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The Impact of Entrepreneurship Engineering Education in Amazonia

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ABSTRACT: In many countries, the entrepreneurship has been introduced as a methodological tool for teaching and learning, providing the technological innovation process within the universities. In the Amazon, a pioneering project was implemented, aiming to apply the entrepreneurship and technological innovation with pedagogical strategies, directed to students of electrical engineering of the first semester.This paper presents the results of a study conducted in NiltonLins University with 129 students of the electrical engineering course, using a problem-based learning model for developing the student's ability related to innovation and also entrepreneurship. Given a set of problems related to the infrastructure at the NiltonLins University, they developed 10 projects of technological solutions. There was also an evaluation of the student's satisfaction at the end of the semester, which showed a high degree of satisfaction.

KEYWORDS: Entrepreneurship, education, Experiential education, Problem-Based Learning, Innovation, Pedagogical Strategies.

I. INTRODUCTION

One of the goals of a university is to empower and motivate students to perform entrepreneurial initiatives that generates employment, technology and economic development [1], thus benefiting the society. The initiative of entrepreneurship, as didactic-pedagogical tool for teaching and learning, is innovative and of great importance within the university, being featured in national and international discussions [2]. While it is of great importance, its implementation has been slow because many professors are not familiar with the concept of what entrepreneurship is and what makes an entrepreneur [3] and are often unaware of the resources available to carry out a pedagogical task [4, 5] combined with the technological innovation process.

The implementation of entrepreneurship as a methodological tool should be necessary, especially for undergraduate courses, particularly engineering. The entrepreneur in engineering can be seen as someone who is motivated to be innovative and can be an agent of change, as [6] quotes for economists. According to [7], the university has a key role in the transmission and adaptation of teaching methodologies of entrepreneurship to the needs and circumstances of students and the requirements of future professions. According to [8], the academic entrepreneurship is now considered a key vehicle to increase the creation of new businesses and generate wealth. [9] mentions that entrepreneurship education is growing and consolidating in the main centers of undergraduate and post-graduate training in various segments, including engineering courses. However, according to [10], the entrepreneurship, stimulated by learning, can be the engine of growth of the local economy and job creation. For the teaching of entrepreneurship happen in universities, within didactic and pedagogic practices and also be included in the curricula, it will be necessary to have an incubator, that is essential for the implantation of business plans and technological innovations developed by the engineering students.

Nevertheless, it is not possible to develop an engineering teaching that stimulates technological innovation and entrepreneurship through traditional methods, once the professor must be knowledgeable and aware of his role in the formation of the student, being the key part in the creation of a conducive environment to technological innovation [11]. Therefore, the goal of the present work is to apply the teaching of entrepreneurship and technological innovation as pedagogical strategies directed to electrical engineering students of the first semester at NiltonLins University, Manaus, Amazonas, Brazil. The Problem-Based Learning Model is a combination of worked and problem solving. Worked is a model of problem solving that consists of three components: a statement of the problem, solution steps and the final solution to the problem [12].

II. RELATED WORK AND CONTRIBUTION OF NEW PEDAGOGICAL PRACTICES

The students that enters the university come from weak public schools and with huge deficiency in mathematics and in positives and technological studies. Data from 2015 IDEB [13] shows that the results of high school stays stagnant in 3,7 since 2011. The high school IDEB has not reached the goal and kept the index of 2011. The goal was to reach 4.3; but IDEB continues at 3.7. The only states that reached the mark were Pernambuco and Amazonas. Almost all students are enrolled in the state public system and the low performance reinforces the urgency to reform secondary education, which should be more flexible and create a new architecture capable of attracting young people. That way, the contact with university will be a whole new reality. The engineering for this student is totally unknown, its methodology and practice are a whole new world and expectations are always present from the second half of the course.

On NiltonLins University's teaching program, it is proposed pedagogical measures since the entrance in the university, the same adopted in this research, in order to do not insert a merely verbal book based teaching and disengaged from the concrete reality of the students. Thus, we can say that the contribution generated by this work is not equal to other works because it allows students to engage actively and productively, giving solutions to the problems experienced in the university community.

In this study, it was defined a methodology where the conception of learning as a knowledge construction process is the adoption of strategies directly linked, so that practical experience can be mobilized for learning. It was also defined that the molds of group work execution are based on the fundamentals proposed by [13], in which the group activities are implemented in accordance with the following practices: "what should be done"; "Why will you do this job"; "So will you do this"; "How do we make this work."

Some classic methodologies that supported teaching and learning in universities have suffered wear and should be reassessed and adapted to a current reality, where the application of innovation and entrepreneurship as a central element is necessary, as the market demands in a globalized world.

Referencing to the classic models of Bloom's Taxonomy, which is an educational proposal to the concepts of cognitive education and may be based under the following. According to [15], it is about a dialogical view of human cognitive, constructivist and co-constructivist. The constructivist is inspired by [16-18], which is given by the construction of centripetal and significant knowledge structure, and not pure uncritical accumulation of information data, while the co-constructivist, inspired by [19-21], enhances the centrifuge construction of knowledge based on internalized social interactions involving an intentional dialogue between experienced and inexperienced people.

In a current conception, according to [22], the cognitive education is part of a systematic perspective of intelligence and therefore based on recent contributions of cognitive psychology, neuropsychology, information process and contextual approaches to development of cognitive, in order to maximize the ability to learn to learn, to think, to study and communicate, rather than memorizing and reproducing information.

III. MATERIALS AND METHOD

The method based on the problem was applied in two engineering groups of the first semester at the NiltonLins University, where from a specific problem, the troubleshooter uses the tools for the analysis of the problematic situation and problem formulation to make the abstraction and reach a general problem. With the problematic on infrastructure of NiltonLins University and suggestions aimed at modernization. The methodology followed the steps presented in Figure 1, on the model of problem-based learning model.

The methodology was intermediated in the relation Work, Science, Technology and Innovation. The strategy is used mainly for research in which projects are developed in teams. The students had as base the university's universe, identifying the problems and solutions, so that both student and professor have a notion of the activities developed by them. Given the established problem, students were led to a process of abstraction, in other words, a generic solution to later be particularized to reach the specific solution, based in [12].

It was set that the innovation projects should carry out as a team for the purpose of developing interaction skills in groups so that students are able to: a) integrate team work with effective and participatory activities; b) create socio-economic impact projects with the confrontation of some contextual issues identified by the student; c) integrate application development teams and evaluations of different types and application interfaces; d) manage projects. Also, the group work is based on the study in a group or team, in which, according to [23], the elements such as following are involved: subject consciousness, experience and different skills that come together with the explicit intention, through dialogue, joint reflection effort takes hold of reality, to know it in order to make it. As well, the author completes that group work is, consequently, an achievement of a human being who recognizes in his fellows as a source of relations, of freedom, dialogue and the possibility of growth. However the team work requires from its members to have a minimum of openness to freedom: to respect the limits of others, listening and attention, so that each contribution is reflected, questioned, clarified and enriched, in a concept of knowledge construction.

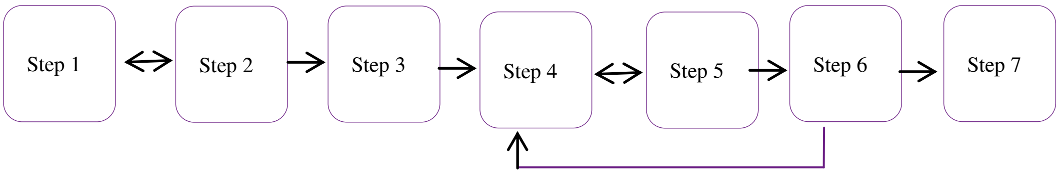

Fig. 1.Problem-based learning for enhancing students of engineering.

In Figure 1., it is described the methodology adopted in the research in which followed steps. Step 1, it is set a theme as correlation in a series of problems (formulation of the problem to be solved and the value creates with the evaluation of its commercialization potential). In Step 2, it is made an analysis of the competences, strengths, finances and weaknesses of one's related to be a solution to the problem. In Step 3, it is made the division of the team into groups that are responsible for products solutions, finances, society and marketing). Step 4, it is made a research in groups. Step 5, it is made a summarization of the findings for futher development of the idea of the product /service. In Step 6, it is made the creation of the prototype of the service and testing. And Step 7, describes the reflection on what is acquired.
The evaluation about student's satisfaction with the introduction of the entrepreneurship approach according to the model was conducted based on their reflections about the following questions, answered in class.
The questions for satisfaction evaluation were based on the [12] research. In which includes: a) What was new to you in the study course? ; b) What did you like/dislike in your activities?; c) What do you consider to be valuable to you?; d) How are you going to use the experience acquired?; e) Are you satisfied with the activities during the course?; f) Comment on your answer.

IV. EXPERIMENTAL RESULTS

On the first five weeks of class, the students elaborated innovation projects prototypes, with application in solar panels, automatic frequency control systems, warning systems for start and end of classes so that professors do not exceed the time of another professor, whiteboard with additional lighting in the absence of electricity, automatic shutdown of air conditioners and internal lighting of classrooms, among other projects.
The solutions developed by students were presented through a test, with operating project models in a technological fair, which had the participation of the community of NiltonLins educational complex, in a multidisciplinary composition of the faculty of NiltonLins as part of the University's efforts to make educational opportunities in environments that promote the technological and creative development of engineering students, in order to establish a new teaching model for this course based on innovation, interdisciplinary, in appreciation of humanistic education, entrepreneurship and the use of technology, also in the service of social needs and sustainable development.
The technological fair also had the participation of other invited institutions such as Amazonas State University and SENAI Institution of innovation in Brazil, which evaluated the projects in terms of entrepreneurship and innovation. This event stimulated researches, partnership formation and the development of new technologies and innovation. It allowed the identification of talents, the capture of curriculum and assessment work/projects. It was a favorable environment for sharing ideas and experiences and networking opportunity.
The fair happened on July 9 and 10, 2016 during the afternoon and evening, and it was observed that all students, were excited to present their projects.
As discussed in the methodology, the students worked in teams, which generated 10 technological innovation projects presented in Figures 2 to 11, with description of the problem given by the professor and the solution proposed by the research groups in the form of proof of concept, which are presented below:
Project 1
Problem: Time wasted in classroom in performing the attendance.
Proof of Concept: Automated system with Arduino UNO, TAG's and biometric reader to validate the presence of the student in the classroom. Where the professor has the control of releasing the beginning and end of the validation

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period. Figure 2 shows the photographic of the students members of the team and their experiment. In Figure 2, it is represented by A, the development team during the fair, and by B, presents the circuits prototype, and by C, it is represented the biometric reader.

(a) (b) (c)

Fig. 2. Pictures related to Project 1 with the presentation of a model as proof of conception.

Project 2

Problem: Wasted resources on labor to turn on and off the classroom's equipment and lighting, considering that the university has 500 classrooms.

Proof of concept: Automated system with Arduino UNO microcontroller with a timer to power on and off the cooling system (air conditioner) and also lighting, using LED lights. The proof of concept also featured a display that should be placed in the classroom door to tell you which professor is in the classroom and what discipline is being administered, and tells the professor when it is exceeding its time in the classroom.On Figure 3, represented by A, it is presented the corresponding development team and, represented by B, there is an image of the prototype that represents the proof of concept of project 2.

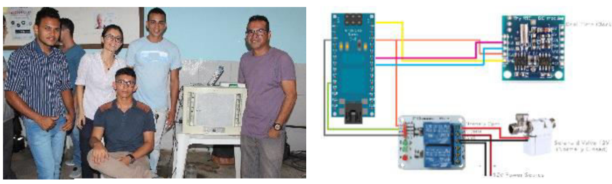
(a) (b)

Fig. 3. Pictures related to Project 2 with the presentation of a model as proof of conception.

Project 3

Problem: The same definition of Project 2.

Proof of Concept: Automated system with microcontroller timer to power on and off the cooling system (air conditioner). The students presented a proof of concept with an air conditioner. On Figure 4, it is presented the picture of the team and its experiment, in which the development team is represented by A, and the project's prototype is represented by B.



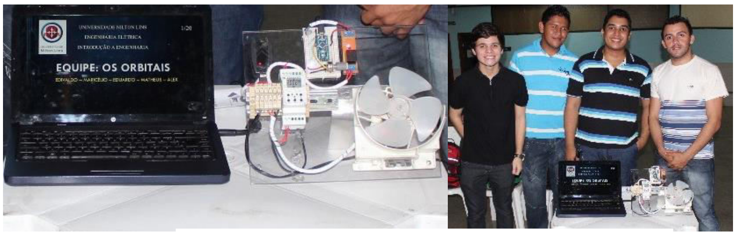
(a) (b)

Fig. 4. Picture related to Project 3 with the presentation of a model as proof of concept.

Project 4

Problem: The same definition of Project 2.

Proof of Concept: Automated system with timer actuation Coel BWT40R and Arduino UNO to power on and off the cooling system (air conditioner). The students presented as proof of concept a device with cooler. In Figure 5, it is presented by A the prototype of project that was developed, and B represents the members of development team.



(a) (b)

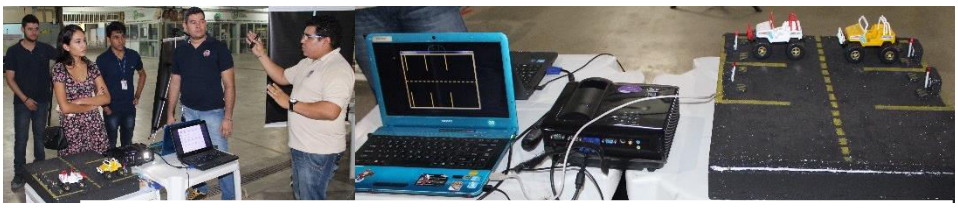
Fig. 5. Pictures related to project 4 with the presentation of a model as proof of concept.

Project 5
Problem: When there is no electricity and the professor writes the subject content on the board, this content gets lost, since students cannot write it all down.
Proof of Concept: Automated system with microcontroller that detects the absence of electricity and triggers LEDs lights positioned at the top of the board, so the professor can complete the content. In Figure 6, the development team is presented with the prototype of what was developed by them.

(a)

Fig. 6. Pictures related to project 5 with the presentation of a model as proof of concept.

Project 6
Problem: The NiltonLins University has a floor area of 1,000,000 m^2 (one million), with a student body and faculty of 16.000 students and 630 professors, as well as more than 10 parking lots. Thus, despite the huge floor area, there's a traffic jam between 5:30 to 7:00 PM, during the entrance of the night shift students, and at the end of class from 9:30 until 10:30 PM.
Proof of Concept: Automated system with Arduino UNO microcontroller, ultrasonic sensors positioned in every garage and computer interface (applications) accessed by the faculty and students of the university indicating the number of places in each car park, thus avoiding the traffic in the inner area of the university. In Figure 7, represents the team's presentation during the fair, represented by A, and also the prototype that was developed by Team 6.



(a) (b)

Fig. 7. Pictures related to project 6 with the presentation of a model as proof of concept.

Project 7

Problem: As presented in Problems 2 and 6, the NiltonLins University has a huge infrastructure to conduct their educational potential in the Amazon, resulting in a high energy consumption. The NiltonLins University was built in a relatively flat area, with building constructed area of 600,000 m^2, having a good useful area for solar panel installations.
Proof of Concept: Automated system with Arduino UNO microcontroller and a mechanic arm for angular gyrus coupled to a solar panel in order to better use the sun light, since the panel automatically rotates with the incidence of radiation on the proposed device. Students made use of a car battery and a lamp to show the operation of the solar panel for educational purposes. In Figure 8, it is represented by A, the development team with the presentation of their projects, and B represents the prototype developed by them.

(a) (b)

Fig. 8. Pictures related to project 7 with the presentation of a model as proof of concept.

Project 8
Problem: Given the high number of students, there are visually impaired students in need of audible warnings in case of a power outage or evacuation at the University NiltonLins.
Proof of Concept: Automated system with Arduino UNO microcontroller and light sensor coupled to a cornet system and LEDs lamps to signal sonically and through flashing lights that the building must be evacuated. In Figure 9, it is presented the prototype developed by team 8.

(a) (b)

Fig. 9. Pictures related to project 8 with the presentation of a model as proof of concept.

Project 9
Problem: The NiltonLins University has a post graduation program in architecture and as requested by the program, there is the need to modernize laboratories with water temperature control of the fish aquariums that are used in the program's research. Sometimes there is death of fish in the laboratory due to excessive temperature falls or rises.
Proof of Concept: Automated system with Arduino UNO microcontroller and a temperature sensor to control the aquatic environment. The system implemented by the students informs the temperature via wireless network to the researcher's mobile phone and generates an alert to temperature critical cases, giving the researcher a fix alternative of this temperature problem with appropriate procedures and techniques. In Figure 10, represented by A, it is presented the prototype developed as the proof of concept, and B represents the development team during the presentation of their projects during the fair.

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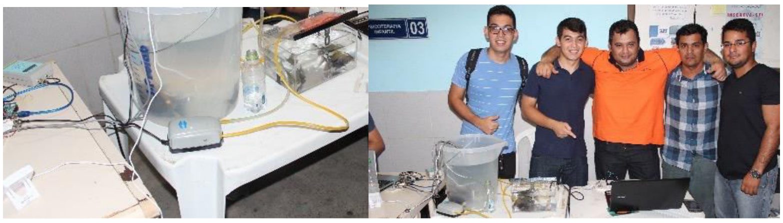

(a) (b)

Fig. 10. Pictures related to Project 9 with the presentation of a model as proof of concept.

Project 10
Problem: The NiltonLins University has a high loss of whiteboards erasers and markers, given the high number of students body.
Proof of Concept: Automated system with Arduino UNO microcontroller and electronic TAG's in which every professor has its own identification. The didactic material is kept in an acrylic box in every classroom, which only opens with the input of a password in a keyboard or the TAG. The system also controls which professor used the box and the amount of material kept inside the box. In Figure 11, represented by A, it is presented the team during their presentation during the fair, and B represents the public experience during the presentation of their prototype.

(a) (b)

Fig. 11. Pictures related to project 10 with the presentation of a model as proof of concept.

In terms of assessment of student satisfaction to the application of the method, it was analyzed by quantitatively counting categories answered by students for each answer. The questions answered by the students were indicated in Section III . The results of quantitative content analysis of each student regarding your work were summed up all the numbers for categories and the diagram of the comparison of positive and negative aspects was built and presented in Figure 12. Based in [12] two columns are provided for each of the five questions – one for the case when students' reflections had positive (+) and the other – when negative (–) rating. The columns are named by the key word of each question - "New", "Liked", "Valuable", "Useful" and "Satisfied".

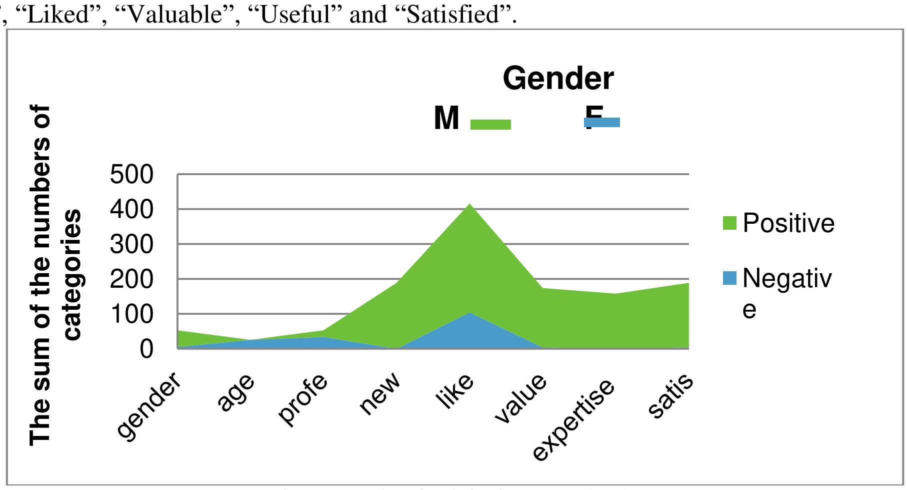

Fig. 12.Results of satisfaction on student´s.

The diagram presents that most students who participated in the course recognized the content and the activities as a valuable experience; seeing the perspectives of using the knowledge acquired and the skills developed in the future for personal challenges. The students expressed their satisfaction with the performed activities. However, some of them didn't like certain points which were delimited by: the timetable; some aspects of the study content and their individual peculiarities which interfered their work in group, speaking in front of the audience, acting creatively and thinking critically, considering that most of the students are young and male.

V. CONCLUSION

Based on the positive results obtained and presented in the Results section, the method adopted emphasizes that learning achievement is maximized and at the same time the necessary amount of cognitive load is minimized. At the beginning of the semester until the half of it, the students clearly demonstrated difficulties to build a proof of concept for their ideas, but the use of the model needs to be applied by the professor as a progressive motivation to success.

In these terms, the students were motivated to solve the problems identified by them during the period, in order to face the problems related to the method, which includes the creation of a new product.

As to the applied methodology, it stimulates the learning along with the promotion a new teaching and evaluation systematic, improving the quality of the educational advance and the quality of the educational practice in the higher education.

The use of the method based on the problem allowed the engineering electric course the implementation of cognitive strategies, which implies new exercises of thought. It allowed students to create new knowledge and its links to innovation. It was observed that the students created skills and competencies such as communication, persuasion, creativity and skills to perceive entrepreneurial opportunities.

For this proposal to work properly with no motivation or excessive activities to some students over others, the project's conduction respected the interrelations between the groups, through the identification of relevant topics, and situated with concrete and realistic problems of students, so that the group's activities are simultaneously motivating.

This research provides evidence of the openness of the university's students to the studies within the electrical engineering course in first semester which was based on the problem-based learning model. The majority of the students appreciated the novelty, usefulness and value of their experience, expressing their positive attitude and satisfaction. However there was as well certain criticism of some aspects that the students disliked as well; they should be thoroughly analyzed and thought over to find appropriate solutions. As a whole, the model has been proved to have a universal character as it can be successfully in universities.This research consisted in a pilot practice, but with good results in terms of teaching and learning, given the adopted methodology. It will be reapplied within the NiltonLins University for other engineering courses and even in the practice of teaching of human and social areas, for future researches.

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