooms, some toys that could be developed by the team in the University Laboratories and using reduced financial costs were also chosen. For the structural problems presented, it was decided to facilitate the CMEI's access to solutions projects carried out through research and supervision of the University professors that would meet the demands presented, with the possibility of those solutions being executed also by the student's team. The thermal solution proposed was the use of tetrapak packaging as a surface coating for thermal isolation[2] , and for disturbing noise it was suggested a isolation structure between rooms and some changes in furniture using non expensive materials and donations.

10.4 Results

The students researched for the best solution to all requests, so then pedagogic toys that encourage motor coordination were made using reduced financial costs, (Figure 10.1). Among them were one made of MDF (a) furnish the large doll house the school has, and three made with PVC pipe (b) cat bed toy, (c) pit toy and (d) water curtain toy.

Figure 10.1 – Pedagogic Toys.

In addition to manufacturing toys that have benefited all CMEI children, the proposed solutions to structural problems will also have a positive impact when implemented, as can be seen in Figure 10.2 as an example for the sound insulation solution, which one reached 1 and 5 years old children. The Figure 10.3 shows the children benefited from the acoustic solution.

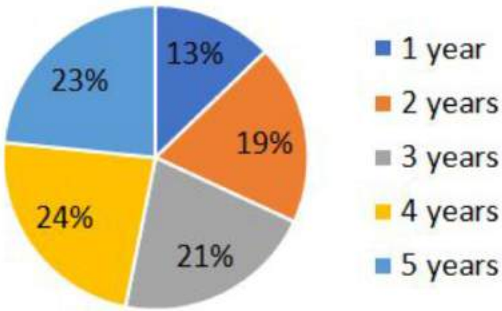

Figure 10.2 – Students by Age.

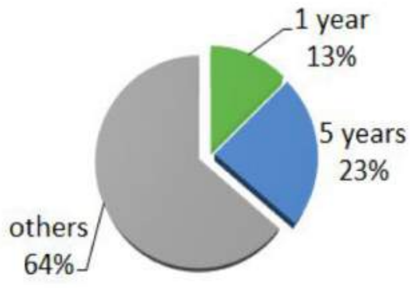

Figure 10.3 – Children Benefited from The Acoustic Solution.

The project was also submitted in the 5th (OEU) looking for improving its structure and advertising the project, in order to mobilize more people and resources, making it more effective. The team “Engenheiros da Infância” participated in the competition at the same time as performed its first action in the CMEI Cecilia Meireles. At the end of the competition the team was in sixth place.

10.5 Conclusions

The results were satisfactory, generating great fulfillment in those who benefited from the actions, such as the children’s teachers, parents and the children themselves, also, in those involved in the students team responsible for the project. The action benefited a total of 94 children and 25 staff members, teachers and support team, besides the students and volunteers involved in the execution.

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CHAPTER 11

“Engenheiros da Infância” in The 5th Entrepreneurship University Olympiad (OEU): An UFG’s Engineering School Extension Project Learning How to Entrepreneuring

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Abstract: This work is related to the participation of the project “Integrated Education: the University back to the child education” created by undergraduate students at Universidade Federal de Goiás (UFG) on the 5th Entrepreneurship

University Olympiad (OEU), organized by Centro de Inovação e Empreendedorismo (CEI) in partnership with the same University on October 2018. The project group, better known as “Engenheiros da Infância” (Childhood Engineering), was registered in this competition on the social category, which aims non-profits projects. The category was chosen due to the team’s interest in approaching Engineering students to act in order to improve and collaborate to childs education. The main challenge was to suggest some practical solutions to structural problems, which affect the quality of education from Municipal Child Education Center (CMEI) in Goiânia, capital of the state of Goiás at Brazil. The project was registered in the 5th OEU looking for improving its structure and advertising the project, in order to mobilize more people and resources, making it more effective. The team “Engenheiros da Infância” participated in the competition at the same time as performed its first action in the CMEI Cecilia Meireles. First act of the team was creating, pedagogic toys, using reduced financial costs, that encourage motor coordination development. The toys were designed by the team and used UFG’s Mechanical Engineering School laboratories equipment for production, such as a laser cutting machine. Alongside with creating pedagogic learning toys, teachers working at the Municipal Center of Education presented problems not direct related to education, but also related to Engineering knowledge acquired by a graduate student in his academic experience, such as poor acoustic insulation between classrooms and high temperatures under the courtyard ceiling. While participating in the OEU, the group could notice several aspects concerning entrepreneur competences presented in this project. The participation in the Olympiad ended with a final report submission, which included details of project structuring as work plane and its actions, as well as all manufacturing processes and Engineering

suggestions made in order to improve teacher’s working conditions. There was also the inauguration from all toys manufactured during a special event to celebrate the children’s day, organized by the municipal institution. In conclusion, the obtained results were satisfactory, with the team “Engenheiros da Infância” tooking 6th place in the competition, which brought on the Engineering students growth and knowledge, also, the satisfaction of those benefited by the actions of this group, as well as to other parties involved in the process.

Keywords: Entrepreneurship, Learning skills, Pedagocic Toys, Competition, Olympiad.

11.1 Background

The Integrated Education Extension Project: The University Back to Child Education is intended to use theoretical knowledge, the experience of technician and teachers, and access to University laboratories, as well as the involvement of the wider community in order to propose improvements and practical solutions to problems that affect quality of CMEIs (Municipal Center for Early Childhood Education) education in Goiânia. Thus, the University can contribute to its role of seeking solutions to social problems of the population[1]. With objective of disseminating entrepreneurial culture in the academic community and contributing to the development of entrepreneurial competence in different areas of knowledge, the UFG Center for Entrepreneurship and Innovation (CEI) started the Entrepreneurship University Olympiad (OEU), already in its 5th edition in 2018[2]. Also by mobilizing students, they propose the development of actions that can alleviate social problems and, for this purpose, open two categories in the competition: the business and social categories.

11.2 Purpose/Hypothesis

The group "Engenheiros da Infância" (see Figure 11.1), was enrolled in the 5th University Entrepreneurship Olympics, that occurred in September and October 2019, with the objective of boosting the project, in order to promote a better structure for it, enhancing its actions and reaching a larger public.

Figure 11.1 – Team participating in Bootcamp and its logo.

11.3 Design/Method

The "Engenheiros da Infância" team competed in social category while holding its first action at CMEI Cecilia Meireles. The beginning of the Olympiad took place with the teams participating in the Bootcamp held over two days, in which participants had mentoring moments and group activities (see Figure 11.2) to develop skills in order to perfect their enterprise. Throughout this process the “Engenheiros da Infância” team refined their work plan by establishing the actions they would take on their first activity in CMEI Cecília Meireles, and how it should be developed to achieve better results.

Figure 11.2 – Team participation in Bootcamp held by the Centro de Empreendedorismo e Inovação (CEI/UFG).

In addition to the actions, the team proposed a schedule for carrying them out, as well as a marketing and fundraising plan, following all guidelines received throughout the Olympiad.

11.4 Results

With the participation of the “Engenheiros da Infância” in 5th Entrepreneurship University Olympiad, the project grew a lot, and it achieved good visibility among the community, winning volunteers for the actions, sponsorships and support in general. It was possible to make the proposals of its work plan, enabling the production of toys and their inauguration in the week of the child, organized by CMEI. The solution to the other problems were also presented, and for its application, the project and CMEI maintained the partnership.

11.5 Conclusions

In the end the results obtained were satisfactory, with the project being in sixth place in the competition and generating great satisfaction in those who benefited from the actions, as well as in all those involved in the process.

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CHAPTER 12

"Engenheiros da Infância" Hold Workshops at "Curta o Campus - Autumn Edition" Event

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Abstract: The present work concerns the participation of the extension project of the Universidade Federal de Goiás (UFG) “Integrated Education: The University back to early childhood education”, at the “Curta o Campus - Autumn Edition” Event, organized by Pró-Reitoria de Extensão e Cultura (PROEC/UFG). This event aims to bring the population closer to the dependencies of the University and activities developed by the academic community. Likewise, the extension project group, better known as “Engenheiros da Infância” (Childhood Engineers), seeks this approach by using theoretical knowledge, contact

with University teachers and access to the laboratory structures of Universities to solve problems presented by the municipal Children's school. The group acts suggesting improvements in infrastructure problems and developing pedagogic toys according to the need presented by the children's teachers, promoting different activities and learning skills to their students. The team Childhood Engineers alongside with PROEC suggested a workshop of recreational toy development for children from ages of five to ten years old. Aspects of psychomotor development, social interaction, environmental impact and stimulation of scientific knowledge were taken into account, when manufacturing the toys. In order, to meet all requirements previously exposed the toy chosen was the "Vai e Vem"(Come and Go). Among with the materials needed for the production of a "Vai e Vem" toy, are two plastic bottles cut in half. To collect the necessary material a campaign was carried out with the community through the social media from Childhood Engineers of PROEC, resulting in the collection of approximately one hundred and thirty bottles. During the workshops, it was also emphasized to the children the importance of the correct destination and reuse of recyclable materials present in our daily life. During the workshop, there were made forty-six toys providing an afternoon of fun, cultural rescue and interaction for children and their families.

Keywords: Engenheiros da Infância, Curta o Campus, Come and Go, Workshop, PROEC.

12.1 Background

Extension actions should act as a necessary instrument so the University's main products, research and teaching, be as available as possible to useful applications in society[1]. Nunes and Silva (2011) say that University extension is an educational, cultural and scientific process that enables the relationship between University and society, and its social transformations must go beyond academic walls[2]. The extension project "Engenheiros da Infância" (Childhood Engineers), a group formed by students from the Universidade Federal de Goiás (UFG) aims to bring the University closer to early childhood education using theoretical knowledge, contact with teachers, access to the institutions laboratory structures to solve proposed problems in infrastructure and developing equipment and toys according to the need presented in CMEI's (Municipal Center of Early Childhood Education) of Goiânia and region. With the same purpose of integrating academic knowledge, local issues and community participation, one of the goals that define the Contemporary University Extension Policy, PROEC (Diretory of Extension and Culture of UFG) started the project "Curta o Campus" (Enjoy the Campus). The proposal aims to integrate University community and external community, providing different actions to members of academic field and making them accessible to the population[3].

12.2 Purpose/Hypothesis

The team of "Engenheiros da Infância" signed up for the third edition of the event, to be held in March 2019 the autumn edition. PROEC project provides the opportunity for members of the academic community to engage in activities that involve the population outside it. Bearing in mind this proposal, the objectives of the extension project group and the fact that children learn by playing, the team of students proposed holding toy workshops with children, reusing recyclable materials.

12.3 Design/Method

After research and considerations about the conditions under which the toy manufacturing workshop would be held, such as the environment, the age of the public, the available resources and others, it was decided of performing the activity using PET bottles. The toy selected was “Vai e Vem” for its workshop. In addition to PET bottles, the other materials used in the workshops were also reused and low costs. The PET bottles were collected during the event divulgation and the other materials provided by PROEC, they were plastic wire, strings and adhesive tape. Figure 12.1 presents the toy “Vai e Vem” made in the autumn edition by the children. It takes two PET bottles, four caps and adhesive tapes. The toy stimulates gross motor coordination and promotes group play. At the end of the activity the children took the toys with themselves so they could play at home with their friends.

12.4 Results

Approximately eighty children were benefitted during this autumn workshop, in which 44 “Vai e Vem” toys were manufactured. To make the toys, a total of 88 PET bottles and 176 bottle caps were reused, and many more were sent for

Figure 12.1 – Toy manufacturing workshop "Vai e Vem" during the event.

recycling. These numbers show that the workshop had a important approach to the theme of reuse and recycling of materials on a daily basis, which has a positive impact on children presented at the event, learning how to better use waste materials.

12.5 Conclusions

The workshop results were satisfactory, attending a large number of children and motivating the group to perform more actions like this in other event editions. The use of recyclable materials for toy manufacturing also promoted the awareness of children and parents involved in the activity. The involvement and satisfaction of the public showed how important it is for extension to fulfill its role in integrating the University and society, and the relationship between the two is extremely important for both to develop their activities and their roles in the best way possible.

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CHAPTER 13

Knowledge Exchange and Skill Development: Case Studies

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Abstract: Generally, the desired and required profile of the graduated student in Engineering, i.e., the professional trainee, or the Engineer, accounts for a generalist, humanistic, critical-thinking and reflexive background formation, which make this professional capable of comprehending and developing new technologies, stimulating his critical and creative role in identifying and solving problems, bearing in mind its political, economic, social, environmental and cultural aspects, with an ethical and humanistic approaching, in accordance with the demands of society, and in accordance with the national curricular guidelines proposed by the Brazilian Ministry of Education (MEC). This way, this work aims to present and discuss the results of three extension projects (case studies) that have significantly added opportunities, in addition to those offered in class, during the formation of Engineering, aiming the innovative, educative and entrepreneurial activities. The first Project (study case) has provided the knowledge exchange and professional and graduation experience exchange between the Professionals/Engineers (ex-students) and the undergraduate students, including the undergraduate students' initiatives (as protagonists) in order to approximate the undergraduate students to their future career. All activities have been carried out highlighting the demands of the Engineer's career, interacting Engineering students and graduates, from the internal and external communities to the University. Yet, the second study

case has promoted the learning in the educational area, where the undergraduate students have acted as a teacher at a preparatory class for the ENEM (the Brazilian national exam that promote the access to state Universities all over the country). In addition, this case has promoted the social integration of students of higher education with high school students. It must be emphasized the importance of this educational support, including the advising of each student according to his individuality, so that he could complement his studies and overcome possible academic difficulties. This advising process increased the knowledge, the didactic training of the undergraduate students, and improved the life in the campus and the contact to young students from different educational institutions of the region. Finally, the third one has been focused on improving the student's ability of speaking, discussing and solving problems in English language, aiming at expanding the studies of the area, preparing them to work in Brazil and abroad. The methodology used in this work has been based on the results presented by the participants (mainly the undergraduate students) and on the perceptions of the students, with impacts on the transformation, where they developed the skills of: speaking and written communication; team work; planning and teaching plans of the subjects that have been addressed; promoting/marketing the activities; execution; evaluation; and to present proposals for improvements for future projects. Therefore, the results were satisfactory and motivators (considering the variety of opportunities provided in the Engineering courses), and they contributed to the development of skills during the formation of Engineering students, aiming good academic performance (with incentives in the continuation of the course) and professional, facing the job market, which has challenging and innovative realities, with commitment to social responsibility and sustainable development.

Keywords: Engineering, Extension Project, Knowledge Exchange, Skills.

13.1 Background

In order to develop the students' skills, it is necessary the usage of some strategies that enhance the active learning process, providing general skills apart from the specific skills of the Engineering course, which prepares the professional for different job market requirements[1-3].

The motivation of this work is based on the knowledge exchange in order to develop the aforementioned skills during the formation of undergraduate students in Engineering, aiming the innovative, educative and entrepreneurial actions, which comply with the curricular guidelines for Engineering courses of the Brazilian Ministry of Education[4]. Therefore, the main objective is to develop complementary activities by means of extension projects, adding to the knowledge, practice and recommended characteristics of the egress profile, the: holistic and humanistic vision, critical thinking, philosophical, creativity, cooperativity, ethical, and with proper technical training.

13.2 Purpose/Hypothesis

The development of competencies has been achieved by means of three extension projects, which had the students as protagonists in all stages, learning by themselves, and dealing with a variety of situations and contexts. These extension projects have provided: the sharing and transfer of knowledge between University and professional, which shared their experiences during the under graduation courses and during their professional lives, and the under graduate students, which could approach them to the professional environment; the learning in the area of education, and the social integration of students of higher education with those of secondary education; the day-by-day communication, in the English language, which has prepared them for the work in the national and international job market.

13.3 Design/Method

The methodology used in this study was based on the results presented by the participants and on the analysis of students' perceptions (from different term of the courses), with impacts on the transformation and amplification of the training, recorded through questionnaires and reports.

13.4 Results

It is illustrated in Figure 13.1 the extension projects carried out (case studies).

The analyzes of the results of the questionnaires and of the students' perceptions show a significant improvement, including the skills acquired by the participants from the internal and external communities to the University, such as: technical and complementary knowledge; oral and written communication; team work; decision-making in problem-solving and global awareness-

Figure 13.1 – Extension projects carried out.

raising, with voluntary work (humanistic and holistic training); scheduling and teaching plans of the disciplines, as part of the practice on teaching; promotion/marketing of the developed activities; execution; evaluation; and presentation of proposals for improvements for future projects (with innovative and entrepreneurial perspectives).

13.5 Conclusions

In the analysis of participants' perceptions, the importance of the implementation of academic activities of content synthesis, integration of knowledge and articulation of multidisciplinary and transdisciplinary perspectives in their practice is emphasized, providing to the graduates, throughout their formation, the general competencies discussed in this article. Technological advances occur dynamically every day, requiring professionals in the field of Engineering hard training and constant updating. Consequently, this work has successfully achieved the proposed goals, contributing to the students' abilities and characteristics in the presented segments, aiming at good grades (with greater motivation) and professional performance in the job market, following the challenges of the current national and international scenario.

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CHAPTER 14

Coffee Project (Connections Knowledge): Conversation Wheels

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Abstract: The Coffee Project (Connections Knowledge): Conversation Wheels is developed by Grupo PET - Engenharias (Conexões de Saberes) of the Universidade Federal de Goiás (UFG) located in Goiânia, Goiás, Brazil. The purpose of this project is to create foreign language conversation groups at the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) and the Escola de Engenharia Civil e Ambiental (EECA) so that the participants will develop their knowledge of the chosen language. The first step was to create a form in the Google Forms Platform. In order for this form to reach the possible participants of the project, an e-mail was sent to the courses coordinators of the EMC/UFG and EECA/UFG where they were applied to the students. Engineering students interested in the project should mark the foreign languages they would like to develop in conversation groups where they could mark more than one language. From the answers obtained, 94.3% of the students are interested in studying English language. This result was already expected due to the relevance of the English language in the world. The study of French ranked second as the preferred language of the answers collected, and 28.3% were interested in groups of conversation of that language. Again, this result was also expected due to an exchange project for France present at the EMC/UFG, the BRAFITEC (from French language: (BRAsil France Ingénieur TECnologia). In third place, with 15.1% of the answers, was the Spanish language. German language followed immediately in preference with 5.7%. The Greek language ranked last with 1.9% of stakeholders. The form also had Italian language, but this language was not chosen by any student interested in the project. In May, the second stage of the project will be carried out with the formation of the English-speaking group, and in June, the same stage will be held for the French language. The final step will be writing a final report of the project with the

results obtained throughout the project development.

Keywords: Coffee Project, Connections Knowledge, Conversation Wheels, English Language, French Language.

14.1 Background

An student and former member of the Grupo PET - Engenharias (Conexões de Saberes)[1] reported during a meeting that she set up a foreign language conversation group at the French University where she was doing exchange. From this, we had the idea of making the “Conversation Wheels” in the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) of the Universidade Federal de Goiás (UFG). During the planning of the year 2019, it was decided that the idea would be transformed into a project, and so the “Coffee Project (Connections of Knowledge): Conversation Wheels” was born with the objective of developing the participants’ knowledge in a certain foreign language.

14.2 Purpose/Hypothesis

Considering the importance of the foreign language for the professional career and also for the studies, many students of the EMC/UFG would enroll in the project since it would make the foreign language more present in the participants’ coditian and would increase the knowledge of the participants in certain languages. Indeed, the second language pedagogy and translation is important[2], but the natural conversation is very important in the work context.

14.3 Design/Method

For the choice of foreign languages, a form was created in the Google Forms Paltform[3]. In this form, the following data was collected, in relation to the possible participant of the project: the e-mail address; the course he was going to do at the University; if the student had already studied some foreign language; if the likely participant responded positively to the previous question, which language(s) he/she had already studied; if the student would be interested in participating in foreign language conversation groups; if that last answer was "yes", which language(s) the student would be interested in; and what would be the best day of the week and schedule. The form was sent to the EMC/UFG and Escola de Engenharia Civil e Ambiental (EECA/UFG) courses coordinators where they were applied to the students. Ideed, a form was created in the Google Forms Platform for the registration where it collected the name, age, e-mail and level of education of the participants. In order for this form to reach the possible participants, a message was sent to WhatsApp groups that the members of the Grupo PET - Engenharias (Conexões de Saberes) participate, as well as publications on Facebook and Instagran. In addition, pasted posters publicizing the event in the main buildings of the University campus of UFG. The dynamics were assembled with the following steps: presentation; get-to-know-you/introduction by "icebreaker"; guessing game; and theme discussion. The chosen theme was: "Will machines cause unemployment for humans?".

14.4 Results

Regarding the first form, 94.3% of the respondents had already studied a foreign language. Against 5.7% they had never studied. 94.3% had already studied English language, 28.3% had studied French language, 15.1% studied Spanish languag, 5.7% had studied German language and 1.9% had studied Greek languag. Concerning the interest in participating in "Conversational Wheels" of some foreign language, 86.8% of the students who answered the form were interested in participating, 13.2% might be interested and no one showed lack of interest. It was asked which language would be most interesting and obtained: 98.1% of the interviewed in English language, 22.6% in French language, 11.3% in Spanish language, 5.7% in German language and 0% in Italian language. The Figure 14.1 shows a graph with the languages preferred by EMC and EECA students.

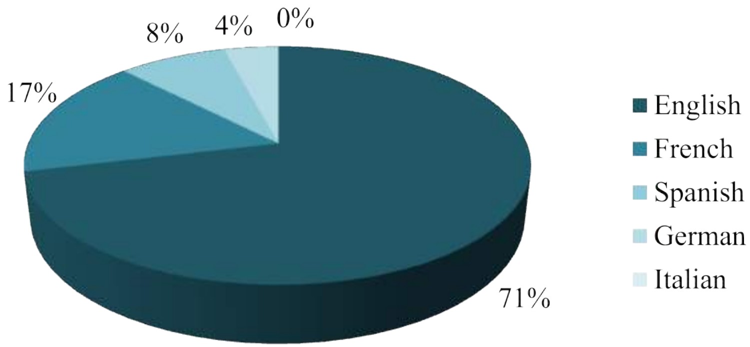

Figure 14.1 – The languages preferred by EMC/UFG and EECA/UFG students.

From Figure 14.1, the French language was cited because of the BRAFITEC (from French language: (BRAsil France Ingénieur TECnologia)[4]. Indeed, the students from both schools participate in this Program which influences the choice of the French language. On the best time for the “Conversation Wheel”, 56.6% would prefer the afternoon period, 33.9% would be at night, 16.9% would be on weekends and 11.3% would be in the morning period. Like this, the English language was chosen as the language for the first event of the project and on 22 May 2019, in the afternoon. For enrollment, we obtained 20.7% of the answers in relation to the first form and 63.6% of the participants attended the event. That was accomplished on the date marked and lasted for an hour and a half.

14.5 Conclusions

The number of participants in the event was different from that expected since only 13.2% of the people who responded to the first form were actually to the event. The reason may be the lack of knowledge in the language and therefore have fear and participate in events such as the one proposed in this project. But, as there were participants, the “Conversation Wheels” with the French language will take place in the month of June.

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CHAPTER 15

Engineering Competition Project: Insights of A Case Study

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Abstract: Project-Based Learning (PBL) is a well-known pedagogical approach

and one of the active learning methods, which allows the students to develop a variety of different personal and professional skills, such as decision making, the ability to design, team working, interpersonal communications, and more. Among other traits, PBL contributes to Engineering education by empowering the students to develop Engineering competencies and job-related skills during the learning process in academia. Many researches investigate different aspects of PBL such as motivation, improving academic achievements, reflecting on students' own understanding, and more. The current study aims to describe how a competition between groups of students who design and perform projects during a PBL process influences students' competencies. During the Fall semester of 2017, 17 students were involved in the elective course of Competitive Project. Groups of three students were asked to develop and build an autonomous carriage, based on electronic kits, that could navigate itself toward a given target. At the end of the course, a competition was conducted between all the carriages. The carriage must arrive at the target - a source of infrared radiation (IR LED) - through a field with obstacles. The time of arrival at the goal was measured, and the groups were evaluated and graded according to it. The group that took the first place got the grade 100. After finishing the project, the lecturer and five of the students were interviewed about their experience. The lecturer and students' answers were analyzed according to a qualitative methodology. The results show that the competitive PBL approach brings about a performance of meaningful learning through project work among the students. Additionally, a competition facet contributes to students' high motivation and development of Engineering competencies such as self-reliance, creativity, making decisions and taking responsibility for them, striving for the best yet reliable results, team-working skills and others.

Keywords: Active Learning, Competition, Project-based Learning, Students' Competencies, IR Led.

15.1 Background

More and more Engineering educators believe that Project Based Learning (PBL) is a very important instructional approach and one of the active learning methods that enables students to master their academic skills and content knowledge, and develop interpersonal and individual practical skills, such as as decision making, the ability to design, teamwork, interpersonal communications, which are necessary for their future professional success. Among other traits, PBL contributes to Engineering Education by empowering the students to develop Engineering competencies and job-related skills during the learning process in the academia. Many researches[1-5] investigate different aspects of PBL in Engineering Education, for example, motivation, improving academic achievements, reflecting on students' own understanding, and more. Nonetheless, a study that explores how competition between groups of students who design and perform PBL influences students' competencies has yet to be found.

15.2 Purpose/Hypothesis

The research question is in how competition between students' groups is reflected in the lecturer's attitudes and students' traits, which were developed during PBL design process.

15.3 Design/Method

During the Fall semester of 2017, 17 students were involved in the elective course of Competitive Project. Groups of three students were asked to develop and build an autonomous carriage that could navigate itself toward a given target, based on electronic kits. At the end of the course, a competition was conducted between all the carriages. The carriage had to arrive at the target - a source of infrared radiation (IR LED) - through a field with obstacles. The time of arrival at the goal was measured, and the groups were evaluated and graded according to it. The group that took the first place got the grade 100. After finishing the project, the lecturer and five of the students were interviewed about their experience. The lecturer's and students' answers were analyzed according to a qualitative methodology.

15.4 Results

During the in-depth interview the lecturer of the course (an experienced lecturer with more than 20 years of Engineering experience and about 25 years of pedagogical experience) was asked to characterize the specific traits of students' learning in the Competitive Project course. The lecturer emphasized the next prominent characteristics:

- High complexity of students' projects. According to the project specification, students had to build one autonomous carriage and use at least one source of IR radiation (the target), one ultrasound sensor on the carriage for obstacles' detection, and one microcontroller Arduino for motor control installed on the carriage. All groups of students built two carriages - one for the experiments and one for the integration of ready-made blocks. Most of the groups used two or more IR LEDs for better area scanning and three-four ultrasound sensors installed on the sides of the carriage for more accurate detection of obstacles. Some of the groups used two-three microcontrollers.

- Creativity. One group installed a Wi-Fi module on the carriage, which transmitted the information to a computer from ultrasound sensors, and the students used it for error detection and its correction in real-time. The groups developed different algorithms for bypassing obstacles.

- Motivation. The students were highly motivated to succeed. They expressed high motivation in their efforts through the number of consultations they had with the lecturer, the quality of the built appliance, the product-oriented design process and their interest in the required knowledge.

- Time burden. The competitive aspect of the project was expressed in the additional time required to solve various problems, which arose during the design, testing and fixing of the real appliance. During the semester, the students were continuously present in a project lab, working until very late hours.

The interviewed students related to the mentioned above traits:

- Creativity

 - Y.: "Everybody must choose his own direction, to develop things, which are absolutely new for him, and it is good".
 - L: "IR detection was an additional challenge. In the beginning we built a basic IR transmitter. We didn't know that there were IR reflections from every object, disturbances from the sun, and from fluorescent lights. We performed an actual research and found the material that blocks IR radiation. We built the base of the sensor from this material in a way that only IR signal from the source could arrive to it, but reflections couldn't. In addition, we found an IR communication protocol, which is stable to disturbances, and used it".

- Time burden
 - B: "We invested seven hours at home and five-six hours in a project lab in the college per week".
 - P: "It took me about seven hours every week, and maybe more in last two weeks of the semester". The interviewed students expressed their reflections on the course:
 - L: "The process that I went through changed the way I think. Today when I start designing I think ahead about the problems which can appear, and I try to prevent them".
 - M: "The fact that you create by yourself…there is an additional value to it. I like creating"!
 - P: "We worked as a real team. We divided all the work among the friends in the group, everybody was responsible for his area, for

decision making, for the work of a specific block, but all of us helped one another and other groups".

15.5 Conclusions

According to the results, it can be concluded that the competitive PBL approach brings about a performance of meaningful learning through project work among the students. Additionally, a competition facet contributes to students' high motivation and the development of Engineering competencies such as self-reliance, creativity, making decisions and taking responsibility for them, striving for the best yet reliable results, team-working skills and others.

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CHAPTER 16

Challenges and Experience with Multidisciplinary Capstone Projects in Mechanical Engineering

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Abstract: Mechanical Engineering is one of the oldest Engineering disciplines in higher education. Due to fast development of advanced technology, Mechanical Engineering becomes a multidisciplinary Engineering field. For the purpose of bridging theoretical knowledge and practical implementation, a one-year project-oriented capstone course, Special Topics in Mechanical and Electro-Mechanical Engineering, has been offered for the third year undergraduate students since 2015. Not like most capstone courses designed with one single project for all participating students, our capstone course needs to adapt to inherent multidisciplinary nature of the department and must have a unique framework with different mindset. It's highly believed that overall performance including sense of accomplishment and learning motivation can reach the maximum if students can work on the project that they are interested in. As a result, design of this capstone course stems from allowing all third-year undergraduate students have opportunity to conduct a project with strong motivation and personal interests. After the one-year capstone course comes to an end, all teams must participate in an annual departmental-level project exposition and competition. Both written reports and poster presentations are required for final demonstration. Versatile project contents verify multidisciplinary nature of the capstone project course. Course evaluation by

questionnaire with ten questions was conducted to examine course performance from the viewpoint of students. The results display promising positive feedback from students especially on difficulty level, course effectiveness, as well as being helpful for Engineering practice, teamwork, and conflict management. Nevertheless, challenges still exist to be overcome to enhance course performance. The first challenge is that 12.5% of participating students could not find interest in the project they were working on. The second challenge appears to be the capstone course did not demonstrate sufficient helpfulness to both cost and time management for student teams. Consequently, over one-fourth negative feedback is shown on project achievement to be expected.

Keywords: Capstone Course, Engineering Education, Multidisciplinary Projects, Project-based Learning.

16.1 Background

Due to fast development of advanced technology and innovation, Engineering disciplines cannot be simply separated as individual ones like before. In order to provide sufficient domain knowledge and skills to college students, multidisciplinary curriculum design is found in most current Engineering institutions. Mechanical Engineering probably is one of the oldest Engineering disciplines in higher education. Many Engineering disciplines such as Ocean Engineering, Industrial Engineering, Material Science, and Manufacturing Engineering, etc. are originated from Mechanical Engineering. Nowadays mechanical Engineering is still a multidisciplinary Engineering field.

16.2 Purpose/Hypothesis

In order to reflect its Engineering multidisciplinary nature in the real world, Department of Mechanical Engineering in National Sun Yat-Sen University changed its departmental title to Mechanical and Electro-Mechanical Engineering since 2001 after more than two-year discussion. Besides, for the purpose of bridging theoretical knowledge and practical implementation, a one-year project-oriented capstone course, Special Topics in Mechanical and Electro-Mechanical Engineering, is offered for the third year undergraduate students. Project-based learning (PBL) is a student-driven, teacher-facilitated approach to learning through inquiry[1]. Most capstone project courses for either individual department or interdisciplinary framework focus on one single group project for all student teams[2,3]. Nevertheless, our capstone course needs to adapt to inherent multidisciplinary nature of the department and must have a unique framework with different mindset. The multidisciplinary project-oriented capstone course demonstrated positive effect on creative thinking in verbal aspect using the New Creativity Test (NCT)[4].

Obstacles to multidisciplinary teamwork consisting of communication problems, scheduling difficulties, etc. can limit the team performance. Five curriculum tools including early involvement in senior project teams, specific training for teamwork, etc. were initiated to help students moving towards success in project teamwork[5]. A one-semester interdepartmental (Computing Engineering, Electrical Engineering, Industrial Engineering and Mechanical Engineering) multidisciplinary capstone course was developed at the University of Houston through a three-year transition[6].

16.3 Design/Method

Basically, our department would like to have students working on the project that interests them most. Interest can always give students strong motivation to complete the project with satisfactory performance. Consequently, sense of accomplishment can also be established to strengthen students' mental construction to deal with actual Engineering problems in the future. Therefore, two phases of the matching process were designed. Either student teams can directly talk to professors to initiate projects or choose a project from the project list collected by the department. In order to make sure that the matching process works properly, student teams need to accomplish a project proposal including a possible project title, time schedule plan, budget estimation, assignment of responsibility for team members, and advisor's signature after the meeting with the advisor. Besides, a progress report has to be submitted in the middle of the academic year. About 50% of faculty members were involved in the multidisciplinary capstone course to provide about three dozens of Engineering projects.

16.4 Results

In order to explore course performance from the view point of participating students, a course evaluation questionnaire with ten questions was conducted. Results of the course evaluation based on feedback from fifty-six junior students are summarized in Table 16.1. Encouraging outcome is clearly displayed in high percentages in moderate and positive responses. Nevertheless, negative comments over 12% are found in the following five items: interest

(12.5%), helpful for cost management (19.6%), helpful for time management (16.1%), recommend to future junior students (14.2%), and achievement expected (29.1%).

Table 16.1 – Results of course evaluation questionnaire.

Percentage (%)	Very negative	Negative	Moderate	Positive	Very positive
Interest	8.9	3.6	25.0	44.6	17.9
Difficulty	1.8	1.8	44.6	39.3	12.5
Fruitful and rewarding	3.6	3.6	10.7	55.3	26.8
Helpful for Engineering practice	3.6	0.0	10.7	71.4	14.3
Helpful for teamwork	5.3	5.4	14.3	62.5	12.5
Helpful for conflict management	5.4	5.5	27.3	54.5	7.3
Helpful for cost management	8.9	10.7	48.2	21.5	10.7
Helpful for time management	5.4	10.7	41.1	33.9	8.9
Recommended to future junior students	10.7	3.5	28.6	41.1	16.1
Achievement expected	7.3	21.8	34.6	23.6	12.7

16.5 CConclusions

Some participating students reflected little interest in the projects they were working on. It indicates that more projects need to be proposed for students especially for those research groups with limited project numbers. This effect apparently was transferred to increase of the negative assessment on “recommended to future junior students” and“achievement expected”. Not surprisingly, due to the fact that most faculty advisors take good care of cost of the capstone projects for students, negative feedback on “help for cost management” is therefore caused. Students usually did not pay attention to the time management at all and they always thought they should have had plenty of time to accomplish the capstone project. However, they did not consider a lot of time was required for reading and they were still responsible for examinations and projects for other courses. Consequently, recommended to future junior students and achievement expected could not be highly anticipated.

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CHAPTER 17

Comparative Study About Tests of Pervious Concrete as Learning Tool: Evolution of The Trait, Methods and Complementary Analysis

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Abstract: The execution of pervious concrete pavements has been used over the years as a pedagogical resource in the Civil Engineering course at UNEMAT - Universidade do Estado de Mato Grosso, campus of Tangará da Serra - MT - Brazil. With the purpose of aggregating scientific knowledge to the academics, providing advances in the technique used in the production of pervious concrete, as well to the development of the University's physical space. In this article, some of these studies will be presented in order to discuss the scientific observations made by academics in the development of practices and to evaluate the evolution in the methodologies of trait and execution. The characteristic that allow water infiltration has made porous concrete chosen to remedy problems due to the accumulation of water at several points on campus. In addition, another necessity was to promote the interconnection between classroom blocks. The works were evaluated taking into account the reports developed by the academics during the activities. In this analysis, the advancement of the techniques employed even when the students did not have

the appropriate equipment. It was possible to observe modifications in the techniques of staining the concrete and the level of difficulty of the drainage process involved. The results were discussed in view of both the evolution of the technique of preparation of the pervious concrete pavement by the academics, as well as the practice as a didactic and social resource. Recently, besides the permeability, the thermal properties of porous concrete have also begun to be explored. Would the pervious concrete pavements presents betters thermal performance than the conventional ones? In the state of Mato Grosso for presenting high annual average temperatures if, the pervious pavements contributes to a lower heat retention compared to the conventional one, this would show an excellent alternative for the substitution of the conventional pavements, prioritizing the thermal comfort of the academic community. Because of that, a comparative analysis was performed between the temperature values recorded in the porous pavements, in the conventional and green areas of the campus. The methodology of this research consisted in performance of temperature measurements with an infrared thermometer, the measurements was for 20 days distributed in four months, four times per day (8 a.m., 11 a.m., 5 p.m., and 7 p.m.). The rainy season in the region caused some variations in the results, since conventional concrete, when moist, takes longer to lose this moisture and absorb heat. The colors chosen in the painting also influenced results, because, in the pavements that the permeable concrete was not painted, showed lower temperatures than the conventional. The development of activities related to the analysis and production of pervious concrete contribute to the academic training of students of the Civil Engineering course on two fronts: obtaining technical knowledge and capacity for teamwork, exploring all the basic procedures of the routine of a real work.

Keywords: Pervious Concrete, Conventional Concrete, Pavement, Thermal Analysis, Learning tool.

17.1 Background

At Universidade do Estado de Mato Grosso (UNEMAT), campus of Tangará da Serra - MT - Brazil the academics of the Civil Engineering course, perform pervious concrete sidewalks relying on the guidance of Professor Elias Antunes. To fulfill the activity proposed by him, they performed by improvised methods due to lack of resources[1-2], such as machinery and tools. Even without ideal situations, the results were promising and remedied problems with water accumulation. The tests produce improvements for the academic community and contributes for learning and research for students of the Civil Engineering course.

17.2 Purpose/Hypothesis

Based on the pervious pavements of the campus, there is a comparison between them to observe the advances and improvements made by the students, showing how the practical projects are value for the academic life. Allied to this comparative study, it was made some thermal analysis of the pervious concrete, trying to prove that the pervious pavement absorbs less heat than the conventional pavement.

17.3 Design/Method

To make comparisons between the techniques employed and the advances, it was realized a bibliographic review of the reports produced by the students during the execution of their concrete. Therefore, we can compare the executive methods, equipment used and additives. Obtaining the evolution of the technique and the educational gain. The temperature analyses were performed by infrared thermometer, during 20 days distributed over four months and four measurements per day at the following hours 8 a.m., 11 a.m., 5 p.m., and 7 p.m. In some moments of the research, it was impossible to perform measurements for consecutive days, because of the rainy season characteristic for this region. Data collection began at 28/02/2019 and finished at 14/05/2019, with an average of 5 days of collection per month on five pervious sidewalks in the campus and it was measurement in degrees Celsius. For the disposition of the data will be made thermal amplitudes in three parts, morning, afternoon and night. For the amplitude of the morning will be made the difference between the measurement of 11 a.m. and 8 a.m., for the amplitude of the afternoon the difference will be between 5 a.m. and 11 p.m. The data collected at 7 p.m. is for observation of the thermal delay, comparing the measurement of 7 p.m. and 5 p.m. it was named as night in the results.

17.4 Results

The collected data were arranged in tables, making the averages of the amplitudes to have monthly values. Subsequently, the averages of the months, so we can evaluate the data obtained in a more simplified way. In the tables, abbreviations were used to indicate each material, PC-pervious concrete, CC-conventional concrete and GA-green areas. As we can be observed in Figure 17.1.

Average											
Locality 1	Morning	Evening	Night	Locality 3	Morning	Evening	Night	Locality 5	Morning	Evening	Night
PC	22,48	-14,71	-2,49	PC	12,53	-10,76	-2,28	PC	19,35	-13,81	-1,88
CC	15,15	-11,45	-1,43	CC	13,36	-8,69	-1,44	CC	11,32	-6,39	-2,01
GA	10,41	-8,64	-1,83	GA	10,95	-9,75	-0,68	GA	9,56	-8,47	-1,71
Locality 2	Morning	Evening	Night	Locality 4	Morning	Evening	Night				
PC	5,46	-1,90	-1,60	PC	5,99	-1,43	-1,48				
CC	5,49	-2,15	-1,28	CC	8,41	-3,01	-1,70				
GA	6,16	-3,39	-1,29	GA	6,83	-4,48	-2,73				

Figure 17.1 – Average of 4 months per locality in degrees Celsius.

17.5 Conclusions

Through the observation, can notice advances in the technique of production of sidewalks, learning about the trait and method of execution of pervious concrete. In some sidewalks, the students did staining tests, with the addition of dye or paint of the concrete. It is remarkable the improvement of academics seen the improvised methods and conditions with the sidewalks were made. Creativity, the ability to solve problems and cope with short deadlines and small budgets have been widely developed and are of great importance to the professional of the constructive sector. As for the study of temperature, it can be noted that the permeable concrete absorbs heat faster than the conventional yet loses the heat faster as well. This is due to the existing pores in its composition, allowing the air to come in and out more easily.

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CHAPTER 18

Interdisciplinary Learning: Development of Chicken Eggs Incubator for Scientific Testing

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Abstract: The estimate for new cancer cases until 2030 is 26 million and about 17 million deaths. Costs, in global economy, from cancer related illness alone reach one trillion dollars due to disablement and premature deaths, without accounting for medical costs. Considering this issue, UNIFEB (College of the Educational Foundation of Barretos) professors and students proposed an interdisciplinary approach between Electrical Engineer and Medical Physics courses and the Cancer Hospital of Barretos to improve research and development of cancer drugs. The Cancer Hospital of Barretos promotes specialized oncology treatment, nationwide, supporting prevention, research and learning programs such as this study. The Hospital requested the construction of a chicken egg incubator to the Technology Innovation Center (CIT) from UNIFEB. The incubator will be used to research new cancer drugs and treatments using in vivo chicken embryos chorioallantoic membrane (CAM) testing. CAM is a simple and cheap model to study the effects of tumor growth and migration. This study's objective was to produce an incubator that has electronic controlled

and monitored temperature and humidity and could be sterilized through a germicidal ultraviolet light. A commercial cold chamber was used and adapted to serve this purpose. A digital controller from Full Gauge is responsible for monitoring and controlling the humidity and temperature inside the chamber and a ultraviolet light can sterilize it after use.The product development contributed to the Electrical Engineers' practical learning within the skills and competencies requirements necessary to today's professional in the industry. The microbicide capacity of this machine is an innovation, allowing researchers to study antiangiogenic substances following safety protocols for experiments. This equipment, after tests, should be available and widely used commercially. The good technical interaction between researchers at Hospital de Cancer de Barretos and UNIFEB teachers and students was key to the success of the initial proposal, making product development partnerships like this a step forward in Brazil's technological advance.

Keywords: Angiogenesis, Cancer, Incubator, Interdisciplinary Teaching, SUS.

18.1 Background

The Hospital de Câncer de Barretos promotes nationwide hospital treatment, specialized in oncology, to patients through the public healthcare system (SUS), and also supports research, teaching and prevention programs[1]. One of these programs is a cancer drug research using antiangiogenic substances on the Chorioallantoic Membrane (CAM) of chicken eggs. The hospital asked to the Centro de Inovações Tecnológicas (CIT) from UNIFEB for a chicken egg incubator with real-time monitoring and controlling of temperature and humidity and also the capability of chamber sterilization. The test performed on CAM needs fertilized chicken eggs incubated at 37ºC and 70% humidity for three days. It is then opened a round shaped window at the chicken egg shell, covered with a plastic tape and incubated for six more days. Tumor cells are then injected to the CAM, roughly 3x10 6 cells suspended in 20 μ1 of matrigel. On the 13 th day, grown tumors will be photographed using a Stereomicroscope (Olympus SZ2-LHAD). Inhibitors and other drugs can be tested in ovo to study its effectiveness. Embryos are then sacrificed at -80ºC for 10 minutes, and their CAM is removed from the shell and fixated in 4% paraformaldehyde in order to be photographed ex ovo. Results are expressed as the percentage of each group's average growth.

18.2 Purpose/Hypothesis

To facilitate the use of CAM method, a incubator with temperature and humidity control, must be developed. As an innovation, the sterilization will be automatic using an ultraviolet (UV) light. The main objective is to design, develop and construct this electronic controlled incubator for the Hospital de Câncer de Barretos for future studies on antiangiogenic substances. As requested by the hospital, the incubator inner walls and grills should be made of stainless steel and the grill supports must be of autoclavable nylon. Also, the system should bear 300 eggs, temperature range between 15 and 40ºC with forced airflow and relative humidity range between 45 and 70%. Real time monitoring is essential and sound alarms must be installed for power outage and sudden temperature changes.

18.3 Design/Method

A simple commercial cold chamber, would be sufficient for temperature and humidity control and also has enough space for placing hundreds of eggs at the same time, suited for this purpose. Temperature will be increased by a resistor or decreased by the cold chamber compressor, and humidity will be added by a common ultrasonic humidifier. The system control must be able to determine parameters' values from system response to various inputs, making the PID control type recommended for this application 2. Costs related to system analysis often surpasses simple PID controllers[2] available in market today. A FullGauge PID controller, Figure 18.1, was chosen for having three outputs, one for increasing temperature, one for humidity and one for the cold chamber to decrease the temperature. It also has a RS485 serial communication to monitor variables in real time with a computer. The cold chamber electric wiring was assembled together with the others sensors and active parts, maintaining the possibility to cool down the chamber. The UV light was mounted above the grills.

18.4 Results

The objectives were achieved and the final chamber (Figure 18.2) has been used for the last year inside the hospital for cancer drugs research. There is not similar equipment available for purchasing today and the ones available

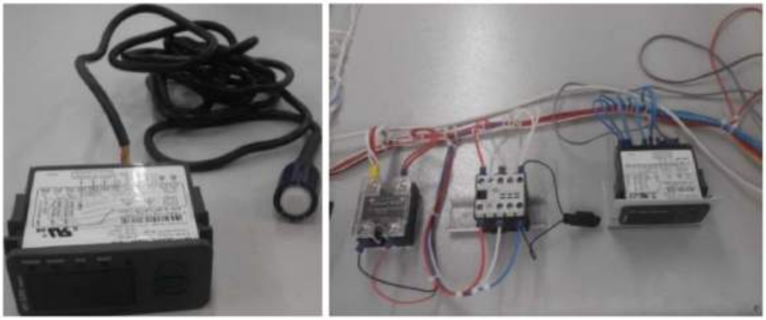

Figure 18.1 – FullGauge controller (left), Wiring assembly (right).

that does not have all the features are very expensive, two factors that encourages development within college and supported by Hospital's programs could become as commercial product.

18.5 Conclusions

The good technical interaction between researchers at Hospital de Cancer de Barretos and UNIFEB teachers and students was key to the success of the initial proposal, making product development partnerships like this a step forward in Brazil's technological advance.

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CHAPTER 19

Determination of the Physical and Mechanical Properties of Concrete with Partial Replacement of The Small Aggregate by Glass: Developed For the City of Vitória da Conquista, Bahia, Brazil

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Abstract: As Brazil is a country with continental proportions and with an abundance of inputs, civil construction develops easily, to the point of representing a significant share of national GDP (6.2%). However, this abundance of resources generates a certain negligence regarding the reuse of this material. The example of this is the glass industry, with a daily production of 6950 tons 2 , but this high production value is not reflected in the reuse of waste from the industry, as far as recycling is concerned the numbers are below what would be a value ideal, only 40% of it is discarded is reused. In the city of victory of the conquest located in the northeastern region of Brazil the situation is similar, most of the tailings generated are simply discarded in a landfill, not using them for recycling is due to the lack of specialized collection and the difficulty different types of glass for proper recycling. The present work aims to verify the technical feasibility of the use of discarded glass in the city of Vitória da Conquista as a small aggregate in replacement of sand in concrete through the determination of its physical and mechanical properties. The obtained waste was obtained by collecting in glassworks of the city, the mate-

rial collected is made of ordinary glass (float) shavings in the shape of blades with a thickness varying between 2mm, 3mm and 5mm and varied length. After the collection, the glass was ground with the help of a jug mill until a material with a grain size similar to that of the sand to be used in the manufacture of the concrete was obtained. Concrete specimens were produced and their aggregate was replaced with ground glass in 2%, 5%, 10% and 15% values. After being submitted to the compression test it is expected to obtain results compatible with the values of conventional concrete provided in the literature and thus to prove the effectiveness of glass as a small aggregate in concrete. It is a research of the experimental type that allowed applications of theoretical notions and aggregate valuable knowledge in the field of research.

Keywords: Concrete, Glass, Reuse, Vitória da Conquista, ABNT.

19.1 Background

The origins of Vitória da Conquista are linked to the efforts of the Portuguese colonial administration to establish communications between the coastal zone and the sertão. In contrast to what happened to the northern coast, the coastal strip that runs south of Bahia de Todos os Santos remained completely isolated from the interior until the mid-18th century. The latest economic indicators pointed to Vitória da Conquista as one of the most promising cities in Bahia. The growth of its Gross Domestic Product (GDP) and the fact that the city is the second fastest growing in the state of Bahia, the third among the interior of the Northeast and the seventh most important among medium-sized Brazilian cities, make the municipality more investment.

In Brazil, only about a third of the glass used is recycled. We humans are part of nature. Nature takes millions of years to decompose the glass. Given the existence of an appropriate environmental policy for the management of glass waste, our study has drawn the attention of the public and authorities to an environmental and ecological awareness and is an innovation in the field of Engineering.

19.2 Purpose/Hypothesis

Aiming at the development of public policies of environmental awareness in the city of Vitória da Conquista, which, despite its size, can be considered a medium-sized city, sinned by not providing its community with an education in the sphere of sustainable development. The objective of this work is to verify the technical feasibility of the use of discarded glass in this city as a small aggregate in partial substitution of sand in concrete through the determination of its physical and mechanical properties[1-8].

19.3 Design/Method

The material used in the development of the present work was obtained from the glazing waste from the city of Vitória da Conquista, located in the northeastern region of Brazil, collected from March 21 to 30. It was composed of a float glass (plain or common glass, the most used in civil construction) with a specific mass of 2.5 g/cm3, the collected waste was of 2 mm, 3 mm and 5 mm thickness and varied length.

After the glass was collected, it was crushed, using a jar type CE-500/D of the brand CIENLAB. Then, the ground material was selected so as to have a 100% low particle size of 6.3 mm in order to obtain a crushed material with a granulometry similar to the sand available for making the concrete.

In the next step the granulometry of the crushed glass was determined and previously selected through the sequential mechanical sieving test according to the guidelines of NBR 7217/1987[5] and NBR 7211/2005[6]. In the next step the specific mass determination test was performed by means of the Chapman flask. The result is obtained from the following equation:

$$\gamma = \frac{500}{L-200}, \tag{19.1}$$

where γ is the specific mass of the kid's aggregate and L is the reading of the bottle.

For the preparation of the specimens, specific metal molds were used for this purpose, they had cylindrical shape with 20 cm of height and 10 cm of diameter in the cross section. The trace of the concrete used was carefully sized by the ABCP7 method in order to obtain a resistance of 25 MPa at 28 days. In the determination of the compressive strength, the test was carried out in accordance with the instructions of NBR 5739/20078 where the test pieces were broken in a hydraulic press of the Autonics brand model MT4W. Samples were made with the following values of glass in substitution of sand 0%, 2%, 5%, 10% and 20%, with 6 specimens for each percentage, totaling 30.

19.4 Results

Table 19.1 shows the results of the compression test, due to the large number of specimens, the values presented are the average of the obtained results, so it is possible to have a better understanding and interpretation of the data.

Table 19.1 – Results of course evaluation questionnaire.

% of glass		Mean resistance (Mpa)	
	3 days	7 days	28 days
0	10.22	15.44	22.06
2	10.64	16.89	24.13
5	10.89	18.89	26.99
10	11.04	16.40	23.43

It is evident the increase of the final resistance (at 28 days) of the concrete with the replacement of the sand by the glass in the percentages of 2%, 5% and 10%, with the most satisfactory result for the value of 5% that presented an increase of 22%, 35% in relation to concrete without addition of glass. The 10% substitution presents a lower final resistance value than that presented by concrete with 2% and 5% of substitution, however its resistance in the first 3 days is superior to the others.

19.5 Conclusions

The present work serves as a starting point for several other studies aimed at the reuse of glass, as well as an incentive to awaken environmental awareness, showing that a product apparently without function as a waste product may surprise everyone with different possibilities of use. It is also interesting to note the importance of this research in the economic bias, since it is the reuse of a discarded material, that is, without intrinsic value by integrating the discarded glass in the construction as a concrete aggregate, we save on the acquisition of other materials such as sand, in addition to making the waste itself marketable, adding value to the cycle of use of this material.

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CHAPTER 20

Analysis of The Technical Feasibility of The Reuse of Plaster in The Manufacture of Lining Plates: Developed for The City of Vitória da Conquista, Bahia, Brazil

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Abstract: Civil construction is one of the sectors that strengthen the Brazilian economy, with an average annual contribution of 6.2% of the national GDP. And due to its demand for inputs is consequently a large generator of waste. One such waste is gypsum, with Brazil having an annual consumption of 30 kg/inhabitant, and with the arrival of new construction techniques the trend is an increase of this value. The impacts of this type of waste in the nature are severe, since one of its main constituents the calcium sulfate, causes the sulfurization of the soil and contamination of groundwater. In the city of Vitória da Conquista, located in the northeastern region of Brazil, it is no different, it has a large market in the construction sector, but with few environmental policies, which is reflected in the scarcity of materials reuse programs. In this particular city the plaster tailings are simply disposed of in landfills or irregularly in vacant lots. The present work has as main objective to demonstrate the feasibility of the reuse of gypsum waste from the city of Vitoria da Conquista in the manufacture of lining plates by means of the comparison of its properties with conventional plates. The material used in the recycling was collected in works by the city and in trade specialized in the manufacture and sale of plasterboard. The wastes were micronized and duly characterized, de-

termining for this their values of unit mass, fineness modulus and grain size. After the calcination of the samples, the test specimens were prepared using a homogeneous mixture of the pulverized tailings and virgin gypsum, to be submitted to the tests of compressive strength and tensile strength in flexion, taking as parameters the values determined by NBR 13207/94 (Plasterboard - Specification). The results obtained demonstrate the feasibility of the reuse of gypsum waste in the manufacture of new lining plates, since its values of compressive strength and tensile strength in flexion correspond to the expected parameters. For Bauer (2001), hardened gypsum pastes can reach compressive strengths between 5 and 15 MPa and tensile strengths between 0.7 and 3.5 MPa.

Keywords: Plaster, Plates, Reuse, Vitória da Conquista, ABNT.

20.1 Background

The origins of Vitória da Conquista are linked to the efforts of the Portuguese colonial administration to establish communications between the coastal zone and the sertão. In contrast to what happened to the northern coast, the coastal strip that runs south of Bahia de Todos os Santos remained completely isolated from the interior until the mid-18th century. The latest economic indicators pointed to Vitória da Conquista as one of the most promising cities in Bahia. The growth of its Gross Domestic Product (GDP) and the fact that the city is the second fastest growing in the state of Bahia, the third among the interior of the Northeast and the seventh most important among medium-sized Brazilian cities, make the municipality more investment[1-6]. Nowadays plaster is a product at the forefront of technology and its use has become a fundamental building material. Its aesthetic and mechanical properties make it the best choice for comfort and quality of life.

20.2 Purpose/Hypothesis

This study aims to analyze the technical feasibility of the reuse of plaster in the manufacture of ceiling tiles. The research that was developed may have the possibility of recovering the material, maintaining the same physical and mechanical properties of commercial plaster.

20.3 Design/Method

The material used in this work was obtained in works and specialized trade of the city of Vitória da Conquista located in the southwest region of the state of Bahia. Approximately 50kg of plaster were collected from March 15th to 30th, from boards and ceiling frames. This reject is due to manufacturing defects, chips and breakage of the pieces.

Initially the plaster was crushed by hand, thus obtaining pieces of various shapes that did not exceed 15 cm in its largest dimension, this coarse process was only intended to facilitate drying in kiln or calcination of the plaster. The material obtained by manual grinding was placed in metal trays and left in an oven at a temperature of 100 ºC for a period of 24 hours. After calcination, the plaster went through a cooling period and subsequently underwent a mechanized grinding in order to obtain a fine enough powder to compare with the virgin plaster found in the trade.

Measurements were made for different compositions of plaster paste, since there was a replacement of a percentage of virgin plaster mass by recycled plaster, in the values of 25%, 50% and 75% and of course the paste without any addition of plaster virgin.For the preparation of the specimens it was used molded resin wooden molds in the dimensions of 16cm x 4cm x 4cm, after being placed on a flat surface for better uniformity of the specimens, the molds were filled with plaster and water based paste. a water/plaster ratio of 0.80, a value that enables better workability.

In the last stage of the present work, the compressive strength test was performed, where the specimens were ruptured with the aid of an Autonics model MT4W hydraulic press. The essay was guided by NBR 12129/1991.

20.4 Results

After performing the compression tests, the results obtained are shown in the Tables 20.1 and 20.2.

The assay was done for different time periods, conventionally for the 3 and 7 day periods.

Comparing the results shown in the two tables, one can observe an increase in the compressive strength in general, but the really satisfactory results are shown in the specimens composed of 75% virgin plaster and 25% recycled plaster, which correspond to the expected by the literature.

Table 20.1 – Result of 3-day compression test for the virgin plaster percentage in the specimen (values in Mpa).

n	25%	50%	75%	100%
1	1.88	2.69	4.31	8.25
2	1.94	2.44	4.25	7.88
3	1.75	2.69	4.19	7.44
4	2.06	2.38	4.00	7.75
5	2.19	2.56	3.94	7.19

Table 20.2 – Result of 7-day compression test for the virgin plaster percentage in the specimen (values in Mpa).

n	25%	50%	75%	100%
1	2.63	3.00	5.38	9.75
2	2.56	3.44	5.19	9.00
3	2.44	3.06	5.63	8.13
4	2.38	3.38	5.12	8.38
5	2.50	3.25	5.50	8.88

20.5 Conclusions

From the studies carried out in the present work it can be concluded the effectiveness of substitution of virgin plaster by plaster reject in the proportion of 75% to 25%. Thus it is evident the need to apply an environmental awareness policy for the city of Vitória da Conquista, since some materials discarded as useless present if worked a correct way a use.

It can also be concluded the efficiency of the applied methodology, since the obtained results are satisfactory. It is necessary to pay attention to the economic importance of the studies developed in this work, since it was possible to add value to a material considered as waste and destined for disposal.

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CHAPTER 21

Calculus I in Engineering Courses: An Inventary of Adopted Measures to Mitigate the Students' Difficulties

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Abstract: The Engineering courses have in their school programs the subject of Calculus I, which provides a wide range of tools to solve numerous practical problems. However, a significant part of the students present difficulties in the initial contact with that subject. Which makes that issue is discussed in a recurrent way and referenced in the literature under different perspectives. Overall, these papers reveal the concern with the learning of contents inherent to the Calculus I (limits, derivatives and integrals) which if does not occur in a satisfactory way materializes by disapproval of students in the subject. But, in the face of mentioned difficulties in the studies, what have been effectively done by educational institutions to assist the students? Focusing on this issue, this work aims to investigate the initiatives adopted by higher education institutions aiming to mitigate the difficulties of Engineering students in the subject of Calculus I. In addition, we intend to find out the results obtained from the implementation of the strategies outlined with respect to the performance of the students in the subject in question. We start from the premise that reflections aiming at a greater understanding about the disapprovals and the low academic performance in Calculus I are important, but they must foment effective actions. This is a descriptive bibliographical research, based on 4.672 papers published in the Brazilian Congress of Engineering Education (COBENGE) in the period of 2009-2018. Through the reading of titles and abstracts, 292 papers were previously selected. These papers were read integrally

and, at the end of the process, it was found that 134 papers had relevant information in their scope, that is, that would contribute to the purpose of the investigation. For the analysis of the results, two categories were established: (a) previous interventions to the discipline of Calculus I, and (b) concomitant interventions to the discipline of Calculus. The main initiatives were: provision of monitoring in a variety of formats (n = 22 institutions), provision of leveling courses (n = 17 institutions), diagnostic tests to infer previous students' knowledge (n = 11 institutions) and adoption of introductory courses to Calculus I (n = 8 institutions). Moreover, it was identified that several initiatives were not characterized as isolated interventions, but were subject to institutional programs or projects. Finally, it was possible to observe that a small number of studies analyzed, from some perspective, the influence of these initiatives on the students' performance in Calculus I. Although many variables compete and, in some way, interfere with student performance in the discipline of Calculus I the discussions and initiatives listed are deeply rooted in a single variable: lack of mathematical baggage. Literature is abundant - if not unanimous - in pointing out the deficiency in relation to previous mathematical knowledge as one of the great causes for the low performance of Engineering students in Calculus I. Evidently, this variable is relevant, but it is necessary to investigate and implement initiatives related to other fields, such as innovations in pedagogical practices implemented in the classroom.

Keywords: Academic Performance, Calculus I, Implemented Strategies, Incoming Students, Cobenge.

21.1 Background

In the Brazilian Congress of Engineering Education (COBENGE) - an event held annually in Brazil - issues with focus on difficulties of incoming students in Engineering courses in Mathematics subjects have been on the agenda for some time. In particular, the discipline of Calculus I has received prominence and recent publications strengthen the premise that several variables, of different natures, compete and interfere in the academic performance of this curricular component[1-3].

In view of this setting background, the present study has the objective of mapping, based on the academic production disclosed in the cobenge in the period of 2009-2018, the initiatives adopted by the higher education institutions in order to alleviate the difficulties of Engineering students in Calculus I.

21.2 Purpose/Hypothesis

This investigation is guided by the following question: What actions have been implemented by Higher Education institutions or by teachers in order to alleviate the difficulties of freshmen of Engineering courses in the discipline of Calculus I?

21.3 Design/Method

This research is classified as basic descriptive, since it seeks to fill a gap in the knowledge about the proposed3 theme. As for the procedures, it is characterized as bibliographical since it was elaborated based on the papers published in COBENGE. The research universe was composed of 4.672 works, extracted from the COBENGE in the proceedings, in the period of 2009-2018. In order to give a real overview of the initiatives that have been carried out, four main themes have been established for which the associated descriptors have been chosen (see Table 21.1). They guided the selection of the works that constituted the initial portfolio of this research.

Table 21.1 – Presentation of the themes and their descriptors.

Main Themes	Associated Descriptors
Calculus	Pre-calculus, Zero Calculus, Calculus I, Differential and integral calculus, Calculus A
Mathematics	Difficulties, teaching and/or learning of mathematics
Strategies	Monitoring, leveling, teaching methodologies, actions PET
Admission to Higher Education	Incoming students, freshmen, first stage, early stages, basic cycle

Initially, the titles and abstracts of the papers were read in order to identify and pre-select those that could provide indicatives to answer the question posed in this investigation. In this phase, 292 papers were selected and later read in full.

As an inclusion criterion for the second stage (full reading),we select papers that mention any measures adopted by teachers, courses, departments or institutions to assist students in overcoming difficulties related to the discipline of Calculus I. At the end of this process 134 papers were selected to constitute the final research portfolio.

21.4 Results

It was observed that the research is linked to 56 institutions, and about 43% of the works were produced in 2017 ($n = 26$) and 2018 ($n = 31$). It was noticed that 39% of the works, linked to 5 institutions, describe results referring to the same initiatives.

As for the actions prior to student contact with the discipline of Calculus I, the following are the main subjects: the offer of introductory courses to Calculus ($n = 8$ institutions) and levelling courses ($n = 6$ institutions), as well as the application of diagnostic tests to verify prior knowledge ($n = 4$ institutions). As for the actions developed out concomitant with the Calculus, we detected: interventions made from different methodologies used in classes ($n = 14$ institutions), application of diagnostic tests ($n = 7$ institutions), offer of extra-class levelling courses ($n = 15$ institutions) and monitoring in the face-to-face modalities ($n = 17$ institutions) or mediated by technologies ($n = 2$ institutions).

21.5 Conclusions

Although many variables compete and interfere in student performance in the discipline of Calculus I, most of the research converges in relation to one point: the deficiency of the incoming students in the Engineering courses regarding the basic mathematical contents, addressed in basic education. This may justify the predominance of actions aimed at recovering these contents, since they are essential for proper learning of the contents of Calculus I, as well as for success in other basic and specific subjects of Engineering courses.

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CHAPTER 22

Active Methodologies in The Teaching of Mathematics in Engineering Courses: An Analysis from Productions in COBENGEs 2017-2018

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Abstract: Disciplines in the area of Mathematics have remarkable importance as essential tools in the training quality of future Engineers. These disciplines are currently part of the first periods of Engineering courses in Brazil and are responsible for high levels of evasion and disapproval. The recurrence of such facts has led to discussions and paradigmatic changes in higher education, such as the quality of the programs and/or how teachers can innovate their pedagogical practice. In this sense, an alternative that has been emerging in recent times, is the use of strategies of active methodologies in teaching mathematics at all levels of education. Based on this premise, the questionnaire that guided the present research was established: Does the teaching of mathematics in Engineering courses in Brazilian institutions have used active methodologies? In particular, what methodological strategies, considered as active, were used in research work aimed at the teaching of mathematics in Engineering courses? In order to answer these questions, we opted to investigate the academic production published in the COBENGE (Brazilian Congress of Engineering Education - organized by the Brazilian Association of Engineering Teaching - ABENGE) in the last two years, through bibliographical, basic, descriptive and of a qualitative nature. COBENGE is considered the main discussion forum on

Engineering education in the country. Thus, our intention is to identify "if" and "how" the active methodological strategies are being used by the authors to minimize the difficulties presented by the Engineering students in the mathematics disciplines, as well as to identify potentialities and limits of the use of these methodologies. The collection of the works happened through the insertion of the terms "teaching of mathematics" and "active methodologies" in the search filter of the electronic page (http://www.abenge.org.br/sis_artigos.php) in which the annals of the COBENGE are available. The initial analyzes indicated that: the majority of the studies (both in the context of regular classes and in the projects) focus on mathematics disciplines from the initial stages - such as Calculus, Analytical Geometry and Linear Algebra; the technological tools are an essential part for the development of active methodologies; despite some initial resistance on the part of the students, the learning and the use of them was extended with the active methodological strategies applied.

Keywords: Active Methodologies, Teaching Mathematics in Engineering, Cobenge, Abenge.

22.1 Background

Subjects of Mathematics area taught in Engineering Courses are recognized, most part, from the level of difficulty and disapproval rates presented. One variable could foment the perpetuation of that context is the teaching methodology[1-3].

Thus, bearing in mind the use of diversified teaching strategies, - which place the students as a protagonists of their learning and the main responsible for their performance - could contribute to changes in the previously mentioned background, this research aims to verify which are the active methodologies referenced in the papers published in the last two editions of COBENGE, which focus on applied Mathematics subjects on Engineering courses and analyse the obtained results in these studies.

22.2 Purpose/Hypothesis

This research aims to answer the following question: what active methodologies were used in works aimed at the teaching of mathematics in Engineering courses published in the 2017 and 2018 editions of COBENGE? Which possibilities and limitations do these researches present?

22.3 Design/Method

It is a bibliographical research, basic, descriptive and qualitative3. Data collection took place through two independent searches, carried out through the insertion of the terms “teaching of mathematics” and “active methodologies” in the search filter of the electronic page of the Brazilian Association of Engineering Education (ABENGE), where the annals of COBENGE are available. It should be noted that this tool (search filter) performs the scan and indicates the works that contain the search expression in the title, keyword and abstract. The works listed had these items read, which made possible a selection of those that, apparently, were aligned with the proposal of this investigation. In turn, the full reading of the previously elected works made it possible to confirm which could contribute to answer the given question. The inclusion of the term "teaching of mathematics" resulted in 5 papers and the term "active methodologies" in 9 papers. Subsequently it was found that 3 of them were duplicates. Thus, the sample of this study is composed by 11 works (2 published in 2017 and 9 in 2018).

22.4 Results

It was verified that all the analyzed works are inserted in the thematic line "Methods and means of Teaching/Learning of Engineering and Technology" and are linked to 8 institutions, 5 of them of particular character. The Table 22.1 shows the active methodologies referenced and the context (discipline or project) in which they were applied.

Table 22.1 – Presentation of the methodologies referenced according to the application context.

Referenced Active Methodologies	Application context
Problem-based learning ($n = 3$)	Room of active methodologies Subject of Calculus A Subject of Descriptive Geometry
Peer Instruction + Gamefication ($n = 2$)	Leveling Project in Mathematics
Fliped classroom + Hybrid teaching ($n = 2$)	Pré-Cálculus Project
Seminar-based approach ($n = 1$)	Subject of Linear Algebra
None specific ($n = 3$)	Subject of Analytic Geometry and Linear Algebra; Project Calculus II Laboratory Monitoring the subject Calculus I Subject de Calculus II

Of the 11 papers analyzed, 6 developed their experiences in a context of projects, that is, they did not use active strategies in disciplines and regular math classes. This may indicate a slight resistance in testing new methodologies in regular subjects. However, the 5 papers where this happened reported positive results and potential improvements in student learning. The technologies are pointed out in the great majority of the works as possibilities to increase the time, the quality and the interest in the proposed tasks and studies. As the main limitation of the active methodologies, we have the resistance of some teachers and students to the changes in their own posture in the development of the classes. It should also be noted that two pairs of papers were related to the same institution and described the same proposal. In addition, one of the works (whose context is the Active Methodologies Room) was applied to 4 professionals with different training areas, in order to verify the feasibility of the proposal for a future application with students of Calculus I.

22.5 Conclusions

Considering the criteria established for the accomplishment of this research, it was possible to observe that the number of works applying active methodologies in Mathematics subjects in the Engineering courses is still quite insipient, out of a universe of 1,189 (634 in 2017 and 555 in 2018) research, only 11 (0.9%) addressed this perspective. When considering the thematic line “Methods and means of teaching/learning of Engineering and technology”, characteristic space for this type of routing the percentage rises to 1.6%, but still is a little expressive number. In order to innovate the pedagogical practice, making the learner the protagonist of their learning, is an increasingly pressing premise in the educational field and, considering that the future Engineers must be professionals engaged, creative, with leadership spirit, able to work in group and use different technological resources, it is believed that the use of active methodologies is a useful way to promote such characteristics.

One limitation of this study is the period established for data collection, a fact that makes it impossible to present a more realistic picture about the proposed theme. A mapping contemplating a broader temporal cut and also considering other databases, is under development by the authors of this work.

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CHAPTER 23

The INCOMM Research Group and The Science Day C: An Interaction between University and Society in Telecommunications Research Context

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Abstract: Brazilian public Universities work with the Teaching-Research-Extension tripod. In addition to the teaching role, training professionals in various areas of higher education, several professors develop research in different branches of knowledge. Scientific research is essential for the economic and social develop-

ment of the country, because it directly affects the life of the citizen, but much of society does not know the scientific work developed by teachers and students of public Universities. With that in mind, the College of Pro-Rectors of Research, Graduate and Innovation of the Federal Institutions of Education (COPROPI) and the Forum of Vice Presidents for Research and Graduate Studies (FOPROP) proposed on October 25, 2017 the “Science Day C”, a day of national mobilization where activities are carried out in museums, schools, public spaces, with the aim of showing society the importance of scientific research and how it influences everyday life. INCOMM (Information and Communication Research Group), a group within the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) of Universidade Federal de Goiás (UFG), actively researches in the areas of telecommunications and digital signal processing. Thus, in this edition of Science Day C, INCOMM proposed activities to the students of the Marista School of Goiânia, in order to show the importance of its research by for the society and also to encourage the children and teenagers to take an interest in Science and Technology by developing their scientific spirit. Lectures and demonstrations were held with the students of the 6th, 7th, 8th and 9th grades of elementary school, counting on the support of their teachers and locally coordinated by the Math teacher. Videos were prepared demonstrating the concepts and applications of INCOMM-related research, such as applications for digital signal processing in people’s lives (games, health, cell phones) and mathematical demonstrations of signal processing that showed the importance of mathematics and other Sciences. Students were enthusiastic and amazed with the research and discovery possibilities. The response of the classes to the event was measured by the large volume of questions and individual conversations with the students after the presentation. 77% of students did not know the impact of research in society and 82% did not know about the work done by Universities. The reports of the young people after the events revealed their interest in the scientific career and their discovery of new topics of study. They also realized the importance of basic education as a foundation for scientific development and that even in school it is already possible to use the scientific method during the courses. The lectures also helped students getting to know the work developed by INCOMM in the area of telecommunications and everyday applications. We observed that scientific interest should be stimulated since childhood as a way to create future researchers with continuing education. With the event, the importance of the dissemination of the researches of the different laboratories and groups of the Universities was perceived as it encourages the study and interest in the sciences.

Keywords: Brazilian Public Universities, Science, Scientific Research, Education, INCOMM.

23.1 Background

In Brazil, the development of scientific research is mostly carried out by public higher education institutions[1]. Federal Universities work with the teaching-research-extension tripod and these three axes are interconnected. In addition to the role of training professionals to work in society, public Universities are responsible for approximately 90% of scientific research conducted in Brazil and this work is unknown to the majority of the population, which benefits from the advances and results of these works. There is a clear perception of a detachment from society in relation to the knowledge of Universities' work in relation to their scientific research. With the objective of bringing Universities closer to the population and informing about the work of the researchers, C Day of Science was proposed, which took place on October 25, 2017, where higher education institutions developed activities in schools, museums, public and institutional spaces. the scientific knowledge produced by these institutions and how this knowledge affects the life of the population[2].

The Information and Communication Group (INCOMM), a research group at the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) of the Universidade Federal de Goiás (UFG), is actively working on research development in telecommunications, digital signal processing, neural networks. In order to inform the society about the various researches developed by the group, as well as to bring the society of the group closer and develop the scientific spirit in the people, INCOMM participated in the C Day of Science, developing activities at the Marist School of Goiânia with its students[3].

23.2 Purpose/Hypothesis

The purpose of this article is to describe the experience of INCOMM researchers interacting with students of the Marist College and the students' receptivity to scientific knowledge, their perceptions of our research, and the importance of classroom content for the scientific development.

The hypothesis is that most students still can not report their subjects studied in the classroom with the various scientific researches carried out in public institutions of higher education, and that we need to invest a lot in the dissemination of the scientific work of the institutions with the society since it is the main beneficiary of these results.

23.3 Design/Method

The C-Day of Science promoted by INCOMM-UFG was held at the Marist College of Goiânia on October 25, 2017 with students of 6th, 7th, and 8th grades. The classes participated separately in an introduction addressing scientific research in Brazilian public Universities and then presented the various lines of research of INCOMM-UFG and the application of this knowledge in society. An introductory video was presented and then three INCOMM-UFG researchers presented their work and their relationship to the subjects studied by the students at the college.

The importance of studying digital signal processing and its applications in audio, medicine, TVs, mobile communications, etc. was emphasized. The presentation showed the works with brain interface, radars, antenna arrangements[4]. After the presentations, there was a moment of interaction with the students where we can talk and clarify their doubts and listen to their perceptions. The students answered a questionnaire and their data were tabulated.

23.4 Results

Two questions were asked for the children in a questionnaire:

1. Did you have any knowledge of the work of Universities in the scientific field?

2. Do you know the impact of scientific research on society, on everyday life?

The results obtained are tabulated in the Table 23.1. A total of 220 children were interviewed.

Table 23.1 – Sizes aswers the questions.

Questions	Yes	No
1.	18.0 %	82.0 %
2.	23.0 %	77.0 %

23.5 Conclusions

These two proposed questions showed that there is still a gap between the work done in Universities in relation to scientific research and society. Most respondents are unaware of the work of scientists and teachers and the impact of this research on people's lives. A long work of bringing the University closer to society, especially the young public, is necessary to develop the scientific spirit and the pleasure of knowledge and discoveries.

The work also shows the importance of developing a scientific reasoning of young people in the subjects studied in schools. Public higher education institutions are a heritage of society and must be brought closer to the population by showing their work and the impact on society.

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CHAPTER 24

Community Summaê: An Experience in The Telecommunications Classes

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Abstract: Active Methodologies are tools that stimulate students how to learn in an autonomous and participatory way. In traditional classroom model, students usually only listen and take notes, whereas with Active Methodologies the passive learning is replaced by an autonomous process which searches for

the stimulation of students with real problems and real situations. The first use of Active Methodology refers to Netherlands and Canadian experiences. In Brazil, while Active Methodologies are highly recommended in medical schools, the use in Engineering is pretty recent and published works show that most of its applications are in the Mathematics field with few experiences out of pure Mathematics. Based on that, Professor Ricardo Fragelli idealized Summaê after searching for a solution to minimize the high failure rates in Mathematics related subjects in Engineering courses. Summaê consists of a creative environment for learning. Due to the high engagement of students and the participation of both the professors and area specialists, this successful experience has been replicated for the most different courses and subjects, mostly in Higher Education. Summaê has as one of its main characteristics the ease of being adapted to virtual environments since the action itself stimulates the usage of technologies, for example video recording. Summaê provides an emotional safe environment, with entertainment and ludic activities. Until now, it is considered a huge success among students and professors because it improves the relation between these two parties, often seen as antagonists. In November 2018, Community Summaê was applied at the Universidade Federal de Goiás, specifically in the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC), in the Telecommunications Theory Course of the Electrical Engineering degree. The Community Summaê uses the Project Led Education (PLE) methodology and the Problem-based Learning (PBL). In fact, the climax of the Community Summaê consists of a creative environment for learning in specific day. However, many activities are developed throughout the semester before the “big day”. There is also an evaluation of the methodology. So, this work presents the results of this first experience of Community Summaê in

EMC/UFG and how its general impression is very successful due to the good engagement of the students and professors and the strengthening of the Active Methodologies in the local academic community, including cultural presentations by members of the Engineering school. The success was so huge that the results show that 88,8% of the students think that this methodology should be applied again. All the professors involved took advantage of this experience and only one professor among those who composed the assessment board still did not know Community Summaê. Indeed, all the professors who were present said that they would apply Summaê in their classes and courses.

Keywords: Active Methodologies, Problem Based Learning, Project Led Education, Community Summaê, Telecommunications.

24.1 Background

The Summaê was created in 2011 by the professor Ricardo Fragelli, while he was trying to find solution to improve the low approval rates in the math related subjects from the Engineering courses in the Universidade de Brasília, the method became a success and was applied in several different courses and subjects as psychology, nursing and even distance based courses. The Summaê more than a common active learning methods engages the students in use new tools to the learning as video recording, group dynamics. It searches to create a ludic environment through cultural presentation and of course the use of the Summaê main symbol the hats[1]. In 2018, the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) had the first experience with the Summaê, the Community Summaê was developed throughout the semester, but as the original proposal, the whole project culminated in a "big day", with artistic presentations and a great engagement by the students.

24.2 Purpose/Hypothesis

The main purpose of the Community Summaê is to bring a new perspective over the active learning by proving that is possible to always innovate and in this case the innovation specially is due to the fact that the community is involved in the Summaê and is also a fundamental part of the learning process. Also other purposes of the Community Summaê is to present and popularize the active learning methods in a environment the almost always show a big resistance with non traditional methods, also as minor purposes the Summaê is to bring a cultural activity.

24.3 Design/Method

In Free to Learn, Peter Gray argues that in order to foster children who will thrive in today's constantly changing world, teachers, parents and others must entrust them to steer their own learning and development[2]. So, in November 2018, Community Summaê was applied at the Universidade Federal de Goiás, specifically in the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC), in the Telecommunications Theory Course of the Electrical Engineering degree. The Community Summaê uses the Project Led Education (PLE) methodology and the Problem-based Learning (PBL)[3]. Indeed, the climax of the Community Summaê consists of a creative environment for learning in specific day. However, many activities are developed throughout the semester before the "big day" which includes an evaluation of the methodology. So, this work presents the results of this first experience of Community Summaê in EMC/UFG and how its general impression is very successful due to the good engagement of the students and professors and the strengthening of the Active Methodologies in the local academic community, including cultural presentations by members of the EMC/UFG.

24.4 Results

Sixteen people were present in the "big day" event, three professors, eight students from the Telecommunications Theory Course and five people from the University community. When the professor were ask if they knew the Summaê methodology, 66.0% of them answered "yes", this shows how popular this methodology is. When they were ask if they have already applied some active methodologies in their classes, 66.66% of the professors say "yes". This result is very important and it shows how the paradigma of the active learning can be broken where the PLE and the PBL were reminded by two professors. When

with a number between 1 and 5, where 1 means "little innovative" and 5 "very innovative". So, the average of the Community Summaê was 4.66 which means the professors present liked what they saw. Between the students, 0% of them knew the Community Summaê methodology. Indeed, this show a lot of how the University has to grown in the field of the active learning. When questioned if the already did any classe who used active methodologies, 62.5% answered "yes". When they were ask if they considered the Community Summaê efficient, 87.5% of the students answered "yes". When they were ask to evaluate how inovatitive the Community Summaê was, the average of the Community Summaê was 5.0, where 1 means "little innovative" and 5 "very innovative". Between community members, no one knew the Community Summaê, just 20.0% of this group had classes that used some of active methodology. In addition, none of them had participate of an event like this. So, this strengthens the thesis of how important it is to have more events with cultural engagement within the University. When this group asked if they would participate of this kind of activity again, there was a 100% of positive answers, and when they were asked if they would indicate the event again, the same positive result was obtained. About the efficiency of the method, 88.8% of the students considered the the Community Summaê as an efficient method, and 100.0% of the professors would apply the Community Summaê in their classes.

24.5 Conclusions

The Community Summaê has revealed to be a great method to students and professors, and it is a way to keep the University community better connected and engaged. The good acceptance of the method between the professor show that the resistance to active methods can overcomed by interesting and thought-provoking methods.

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CHAPTER 25

Distance Learning Course on Intellectual Property

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Abstract: The increasing diffusion of the media and the search for alternative methods for obtaining continuous and specialized education make distance learning an important strategy in the ongoing training of professionals. The technology market offers a number of platforms, or Virtual Learning Environments (VLE), or Learning Management Systems (LMS) that can support collaborative educational activities. The implementation of Distance Learning (DL) in the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC) occurred through the use of the Moodle platform provided by the Centro Integrado de Aprendizagem em Rede (Ciar) of the Univesidade Federal de Goiás (UFG), which has, as a principle, the articulation between teaching and research in formal and non-formal learning processes in teaching and extension projects. The objective is to make the Ciar a space for the construction and realization of projects that seek the establishment of learning networks, mediated by practices that incorporate the technology of information networks, communication and education and teacher training. Thus, these requirements favor the implementation of the DL at the EMC/UFG. Therefore, it was proposed in the first half of 2015 the Intellectual Property Training Course, which aimed to use the technologies offered by Moodle for training students from the EMC/UFG and others interested in Industrial Property. Several technologies and activities were used during the course such as the use of discussion forums,

the application of questionnaires from audios, videos and readings, the use of chat, the preparation/publication of conceptual maps among others. At the end of the course, it met the expectations of 87.5% of the students, all of them recommended the course to others. In addition, a low rejection of DL was observed. So, since the introduction of DL undergraduate courses in the 2016 selection process and the arrival at Moodle Ipê, the use of DL by EMC/UFG professors is expected to intensify. Consequently, the tools available in Moodle Ipê can be very useful in implementing the new resolution of the national curriculum guidelines for the Engineering course in Brazil.

Keywords: Distance Learning, Intellectual Property, E-learning Tools, Virtual Learning Environment, Moodle Ipê.

25.1 Background

The increasing diffusion of the media and the search for alternative methods for obtaining continuous and specialized education make Distance Learning (DL) an important strategy in the ongoing training of professionals. The technology market offers a number of platforms, or Virtual Learning Environments (VLE), or Learning Management Systems (LMS) that can support collaborative educational activities[1].

25.2 Purpose/Hypothesis

The implementation of DL in the Escola de Engenharia Elétrica, Mecânica e de Computação (EMC)[2] occurred through the use of the Moodle platform provided by the Centro Integrado de Aprendizagem em Rede (Ciar) of the Universidade Federal de Goiás (UFG) · The Ciar has, as a principle, the articulation between teaching and research in formal and non-formal learning processes in teaching and extension projects[3]. The objective is to make the Ciar a space for the construction and realization of projects that seek the establishment of learning networks, mediated by practices that incorporate the technology of information networks, communication and education and teacher training. Like this, these requirements favor the implementation of the DL at the EMC/UFG.

25.3 Design/Method

The University's academic units had an institutional version of Moodle available in 2015, as shown in Figure 25.1[4]. This platform was important for offering some Distance Learning (DL) courses.

Since the introduction of DL undergraduate courses in the 2016 selection process, UFG has provided a more improved version for the Virtual Learning Environment (VLE): the Moodle Ipê[5]. Its interface is shown in Figure 25.2. Note that it must be used for two different purposes: teaching; and research and extension projects. The Figure 25.3 shows the Moodle Ipê (Teaching), available to all UFG professors.

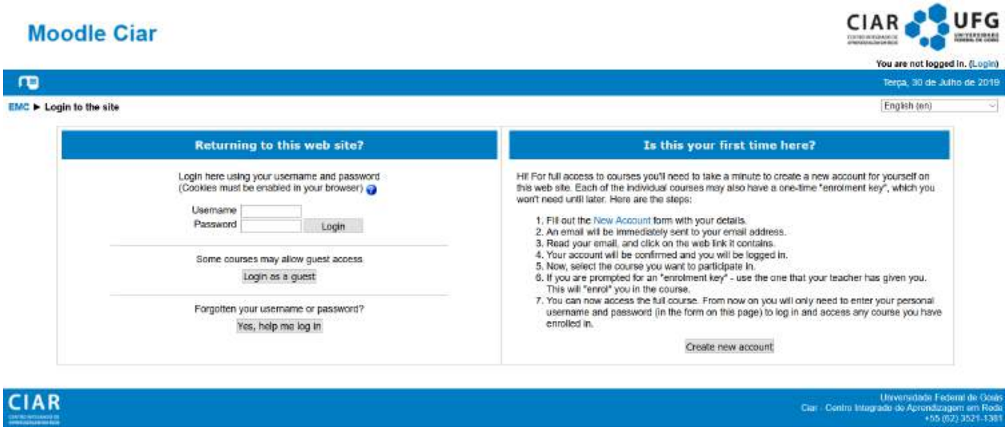

Figure 25.1 – Institutional version of Moodle available in 2015[4].

25.4 Results

It was proposed in the first half of 2015 the Intellectual Property Training Course, which aimed to use the technologies offered by institutional version of Moodle for training students from the EMC/UFG and others interested in Industrial Property. Several technologies and activities were used during the course such as the use of discussion forums, the application of questionnaires from audios, videos and readings, the use of chat, the preparation/publication of conceptual maps among others. At the end of the course, it met the expectations of 87.5% of the students, all of them recommended the course to others. In addition, a low rejection of distance education was observed. The main results of this work were published in an article at the Encontro Nacional de Grupos do Programa de Educação Tutorial (ENAPET 2014)[1]. This like, the Figure 25.4 shows the Best Conference Paper Award received at the ENAPET

Figure 25.2 – Moodle Ipê for two different purposes in 2019[5].

2014.

25.5 Conclusions

Using the VLE by professors at the EMC/UFG is very low. Thus, about 15% of professors make use of available resources, in which case they do not reach the full potential of VLE because they use the environment as a simple content repository to upload files, exercise lists and works[1]. So, Moodle Ipê is expected to intensify the use of DL in EMC/UFG, since this tool has the latest features of the Moodle platform available[5]. Consequently, the tools available in Moodle Ipê can be very useful in implementing the new resolution of the national curriculum guidelines for the Engineering course in Brazil[6].

Figure 25.3 – Moodle Ipê (Teaching) in 2019[5].

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CHAPTER 26

Historical Pathways of The Teaching of Engineering in Brazil

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Abstract: The new challenges faced by Engineering in the 21st century require a closer look at Engineer education. The economic and social development of a country is based on human capital, responsible for making a difference in productivity and competitiveness among nations. Therefore, training and qualifying human resources continually is a must. As Engineering occupies an important position in the generation of knowledge, technologies and innovations, the quality of Engineering undergraduate courses offered in Brazil must be continuously improved in order to increase productivity and stimulate the possibilities of economic growth. The present paper aims to analyze how the teaching of Engineering has developed in Brazil from a historical point of view by analyzing the National Curriculum Guidelines (Diretrizes Nacionais Curriculares - DCNs), and by considering the profession and its military origins. Due to the complexity of Engineer training, the main elements to be considered in this analysis are the human factor and the revision of the DCNs. To our understanding, those challenges are not related to traditional content subjects taught only in Engineering courses, but also in Biology, Medicine, Psychology, Sociology, Economics courses, among others. This paper also discusses different DCNs for Engineering, placing special emphasis on its latest

version approved in July 2018, and comparing it with a new proposal sent to the National Education Board (Conselho Nacional de Educação - CNE) in April 2019. Our findings reveal that the current curriculum for Engineering undergraduate courses no longer meets career expectations of new Engineers. The Engineering curriculum can no longer be viewed as a set of specific content subjects, it must also cover areas related to people, their needs, expectations and behaviors.

Keywords: Engineering, Engineering Education, History of Engineering, National Curriculum Guidelines, DCN.

26.1 Background

According to the 2019 proposal for Engineering National Curriculum Guidelines outlined by the Entrepreneurial Mobilization for Innovation (Mobilização Empresarial pela Inovação - MEI), the Brazilian National Confederation of Industry (Confederação Nacional da Indústria - CNI) and the Brazilian Association of Engineering Education (Associação Brasileira de Educação em Engenharia - ABENGE)[1], the number of Engineering graduates produced in Brazil is still small if compared to that of other countries. In Brazil, undergraduate courses are regulated by National Curriculum Guidelines (Diretrizes |Nacionais Curriculares - DCNs), designed and enforced by the National Education Board (Conselho Nacional de Educação - CNE). Those guidelines are applied to all undergraduate courses to promote learning equity, ensuring that all students have access to basic content subjects; however, without ignoring the different local contexts. Thus, as we understand, those guidelines should be flexible enough to meet the needs of diverse contexts, aiming at their continuous improvement and the integration of technological as well as methodological innovations.

26.2 Purpose/Hypothesis

Since we believe Engineering occupies an important position in the generation of knowledge, technologies and innovations, it is of paramount importance that the quality of Engineering undergraduate courses offered in Brazil must be improved in order to increase productivity and stimulate the possibilities of economic growth. The review of DCNs is essential in this process. DCNs comprise a set of regulatory principles, rules and procedures that guide Universities in the formulation, articulation, implementation and evaluation of their pedagogical proposals. Thus, as we understand, those guidelines should be flexible enough to meet the needs of diverse contexts, aiming at their continuous improvement and the integration of technological as well as methodological innovations.

26.3 Design/Method

The present paper aims to correlate the history of Engineering training in Brazil with the history of education in the country, by analyzing the DCNs for Engineering courses. To begin with, it is necessary to understand what Engineering is. The proposal designed by MEI/CNI and ABENGE presents one of the oldest and best-known definitions: “Engineering is the art of directing the great sources of power in nature for the use and convenience of man1”[1], Thomas Tredgold (1788-1829). In Brazil, Engineering projects began with the arrival of Engineer-officers commissioned to construct civil and religious buildings. After the Brazilian Revolution of 1930 and the rise of Getúlio Vargas to power, the expansion of public power and government bureaucracy, with the help of agencies related to economic policies at several levels, was crucial for the advancement of capitalism, allowing the emergency of two new fundamental classes: the industrial bourgeoisie and the urban proletariat[2]. In that scenario of developmental advancement, the then president of Brazil, Getúlio Vargas, passed Decree N. 23,569, on December 11, 1933, regulating the practice of Engineering, Architecture and surveying professions [3]. Such regulation was revised by Law N. 5,194, on December 24, 1966, later known as the Law of CREA (Conselho Regional de Engenharia e Arquitetura - Regional Professional Association of Engineers and Architects)[4]. In 1946, with the enactment of the Federal Constitution (paragraph d, section XV, article 5), the Union is granted the right to legislate the guidelines for national education[5]; however, only 15 years later, on December 20, 1961, Law N. 4,024, the Brazilian National Education Law (Lei de Diretrizes e Bases da Educação Nacional - LDBEN), was passed, followed by the creation of the Federal Council of Education (Conselho Federal de Educação - CFE), responsible for administering elementary, middle, high school, and higher education systems. As far as higher education is concerned, the council is responsible for “establishing course duration and minimum curriculum[6]”, according to Decision CFE N. 48 (April 27, 1976)[7]. That decision “[...] favored the accumulation of content as a guarantee for the education of a good professional and learning process was exclusively teacher-centered[8]”.

26.4 Results

As a consequence, the resolution, on one hand, was criticized since, "[...] it allowed no flexibility in curriculum design by determining minimum syllabuses for the courses with different durations[9]"; on the other hand, it was approved by some teachers who reported that it "[...] provided great flexibility by allowing higher education institutions to define specific contents[9]". The Chamber of Higher Education (Câmara de Educação Superior - CES) set out the DCNs for Engineering courses through Decision CNE/CES N. 11 (March 11, 2002)[10], introducing the following changes:

1. minimum curriculum with prerequisites no longer required;
2. development of student's skills and abilities instead of a content-based approach;
3. student-centered learning replaces teacher-centered learning, students are stimulated to play active roles in their training.

The faculty was directly affected by the new scenario since "[...] the changes in legislation indicates that teachers must master not only technical knowledge, but also teaching/learning methods and approcahes[11]". The proposal designed by MEI/CN and ABENGE was submitted to the National Council of Education/Chamber of Higher Education (CNE/CES) for appreciation in March 2018. The proposal suggested minor and major changes in items of the decision and added others. The main items can be considered innovative: competence-based training, entrepreneurship teaching, Pedagogical Project, freshman welcoming activities as well as faculty development programs.

The proposal by MEI/CNI and ABENGE anticipates the following:

> The main point is to add more meaning, dynamism and autonomy to the learning process in Engineering, by engaging students in practical activities, preferably since the beginning of the course. Some of the strategies are: active methodology-based learning, concrete problems solving, interdisciplinary knowledge-based activities, among others, aiming at improving teaching techniques and reducing University dropout rates[1].

DCNs should, then, be capable of promoting modernization in Engineering courses, by updating content, focusing on the student as an active producer of knowledge, integrating companies and University, prioritizing interdisciplinarity and transdisciplinarity as well as enhancing the important role of teachers as change agents inside and outside the classroom. The multifaceted demand for Engineers should be reflected in a multifaceted supply of University-level Engineering programs as well.

The development of curricular guidelines for Engineering courses must anticipate flexibility and innovation so that Engineer training in Brazil can reach levels compared to those of world centers of excellence.

26.5 Conclusions

Through the history of Engineering and Engineering Education in Brazil, we can notice that they have been strongly aligned with the different historical periods and educational reforms in the country. The military origins of Engineering in Brazil and in the world are also evident.

Based on the education in Engineering we have had and on our teaching experience, we can confirm that teaching Engineering in Brazil until 2002 can be correlated with several government decisions and its inherent traditionalism: such decisions determined the way courses should be. This traditional teaching model is explained, at least in part, by the military origins of Engineering.

As a result, such traditional practices are continuously reproduced due to the Engineering Education professors have had. This is our case: we are highly qualified from a technical point of view, but poorly prepared from a didactic-pedagogical point of view. In order to establish innovative guidelines, to design and implement new curricula for Engineering courses, we need to imagine a professional capable of coping with unpredictable situations. Whatever the change in teaching methodologies is, the faculty must be highly valued.

The current curriculum design no longer meets what is expected from an Engineering graduate. This is probably the reason for alarming dropout rates in Engineering courses and repeat complaints about recent graduate's lack of preparation for social challenges and the work force.

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CHAPTER 27

RAP: Annual Permitted Revenue

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Abstract: The motivation for the elaboration of the article was given through the Administration discipline given in the first semester of 2019 in the School of Electrical, Mechanical and Computing Engineering, whose objective is to develop a board game with free study theme. For this, our object of study was in our area of formation where we address the main problems that can occur in generation and transmission. Thinking about it, we developed the RAP (Annual Permitted Revenue) game, which according to ANEEL (a Brazilian abbreviation/acronym for National Electric Energy Agency) the acronym RAP is the remuneration that the transmitters receive for the provision of the public service of transmission to the users. For the transmitters that were tendered, RAP is obtained as a result of the transmission auction itself and is paid to the transmitters from the commercial start-up of their facilities, with review every four to five years, under the terms of the concession agreements. As the aim of gamification is to encourage learning through games, we model the real structures in the players.The basic electricity transmission network (voltages above 230 kV) is managed by ONS (National System Operator). Each player represents an energy transmitting company, except one player representing

the interests of the ONS. In the course of the game occurrences will occur and the transmitting companies will have to solve the problems (multiple choice questions, true or false and still discursive), if the player's response is wrong, this will be penalized. As in Brazil, the National Interconnected System is interconnected radially, so the board is also radial. In the development of the game, bibliographical research was carried out to identify the main causes and consequences of faults in the transmission lines, substation and generation, the practical knowledge of the group members was also taken into account (one of the authors works in the local power generation and streaming). The methodology used returned to the authors relevant questions in the gameplay of the work developed, being the following: The evaluation revealed that 100% considered the game with total systemic vision (need, utility and others); 50% with total practicality (ease to understand and decide the purchase); 50% with total clarity of the project and innovation; 50% with total harmony between the elements (social, cultural, environmental, etc.); 100% with total presentation of the intrinsic theoretical foundations; 75% with total unprecedented theme. The evaluation of the users was considered positive, and the game could then be implemented in the training processes of new employees in the transmitting companies.

Keywords: Administration, Energy, Gamification, Generation, Transmission.

27.1 Background

The motivation for writing the article was due through the administration discipline that was given in the first semester of 2019 at School of Electrical, Mechanical and Computing Engineering, the purpose was to develop a board game without needing to be unpublished with both knowledge of the discipline and the course of formation and after would generate a scientific article[1-7].

Then the game RAP (Annual Permitted Revenue) was idealized and implemented, with the purpose of understanding the operation of an energy-transmitting company. The profiles indicted to the players are professionals of electricity's area.

The learning that we hope to extract is through of the gamification of the transmission lines, being possible that new administrators and professionals of electricity's area may understand how it works and how it operates the transmission line, presenting the function of an energy-transmitting company.

The choice of the theme for this article within the electrical Engineering course was due through interests of the authors in this study area and the professional experience lived by one of the group members. The game was thought the game was thought almost in its totality in the gameplay, leaving simple rules and short but without losing challenges and decisions that players must make.

27.2 Purpose/Hypothesis

The object of the game is to improve learning and gamification makes this object possible, which is learning in a fun way and not formal. Like the game was thought to a specific public it was assumed that the professionals have prior knowledge about some relative questions to generation, transmission and distribution, that questions which don't belong to the game, RAP will complement them. With administration knowledge, we developed the brand of the game, two standard colors and the default font. The board, the occurrences and the brand was built by the authors with unprecedented, only the RAP currency was made with patterns in our society, arts were created with an image editing program.

27.3 Design/Method

The method used to the development is improved of the game, occurred through group meetings every week where each member had a specific function and the leader was responsible for demanding the results of the other members. In every new meetings was proposed a debate and questions were done for instance: Does the game is playable? Does the game represents concepts from the course? Does the game is fun? Do the rules are clear? Does the design is as we wanted? If there were some negative answers the item was studied with the purpose of achieving the proposed object.

Other part of the methodology was to bring the extern vision of other people for what these ones could point out items that the group wasn't able to visualize, bringing more clarity of the possible solutions to be implemented, this way the teacher proposed that other groups played and evaluate the equips' game. With those data new actions were taken to improve the game.

27.4 Results

The methodology used brought to the authors relevant questions in the gameplay of the developed work being them: the first evaluation showed that 100% of people considered the game with total systemic vision (necessity, utility and others): 50% with total practicality (ease to understand and deciding in the purchase); 50% with total transparency of the project and innovation; 50% with total harmony among the elements (social aspects, cultural, environmental and other aspects); 100% with total presentation of the intrinsic theoretical foundations; 75% with total unpublished of the theme. The second evaluation showed that 83% of people considered the game with total systemic vision (necessity, utility and others); 40% with total practicality (ease to understand and deciding the purchase); 80% with total transparency of the project and innovation; 58% with total harmony among the elements (social aspects, cultural, environmental and others); 80% with total presentation of the intrinsic theoretical foundations; 50% with total unpublished of the theme. The Figure 27.1 presents of a systematic way the results obtained in the first and second evaluation.

27.5 Conclusions

In spite of some items of evaluation has suffered a repair from first to second evaluation, the game was considered positive being able the game to be implemented in a training process of new contributors in the transmission companies.

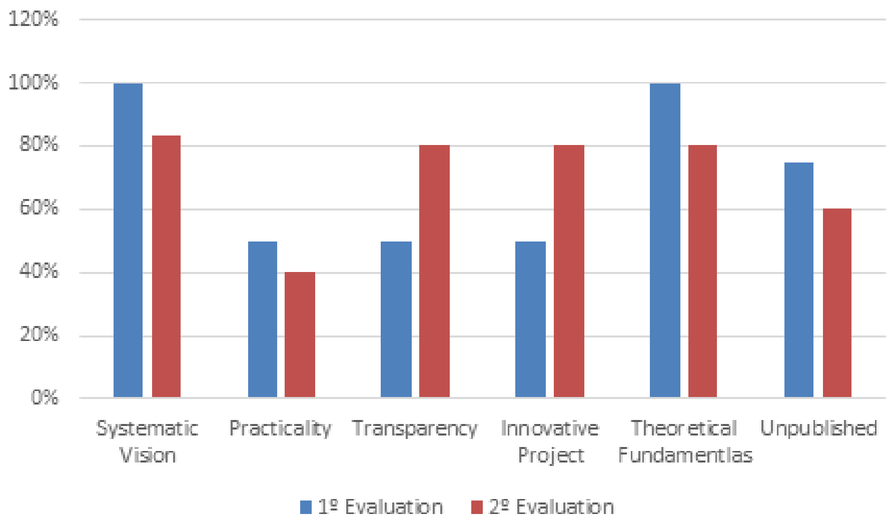

Figure 27.1 – Evaluation of the game RAP.

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CHAPTER 28

A Cross-disciplinary Active Teaching Method Application: An Undergraduate Education Case Study

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Abstract: Active teaching methods have been widely and hermetically adopted in contemporary higher education, from undergraduate Science, Technology, Engineering, and Mathematics (STEM) courses to humanities like History, Political Sciences, Medicine, and Psychology, but very few cross-disciplinary uses have been reported. In this work, we describe the successful application of a single collaborative active teaching method in several extension projects of the Electrical Engineering and Geography Department of PUC-Campinas, carried-on in the period from 2016 to 2018. In the first case, the purpose of the projects is to promote the social and digital inclusion of visually impaired adults and children with cerebral palsy, through the appropriation of low-cost Electrical Engineering solutions. In one project this was achieved by developing a device that helps to evaluate the degree of visual impairment and permits the application of methods and processes for visual rehabilitation. The target audience in the Electrical Engineering projects is the health professionals, occupational therapists, physiotherapists, and social workers, of two partner institutions associated with the project. The Geography Department project example, on the other hand, focused on space organizations, turns its attention to a group of artists working on the outskirts of the city of Campinas. The project's partner group works on the preservation of afro-descendent culture since 1975. In this case, the social recognition of its group nature, organized into territories, is fundamental to guarantee the right to land tenure and promotion of citizenship. The goal of this work is to demonstrate how the participation of undergraduate students in two highly different extension projects, using the same active teaching method, can better prepare them for their personal and professional life. This is verified by applying a thirteen rating scale questions survey to all participating students at project's end. The active teaching method for all projects is based on coplanning, cospecification, codesign, codevelopment and covalidation of systems, process, and methods. The practice employs conversation rounds with the target audience, guided by a virtuous cyclic process which includes steps like information capture, validation, guidance, and feedback. These rounds are essential for common problem understanding and solution construction, all performed through dialogues and discussions with the target audience. The method also includes the construction of pedagogical materials like booklets, maps, audio material, and guidance manuals. During the extension project participation, the students had the opportunity to experience situations and challenge not present in regular course classes, like interaction with professionals of different areas of expertise and people with different cognitive capabilities. Analysis of the survey answers indicates that 100% of the undergraduate students agree that participating in the project was important or very important in communication development, problem identification, and proactivity skills. The results indicate that the application of the same active teaching method into two diverse extension projects can contribute to better undergraduate education.

Keywords: Active Methodology, Cross-disciplinary, Undergraduate Education, University Extension, STEM.

28.1 Background

The rapidly changing market requirements impinge strong demands on undergraduate students' abilities. They are now urged to acquire soft skills like, be persuasive in multiple social contexts, to be fluent in working with different kinds of intellectual and social capitals and to have a high level of cognitive flexibility[1,2], besides having a strong technical background in the area of expertise. The academic world has answered this demand by adopting new teaching strategies, like active teaching methods and even making, sometimes, a complete overhaul in the whole course matrix. The use of such technologies has been demonstrated in the past decade[3-6] in different courses, like Psychology, Chemistry, Medicine, Science, Technology, Engineering, and Mathematics (STEM). Nevertheless, a search in the literature shows no report of a cross-disciplinary application of the same active method simultaneously to humanities and STEM courses. This work refers to the application of a Cooperative Problem Based Learning (CPBL) technique to extension projects from Electrical Engineering and Geography Departments at Pontifícia Universidade Católica de Campinas (PUC-Campinas). The overall goal of Electrical Engineering Department extension projects is to promote the social and digital inclusion of visually impaired adults and children with cerebral palsy, through the appropriation of low-cost Electrical Engineering solutions. The target public in this case is the health technicians of two partner institutions, the Centro Cultural Louis Braille de Campinas (CCLBC) and Therapies Serviços de Fisioterapia e Terapia Ocupacional Ltda. The Geography Department extension projects, on the other hand, focus on space organizations, engaged closely to a group of artists working on the outskirts of the city of Campinas. The project's partner group works on the preservation of afro-descendent culture since 1975. Preliminary results of both extension projects can be found in Metodologias Ativas no Ensino Superior[7].

28.2 Purpose/Hypothesis

The purpose of this work is to demonstrate that a single active teaching methodology can be applied to extension projects in humanities and STEM courses. Furthermore, it is demonstrated that the student's participation in the projects better prepared them for their personal and professional life. The projects were conducted at PUC-Campinas, with 20 students enrolled or executing related projects during the period of three years (2016-2018). This study case refers to the knowledge and information exchange between Electrical Engineering and Geography students and health technicians and a group of artists working on the outskirts of the city of Campinas.

28.3 Design/Method

The active teaching method for all projects is based on coplanning, cospecification, codesign, codevelopment and covalidation of systems, process, and methods. The process is discussed in detail elsewhere[8]. The method is basically a Cooperative Problem Based Learning (CPBL) technique, which is the integration of principles of cooperative learning (CL) into problem-based learning (PBL), that strongly interacts with the society (non-technical people), identifying problems and pursuing the proper solutions. The evaluation of much of a contribution the participation on extension projects made to the professional and personal life of 20 students was made by the application of a survey at project's end. The students were asked to rank from 1 (no contribution) to 5 (high contribution) on how the participation on the extension project contributed to the enhancement of the following competencies: logical reasoning, thorough communication, problem identification, problem analysis, proactivity/creativity/innovativity, complex problem solving, systemic thinking, teamwork, conflict resolution/negotiation, new knowledge and culture appropriation, project management, people management, and leadership. The open question requested the students to point out which personal ability was most enriched by participating in the project.

28.4 Results

The answers to the thirteen rating scale questions survey are summarized in Table 28.1. Participation on extension projects improved, from the student's point of view, all the abilities measured, except for a single student that ranked poorly the contribution in problem analysis, negotiation, and leadership. All students attributed a strong contribution to the enrichment of communication, problem identification, and proactivity.

Figure 28.1 shows the answer distribution for the open question. The students pointed out that the participation on the extension project contributed the most on the development of teamwork skills.

Table 28.1 – Survey answer's summary (%).

Competency/Rating	1	2	3	4	5
Logical reasoning	0	0	15	60	25
Thorough communication	0	0	0	30	70
Problem identification	0	0	0	35	65
Problem analysis	0	5	0	35	60
Proactivity/creativity/innovativity	0	0	0	45	55
Complex problem solving	0	0	5	45	50
Systemic thinking	0	0	15	60	25
Teamwork	0	0	15	20	65
Negotiation/conflict resolution	5	0	20	45	30
New knowledge and culture appropriation	0	0	5	30	65
Project management	0	0	10	40	50
People management	0	0	10	55	35
Leadership	5	0	20	30	45

28.5 Conclusions

The results indicate that the same active teaching method can be successfully and simultaneously applied to extension projects in the Electrical Engineering and Geography departments, demonstrating a cross-disciplinary attribute. The survey carried on at the project's end demonstrates that participation on the extension projects can contribute to the undergraduate education fulfill the market demands.

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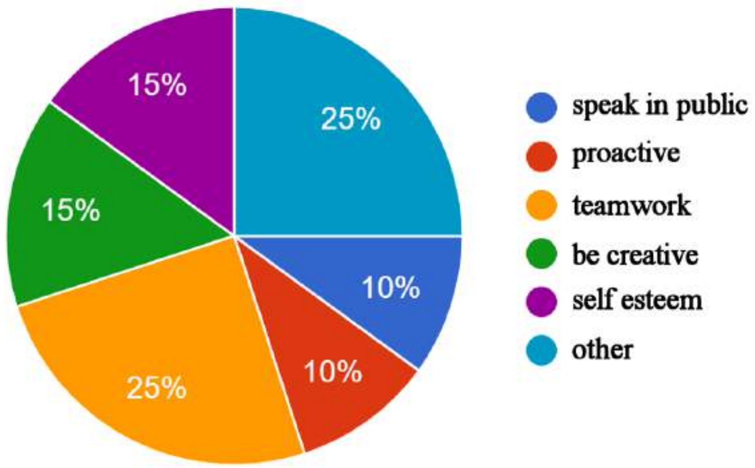

Figure 28.1 – Open question answer distribution (%).

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CHAPTER 29

The Empowerment of Students Resulting from the Extension Projects Actions: Students Empowerment through Target Populations Fostering

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Abstract: This article refers to the contribution in the empowerment of Electrical Engineering undergraduate students as a result of participation in social interventions and actions of two different Extension Projects. Project A fosters environmental sustainability, by way of involving actions with construction workers and project B, which is focused on the promotion of visual rehabilitation of the visually impaired through the construction of cognition development tools. This article emphasizes that the actions of extension projects in promoting the empowerment of the target populations likewise promotes the same on project's participating electrical Engineering undergraduate students, therefore, evidencing an important side of the Extension Programs. The methodology of the work includes socio-educational workshops with the incentive to dialogue and exchange of ideas between the University crew and the project's target population. In general, extension interventions boost self-awareness that facilitates choices and actions in the community (collective and critical awareness) by adding value to individual actions. These actions improve the individual and the community as a whole, in a process of overcoming challenges of social transformation. Empowerment favors the dignity and freedom of citizenship, by enabling better choices and facilitating future personal developments. The methodology also includes systematic workshops with the target populations and orientation meetings with the students. The empowerment of the students has its origin in the actions of the Extension that begins with participation in socio-educational workshops and meeting preparation under the professor guidance. The target population profile study and consequent deepening of the problem understanding encourage the students to be resourcefulness and to pursue dialogues in the workshops or in the conversation rounds. The freshman students, usually shy and with a classroom-centered model thinking, faces a different reality beyond the classroom and needs to assume a protagonist role to accomplish the objectives of the work. The results of the participation in extension projects show that students grow a critical view of social issues and in academic maturity. The project's participating undergraduate students begin to envisage alternatives and improvements to social fairness aimed to promote the autonomy of the target populations. This is accomplished through the elaboration of cultural materials and technical papers for future conference presentations. In short, the students increase their ability to interact in different realities and begin to eagerly participate in the academic community. The Extension Projects are carried out with the support of the Pró-Reitoria de Extensão e Assuntos Comunitários da PUC-Campinas partnering with organized social groups or communities of the city of Campinas-SP, Brazil.

Keywords: Extension Projects, Student Empowerment, Sustainability, Workshops, Populations Fostering.

29.1 Background

Since 2014 the Electrical Engineering Department, aware of the market demands for the undergraduate student has been eagerly promoting a renovation on teaching methods. Graduating Engineering students are expected to be research autonomous, have a high degree of maturity and especially able to cope with adverse or unexpected field situations. With this in mind, the authors tailored the student's activities in their University extension projects to meet these demands. During their regular year studies, the undergraduate students from the Pontifícia Universidade Católica of Campinas (SP/Brazil), PUC-Campinas, have the possibility to participate in Extension Projects proposed by a mentor/teacher. These Projects are carried out in the socially underprivileged communities of the city and are unique opportunities for the student's social skills development. The Projects are aligned with the institutional policies/mission of PUC-Campinas with respect to the integral formation of the human person and the construction of a fair and solidary society[1].

29.2 Purpose/Hypothesis

This article refers to the impact on the Electrical Engineering undergraduate market preparation due to their participation in two extension projects, named Project A and B, carried out in the last six years. The Projects promote the autonomy of the partner communities and the empowerment of the Electrical Engineering undergraduate students in the academic and social fields. The participating students find in the communities another reality, very different from the classroom or their social circle of relationships. The actions of the

Projects promote awareness and knowledge, both in the community and in the students. Collective and critical awareness is promoted through dialogue and collaborative work with the community, in a process of overcoming relationships challenges which leads to social transformation. The students have active participation in this process, as protagonists of these actions, with collaborative and autonomous attitudes that lead to personal growth and raising of the students' social maturity levels and empowerment.

29.3 Design/Method

The extension project development method is based on collaborative work between the University team and the target population. Conversation rounds at the partner's site, for ideas and perception exchange, occur on a monthly basis while students-professor guidance meetings are held weekly or more often if needed at the University grounds. The evaluation of how much the participation on the extension projects contributed to the student empowerment was assessed by applying a three questions rating scale survey to all participating students at project's end. The students were asked to rank from 1 (no contribution) to 5 (high contribution) on how the participation on the extension project contributed to the enhancement of their capability of establishing a thorough communication, enhance their own autonomy, measured as proactivity/creativity/innovative enhancement, and capability to perform teamwork.

29.4 Results

Table 29.1 shows the increase in the number of students participating in both A and B extension projects in the period from 2014 to 2019 which respond to the applied survey at projects' end.

Table 29.1 – Projects' student participation and number of respondents.

Year	Project A	Project B	Students	Respondents
2014	2	1	3	1
2015	1	1	2	1
2016	3	1	4	2
2017	5	4	9	5
2018	4	7	11	8
2019	8	5	13	8
		Total:	42	24

The Figure 29.1 shows the answer distribution for the three-question ranking survey.

Essentially 100% of the Electrical Engineering students that answered the ranked survey highly rated dialogue and proactivity as the most social skill developed through participation in the University extension projects. These skills are fundamental to self-confidence and, therefore, contribute to student empowerment and professional maturity[2]. Due to the actions of the extension projects, the students left the classroom, in the intervention process in the community, to experience another reality, different from yours, which is the reality of the target public. This allowed students a better critical view of social issues and gave them a field of action as transforming agents of reality. This

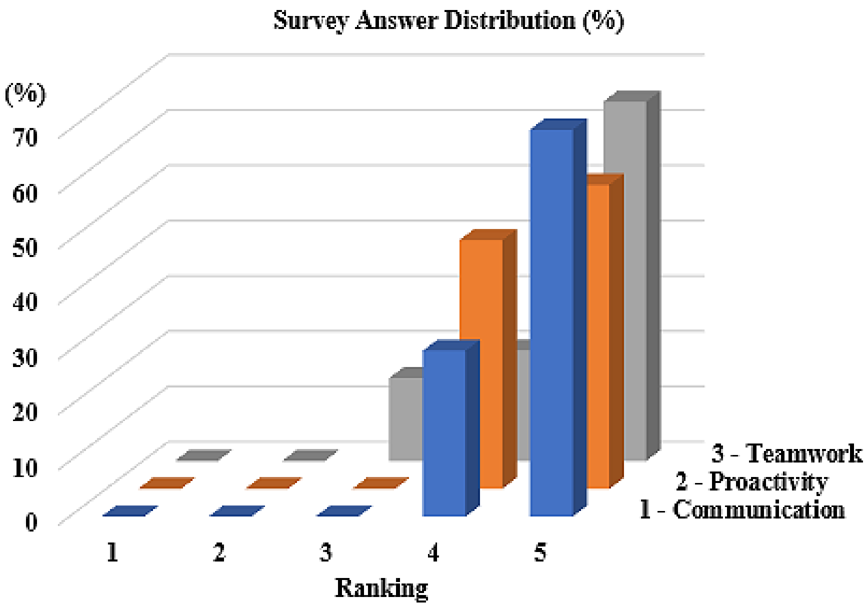

Figure 29.1 – Answer distribution for the three-question ranking survey.

enables students to develop into Engineering solutions geared to social issues. Students become aware that the knowledge produced can serve society[3].

29.5 Conclusions

The student's empowerment began when faced with other realities, social and academic, with overcoming promoted by the new challenges. Extension projects allowed for the exercise of citizenship, with freedom of dialogue and respect for others in the community and, indirectly, with society. After a few months, the student feels empowered to express his opinions, ideas, and facts through dialogue, in the community, and in the academic world. With the extension actions, students gain the ability to interact in different realities and to participate in the academic community. The student acquires greater autonomy and protagonism for future actions within the scope of his existence and in the academic world, being able to collaborate effectively for a better society. The involvement with the extension actions also motivated the Electrical Engineering undergraduate student to write articles and create technical-cultural materials that promote the autonomy of the target public, simultaneously favoring students' academic growth. Students began to think and express themselves appropriately, both in the local and in the academic communities.

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CHAPTER 30

Power Electronics Education: A Contemporary Teaching Approach

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Abstract: Currently, there is a growing demand for methodologies that best qualify Engineering students at Universities. These methodologies require a substantial change in Engineering Teaching programs improving or even changing the traditional ways of imparting knowledge to students. In Power Electronics Study the factors that make learning difficult for Electrical Engineering students, in order for them to achieve full understanding of the subjects addressed in a first discipline in this area, are the academic maturity required coupled with their multidisciplinary nature. The problem is aggravated in practical activities, which demand the availability of a laboratory infrastructure with specific characteristics not always available. An alternative for the study of Power Electronics, with a more contemporary focus, is to introduce, through a new Instructional Design (ID) Project, not only the incorporation of more Hands-On activities that approach truly meaningful (authentic) contents, but also, new methodologies and technologies to support educational objectives that make full use of Digital Information and Communication Technologies (DICTs).This work proposes to develop and carry out a methodological design of a blended teaching for a power-electronics-based practical training program (PEBPTP) for students of the Electrical Engineering Course of the Federal Uni-

versity of Maranhão in Brazil. The proposed program is mainly based on the use of a digital controller (unified) based on FPGA, developed and realized specifically for control and power inverters study. From controller's VHDL Code already realized, a Reuse Logic Block is generated (Intellectual Property Core (IP Core)), for use within the LabVIEW FPGA Hardware Description Environment (HDL). A Graphical Interface (GUI), more intuitive, and developed from the LabVIEW environment, will support the realization of the PEBPTP, for parameterizing the Controller, and show relevant figures of merit of the performance of the converter being study. The active methodologies, converging with the diverse possibilities of resources of the DICTs, implanted in the classroom, with the adequate contextualization of the specific resources of each area, contribute increasingly to the student being protagonist of their own knowledge construction. Finally is proposed, and in full adherence to a novel trend, that both the PEBPTP and the unified controller previously developed in FPGA are embedded in what is being named Lab-on-a-Chip (LoC). This embedded structure will allow access to the laboratory hands-on program via a web service that uses a fully programmable logic device (PLD) that incorporates an integrated structure known as System-on-a- Chip (SoC).The above proposals and experiences involve the mastery not only of curricular and technological knowledge, inherent to the training of an Engineer, but of mainly, the pedagogical technological knowledges and correct use of DICTs. At this point, in particular, is founded our contribution within the context of Engineering Teaching, to advance in the improvement or perhaps in the modification of the "classroom" of Engineering courses, which today go beyond the physical space of the University.

Keywords: Active Methodologies, Blended Teaching, DICTs, Instructional Design, PEBPTP.

30.1 Background

Accelerated technological advances in Power Electronics impose greater rigor in the availability of didactic resources, though both from the points of view of content and form, since they must facilitates the construction of knowledge, mediates the interaction between student and educators, and develop specific skills and competences. In practical activities, the demands for Authentic Learning experiences are increasingly a necessity within the classroom[1].

On the other hand[2] to make effective the methodological reformulation of a certain subject of study is not a trivial task for Engineering Educators. The process demands the need to appropriate academic and methodological techniques in the areas of teaching and pedagogy.

30.2 Purpose/Hypothesis

An alternative for the study of Power Electronics, with a more contemporary focus, is to introduce, through a new Instructional Design (ID) Project, not only the incorporation of more Hands-On activities that approach truly meaningful (authentic) contents, but also, new methodologies and technologies to support educational objectives that make full use of DICTs[2].

At the Federal University of Maranhão/Brazil, the subject of the practical discipline of Power Electronics, of the Electrical Engineering Course, deals with: Projects, simulations and practices. Applications of power semiconductors. Operation of basic converters: rectifiers and inverters. In order to support practical activities of this discipline, within a contemporary perspective, the LabMOPA EPI has proposed, within its guidelines of produce material and methodologies to support the teaching of Electrical Engineering, the development of several PEBPTPs focusing on the study of power converters that performs the Basic Conversion Functions of CA-CC and CC-CA.

30.3 Design/Method

This work proposes to develop and carry out a methodological process of mixed teaching for PEBPTP, focusing on the practical study of VSI. The work discussed and used educational methodologies[3] and models such as ADDIE ID Method[2] and Blended Learning[4,5] with Active Methodologies[6,7] such as flipped classroom. On the other hand, for the Engineering project, the work discusses and uses technological methodologies and tools to develop the hardware's support platform for the training program. The proposed hardware is based mainly on the use of a digital controller (unified) based on FPGA[8], developed and realized specifically for control and study of power inverters. From this controller, perfectly adjusted to the training program, a Reuse Logic Block (IP Core) is generated for use within the LabVIEW FPGA (HDL) Environment. Developed from the LabVIEW FPGA and LabVIEW environment, to parameterize the Controller and show relevant merit figures of the particular inverter topology performance selected for study, a Graphical Interface (GUI) supports PEBPTP, and made control and measurements more user-friendly.

30.4 Results

The above proposals and experiences involve the mastery not only of curricular and technological knowledge, inherent to the training of an Engineer, but of mainly, the pedagogical technological knowledge and correct use of DICTs. At this point, in particular, is founded our contribution within the context of Engineering Teaching, to advance in the improvement or perhaps in the modification of the "classroom" of Engineering courses, which today go beyond the physical space of the University. All the aspects of construction of a PEBPTP-VSI, presented in this work, were developed and tested in laboratory. The application of this new pedagogical strategy is under way. It is intended gradually to implant this culture within the UFMA's Electrical Engineering Course.

30.5 Conclusions

It is more than propagated in pedagogical environments that learning is facilitated when the student participates in the process. The mere transmission of information without adequate contextualization or even reception by the student, does not affect an effective process of teaching and learning. The active methodologies, converging with the diverse possibilities of resources of the DICTs, implanted in the classroom, with the adequate contextualization of the specific resources of each area, contribute increasingly to the student being protagonist of their knowledge. Faced with the imperative of new models of education conceived based on the intensive use of various forms of communication and knowledge construction. Today it is questioned whether “the existence of a single basic learning space, such as the classroom in person, is, in fact, the most appropriate in a world in which territoriality coexists more and more with another space of exchanges and symbolic productions, built by digital networks of communication and information”.

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CHAPTER 31

Design of a Low-cost Weather Station for Use in Sensor Network Systems for Agriculture and Engineering Education: A Case Study

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Abstract: In agriculture, knowledge about meteorological and climatic variables is essential for taking action in various activities, and may be the difference between their success and their failure. However, often due to cost, the density of weather stations is low in several regions, causing great uncertainty in the models of climate estimates. The need for an affordable solution to this problem led to the construction of a low- cost weather station that would meet the metrological demands for climate-quality monitoring in plantations, and could be easily extended to Engineering education for its statistical techniques for sensors calibration, microcontroller programming and hardware design. Thus, for the development of the project, a survey was made of the sensors and transducers most used in climate variable measurement systems in an activity of planting (anemometer, thermometer, rain gauge, hygrometer, radiometer, gas sensor) and metrological tests in order to obtain their error curves if the accuracy and precision information was not provided by the manufacturer; an electronic circuit was designed to integrate them; a software was programmed for data capture and embedded in an Arduino Pro Mini; and another one for the sending of data, through a NodeMCU. It is important to note that the sensor network system has been calibrated and its characteristics used in the construction of the station fulfill the metrological requirements for the measurement of climatic variables. Thus, it is possible to construct a low-cost calibrated weather station with good metrological characteristics, whose unities are the same as used by INMET - Instituto Nacional de Meteorologia, and which can be used in the study of Metrology discipline, since it contains a good range of sensors for a practice of theoretical activities, such as the use of statistical techniques such as the Chauvenet criterion, complemented by the study of Student's "t" Distribution; and also direct tests, as well as the implementation outside the classroom, enabling more accurate readings of the environment and creating the basis for several future researches that depend on environmental variables, such as estimation of evapotranspiration rate, soil irrigation design, water balance of the region, among others. Indoors, the students were able to verify the valid range of the sensors values using 29 degrees of freedom and 95% measurement certainty criterion. Besides that, the implementation of the imbedded codes and computer networks establishment allowed them a multidisciplinary integration of skills. We would like to thank CEFET-MG, FAPEMIG and PET/SESu/FNDE for their support in this project.

Keywords: Agriculture, Engineering Education, Metrology, Sensor Network System, Weather Station.

31.1 Background

In agriculture, knowledge about meteorological and climatic variables is essential for taking action in various activities, and may be the difference between their success and their failure[1-2]. However, often due to cost, the density of meteorological stations is low in several regions, causing great uncertainty in the models of climate estimates. Besides that, a weather station contains a considerable number of sensors (as anemometer, thermometer, rain gauge, hygrometer, radiometer, gas sensor)[3] which can be used in Engineering classes in various ways.

31.2 Purpose/Hypothesis

The purpose is the construction of a functional weather station with a meteorological analysis of its sensors. The schematic diagram in Figure 31.1 represents its parts. The sensors collect data from the environment and then a microcontroller processes them and moves them forward to a WiFi module; from there, the module send the data to the cloud through a MQTT protocol.

The development of its parts was approached in different subjects of the course: the sensors analysis were developed in Metrology classes, and the Microcontroller and Wi-Fi communication part was approached in Programming and Computer Networks classes, respectively.

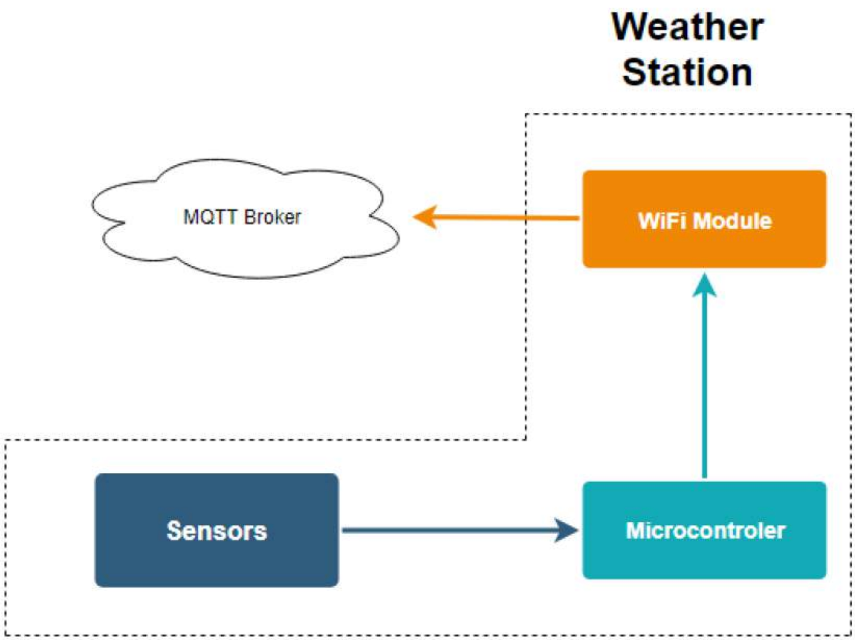

Figure 31.1 – Schematic diagram of the project.

31.3 Design/Method

For the sensor calibration process, the rain gage sensor of the weather station will be used to exemplify it. Its physical structure contains a funnel that takes the rainwater to an intern scale system. When it swings, it moves a magnet that triggers a reed-switch connected to the microcontroller. Therefore, it is possible to correlate the number of swings on a base of time with the rain flow rate. To investigate its reliability and create his error curve, the Student “t” Statistic Distribution was used, and the students in class calculated metrological variables such as repeatability, random error, tendency, systematic error[4-5].

After that, a circuitry was made from the prototypes and two programs were developed: one imbedded in an Arduino Pro Mini for processing the captured data from the sensors; and another one imbedded in a NodeMCU to send this processed data via WiFi to a MQTT broker[6].

31.4 Results

Still using the rain gage as an example, it is possible to verify that according to the rain intensity convention, to a 29 degrees of freedom and 95% measurement certainty criterion, the values are valid since they are kept inside the standard deviation for the “weak” and “moderate” rain range after that, the random error increases as the rain turns from “strong” to “very strong” around four times the average value, demonstrating the nature of high-end measurement scales of general sensors in the Metrology classroom analysis.

The Figure31.2 shows the pluviometer measurement behavior.

31.5 Conclusions

Besides that, the implementation of the imbedded codes and computer networks establishment allowed them a multidisciplinary integration of skills.

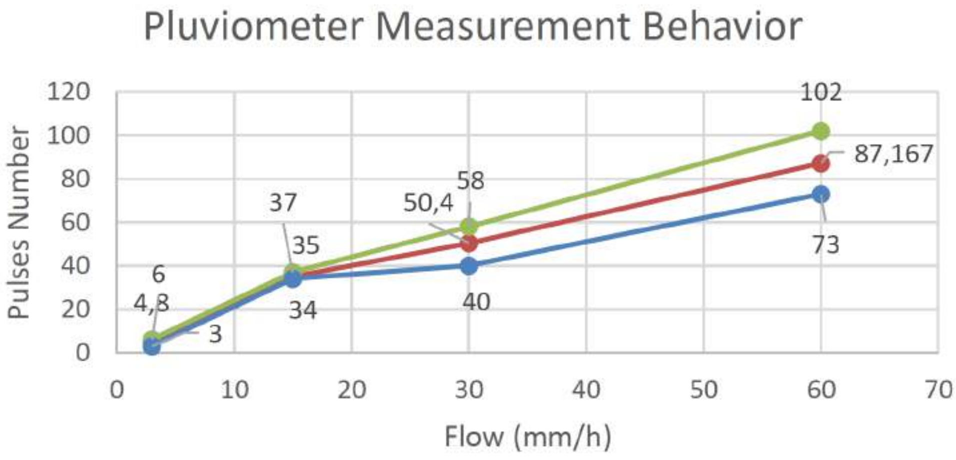

Figure 31.2 – Pluviometer measurement behavior.

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CHAPTER 32

Agile Methods to Enhance Iterations in Designing Solutions for Active Ageing

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Abstract: Agile methods to foster rapid creative iterations were introduced in the squad “Studio Silver” at the Industrial Design department of the Eindhoven University of Technology. These methods are used in order to build understanding of the needs and social interaction of healthy and active ageing and design interventions for new behavioral patterns and increase quality of life. To nurture Agile iterations, we integrated a working approach for the students, consisting of trial-reflection-iteration and feedback loops. Throughout the implementation of the squad (i.e. a studio approach of approximately 30 students for collaborative communities in which students work in design and research projects), students present their progress in terms of short write-up of the design proposals, presentations, and prototypes several times in a period of 16 weeks. Formative feedback serves as feed-forward method to stimulate new actions in the design allowing spacing effect in rapid prototyping and supporting long-term learning. We conducted a study in semester 2, 2019, to investigate the effects of feedback and reflection on students’ deliverables. Two interim feedback moments were introduced. The first one took place in week 4 for students to present design/research proposal to demonstrate why there is a design/research challenge, how they plan to tackle it, what they expect to

achieve and what they have already achieved. In week 8, students submitted a reflection that summarized the feedback, which they have received in the rubrics regarding the integration of competence areas, design research process, and demonstrators, and presented their reflection on their understanding of the feedback received. In addition, students' perceptions on coaches' feedback style was collected to learn whether coaches' attitudes stimulate reflections and iterations. Results of interim feedback moments from the selected deliverables of 10 students indicated that most of the students made improvements in their design and research processes showing that this Agile method on feedback-reflection loop stimulates iterations. Regarding students' perceptions on feedback and coaching style, this helps students reflect, understand better and adjust the design scope/research challenge of the project.

Keywords: Design-based Learning, Engineering Education, Feedback and Assessment, Interdisciplinary Education, Reflection-in-Action.

32.1 Background

Studio Silver is a squad aiming at educating future industrial designers to develop societal solutions for healthy and active ageing in the Department of Industrial Design at the Eindhoven University of Technology, the Netherlands. Next to the required design competencies, students are required to develop a high-level empathic research capacity towards the target user groups in addition to related knowledge, skills and attitude to work with complex stakeholder network involved. The instructional set-up of *Studio Silver* is based on the studio approach stimulating the design in context with and for the target user groups. The asset of this set-up is that it trains students not just by design researchers but also by design practitioners and experts from the field. In order to stimulate students to reflect upon results and run a new iteration in the design and research process we included several feedback moments along the project process.

32.2 Purpose/Hypothesis

The purpose of this study was to investigate to what extent does the approach trial-reflection-iteration and feedback loops support students to make progress in their design and design research projects towards the end deliverables. In addition, we also were interested to study students' perceptions on coaches' feedback towards fostering iterations in the design process. The feedback-reflection approach we applied for this study is adapted from Gibbs[1] model consisting of several loops of feedback upon which students reflect. To apply this model, we integrated two interim feedback during coaching moments and applied feedback methods[2,3] from research in different periods of the squad project life, i.e. weeks 4 and 8.

32.3 Design/Method

The research method consisted of a qualitative analysis of students' midterm deliverables in two different moments of the semester (i.e. week 4 and week 8). We compared these deliverables, i.e. design and research proposals, in order to find out whether there have been improvements in the follow up design iterations compared to the first iterations of design and research proposals. In addition, we collected students' perceptions on teachers' feedback to understand whether this type of feedback influenced students to adjust the working approach. The analysis of the deliverables comprised a limited number of students ($N = 10$) from the total group of 23. Some of the deliverables, i.e. design and research proposals, were a product of 4 students working in a group, and those also handed in one form together. Other forms were from the individual students. A rubric was used to assess students' progress focusing primarily on the design research process. To collect students' perceptions, we designed a 5- Likert scale structured questionnaire validated by empirical research studies[4]. All students enrolled in the squad "Studio Silver" ($N = 23$) participated in this survey.

32.4 Results

Results indicate that 5 out of 10 students did not have a clear and specific design research process at the beginning (week 4), while 4 of these 5 had in the second iteration (week 8) a clearer plan and process defined showing that students were on track according to the coache' expectations on progress and quality of deliverables. Furthermore, 1 of the 5 students was still uncertain, although the student was aware about the clear activities to conduct in order to adjust the work and continue with the process. Regarding the results of the structure questionnaire, students' perceptions are positive regarding the influence of the feedback to help students reflect, understand better and adjust the design scope/research challenge of the project. Table 32.1 summarizes the results of the qualitative study, i.e. first and second deliverable. In addition, students reveal that the feedback supported them to create iterations and to develop a prototype of an interactive system. This is because that feedback focused also on encouraging students to explore other design alternatives and additional activities.

Table 32.1 – Differences in students' 1st and 2nd deliverables.

Students	First deliverable	Second deliverable
Student 1	defined design research process as inductive research, qualitative data analysis is desired.	need to communicate better what the inductive research process is and the also consequently carry that out
Student 2	iterative design process, literature, persuasive principles, user research	already made low-fi prototype, first user feedback provides insights to re-iterate
Student 3	really general, need to be more specific	already have a concept, now it is clear that two other iterations are needed
Student 4	really general, need to be more specific	came to the focus on stimulating conversation between residents of a dementia centre. There is a plan to develop this via a number of user tests using different stimulus (images and questions)
Student 5	already have a clear view on what she wants to do, already concepts, clear plan	already have a working prototype, explored different materials, now the focus is on interaction and trigger interaction.
Student 6	follow design for one process, already planned out	clearly worked out process, focus on data analysis, design in progress
Student 7	have a general process to start with	student was kind of confused and did not know what to move forward after the first expiration and ideation, switch is made to do a design research project and focus on researching one interaction quality
Student 8	have a general process to start with	there is a concrete plan now to make the design context more specific. Yet the student still needs to take actions to make it clear and specific, but the awareness is there
Student 9	did not have a clear plan, need to be more focused and specific	already done a lot of user exploration, good insight and first concept, now have a detailed plan to move forward
Student 10	have a very clear design research process defined	really on track, clear view of the process, and detailed activities planned out

32.5 Conclusions

We conclude that the iterative and reflective coaching process has helped students make good progress towards mastering a mature design research process. Moreover, students' perceptions on coaches attitudes and coaching style confirm the theories on stimulating learning through iterations in design processes. Therefore, the introduction of Agile methods support the education of future Engineers and nurture the necessary competencies in the design research process enabling design solutions for healthy and active ageing. The nature of the Agile approach brings in interesting insights on promoting students quick transformations on preliminary designs and research proposals, supported by sound reflection in action.

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CHAPTER 33

Reliable and Low-cost Alternatives for Virtual Instrumentation: Development of Virtual Instruments to Be Applied on Engineering Education

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Abstract: Virtual instrumentation is a concept directly connected to the virtualization of systems, equipment, controllers, and processes, using, basically, a data acquisition board and a software that processes, treats, and presents the information to the final user. Consequently, due to both simplicity and efficiency, it has been acquiring space for various purposes. This work proposes the development of low- cost and satisfactory metrological characteristics virtual instruments to be used in teaching and researching in Engineering. Thus, two prototypes were built: an ammeter and a voltmeter, both virtual and suitable to

measure continuous values. MyOpenLab® is a free development software that presents a wide variety of tools and an uncomplicated application. Therefore, both MyOpenLab® and the signal acquisition board, Arduino® Uno, were selected considering their effectiveness and low-cost. For the development of the ammeter, it was also necessary to use a DC sensor and the ACS712 was chosen. In view of the fact that it is an experimental research, it was necessary to collect the data for validation and calibration of the virtual instruments. Initially, in order to verify the precision of the instruments, various measurements of current and voltage were made, by one of the authors, on three different days and times. The intent was to observe if they were able to repeat the results under different climatic conditions. In order to verify the accuracy of the instruments, the average of each value measured was compared with the measured by an Agilent U1242B multimeter, used as reference in the calibration by comparison process. The results obtained with the calibration were satisfactory for both virtual instruments, since they presented a low systematic error. Therefore, it was concluded with this research that it is possible to create quality virtual instruments, which can be used to supplement the demand of students and professors of institutions that do not have many lab resources. The authors would like to thank CNPq, PET/MEC/SESu and CEFET-MG for their support on this project.

Keywords: Accuracy, Calibration, MyOpenLab®, Virtual Instruments, Precision.

33.1 Background

Nowadays, the speed which technological developments occur, in addition to their coverage, contribute to the advent of another cycle of transformations on a global scale. The Internet of Things (IoT) is one of the main phenomena related to this technological Revolution. This concept has been changing the way humans interact with the rest of the world, and vice versa. Many Universities don't have physical resources, in quantity or quality, nor financial resources, sufficient to supplement the demand of students. Thus, an alternative to the use of costly equipment, would be the development of low-cost virtual instruments with good metrological characteristics. These would provide students with tools to perform their laboratory activities virtually. As consequence, educational institutions would have new technological resources to improve the practical quality in teaching and researching in Engineering and related fields.

33.2 Purpose/Hypothesis

Therefore, it is proposed, the development of high-performance virtual instrumentation methods and techniques, with satisfactory metrological characteristics and low cost, to be used in instrumentation and control systems, applied to teaching and research in the area of Engineering.

33.3 Design/Method

With objective of validating the proposal, two prototypes were built: an ammeter, and a voltmeter, both virtual and suitable to measure continuous values. Their measuring ranges are, respectively, 0 to 5V and 0 to 1.5A. MyOpenLab® is a free development software that presents a wide variety of tools and an uncomplicated application, allowing the user to simply implement the interface of the instruments as well as the logic behind their operation. It, also, permits some types of electronic boards related to signal acquisition to be used to connect the virtual instruments to the field. Thus, both MyOpenLab® and the signal acquisition board, Arduino® Uno, were selected considering their effectiveness and low-cost. For the development of the ammeter, it was also necessary to use a DC sensor and the ACS712, x05B model, was chosen. An Agilent® multimeter, U1242B model, was used as standard for a comparison calibration process. In order to obtain the systematic error estimation of the virtual voltmeter and ammeter, respectively, it was necessary to calculate nV and nA, that are the number of samples to be performed. The minimum value of this parameter may be calculated using Equation 33.1.

$$n_0 = \frac{1}{E_0^2} \tag{33.1}$$

where, n_0 is an approximation of the sample size and $E0$ is the tolerable sample error[1].

Considering a desirable confidence interval[1] of 95%, it was found that a total of $n0 = \frac{1}{0.052} = 400$ samples would be necessary, so that the error remains within the tolerable limit (5%). The variables (voltage and current) would be measured in intervals of 0.2 V and 0.1 A, so it was still necessary to divide $n0$ by their respective interval numbers. Therefore, were made $nV = 16$ e $nA = 27$ samples, for each interval value, within all the instruments operating range. Then, averages of these values, point to point, were compared to the ones measured by the standard. Thus, it was possible to obtain the systematic error curves of both virtual instruments. The influence of random errors were not treated in this study. The procedure of comparison with the standard, was performed on three different days (May 22nd, 24th, and 25th) and times (15:00, 13:40 e 9:15) by one of the authors. The location was in PET laboratory, at CEFET/MG, campus Leopoldina. It was, also, observed, that the temperature differences presented on these days (25°C, 22°C and 22°C), had low influence on the obtained results.

33.4 Results

In Figures 33.1 to 33.6, were presented comparative graphs between the values measured, during three days, by the standard (blue curves) and the developed virtual instruments (orange curves). It should be noted that each point of this last curve represents the average of nV and nA, respectively, voltage and current measurements performed.

Figures 33.7 to 33.12, exhibit charts containing an estimative of the systematic errors presented by the virtual instruments during the three days in which the measurements were taken. It can be verified, therefore, that both virtual instruments showed satisfactory performance, presenting low systematic errors.

33.5 Conclusions

In this work, two virtual instruments (voltmeter and ammeter), capable of measuring continuous values, were developed. They both presented a satisfactory metrological performance when compared to a commercial measurement instrument. For this work, the range of values worked were 0 to 5V for the voltmeter and 0 to 1.5A for the ammeter, which is a small range of values. The intention, however, was to evaluate the potential of these instruments and present them as an inexpensive and reliable alternative to be applied in Engineering Education, since virtual instruments are more flexible in relation to their functions if compared with a commercial measuring instrument. So, it is proposed in future works to extend the range of measurement values, as well as to virtualize other types of instruments, such as an oscilloscope.

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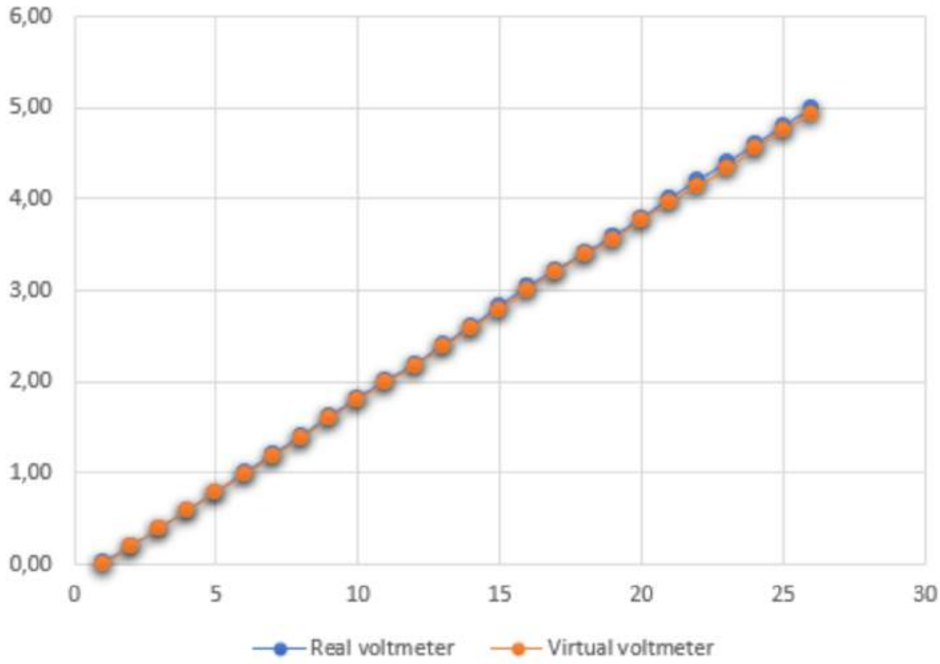

Figure 33.1 – Comparative graphic of voltage measurements performed on 22 May 2019.

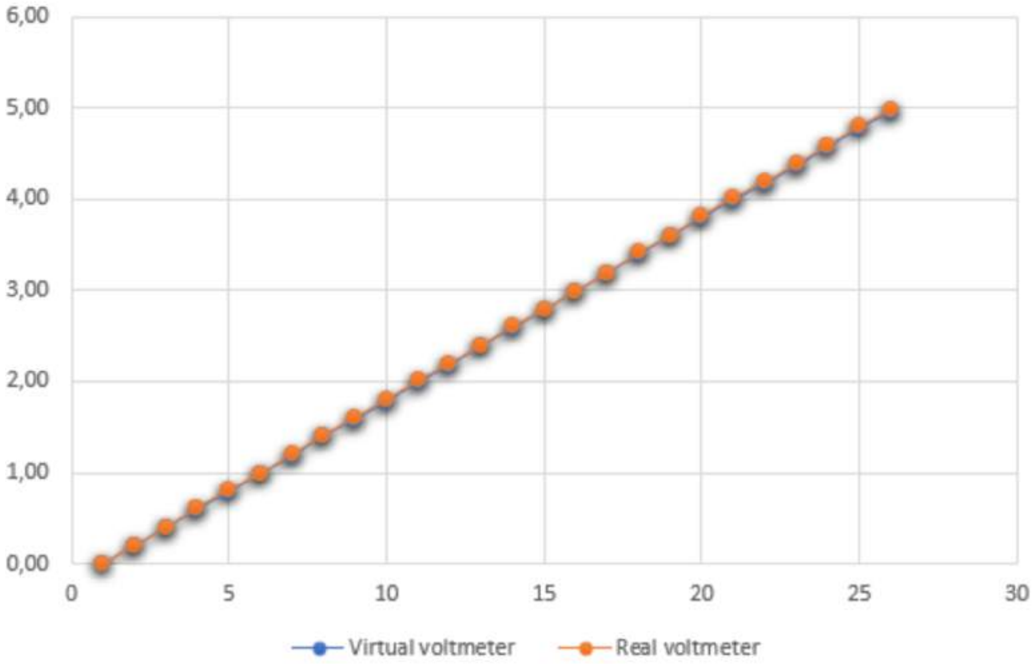

Figure 33.2 – Comparative graphic of voltage measurements performed on 24 May 2019.

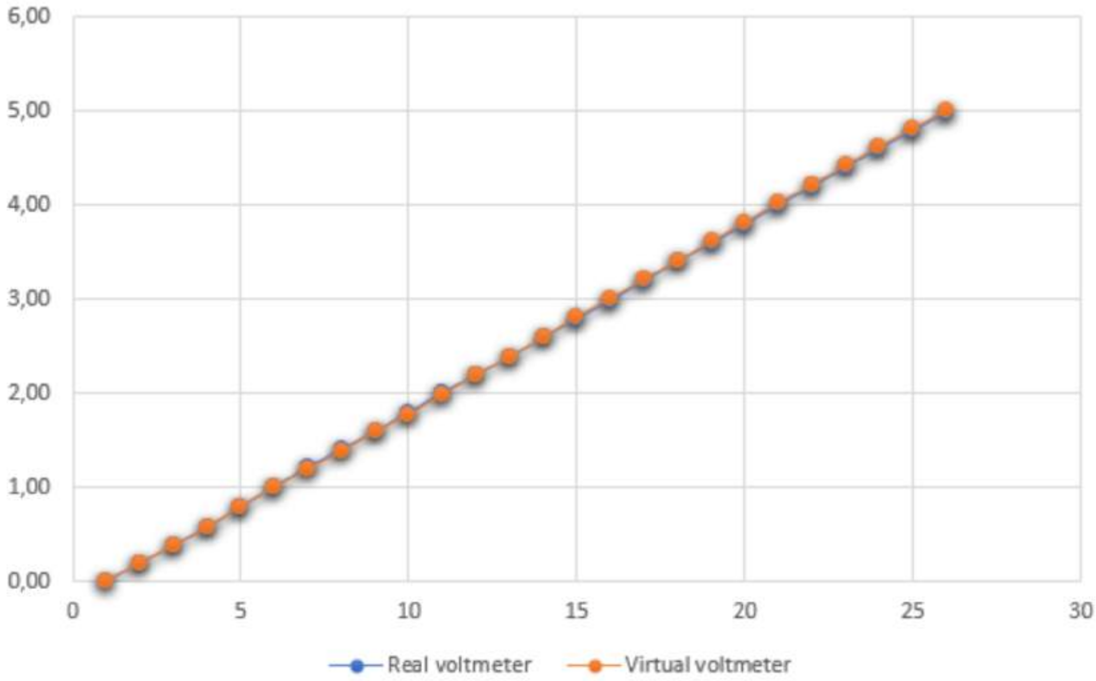

Figure 33.3 – Comparative graphic of voltage measurements performed on 25 May 2019.

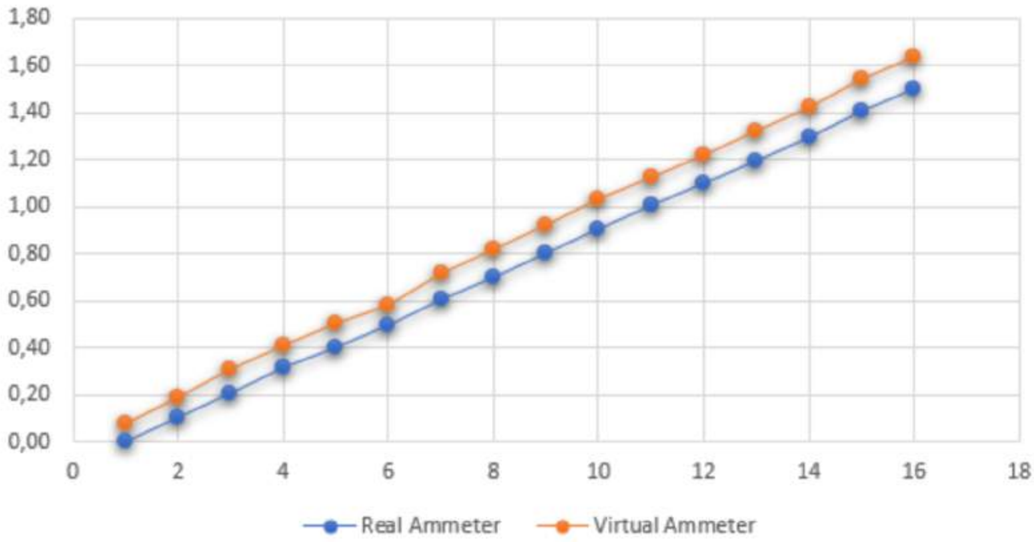

Figure 33.4 – Comparative graphic of current measurements performed on 22 May 2019.

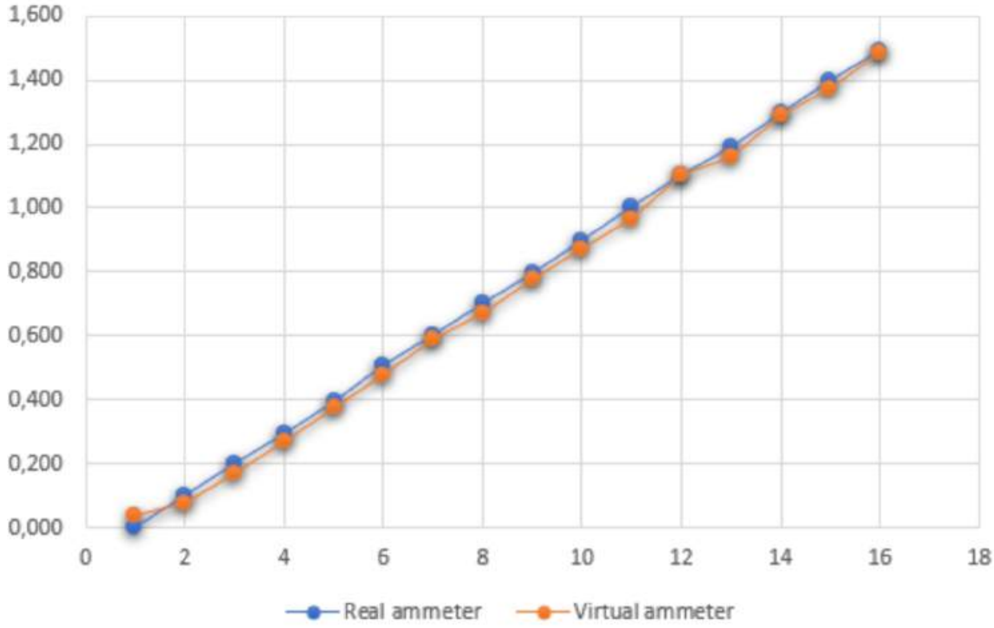

Figure 33.5 – Comparative graphic of current measurements performed on 24 May 2019.

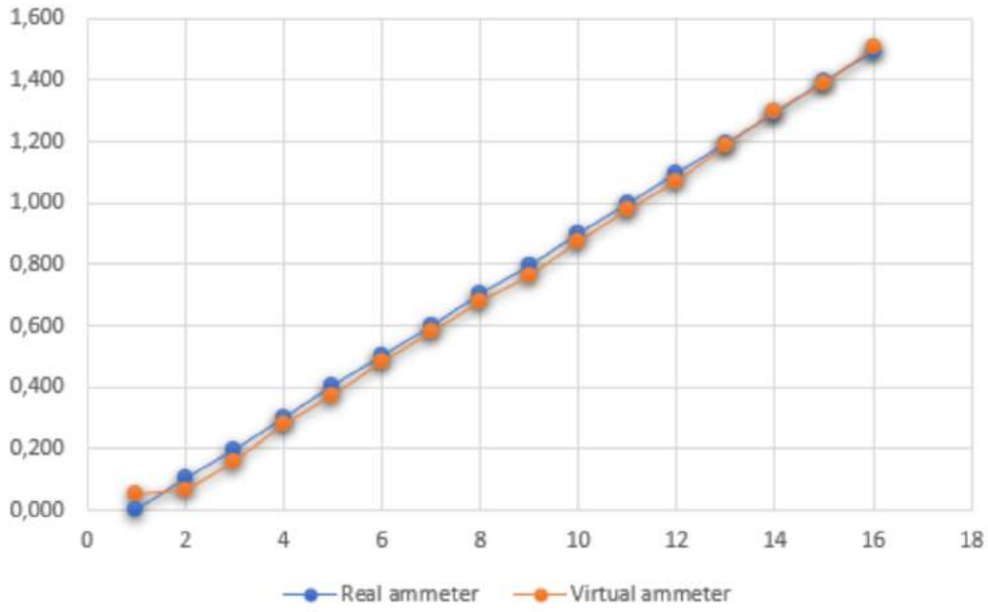

Figure 33.6 – Comparative graphic of current measurements performed on 25 May 2019.

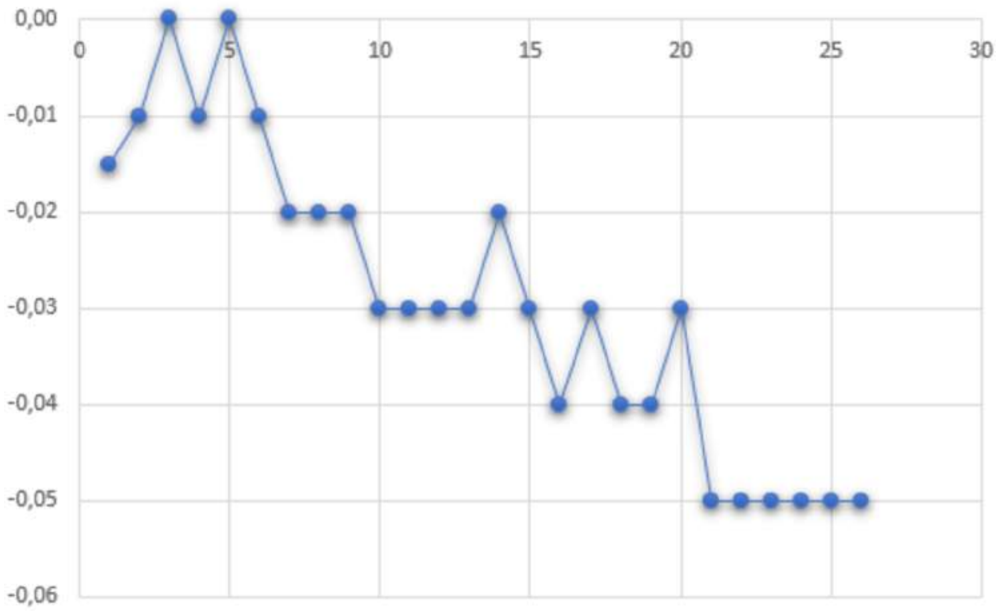

Figure 33.7 – Chart with the systematic errors presented by the voltmeter on 22 May 2019.

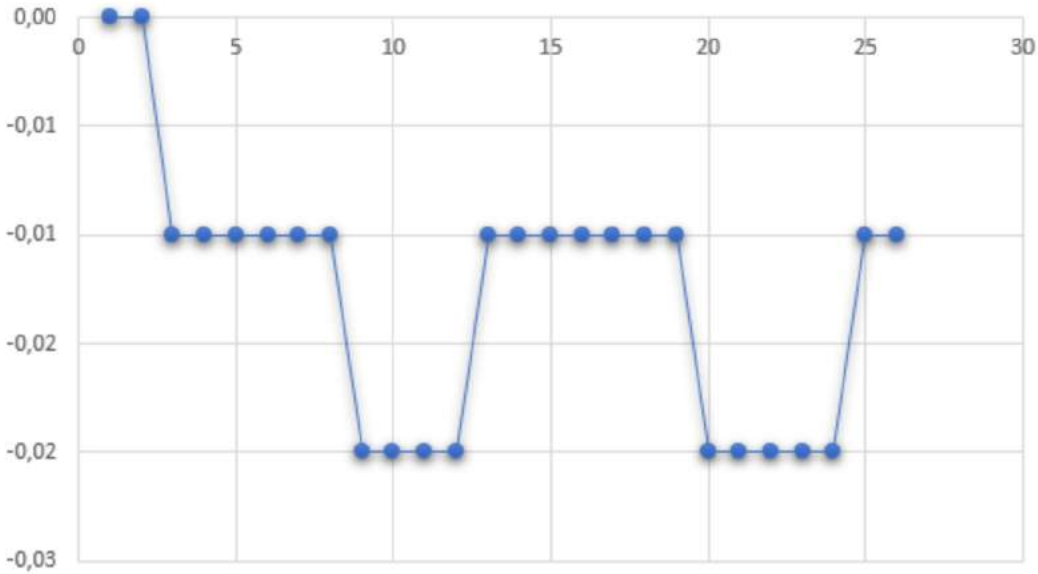

Figure 33.8 – Chart with the systematic errors presented by the voltmeter on 24 May 2019.

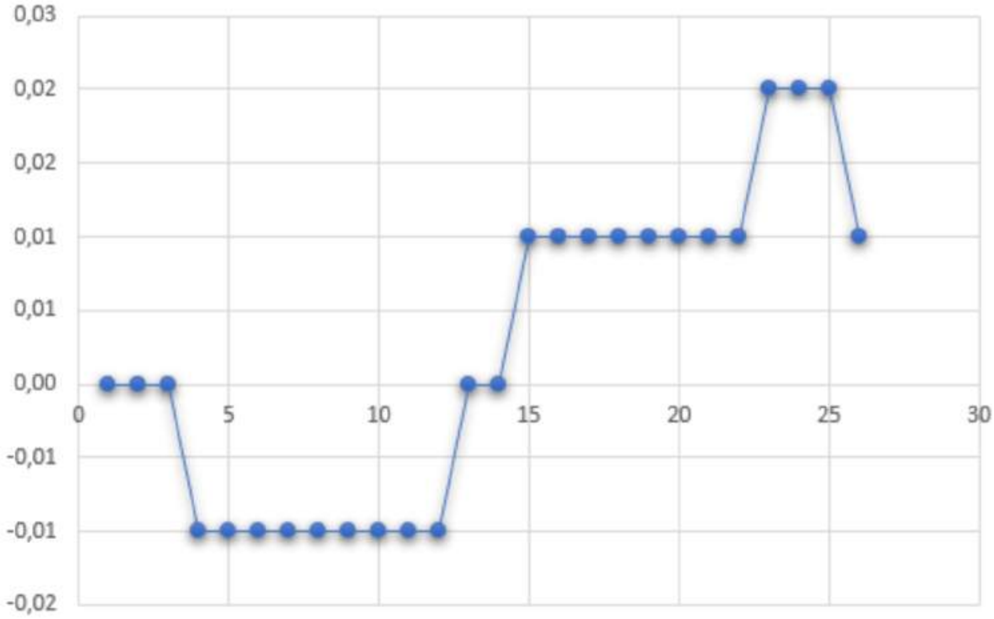

Figure 33.9 – Chart with the systematic errors presented by the voltmeter on 25 May 2019.

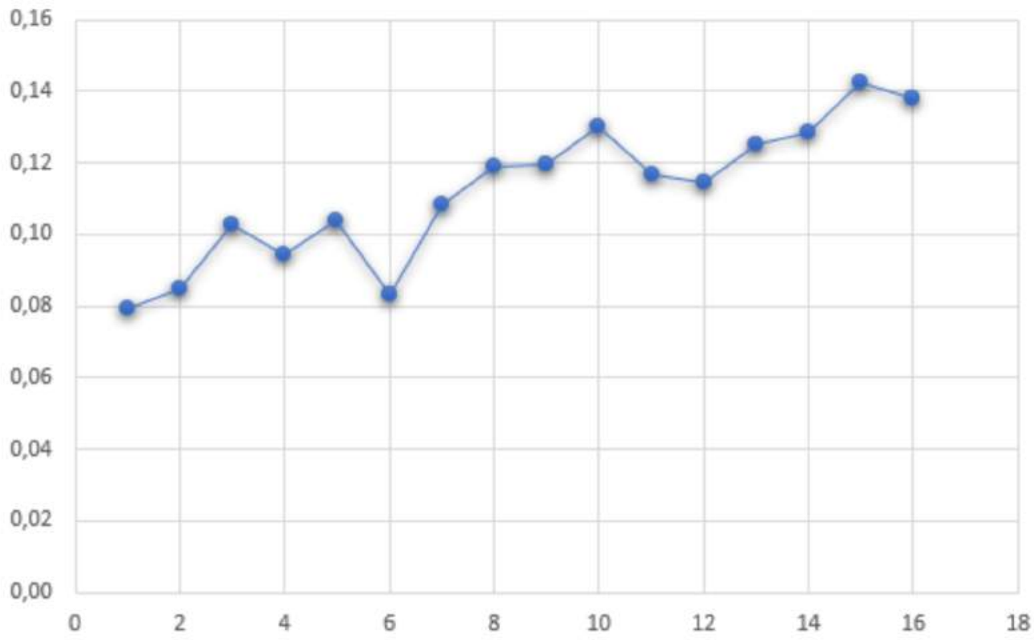

Figure 33.10 – Chart with the systematic errors presented by the ammeter on 22 May 2019.

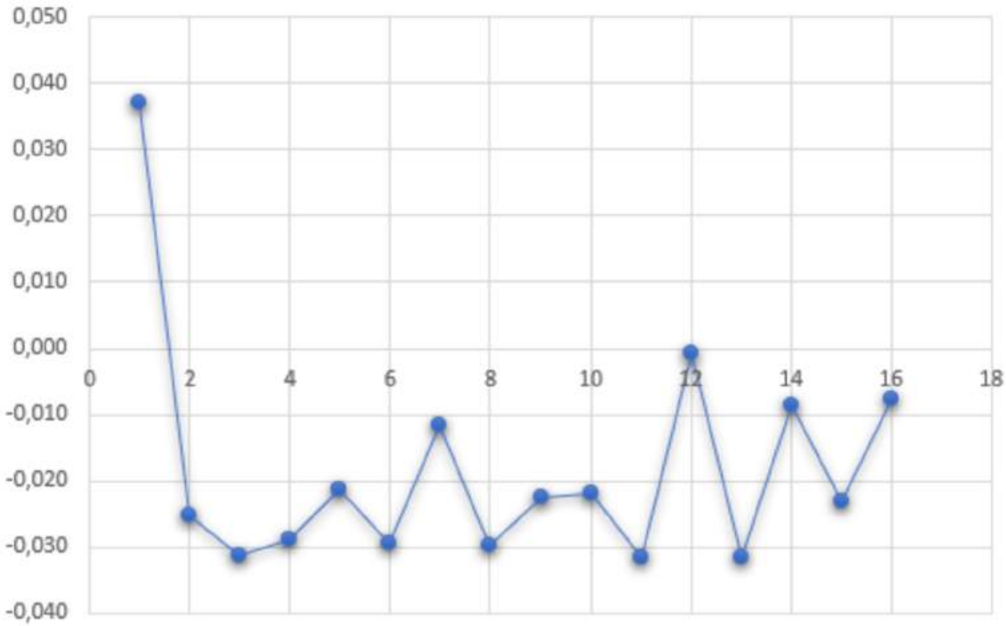

Figure 33.11 – Chart with the systematic errors presented by the ammeter on 24 May 2019.

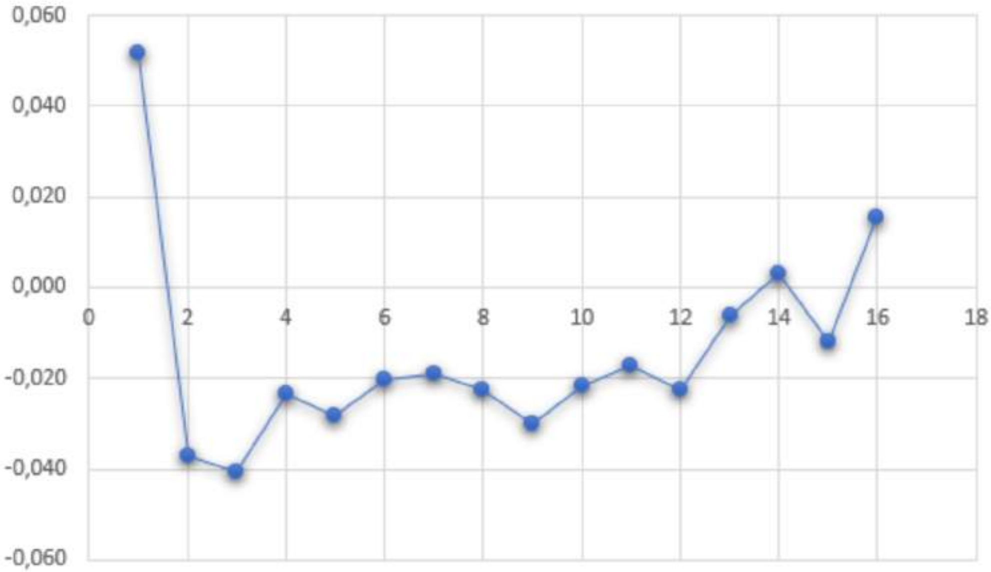

Figure 33.12 – Chart with the systematic errors presented by the ammeter on 25 May 2019.

CHAPTER 34

Engineering since High School: The Development of Skills Deemed Necessary to Higher Education and The Vocations Awakening in Students Arising from Brazilian Public Schools

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Abstract: In accordance with the Programme for International Student Assessment (PISA), the Brazilian Basic Education is lagged in comparison with the international context. Back in the 2015 PISA edition, Brazil was allocated between 59 to 66 rank position out of a 73 countries rank in mathematics, reading and science courses. These rates had no significant improvements in comparison with previous years. The average grade corresponding to sciences remained steady since 2006, and of reading, since 2000. Mathematics showed a considerable 21 points improvement since 2003, however it decreased 11 points between the years of 2012 and 2015, according to the Organization for Economic Cooperation and Development. In order to minimize the situation, the project "Electronic Instrumentation Project For High School Students of Public Schools, and its derivatives", was submitted to the National Council of Scientific and Technological Development - CNPq, in public calls in the category of Institucional Program of Scientific Initiation Scholarships to High Schools (in Portuguese, PIBIC-EM). Furthermore, with funding from the Universidade Federal de Campina Grande, two editions of the Extension Scholarships Program (in Portuguese, PROBEX), were entitled "Skills and Competences Development in the Technology Area for High School Students". Both projects happened in the city of Campina Grande, state of Paraíba, Brazil, between the years 2016 and 2018, under the coordination of the students in Electrical Engineering Anyelle K. F. de Queiroz, Joyce V. Morais Rodrigues, Marya M. Vieira Formiga and Rayanna M. de O. Francklim, supervised by Jalberth Fernandes de Araújo and Raimundo Carlos S. Freire, professors in higher education. The projects had as its premises to awaken vocations in high school students from public schools for the great area of Engineering, by presenting applications such as: Energy Generation, Distribution and Transmission Systems; Microelectronics;

Telecommunications; Automation and Control, Civil Construction; development of prototypes in the Biomedical area, among others. Aiming not only to alleviate possible struggles in the Exact Sciences, but also to work other crucial skills such as group dynamics, eloquence, and above all, motivate them to pursue their future careers in the great area of Engineering. The projects generated a number of positive impacts, among which: awards in a technological development contest, approval in exact courses: 70 percent of the students in the 3rd year of high school were approved in courses involving the area and 80 percent of high school students enrolled for the new edition of the project. Accordingly, we can consider the motivating and essential results for the students growth. The teaching done in a practical, playful and challenging way incites the debate, makes the knowledge instigating and, therefore, attractive.

Keywords: Basic Education, Electrical Engineering, Microelectronics, Vocations Awakening, PISA.

34.1 Background

The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students who are nearing the end of their compulsory education. PISA assesses how well they can apply what they learn in school to real-life situations. Over 90 countries have participated in the assessment so far which began in 2000. The 2015 PISA edition revealed that the average performance of students in Brazil is significantly below the

OECD average in science (401 points, compared to the average of 493 points), reading (407 points, compared to the average of 493 points) and mathematics (377 points, compared to the average of 490 points). Brazil's average performance in science has remained stable since 2006, the last time science was the major domain assessed in PISA (the approximate 10-point increase in scores, from 390 in 2006 to 401 in 2015, is not statistically significant change). These results are similar to trends observed across OECD countries: the small decline from 498 points in 2006 to 493 points in 2015 is not statistically significant. Nevertheless, while results have remained stable in science since 2006 and in reading since 2000, the country's performance in mathematics has improved by 21 score points since 2003, however it decreased 11 score points between the years of 2012 and 2015[1-3].

According to the special edition of the University of Sao Paulo (USP) journal, in 2016 the acceptance rate of students who attended Brazilian public institutions during High School was of 34.6%. However, on a closer analysis on how this number is reflected in each USP campus, a great disparity amongst the areas distributed is duly observed. Whereas some of USP campuses have already half of its egresses aroused from public schools, others still are with that acceptance rate lower than expected. For instance, at the Sao Carlos Engineering School (also known in Portuguese as EESC), only 14.1% of the freshmen students attended High School in Public Institutions. The second lowest acceptance rate came from the Ribeirao Preto College of Dentistry (in Portuguese known as EESC), where only 17.5% of the entrant students came from public institutions. The third lowest acceptance rate was at the Sao Carlos Chemistry Institute, with 18.3% percentage[4]. The National Evaluation System of Basic Education (in Portuguese, Saeb) is a set of large-scale external evaluations whose main goal is to elaborate a Brazilian basic education diagnosis as well as understand the elements that may interfere with the student's development and provide an indicative on the quality education offered by the schools. These evaluations are undertaken by the National Institute of Educational Studies and Research Anísio Teixeira, also known as Inep. According to the results from the 2017 Saeb edition, the percentage of senior high school students with the proper Portuguese grammar knowledge is extremely low, only 1.62% of these students achieved the adequate levels of learning that fit the Ministry of Education (MEC). This percentage represents around 20 thousand students out of a 1.4 million total that took the exam. In terms of mathematics, the situation is not that different, only 4.52% of the senior high school students, which represents around 60 thousands of students evaluated by Saeb in 2017, overcame the level 7 on the biggest evaluation carried in the Brazilian Basic Education ever on the Proficiency Scale[5].

34.2 Purpose/Hypothesis

Inspiring and motivating High School students throughout educational activities in Engineering can be one of the key change factors in terms of a country's economic and social development. A report named Engineering and Economic Group: a Global View research from 2016 developed by the United Kingdom from the Royal Academy of Engineering (RAE) considered the impact of Engineering on economic development on a global scale, and it pointed that by increasing the investments in Engineering Education and infrastructure, the country's economic health is overall improved[6-7].

Furthermore, when creating a positive scientific and social impact by promoting greater knowledge access, presenting a friendly college environment whilst working on the development of skills deemed necessary to the Higher Education, projects like the Institucional Program of Scientific Initiation Scholarships to High Schools (PIBIC-EM) and the Extension Scholarships Program (PROBEX) have shown that aligning the School to the University atmospheres reflects directly into the students' school performances, yet it has also shown how the basic education is much to be valued.

34.3 Design/Method

Aiming to diminish the great disparity between the presence of students arising from public schools and the ones coming from private institutions to the Engineering field in Higher Education, the Laboratory of Instrumentation and Scientific Metrology (LIMC) at the Universidade Federal de Campina Grande (UFCG) has been focusing on educational projects in the past few years. Two of these educational projects are here presented: Electronic Instrumentation Project For High School Students of Public Schools in the PIBIC-EM category and Skills and Competences Development in the Technology Area for High School Students which belongs to the PROBEX category. The project recruited students from three public schools located in the city of Campina Grande, in the state of Paraiba, Brazil: Escola Cidadã Integral e Técnica da Prata, Escola Cidadã Integral Monte Carmelo e Escola Normal Estadual Padre Emídio Viana Correia. The selection process was done by an exam where basic problems involving mathematics, trigonometry and physics were applied. After the exam, the students that obtained a score higher than 70% of the total were interviewed and after the number was narrowed down to 30 students the group was divided between the two projects previously mentioned.

After the selection process, the undergraduate volunteers noticed that even though the best students were selected it still was necessary a review of the basic mathematics and physics concepts applied to Electrical Engineering field. So, during a period of two months the subjects approached included trigonometric relations, the international system units, polynomial equations, concepts of resistance, voltage and current and so on. These subjects were reviewed and after these first lectures, an introduction to the electronic devices was performed. To ease the understanding of these concepts, brief laboratory sessions were performed along with the help of the IEEE Circuits Extreme which as an educational kit provided by IEEE to our advisor professor Dr Raimundo Freire to the LIMC, after the use of the educational kit, the students evolved to the use of protoboards and the electronic devices itself. Experiments including the measurement of current and voltage were also performed, by the end of this module a practical project as built. After the Electronic Devices module, it as also presented to the students, the importance and the concepts of Electrical Installations, throughout this part the students started their own electrical project simulating the rooms of a house. To finish the project, the students studied the importance of microcontrollers and lab sessions involving the use of the Arduino Uno platform. The main difference between the two projects here mentioned is that the Electronic Instrumentation Project For High School Students of Public Schools focused on developing overall skills for the Electrical Engineering area. The students had the opportunity to present seminars involving the subjects studied to improve their eloquence and presentation skills and also worked their hands-on skills by building two practical projects: an Adjustable Symmetrical Power Supply and a Residential Electrical Project. On the other hand, the Skills and Competences Development in the Technology Area for High School Students focused on both lecture and experiments using the Arduino Uno Platform as well programming in the C language, along with other experiments using electronic devices

34.4 Results

In terms of results, it is important to highlight the fact that nowadays we have three undergraduate students that have assisted previous editions of PIBIC-EM and PROBEX projects. That endorses the idea that educational projects like these two can indeed motivate students arising from public schools to pursue their future careers in the great area of Engineering.

Furthermore, it is expected that by the end of the project, the students have learned about the importance of Engineering and are motivated enough to start developing and finding new solutions to the daily issues faced by the community. In 2018, there was a state competition named Campus Academy where the students needed to present a solution to a daily issue faced in their lives. Three students of the PIBIC-EM attended the competition and earned the eight position out of a 365 student state rank. When they were asked if the project had somehow impacted their lives, one of the students replied: “The PIBIC-EM project, helped learning how to use more electronics concepts and technology to help society deal with issues daily faced, and from the moment you get involved with opportunities like these, your mind awakens and you start to think further, that was the case of the Campus Academy challenging project".

34.5 Conclusions

In conclusion, it can be inferred that both projects PIBIC-EM and PROBEX not only obtained results in terms of the awakening of vocations, but also, psico-social positive impacts such as: persistence, self-taught, group working, eloquence, ethics, among others. In the end, the students were able to improve skills demanded necessary to the development of their future careers in the great area of Engineering. Furthermore when asked if they would pursue their future careers in the Engineering field, or if they would indicate the project to their schools colleagues, the answer was overall positive, 90% of the students who attended the projects said that they now wish to become Engineers and would indicate these educational projects to their school friends and colleagues.

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CHAPTER 35

Worksheet for Calculations in Distribution of Electrical Power using Microsoft Excel®

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Abstract: The search for the continuous improvement of the quality of the service of electricity supply to the consumer is now a crucial factor for the survival of companies. One of the most important steps in this quest for quality is undoubtedly planning, an essential tool for the decision-making process. In the context of Electric Energy Distribution Systems, planning is a routine activity, since such systems require the continuous analysis of several indicators to solve everyday problems. The study of this important subject integrates the grid of Electrical Energy Distribution course, being crucial for the formation of the Electrotechnical Engineer. As the didactic examples used are usually very simple and do not allow the student to observe the particularities and details of the problems and in order to further improve the training of future Engineers, a spreadsheet was developed to support the Federal University of Campina Grande (UFCG). This work presents the current status of the development of the Worksheet for Calculations in Distribution of Electrical Power using Microsoft Excel®. It was developed in the Visual Basic for Applications (VBA) language of EXCEL® software and, in its current version, calculates the voltage drop, power losses, load flow and provides the voltage profile of the feeder. Such information is obtained after insertion of the power factor, primary feeder voltage, length of the stretches and the type of conductor used. The worksheet requires minimal information from the user and allows the generated data to be exported to a new worksheet, to print reports or to generate the voltage profile

curve. The worksheet has already been applied by the students during exams of the discipline Electrical Energy Distribution. In addition to facilitating the examination, there was a significant improvement in learning and interest in issues related to the electric energy distribution area, since the use of this new tool has enabled the students to understand the entire process of calculating power flow, voltage drops, and losses over a power distribution system.

Keywords: Excel, Load Flow, Power Losses, Visual Basic for Applications, Voltage Drop.

35.1 Background

The electric power distribution system (EPDS) is the part of the power system in charge of supplying electrical energy to the loads (residential, commercial and industrial consumers), with reliability and economy. However, due to the constant variation of the loads over time, problems are common. In the context of the distribution of electrical energy, the daily problems involve calculations of voltage drop, losses and power flow and analysis of the voltage profile[1]. The voltage drop is a natural phenomenon, but it must be kept within certain limits so as not to compromise the operation of consumer equipment, which are designed to operate in a certain range or voltage level[3]. Electrical losses are an important problem in electric power distributors, which receive economic incentives to reduce it5: one of the main problems arising from losses is the financial impact on all users, since all losses are paid by all users. The grid state is determined by the load flow calculation, which consists of the voltage values in all the buses or nodes of the system, for a given generation or load condition.[2] Finally, an important task in everyday life of the professionals of the electric power distributors is the survey of the voltage profile of the feeder, which consists of a cartesian graph of the voltage at each point of the feeder versus the distance from the point to the substation[1-5].

35.2 Purpose/Hypothesis

The teaching methodology of the Electrical Energy Distribution discipline initially consists of presenting the subjects in the traditional way in the class, exposing the theory and mathematical formulation, followed by manual resolution of didactic examples. However, only the examples presented in class were not enough for students to understand the dynamics involving the planning of a distribution system. Thinking about exposing the details of calculations of voltage drop, loss and power flow to students and facilitate the development of these calculations, the Worksheet for Calculations in Distribution of Electrical Power was created in Excel. The worksheet should be intuitive and easy to understand for everyone, since its function is to be used by the students as an auxiliary tool in the discipline.

35.3 Design/Method

The Distribution studies worksheet was built in Visual Basic for Applications (VBA), a programming language belonging to Microsoft® and incorporated into Office® applications. The worksheet was developed in Excel®, making use of macros, forms, listboxes, text boxes, graphical elements and organized tables in a Graphical User Interface (GUI) that aims to facilitate and speed up the process of obtaining the results desired by the user. Although the programming has been executed in such a way that all possible situations are predicted, there is always a probability of bugs, which are being identified by the students and teaching trainees, which are immediately corrected.

35.4 Results

To illustrate the use of the worksheet we used the system shown in Figure 35.1. The results of the simulation are presented in Tables show in the Figures 35.2 and 35.3. The voltage profile of the feeder is presented in Figure 35.4.

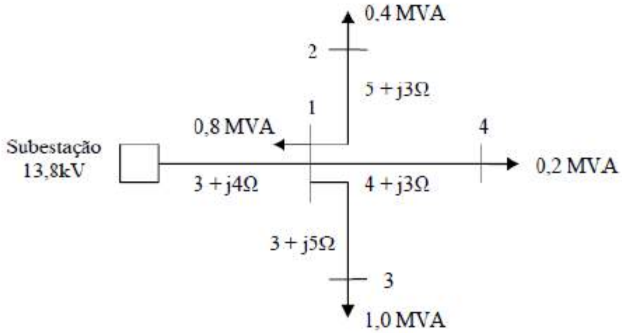

Figure 35.1 – 5 bus system.

Voltage Drog			Power Losses		
Unitary	In the Section	Total	Unitary	In the Section	Total
%/MVA/km	%	%	kW/MVA²/km	kW	kW
2.5205	2.0164	2.0164	12.6024	8.0655	8.0655
3.0456	1.2182	3.2346	21.0040	3.3606	11.4261
2.8355	2.8355	4.8519	12.6024	12.6024	20.6679
2.6255	0.5251	2.5415	16.8032	0.6721	8.7376

Figure 35.2 – Voltage drop and power losses for the test system.

Section		Losses		Load Flow		Destination Bus Voltage	ΔPi+1	ΔQi+1
Origin Bus	Destination Bus	ΔPi(MW)	ΔQi(Mvar)	P(MW)	Q(Mvar)			
0	1	0.107716	0.143621	1.95	1.48	12.8865	0.1077	0.1436
1	2	0.004956	0.002974	0.32	0.24	12.7039	0.0049	0.0029
1	3	0.019349	0.032248	0.80	0.60	12.4516	0.0193	0.0322
1	4	0.000975	0.000731	0.16	0.12	12.8084	0.0009	0.0007

Figure 35.3 – Load flow results for the test system with the number of iterations = 3 and the error = 4.2E-10.

35.5 Conclusions

The worksheet has been applied in the course since 2014 and has been corroborating the importance of the use of computational tools in teaching, since it has motivated the interest of the students and allowing analysis of more complex systems. However, this worksheet can still be improved and new calculations can be added, such as bank allocation of capacitors and voltage regulators. Other important factors in this experience are: i) participation of the students in the improvement of the worksheet and in the identification of errors; ii) students' interest in developing their Course Completion Works in subjects related to the discipline, in particular, in the development of teaching

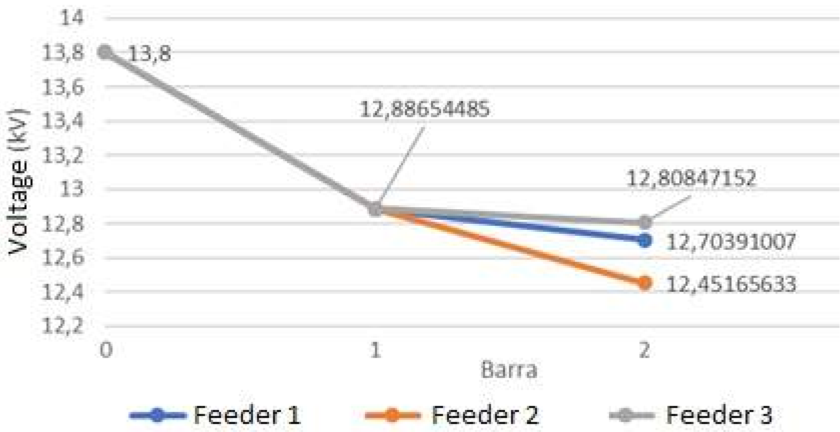

Figure 35.4 – Voltage profile of the feeder.

tools aimed at improving teaching.

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CHAPTER 36

Laboratory of Integrated Practice: Training of Engineers for The 21st

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Abstract: Understanding our mission statement, which is, "Transform our Country through Education", also considering the centrality of students in our educational institutions, we have been challenged to offer a competency-referenced curriculum that allows creating learner autonomy, increasing student's rates and performance. Helping students to learn as well as supporting them to become protagonists of their Life and Career Projects have been one of the main goals of higher education institutions. Therefore, it certainly involves the development of socio-behavioural skills, considering the necessity of dealing with the demands of modern society. Educators around the world, performing both in and out of the classroom, believe that Project-Based Learning - PBL is a critical instructional approach that allows students to master and enhance skills and academic content knowledge, which are essential for improving success, for building personal purposes and attitudes to overcome life's challenges in the contemporary world. The PBL approach provides the student with a deeper understanding of the studied content while putting theoretical concepts and strategies for problem-solving into reflexive practices. At the

same time, it adopts the development of multidisciplinary capabilities related to communication, collaboration, leadership and management. PBL relevantly supports the development of reasoned critical thinking. In this framework, the main goal of the Laboratory of Integrated Practices - LIP as an innovative curricular unit that aim is to articulate core competencies for Engineering students in the two first years of its Bachelor program. In 2018, 2760 Brazilian students took part in this research. Student's perceptions regarding non-conventional academic experiences and active learning methodologies are collected for evaluating the program. From the understanding and reflections that emerge from LIP's practical and reflexive activities, students have prove to become able to conciliate new knowledge with previously known ideas. Notably, once LIP's classes involve mentoring as a critical element for strengthening the training process, each lesson is opened by pre-activities or questions meant to engage students and to build interest while offering opportunities to share what they already know on the subject. This phase includes helping learners to make connections between the preexisting knowledge base and the insights that will arise from assignments, lesson and unities. The 5Es Methodology is additionally contextualised, based on the constructivist learning theory, which suggests that knowledge and meaning are built from people's experiences. The following phases are therefore highlighted, considering a five-stage instructional model for inquiry-based learning: 1)students receive information prior to the lesson, engaging it and promoting connections between past and present learning experiences (Engage); 2) students deepen comprehension, through experiments and other interactions (Explore); 3) students attempt to explain what they have learned and experienced with mentoring interaction (Explain); 4) students deal with new situations in the sense of deepening skills (Elabo-

rate); 5) students provide evidence of significative learning and comprehension (Evaluate). The results obtained from the participant's reports - students and teachers - allows verifying common perceptions regarding engagement, creativity, problem-solving, autonomy, critical thinking and argumentation. The academic gain that arises from social learning also strengthens formative and learning purposes to enhance the formative assessment.

Keywords: Formative Assessment of Learning, Reflexive Practices, Significative Learning, Training of Engineers, Laboratory of Integrated Practices.

36.1 Background

It is necessary to adapt the process of higher education formation to the contemporary world, based on the profile of the student, rethinking the skills that will be worked in the subjetcs, and the teacher as a mentor. Educational reforms and the reorganization of curriculum in higher education have become the focus of discussions in the academic community, with emphasis on competency-referenced curriculum. Is a global phenomenon, in an attempt to respond to the contemporary need for the integral training of students for the job market, trainning workers for the needs of the 21st century[1].

The Laboratory of Integrated Practices - LPI was proposed as a curricular unit in the process of training in Engineering, from a curriculum referenced by competences, for the Engineering students in the two first years of its Bachelor program of the Anima Group. It is considered the incentive to work in groups, aiming at equity with excellence and the relationships between teacher mentor and students. It provides a contextualized learning process and reflective practices, considering academic planning that values the centrality of the student, experimentation with the re-signification of error, in the construction of autonomy and protagonism. The aim of this study was to understand and analyze the perceptions of students and teachers involved in LPI activities (or took part in this research).

36.2 Purpose/Hypothesis

The professional competence can be defined as the ability to mobilize, articulate and put into action the knowledge, skills and values necessary for the efficient and effective performance of the required work activities[2]. It includes the habitual and judicious use of knowledge, communication, technical skills, reasoning, values, emotions and reflections in practice. According to MORIN (1986), "the important thing is not only information, it is the mental or ideological system that welcomes, collects, refuses, places information and gives it meaning"[3]. Whenever the subject establishes a relationship with the information, he can become involved in the construction of his knowledge.The significance of the content presupposes mediation of learning, a specialized form of interaction between student and teacher[4], leading to lasting understanding, important for the student's knowledge and know-how. Durable understanding is the goal of the student-centered teaching, allowing the student build other meanings and relationships from the experiences of learning experienced, encouraging the construction of him autonomy. Thus, the skills of remembering, reasoning, critical thinking, problem solving and acquisition of new knowledge are developed in student training. Challenges arising from this point is to the demand for classroom innovation, considering planning and methodologies focused on student learning.

36.3 Design/Method

It was considered the challenge related to the registration of modes and achievements of student and teacher experiences (LÉVY, 1999), registering student and teacher testimonial, in the search for evidences of the integral formation of LPI students[5]. They are considered adaptations of educational practices and mentoring attitude[6]. In 2018, 2760 students attended the LPI.

36.4 Results

The academic planning of the classes was constructed considering the learning objectives and the selection of the practical activities that would contribute to the achievement and evaluation of the objectives already established. Knowing the importance of students' engagement in the activities, the content was was already available before the face-to-face class (pre-lesson). The methodology 5 E was additionally used as an instructional model for the development of technical and scientific concepts during the accomplishment of the activities of the LPI. Each E describes a learning phase: Engage, Explore, Explain, Elaborate, and Evaluate. (DURAN & DURAN, 2004). Searching for evidences of the integral formation of the students and the learning like social activity we find perceptions that corroborate with the expectations and objectives of the LPI. “In my opinion, LPI classes are a lot of help as it empowers us and encourages us to go deeper into each proposed content. Before with the normal laboratory classes we only did the work and ended up not learning and with this method of pre and post lesson the subject and experiment are well used and we really learn, because to be able to carry out the study we have to study and understand. So this was well thought out to enable each student”.

36.5 Conclusions

The LPI reinforces itself as an articulating curricular unit that enhances the fundamental competences for integral trainning of Engineers, given to contemporary requirements and consonant with the requirements of productive systems of the 21st century.

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CHAPTER 37

“Energia Amiga” Extension Project

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Abstract: The “Energia Amiga” Extension Projetct of the Universidade Regional do Noroeste do Estado do Rio Grande do Sul, UNIJUÍ, has as its central theme the Electrical Energy, based on three lines of action: conscious consumption of Electrical Energy, safe use of electrical installations and technological residues. The projects aim the development and sustainability, making a commitment with the social responsibility and interaction with several areas and segments of society. The project is made by undergraduate students of Electrical Engineering together with undergraduate students in Literature and Design, with the guidance of teachers from the respective areas. The project started in 2018 in public schools of the city of Ijuí, Rio Grande do Sul, where was worked on the main concepts of day-to-day electricity, as well as conscious energy consumption and safety precautions about electricity risks. In 2019, the project

will keep the work with public school students from the city Ijui, and for the first time in Santa Rosa as well, the main focus of the project is in the technological residues area, developing two books about reverse logistic. The books are divide in two volumes, the first one is directed to the third year students and the second volume to the ninth grade students, the academics participating in the project will go to the schools to develop the activities (writing contest, full-size board game, classroom activities) with the students. In addition, to deepen the knowledge presented and to approach new contents, each student receives a book with texts, drawings and various activities, developed by the graduates participating in the project, by the teacher in charge, and carried out with sponsorship of companies and entities of the electric sector. The contents of the book are turned to reverse logistics, addressing its concept, history, development in Brazil, reverse logistic of lamps and batteries and electronic waste.

Keywords: Education, Electrical Engineering, Extension, Reverse Logistic, Energia Amiga.

37.1 Background

The “Energia Amiga” Extension Projetct has as its central theme Electric Energy, based on three lines of action: conscious consumption of electricity, safe use of electrical installations and technological waste. The project seeks development and sustainability, making a commitment to social responsibility and interaction with the various areas and segments of society[1-2]. The activities will be developed on the campus of Ijuí and Santa Rosa, and will bridge the gap between the knowledge of Electrical Engineering, letters and design. This union enables the development of interdisciplinary and appropriate activities for the target audience, from different points of view.

37.2 Purpose/Hypothesis

Electricity brings facilities and comfort to daily tasks in both residential, commercial and industrial sectors. But while energy benefits, a more critical and real view of the impacts of electricity use is needed. There are many positive points, but this does not relieve the conscious responsibilities and attitudes needed when using electricity. The unbridled consumption of electricity requires greater investment in power generation, transmission and distribution systems. In Brazil, the energy matrix is based on hydroelectric plants, which generate impacts on the environment when built. Therefore, the more energy consumed, the more generation systems will need to be built, and consequently, the more natural environments will be impacted. The importance of electric energy is known, and it is not the objective to criticize its use, but the criticism is to use without awareness.

37.3 Design/Method

The project is included in the qualitative line, through the theoretical and practical approach. The team will be made up of professors from the Electrical Engineering, letters and design courses. Electrical Engineering teachers will support technical content and practical activities, including lectures, workshops and courses. The letter course teacher will assist in the preparation of materials for the project activities, including books, handouts and organization of the writing and drawing contest. The teacher of the design course will have sporadic insertions, aiming to advise on the visual identity of the materials made and their correct use according to the age group.

37.4 Results

To start the activities of the Friendly Energy Project in 2019, on June 19, the first action of the project was held with a meeting with the schools of the municipality of Ijuí. And on June 26 the meeting was held with the schools of Santa Rosa (Figure 37.1).

Figure 37.1 – First meeting with schools.

This first meeting discussed the project, its trajectory, results obtained in the year 2018 and the actions that will take place during that year, and also delivered the book with the wording and drawings of 2018 (Figure 37.2).

Figure 37.2 – 2018 Writing and Drawing Contest Highlight Book.

Activities with the classes enrolled in the project begin in August as planned (Figure 37.3) presented at the first meeting with the schools.

Thus, activities with students begin in August, until the time of writing this work occurred only the initial meetings with schools and teachers in charge.

37.5 Conclusions

The “Energia Amiga” Extension Projetct ensures the academic practice and the interconnection of the University in its teaching activities with the demands of society. This is due to the wide range that electric power has.

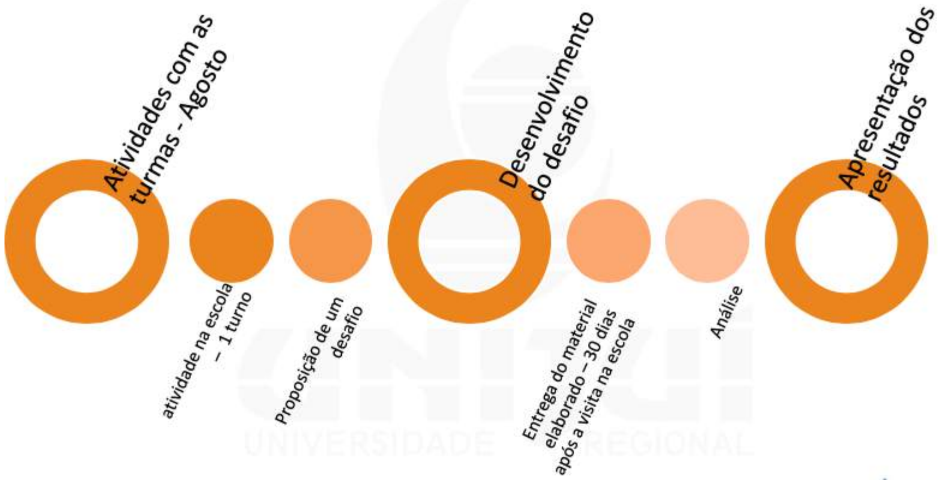

Figure 37.3 – Action planning in schools.

Unijuí's undergraduate courses aim to study and extrapolate knowledge to the community. In this way, the interconnection between University, professionals and society is realized.

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Taking notes

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The National Curriculum Guidelines of the Engineering Undergraduate Course (Engineering DCNs), approved on 23 April 2019 in Brazil, point to continuous improvement in the training of Engineers as one of the critical factors for economic and social development. Indeed, this improvement is an important element due to differences in productivity and dispute between countries. This is the big challenge!

Certainly, the use of Active Methodologies should be encouraged as a way of promoting student-centered education. In fact, it is hoped that the new Engineer can learn autonomously by dealing with complex situations and contexts. In addition, it is expected that it will be able to assume an investigative and autonomous attitude, with a view to continuous learning, the production of new knowledge and the improvement of new technologies, as well as "learning to learn".

As the papers in this book shows, many professors are already using Active Methodologies and initiatives in Engineering Education also come from papers submitted by undergraduate and graduate students. As a matter of fact, the papers in this book come from five different countries, namely: Brazil, Israel, the Netherlands, Taiwan (R.O.C.) and Portugal. As follows, the name of the book was appropriately chosen: "Alive Engineering Education: Innovating Engineering Education beyond Borders". I wish you all a good reading!

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