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An Experience of Project-Based Learning in a Techincal Hig School

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Abstract: The grade course of electrical technical of IFCE Juazeiro do Norte-CE has technical and propaedeutic subjects. In the classroom, many students a lack of commitment to technical subjects is perceived. That results in a low level of learning and a high dropout or retention rate. Some causes of these problems can be attributed to several factors, such as the immaturity of many of these students and the lack of knowledge of the desired course for their professional life. The paper aims to investigate an experience report during the intervention of activities carried out with the 2nd grade of the electrical technical course. The active Project-Based Learning (PBL) methodology was applied in projects for a science fair. The PBL method aims to stimulate the student's self-learning and curiosity, being the teacher is the facilitator of this process. The research is a qualitative type with exploratory and descriptive aspects based on an experience report. A questionnaire was applied to 38 students in the classroom for assessment data collection. Some group dynamics techniques were used to choose experiments from the science fair. During the process of project development, it was possible to see the great interest in research by students. Also, the students demonstrated resourcefulness in the oral presentation of the projects. The engagement with the quality of the presentations and the level of technical knowledge of the teams were some good points. Therefore, we can say that the PBL method is effective for stimulating the learning and creativity of these students.
Keywords: Teaching. Active Learning. Science Fair.

Uma experiência de aprendizagem baseada em projetos em uma escola técnica

Resumo: O curso em eletrotécnica do IFCE *campus* Juazeiro do Norte-CE tem uma grade curricular formada por disciplinas técnicas e propedêuticas. Na sala de aula, percebe-se a falta de compromisso dos discentes com as disciplinas técnicas, resultando no baixo nível de aprendizado, e no elevado índice de evasão e de retenção. A causa desses problemas pode ser atribuída a fatores como, por exemplo, a imaturidade de muitos discentes e a falta de conhecimento do curso desejado para a sua vida profissional. O objetivo deste artigo é relatar a experiência vivenciada durante as atividades de intervenção realizadas com turmas do 2° ano do curso de eletrotécnica utilizando a metodologia ativa de Aprendizagem Baseada em Projeto (ABP) aplicada em uma feira de ciências. O ABP estimula a autoaprendizagem e a curiosidade do discente, e o professor é o facilitador desse processo. A pesquisa é classificada como qualitativa de aspecto exploratório e descritivo a partir de um relato de experiência. Um questionário foi aplicado numa classe com 38 discentes para formar um banco de dados de avaliação. Nos grupos de estudo, foram realizadas técnicas de dinâmica de grupo para

a escolha de experimentos da feira de ciências. No processo de desenvolvimento dos projetos pôde-se constatar o grande interesse na pesquisa pelos discentes. Na exposição oral dos trabalhos durante a feira, a desenvoltura em demonstrar os experimentos, o compromisso com a qualidade das apresentações e o nível de conhecimento técnico das equipes, foram alguns dos pontos relevantes. A partir desses reultados positivos, pode-se inferir que o método ABP é eficaz em estimular o aprendizado e a criatividade dos discentes.
Palavras-chaves: Ensino. Aprendizagem ativa. Feira de ciência.

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1. Introduction

The search for improvement of teaching-learning at the different levels of the intellectual, cultural, and professional formation of the student is an active continuous flow and research source in the scope of the practice of science. In the literature, several works are found on pedagogical practices and methods that aim to awaken in the student the enjoyment of learning, understanding, and discovering your abilities. Otherwise, the stimulating the teacher to apply the new trends of tools and methods as a way to improve classroom work (LIBÂNEO, 1992; SAVIANI, 1991; GADOTTI, 2001; 2007; PERRENOUD, 2000; FREIRE, 1997; AUSUBEL *et al*., 1980).

Among the pedagogical methods of today that, over the years, are consolidating, are the active learning methods, the focus of this work. These methods have as a fundamental characteristic, the differentiation from other teaching methods and the relationship between the teacher and the student. For example, in traditional methods, the relationship between these entities occurs vertically, with the teacher positioned at the top of the knowledge pyramid. On the opposite side, inactive methods of Project-Based Learning (PBL), the relationship between teacher and student happens horizontally and learning is centered on this, that is, the teacher starts to have the role of advisor and, in a way, the teacher and student learn with each other (MORAN, 2018; FILATRO, CAVALCANTI, 2018).

In this discussion, it is necessary to briefly highlight the initial concepts about learning methods developed by William Heard Kilpatrick. The central idea starts from everyday life in a problem situation, and this enables the active role of students and, at the same time, reconciled theory with practice (KILPATRICK, 1918).

In October 2019, the 1st Electrical Technological Exhibition (EXPOTECE) was held during the National Science and Technology Week (SNCT) of Brazil, at the Institute

Federal of Ceará (IFCE), at Juazeiro do Norte city. EXPOTECE is an initiative of the coordination of the electrical technical course and aims to provide the opportunity for the dissemination and exhibition of basic science projects of students. The event aims are to share the experiences of teachers, the community in general, and students from the school itself, and other public and private schools. This event had provided a debate on the central theme of the SNCT in the areas of science and engineering, in line with the electrical technical course. EXPOTECE was an opportunity to implement an intervention project based on the BLP method in the classroom of the 2nd year, of course, to seek to improve teaching-learning.

The IFCE is an educational, research, and extension institution that encompasses several teaching modalities and is equivalent to federal universities in terms of functioning, fostering research, and the practice of extension actions. IFCE is a great institution that has 32 units throughout the state of Ceará. IFCE of Juazeiro do Norte annually offers the electrical technical course in 3 years, similar to the high-school course. The grade of subjects is formed by the axes of general, diversified and professional training. The main aim of a technical course in electrical is the training and to ability the student to meet the demands of the labor market in the industrial environment. Also, the subjects are taught with many hours of theoretical classes.

From these initial considerations, the guiding question of the research is formulated: The introduction of Project-Based Learning methods capable of encouraging and motivating students to learn and to participate more actively in the classroom can be an opportunity for the improvement of teaching-learning of students in the electrical technical course?

This paper aims to describe the experience lived during the intervention activities carried out with classes of the 2nd year of the technical course in electricity using the PBL methods applied in a science fair, seeking to reverse the lack of interest and give motivation to students to learn professional subjects. The papae is divided into sections. In the background section, the theoretical framework and the state of the art are presented, in which a brief review of the concepts about motivations and interests of students in the classroom is presented. Also, the fundamentals of the main teaching-learning methodologies, the main methodologies of teaching, and science fairs as a vector for improving teaching-learning based on active learning by projects.

2. BACKGROUND

2.1 Interest and motivation in classroom

Interest and motivation have different meanings and understandings, both in the day-to-day of people and in the school environment. For Tapia e Fita (2015), the interest depends on both personal and contextual factors. As such at school, as it could not be otherwise, the interest is linked to the motivation to teach and to learn, which in turn, is linked to the dynamic interaction between personal characteristics and the contexts in which school tasks are developed. Bzuneck and Guimarães (2010) explain that the things of interest to the students are those that hold their attention. Otherwise, the interest has value for the person and, therefore, it keeps your attention.

Nevertheless, motivation is a feeling intrinsic to each person. it is what leads us to do something without telling us why or how. In the school environment, motivation can often be observed and this occurs when it leads the teacher to overcome himself, overcoming barriers that hinder learning. The essence of motivation is the action you want to take. For Bzuneck (2000, p. 10) "every person has certain personal resources, which are time, energy, talents, knowledge, and skills, which can be invested in a certain activity". In fact, people have a source of personal resources that can be strong enough to lead to action, which sometimes requires effort to achieve a specific goal and a determinant reason for our will. The interest keeps the attention, in the sense of the desired value, and for there to be motivation it is necessary to have enough energy to be able to overcome the difficulties in the execution of the action.

Corroborating, Balancho and Coelho (1996, p. 17) say that motivation is “everything that awakens, directs, and conditions conduct”. But, students do not always realize the value of classroom activities, and this may be related to the immaturity of students, as they fail to understand the relationship between learning and aspiration of value for their life.

2.2 Main teaching-learning methods

To understand the guiding principles of teaching methodologies, it is necessary to

mention the main pillars of the main teaching methods currently practiced. Traditional education aims to transmit knowledge from the central figure of the teacher. The relationship between teacher and student is vertical. The teacher holds all the knowledge to be transmitted, and the content is predefined by the school through the pedagogical plan centered on rigid rules of behavior. The standardized and inflexible school curriculum is idealized with an emphasis on learning objectives, and with didactic regulations expressly defined (LIBÂNEO, 1992; SAVANI, 1991; GADOTTI, 1995).

The traditional teaching methodology is centered on the expository class, and the teacher is the holder and transmitter of knowledge (SAVIANI, 1991). The active methodology emerged in Europe around the 18th century based on standard education, which seeks to standardize students and their learning. Traditional teaching has as a pedagogical basis the uniformity of students. For this to happen, the traditional school must make students grow on their merit from the knowledge that the teacher transmits to them. In this case, the teacher is considered the owner of knowledge and knowledge, thus leaving his performance as an active subject and students as passive subjects in force. To this end, traditional schools work with a pedagogical course project centered on strict rules of behavior with norms, duties, and rights in the school space.

The constructive teaching is based on the revolutionary ideas of Lev Vygotsky and Jean Piaget, which, different from traditional teaching, in which the student is the protagonist of his learning process, being encouraged to create, experiment, research, practice knowledge (KESSELRING, 2008; PIAGET, 1987). On the other hand, Freire's school proposes the development of the student's critical view through classroom practices. In Paulo Freire's conception, the content to be taught does not need to be rigid, static, plastered, on the contrary, it must be malleable, flexible and, above all, that teaching must have concrete meaning for the student. In

Furthermore, Montessori's school emphasizes the importance of students developing themselves with initiative and independence in their learning process. Waldorf's pedagogy seeks the development of the child as a human being, art as being the fundamental pillar. In this pedagogical process, both the intellectual aspects are developed, as well as the body, soul (concerning the soul), and spiritual aspects (POLLARD, 1993; MÓDENA DUTRA, 2015; KÜGELGEN, 1989; STEINER, 2003).

In active learning methods, research is encouraged and important in this method, as learning is based on solving problems and on experimental case studies. Thus, real or

simulated experiences and challenges arising from essential activities of practice are fundamental points for the development of the learning process based on active methodologies. Additionally, the student's autonomy is stimulated, as well as individual and collective decision-making, always under the eye of the guiding teacher who leads or leads, seeking to keep the student in line with the trajectory until the end (MORAN, 2019; FILATRO, CAVALCANTI, 2018).

The fundamental idea of active methodologies is not new. The educational scholar John Dewey since the 1950s defended the learning-by-doing method, giving importance to the reflective and analytical thinking that only occurs when there is a problem to be solved (CUNHA, 1998).

2.3 Active learning method

The active learning method is a process that aims to stimulate self-learning and the student's curiosity to reflect, discuss, communicate, explain, interpret, and the possible alternatives for decision making, with the teacher being the facilitator in this process (BASTOS, 2006). In Glasser's thought (2001), the way we learn something can be represented by a segmented pyramid with percentage values of learning. Figure 1 shows the pyramid that explains how we learn, which is divided into two parts, in which the first refers to the passive learning method and the second to the active learning method.

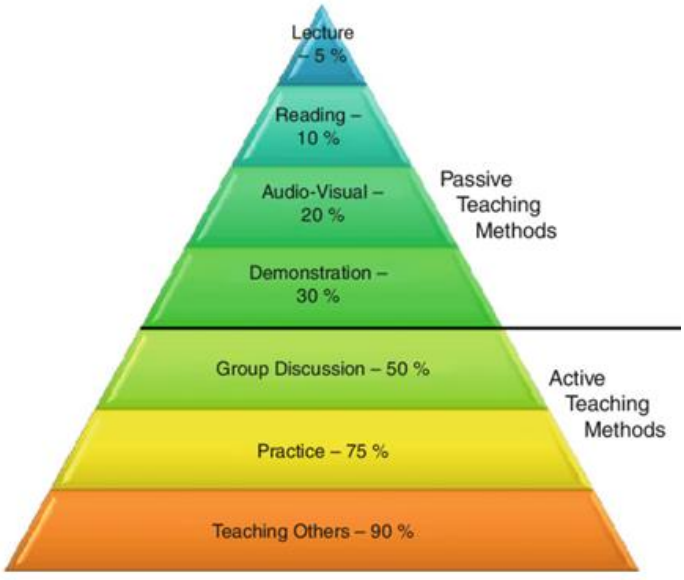

Figure 1 - Learning pyramid. **Search**: Adapted from Silva (2015).

Based on the pyramid above, the active learning method occurs when the student makes use of his mental functions to think, reason, observe, reflect, understand, combine, among others; it is the interaction of thought with the doing of things, and the result of all this forms intelligence. Pecotche (2011) explains that the fundamental difference that characterizes an active learning environment is the active attitude of intelligence, as opposed to the passive attitude, generally associated with traditional teaching methods. But, this in itself does not solve the problem of improving learning, it is necessary to go further; the content must have meaning for the students.

Active methodologies can be approached in several ways, and the most well-known are problem-based learning, inverted room, games and challenges, peer learning, and project-based learning. Interdisciplinary is the pillar of problem-based learning. The purpose of this method is the construction of knowledge and communication between different types of knowledge, in which it seeks to maintain debates and discussions in a relationship of exchange of ideas within a study group, to achieve the solution of a specific problem.

The pedagogical conception of problem as a teaching methodology is supported by the ability of students to participate as agents that transform society because, from the process of identifying real problems and their original solutions, the student is developing his social, political and ethical potential as a citizen. The inverted classroom has a strong appeal to the use of digital technologies. Learning takes place in two moments. At first, the student studies alone a specific topic proposed by the teacher and uses the internet as the main search tool for information. In the second moment, the student shares in the classroom the experiences and understanding of the topic studied with the teacher and with others students.

In approaching games and challenges as an active methodology, student engagement and motivation are essential aspects of learning. Instigating discussions with the insertion of educational games in teaching can increase student knowledge, improve communication and break barriers of the relationship between them and promote critical thinking skills and social collaboration. In this method, the teacher makes content available to the students in the form of tasks and when the class begins the students answer the questions addressed about the content. As with the inverted classroom method, in the

games and challenges approach, the interaction between students in the active peer teaching approach is essential.

2.4 Project-based learning and science fair

The project-based learning method aims to make students acquire knowledge through the collaborative solution of challenges. The student needs to strive to explore possible solutions within a specific context, which encourages the ability to develop an investigative and critical profile in the face of any problem. In this case, the teacher should not expose the entire methodology to be worked on. The students need to seek knowledge for themselves. However, the educator must give feedback to the students about the projects and show what were the mistakes and successes.

Masson *et al*. (2012) made an experience working with Project-Based Learning (PBL). For the authors, the project to be developed in the disciplines is fundamental and should motivate and lead the student to discoveries, covering at least the programmatic content defined for the course. The project is a temporary effort undertaken to create an exclusive product, service, or result and this temporary nature indicate a well-defined start and end. Also, some precautions must be observed regarding the proper management in your project development, such as the application of knowledge, skills, tools, and techniques appropriate to the requirements of the final project.

Campos (2011) explains that, for the development of a project, the guiding teacher must motivate and challenge the student to be part of a team. Although, the methodology is powerful, it is also challenging, requiring vision, structure, and a solid understanding of the project, the result of rigorous planning, schedules, management strategies, and an evaluation of results. According to Markham (2008), for the construction of a project based on PBL, the following aspects must be followed: Development of the project idea; Decision of the scope of the project; Selection of standards; Incorporation of simultaneous results; Development, from the formulation of the project and creation of the ideal work environment.

The development of projects for a science fair can be a viable and interesting application of the PBL method. Science fairs are a teaching-learning strategy and may be able to encourage students through their work to engage in scientific research. The interdisciplinary experiences of a science fair go beyond the syllabus of the disciplines.

Also, the exhibition and presentation of works to the community increases students' interest in science (PEREIRA *et al.*, 2000). Farias (2006) believe that the science fair develops the inquiring curiosity of students and teachers. In this science fair, the planning, execution, and the presentation of projects, enables students to understand phenomena or scientific facts, resulting in collective learning.

Corroborating, Santos (2012) says that the possibility for students to participate in science fairs can develop in them an interest in subjects related to different areas of knowledge and put their investigative skills into practice. In this context, it is about continuous learning, which goes beyond the walls of the classrooms and provides necessary tools for new forms of access to knowledge.Neves and Gonçalves (1989) explain that experimental practices and science fairs increase the student's cognitive development based on scientific knowledge as an empirical rigor in the foundation of scientific practice. The science fair is an action that encourages and encourages students and teachers in the search for new knowledge, offering itself as a starting point for scientific initiation.

3. MATERIAL AND METHODS

This study is qualitative research based on an experience report with methodological aspects of an exploratory and descriptive character. Its focus is not only on the subjective character of the analyzed object but seeking to understand its particularities and unique experience. In the qualitative approach, the researcher participates in the whole process and seeks to understand and interpret the social events of his research, considering the subject of the study belonging to a certain group or social class with his beliefs, values, and meanings (MINAYO, 2004).

Additionally, this research can be considered exploratory and descriptive, since it meets the present case study. Because this is based on the observation, description and experience of people, as it was lived and defined by its own actors. For many authors, in the exploratory phase of the research, the researcher will plan his work, choosing the study objective, delimiting the problem, and defining objectives and the theoretical focus he will use (POLIT; HUNGLER, 1996; LIMA; COSTA, 2005).

The locus of the research was the IFCE in Juazeiro do Norte city. O IFCE seeks to meet the demands of society through the dissemination of scientific and technological knowledge. As well as, the IFCE search to fully participate in professional training end

ethic of citizens (IFCE, 2014). O IFCE offers several teaching modalities, from high school until postgraduate studies. The focus of the present experience report is the students of the 2nd year of the electrical technician course.

The grade of the course consists of two axes of formative knowledge, one core with disciplines of the common (critical, reflective, and humanistic training) and the other with disciplines of the professional core (technical training). Often, in the classroom, in the teaching of professional disciplines, it is easily noticed by the teacher the lack of interest and motivation of the students, and this hurts their learning. With the understanding that the syllabus is basic and essential for the other disciplines to come in years following, the lack of discipline learning results basically in the low level of learning in subsequent subjects, and a high dropout and retention rate. The cause of these problems can be attributed to several factors, and one of them is the immaturity of many students since the classroom is composed of young people aged between 15 and 18 years. Many of them still are unsure to choose the course for their professional life.

The science fair took place in the 2019 SNCT period, on October 22nd and 23rd. The event was held in the covered court of the IFCE itself, in the morning and afternoon shifts, and the experiments were presented in standardized stands. In fact, the initial works started two months before the fair, and the meetings with the students took between their classes.

The classroom had 38 students and the class was divided into small teams, with three or four people, chosen by approximation of friendship, without the interference of the teacher. In total, the classroom was divided into 6 teams of 3 students and 5 groups of 4 students. After, were realized several sessions of group dynamics techniques like brainstorm. This technique aims seek carried out to explore the creative potential of the group, with the guidance of the teacher. The choice of experiments had the following criteria: the experiment should be related to the area of electrical and which involve scientific experimentation, also be feasible and of low cost, do not expose people to the danger of accidents, as well as be attractive and interesting to the public-target.

The methodological steps of the experiments were: bibliographic research, the study of the phenomena involved in the experiment, assembly, and testing of the experiment, making of the banner, and training for the oral presentation of the experiment. The active method of Project-Based Learning (PBL) was applied for the making of the experiments at the science fair.

The data collection methods in the qualitative research approach are exploratory and descriptive, implying in-depth analysis and investigation (MARCONI; LAKATOS, 2003). In this study, the observation technique was used for data collection. The activities were recorded by reports and photographic files, in all stages of the process, from the planning and execution of experiments until the participation in the science fair.

Figure 2 shows the flowchart of the development process of the experiments from the premises of the applied method.

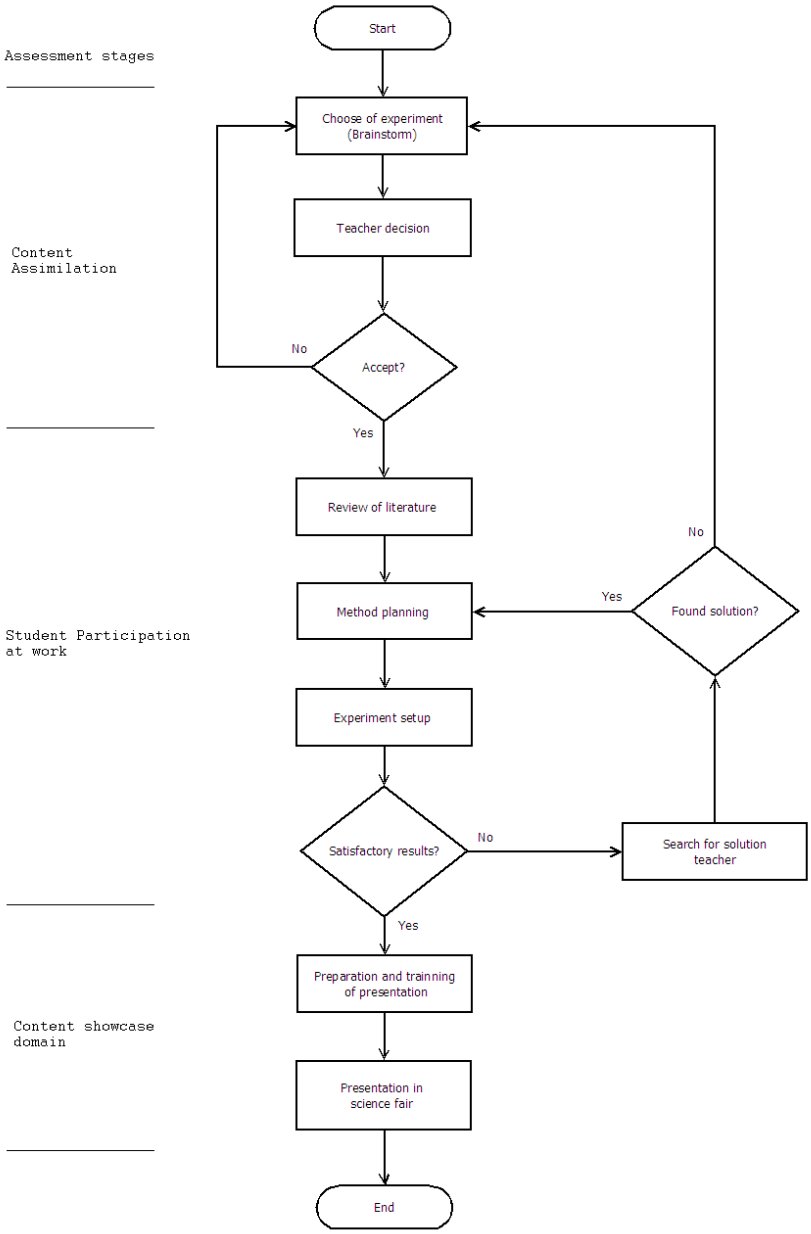

Figure 2 - Project-Based Learning applied

4. RESULTS AND DISCUSSION

4.1 Learning-by-doing

Since the beginning, with the presentation of the proposal to hold a science fair at IFCE, high school students have been anxious and excited in the expectation of researching, building, and presenting their experiments to an audience of their own age group and a similar level of knowledge, even though they know they would study in their spare time. Thus, the activities plan was carried out in three stages.

In the first stage, the work focused on bibliographic research and the choice of experiments, which started well before the event. Bibliographic research and brainstorming sections were very important for the choice of experiments to be presented at the event. The students sought solutions to problems in books, on the internet, and in consultations with teachers from different areas of scientific knowledge related to electrical. We could see throughout the research period that the dynamics of students in group work, with productive discussions and debates, raised the spirits and interest of these students in knowledge. The perception of the students' interest corroborated with the previous discussion by Glasser about the interaction of thinking with doing things and the percentage values of learning, represented by the pyramid in Figure 1.

In the second stage, it was the execution of the project from the decision-making of the choice of the experiment. Figure 3 shows a group of 2nd-year students setting up a base for fixing the low-cost induction motor that they built.

Figure 3 - Setting up an experiment. **Source**: IFCE photographic archive (2019).

At the beginning of the work, we were evident that the students' excitement and interaction with the other classes were great. Also, in this stage, a transition from theory to practice is the moment when problems occur, showing that in practical life what one thinks cannot always be realized. We could see the effort of students to get solutions with help of others teacher and student of higher levels.

On the other hand, it is the moment when the critical and creative thinking of the student emerges, and the walk towards the solution of the problem is conditioned to the implicit knowledge of the student, those acquired throughout his student life. We are facing a concrete case of using active methodologies based on problems and projects.

The science fair aims to encourage and motivate students to learn using the learn-by-doing technique, collaboratively from the solution of a real problem, stimulating the development of socio-emotional skills and the capacity for reflection; seeking innovation and new ways to solve problems. Therefore, we can affirm that active methodologies can transform classes into real and concrete learning experiences, with very promising and relevant results.

The third stage consisted of preparing the presentation of the experiments and making the banners. At this stage, the student needs to organize his ideas convincingly and clearly. The questions arise naturally when you start to write the presentation, linking what was built in practice and cognitive thinking, making a filter for the decision of what is important to present. Also, it is the moment when the teacher perceives the results of his teaching-learning work, the result of the assimilation of learning by the student.

Based on the presentations given by the students, before and on the days of the fair, we can see the resourcefulness in demonstrating the experiments, the commitment to the quality of the presentations, and the level of technical knowledge of the teams acquired during the activities. And this can be attributed both to the good work done by the supervising professors, as well as to the student's learning over the two months of preparation for the event.

4.2 The science fair - EXPOTECE

The EXPOTECE was widely disseminated in schools in the region that offer basic education. Wherefore, the target audiences were those students who are finishing elementary school and those who are finishing high school.

The numbers were very expressive for the first event. In the registration book, 1603 people were added who entered the spaces of the science fair in the two days of the presentation. In addition, the event had 125 students from IFCE itself and 10 teachers who worked directly with students, and other teachers who supported the event.

In total, 28 experimental works were presented at the science fair. Figures 4a and 4b show the people in the event space and the fair banner with some teachers from the electrical course.

Figure 4 - EXPOTECE visitors and the teachers **Source**: IFCE photographic archive (2019).

The event was considered to be of great proportions for the region and its planning and execution had the participation of the IFCE community, students, teachers, people support staffs which were instrumental in the realization of the event. The organization of the fair, with the setting up of experiments at the stands and the reception of visitors, was carried out by the IFCE students themselves. Figure 5 shows a student presenting his experiment to other students from schools in the region.

Figure 5 - Oral presentation of the experiments. **Source**: IFCE photographic archive (2019).

In addition, the disclosure was made through social media, radio, TV and newspapers. The event had great support from the media, with radio, television and printed newspaper articles. Figure 6 shows the article on TV network presented in the local newspaper.

Figure 6 - Article shown on television news**. Source**: https://globoplay.globo.com/cetv-2a-edicao/p/5292/data/22-10-2019/.

Also, during EXPOTECE and within the 2019 SNCT, the invited students from several schools in the region, in addition to participating in the science fair, had the opportunity to visit the laboratories of IFCE (Figure 7).

Figure 7 - Visiting the IFCE laboratories. **Source**: IFCE photographic archive (2019).

During the visit, we noticed that students from other schools were well admired and excited when they entered the IFCE laboratories and other facilities. These visits gave them the opportunity to get to know the technological and scientific environments of the institution.

5. CONCLUSIONS

The choice of a vocational course by the young student, with his immature intellectual and emotional activities, is a difficult task. Often, the wrong choice, of course, results in a lack of interest and motivation to attend classes. In turn, the teacher is considered the master spring in devising strategies to reverse this situation, being able to seek the improvement of his teaching practices from the experimentation of other methodologies.

We aim to make a narrative about an intervention experience carried out with 2nd-year grade of the electrotechnical course based on the active methodology of PBL, which was applied in a science fair; which showed satisfactory results and motivated both teachers and students.

The intervention project through a science fair and the use of the PBL method for the development of the experiments was an experience that showed satisfactory results and that motivated both teachers and students. Throughout the process, from the beginning, with meetings to choose the experiments, study the state of the art and make the prototypes, the students of the 2nd year of the technical course in electrical showed enthusiasm for presenting their work at the fair for hundreds of people.

The science fair and the development process of the experiments are unique moments for the student and teacher, which in the report in question, added the knowledge lived and acquired in the classroom, solidifying their knowledge in practical teaching. The use of PBL as a vector for improving students' learning and creativity, in addition to the science fair, was instrumental in reversing the lack of interest and motivating students to learn professional subjects.

Furthermore, we point out as limitations of this study the impossibility of generalizing the results obtained with more specific conclusions. Since only the experience with second-year classes of high school is reported. Thus, this does not allow us to make generic conclusions, which would require a more accurate methodology and a

longer time for data collection and analysis.

We infer, as a suggestion, the planning an annual school calendar by the school that inserts a date for the science fair as a routine activity, which includes all subjects, professional and propaedeutic, can be a step forward in improving teaching-learning. Also, we can affirm that the PBL method aggregates and contributes to strengthen and integrate the relationship between teacher and student.

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