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USE OF ACTIVE TEACHING METHODOLOGIES TO FIGHT AVOIDANCE IN THE BACHELOR'S COURSE IN COMPUTER SCIENCE AT THE UNIVERSITY OF THE STATE OF MATO GROSSO

Sara Moreira Macedo
Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP
Faculdade de Engenharia
Ilha Solteira – SP
http://lattes.cnpq.br/4032280894625474

Max Robert Marinho
Universidade do Estado de Mato Grosso – UNEMAT
Faculdade de Letras Ciências Sociais e Tecnológicas
Rondonópolis – MT
http://lattes.cnpq.br/3542593918203653

Fernando Yoiti Obana
Universidade do Estado de Mato Grosso – UNEMAT
Faculdade de Letras Ciências Sociais e Tecnológicas
Alto Araguaia – MT
http://lattes.cnpq.br/1633968449319130

Lucas Kriesel Sperotto
Universidade do Estado de Mato Grosso – UNEMAT
Faculdade de Letras Ciências Sociais e Tecnológicas
Alto Araguaia – MT
http://lattes.cnpq.br/2335475405623609

Daniela Cabral de Oliveira
Universidade do Estado de Mato Grosso – UNEMAT
Faculdade de Letras Ciências Sociais e Tecnológicas
Rondonópolis - MT
http://lattes.cnpq.br/2113470352941981

Edinaldo Serra Cardoso Júnior
Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP
Faculdade de Engenharia
Ilha Solteira – SP
http://lattes.cnpq.br/6990476825546492

Leonardo Xavier do Nascimento
Universidade Estadual Paulista "Júlio de Mesquita Filho" – UNESP
Faculdade de Engenharia
Ilha Solteira – SP
http://lattes.cnpq.br/6119321751001436

Thalita Oliveira Rocha
Universidade do Estado de Mato Grosso – UNEMAT
Faculdade de Letras Ciências Sociais e Tecnológicas
Alto Araguaia – MT
http://lattes.cnpq.br/6468442737392102

Abstract: According to the last Brazilian census, about 23% of the population has some type of disability, whether physical or mental. Given this fact, software systems and online educational content have to serve as tools to facilitate learning for students with disabilities, and must adapt to users so that there is a lower evasion of these students. This article presents a study of requirements elicitation to promote accessibility, using the Point of View-Oriented Survey technique, which recognizes the existence of several perspectives and offers a framework to discover conflicts in requirements from the perspective of different stakeholders. Thus, functional requirements of software for accessibility were listed, covering the categories of elements and characteristics of the pedagogical theory of connectivism.
Keywords: Active teaching methodologies, Dropout, Electronics, Computer science.

INTRODUCTION

Dropout rates are factors that are present in higher education institutions, where according to Vallim et al. (2009), there is great concern and lack of motivation regarding the number of dropouts in exact science courses.

Silva and Obana (2018) state that studying mathematics and Portuguese are the basis for the future of young people who intend to enter a university. For exact science courses, mathematics is the fundamental basis for taking them and that the lack of this knowledge can be one of the factors that provides the high dropout rate in higher education.

The national literature has been dedicated to the investigation of the dropout of students in higher education courses in exact sciences (Physics, Chemistry, Mathematics and Engineering), highlighting the central role of institutional aspects in the decision to drop out of students and also stressing that no relationships were identified between the socioeconomic variables with dropout rates (BRAGA; MARIA DO CARMO; BOGUTCHI, 2003).

When it comes to higher education courses in the area of computing, there are numbers in Brazil and in other countries that point to high dropout rates. According to ''Portal G1" (2012), which reports a survey carried out by SEMESP (Union of Entities Maintaining Higher Education Establishments in the State of São Paulo) which points out that:

> "For every three students who enter the information systems course, only one receives a diploma. In Computer Science, for every four students who enter the course, only one finishes (PORTAL G1, 2012)".

In Ireland it was found that Computer Science courses experienced the highest enrollment rate, with 27% of students still in their first year (MOONEY et al., 2010). In Helsinki, Finland, Computer Science courses at the University of Technology have 500 to 600 enrollments per year and dropout rates have varied between 30 and 50% (KINNUNEN; MALMI, 2006).

A study carried out at the University of São Paulo (USP) highlighted that the dropout rate from 1998 to 2008 in the areas of Exact Sciences was the highest when compared to the other areas, at 79.88% (SILVA et al., 2022).). Hoed (2016) states that the student's intention to drop out is a late discovery, as it occurs after leaving or when he has already assumed a strong intention to leave the course or institution.

According to Adachi (2009), some causes could be listed:

> Circumstances focused on the individual characteristics of students (such as personality, personal difficulties in adapting to university life, discovering new interests, etc.). Factors internal to the institutions (such as outdated, elongated curricula, rigid chain of prerequisites, insufficient teaching support structure, etc.). Factors external to the institutions (such as issues related to the labor market, lack of social recognition of the career, devaluation of the profession, etc.). the causes being more varied. Due to the diversity of possible causes and the often subjective nature of the reason that leads to student dropout, it is a non-trivial task to try to predict whether the student will stay or not until the end of the course (ADACHI, 2009).

Given this context, the active methodology appears as a parameter that can be applied in order to reduce the dropout of students in exact science courses. According to Bonwell and Eison (1991) active methodologies in education can be recognized as a New School movement. In general, they are considered technologies that provide students with engagement in the educational process and that favor the development of critical and reflective capacity.

Hannafin, Land and Oliver (1999) state that active methodologies promote proactivity through the students' commitment to the educational process, linking learning to significant aspects of reality and developing reasoning and skills for intervention in reality itself and collaboration and cooperation between participants.

According to Moran (2017), active methodology is influential instruction that uses unique and specific techniques and methods to guide the strategy of the teaching process, thus complementing the positive methodology that effectively focuses on the teaching process and the student's learning structure. strategic orientation in a systematic and flexible way.

Thus, the objective arises to apply an active methodology in the area of exact sciences, precisely in the Computer Science course at the University of the State of Mato Grosso (UNEMAT). The Computer Science course at UNEMAT, Alto Araguaia campus, has a high level of dropout and dropouts. This way, this work discusses a study applying active methodologies, introduced in the electives of Fundamentals of Electronics of the 3rd Semester and Embedded Systems of the 6th Semester, also being used in the professional qualification course in Fundamentals of Electronics or Basic Electronics, through a project end of the course for the construction of an Oscillator Circuit with a Decade Counter, in the style of the ARC Reactor.

In order to present the need to adopt active methodologies in the computer science course, the study was divided into chapters. In the second chapter, the material and active methods of learning in the subjects of Fundamentals of Electronics, Embedded Systems and in the professional qualification course in Fundamentals of Electronics were presented. In the third chapter the fruits of the development are presented and in the fifth chapter the conclusions are presented.

MATERIAL AND METHODS

This section will discuss how to adopt the active methodology for teaching and learning in the subjects of Fundamentals of Electronics, Embedded Systems and the professional qualification course in Fundamentals of Electronics at the Specialized Reference Center for Social Assistance (CREAS), as well as the materials used in the construction of the ARC Reactor and 4x4x4 LED Cube.

APPLICATION OF ACTIVE METHODOLOGIES IN ELECTRONICS FUNDAMENTALS

According to Morgan (2017) there are several active learning methods, with different techniques and processes to achieve desired results. According to Freire (1970) in the active methodology, the teacher is the protagonist with the methods of memory and evaluation and the students are the main promoters of the teaching process.

Among the existing active methods, the present study is based on project-based learning or problem-based learning (PBL) methods. According to Lázaro, Sato and Tezani (2018), project-based learning advocates the ability to think "doing through learning", unlike traditional methods.

In this method, activities are carried out around a related problem, whose main objective is to obtain the final product through decision-making, research, creative critical thinking and skills to build a new process or result. According to Moran (2017), the active problem-based method offers students the possibility to solve a given problem, so that the main agent responsible for learning is the student.

Therefore, teachers are responsible for formulating tasks and elaborating problems, and students are responsible for finding new solutions and knowledge to solve problems. In this sense, the PBL methodology directs the development of autonomous students, capable of working individually and in groups, seeking appropriate solutions and developing new skills (LÁZARO; SATO; TEZANI, 2018).

The active teaching-learning methodology adopted in the present study is based on projects and problems. Given this context, the study recommended that students analyze the problems and try to solve them, in order to find solutions individually or in groups, so that students could complete the project independently. Another purpose of the study is for students to generate their own concepts and procedural knowledge.

The contents applied to the Elective Course of Fundamentals of Electronics were guidelines for the assimilation of the main concepts for the development of this project, and can be accessed at https://bit.ly/FundamentosDeEletronica-FE. The concept for the construction of the ARC Reactor was adapted from the TecMundo® **website,** which provides the structure of the ARC

Reactor schematic for its construction, and can be found through the website: https://www.tecmundo.com.br/ area-42/37338-area-42-how-to-make-the-iron-man-arc-reactor-video-.htm.

Soon after, the classroom was divided into several groups of students, with a minimum of theoretical classes, presenting the content in small blocks, and a list of regular exercises, which ranged from explanation of electronic components to electronic problems.

All the concepts involved were related to the execution of the final project prepared for the preparation of the construction of the ARC Reactor, which follows the project-based active learning model. After completing the five lists of exercises, which contained self-explanatory content on the working principles of the basic components, the construction of the electronic circuit of the ARC reactor was started.

Theoretical classes corresponded to about 10% of the course load, so that after completion, the students were sent to the Laboratory of Electronics and Embedded Systems (LESE), where they performed all the proposed exercises and the beginning of the development of the ARC Reactor as the final project. The students were supervised by the responsible professor and assisted by volunteer monitors. The teacher in charge made sure that the activities were carried out in pairs.

CONSTRUCTION OF THE ARC REACTOR

For the construction of the ARC Reactor, the instructions contained in the electronic address https://bit.ly/CircuitoProjetoArcLESE were used as a basis. Figure 1(a) illustrates the schematic of the printed circuit board, from which the students built the electronic part of the Reactor (Figure 1(b)).

After assembling the electronic circuit and carrying out the processes for the construction of the ARC Reactor, the results illustrated in Figure 2 were obtained.

It can be seen that in Figure 2(a) the device is inactive (no power supply) and in Figure 2(b) the ARC Reactor is connected to a power source and working. In the ARC Reactor, the potentiometer can be activated, changing the speed with which the LEDs flash and rotate around the center. For this ARC Reactor, single-color glowing leds were installed. We already have a new ARC Reactor with RGB LEDs, which has the addition of 3 more potentiometers where each one controls the intensity of each color, present in the LEDs, which makes the ARC Reactor can shine with all the colors of our spectrum visible.

APPLICATION OF ACTIVE METHODOLOGIES IN EMBEDDED SYSTEMS

For the development of this study, it was necessary to pre-knowledge the concepts of the Elective of Fundamentals of Electronics, since they will be applied in the Elective of Embedded Systems, of the Bachelor's Degree in Computer Science at UNEMAT. Also being taught using active learning methodologies, the Embedded Systems elective followed as a guideline for the assimilation of the main concepts for the development of the study, the contents that were granted through the website https://bit.ly/SistemasEmbarcados-SE.

The concept for the construction of the 4x4x4 LED Cube occurred through videos, but the innovation of the study was the use of Arduino®. Starting from the problem-based learning model, the classroom was divided into groups of students, with a minimum of theoretical classes, presenting the content in small blocks, and an experiment list. Several experiments were also made available to be programmed in the Arduino® IDE, as well as to

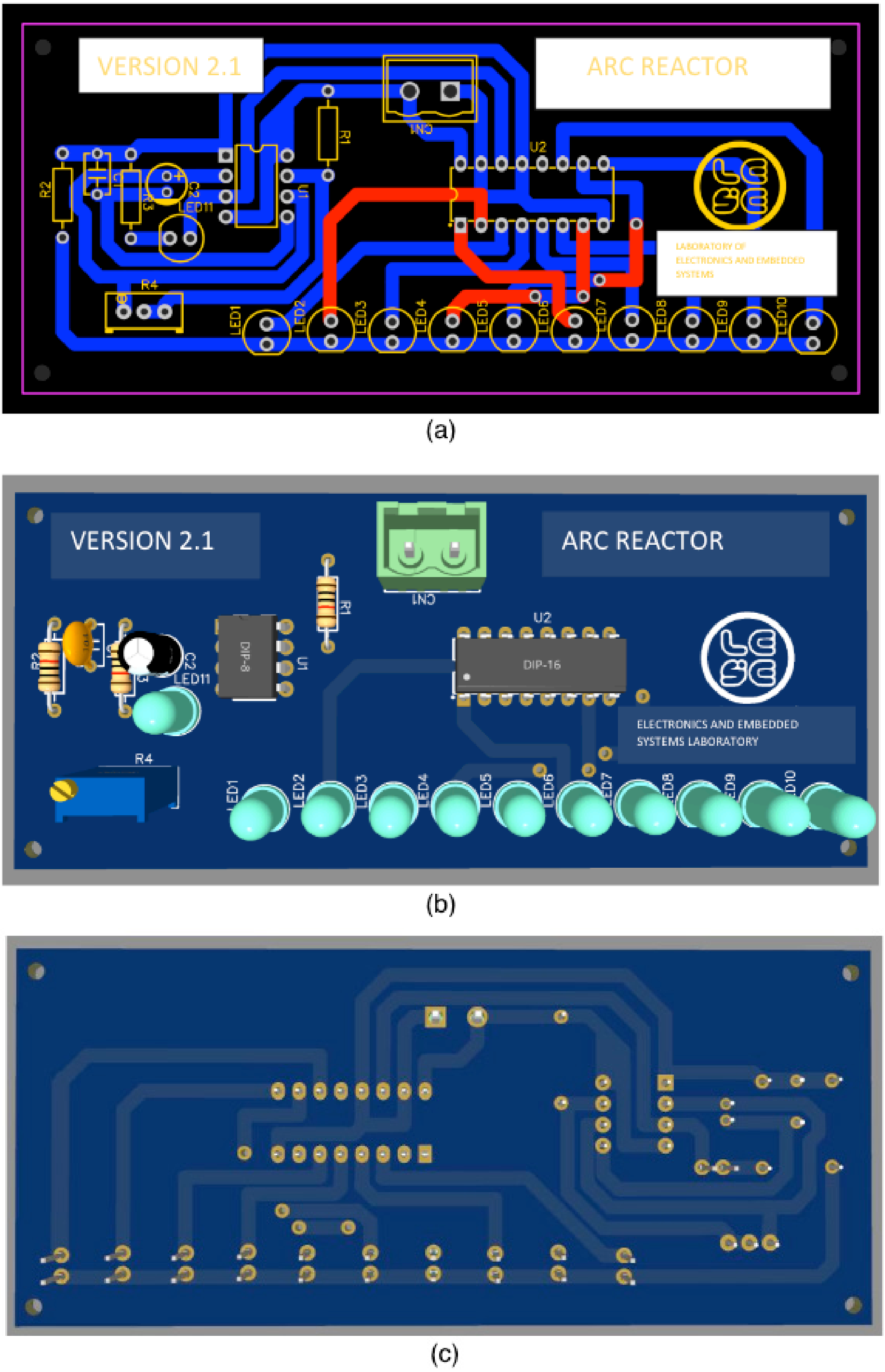


Figure 1. Combination of NE555 and ND4017 CI's – (a) Printed Circuit Board designed on the EasyEDA® platform, (b) 3D Model of the Printed Circuit Board (Top), (c) 3D Model of the Printed Circuit Board (Bottom).

Source: Author (2022)

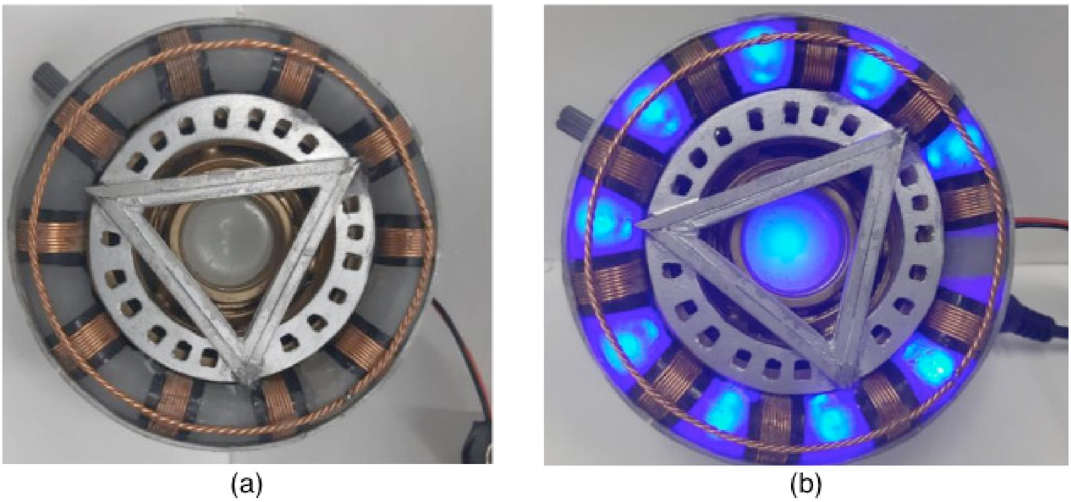


Figure 2. ARC reactor completed – (a) ARC reactor inactive, (b) ARC reactor working.

Source: Author (2022).

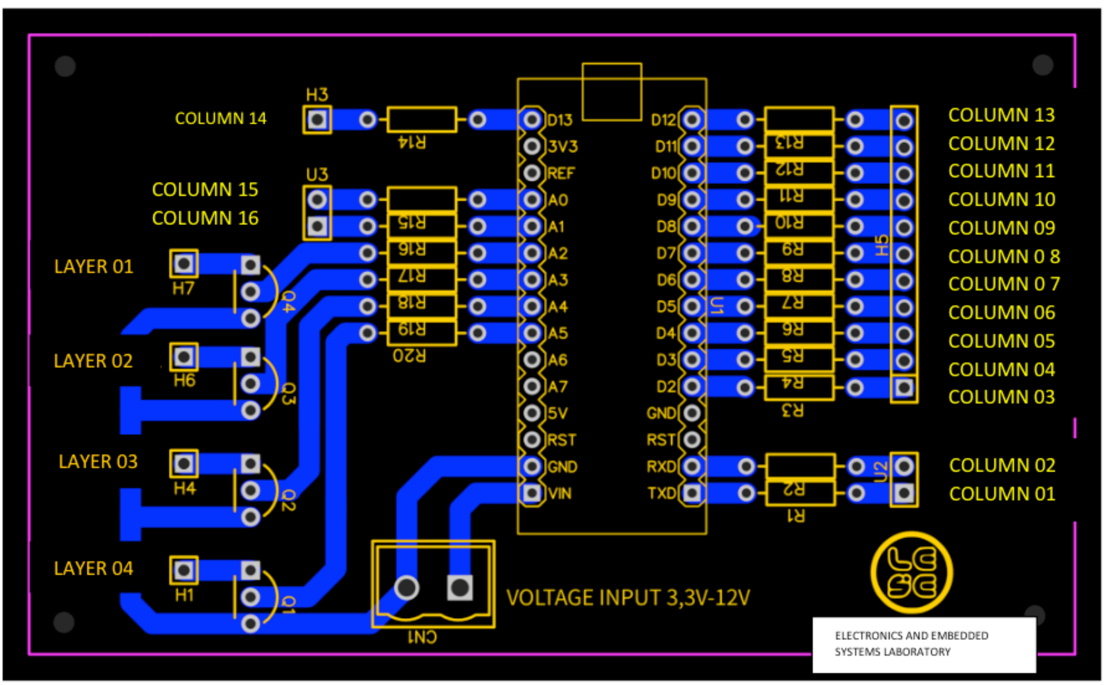


Figure 3. 4x4x4 LED Cube Logic Circuit Design.

Source: Author (2022).

build electronic circuits for the programming to work. All the concepts involved were related to the execution of the final project designed to prepare the construction of the 4x4x4 LED Cube, which followed the project-based active learning model.

The study consisted of the assembly of the electronic circuit and its programming, making it evident that basic knowledge of electronics acquired in the Elective of Fundamentals of Electronics and basic programming in Arduino obtained during the classes of Embedded Systems, facilitate the process of construction of the final project. (ROCHA et al., 2020). After finalizing the lists of experiments, the construction of the electronic circuit of the 4x4x4 LED Cube was started.

Theoretical classes taught represented 10% of the course load, which, once completed, allows students to be sent to the Laboratory of Electronics and Embedded Systems (LESE), to carry out the proposed experiments, with the aim of the student adding relevant knowledge that allow the construction of the 4x4x4 LED Cube.

CONSTRUCTION OF THE 4X4X4 LED CUBE.

For the construction of the 4x4x4 LED Cube, 64 high brightness LEDs, 20 220Ω resistors, 05 10kΩ resistors, 05 BC547, BC548 or BC549 transistors, 10x5 islanded board, 1 arduino nano V3 328 + USB cable were used. Figure 3 illustrates the circuit model built for the 4x4x4 LED Cube.

To carry out the project illustrated in Figure 3, an islanded board was used so that the student himself soldered the electronic components, creating the rails that interconnect the terminals of the components. Thus, a plate similar to the model illustrated in Figure 4 was obtained.

It can be seen in Figure 4 the expected result of the 4x4x4 LED Cube PCB. Soon after this stage of assembling the plate, the rest of the processes were carried out, which result in the Cube fully assembled as illustrated in Figure 5, Figure 5(a) being when the cube is inactive and without the finishes, and Figure 5 (b) when the cube is painted and working, any type of figure can be made by programming with the Arduino® IDE, totally different from the ARC Reactor which is a non-programmable electronic circuit.

APPLICATION OF ACTIVE METHODOLOGIES IN THE PROFESSIONAL QUALIFICATION COURSE IN FUNDAMENTALS OF ELECTRONICS

The professional qualification course in Fundamentals of Electronics was developed by UNEMAT, through a Bachelor's degree in Computer Science together with LESE, ceded at CEPAIA, where the Reuse and Recycling of Electrical and Electronic Equipment (PRREE) project is located (OBANA et al. al., 2021). In partnership with the Specialized Reference Center for Social Assistance (CREAS) in the city of Santa Rita do Araguaia – GO, this course was taught to children and adolescents from the 5th grade to high school.

The course offered knowledge about electronics, such as: assembling circuits, knowledge about components such as capacitor, resistor, potentiometer, light-emitting diode (LED) and use of breadboard. This way, basic knowledge about electronics was introduced to students, making them able to assemble, control and create electronic circuits. Figure 6 illustrates some classes of students during class time during the course.

RESULTS AND DISCUSSIONS

The results and discussions of the present study demonstrate by means of graphs some observations regarding the consequences of

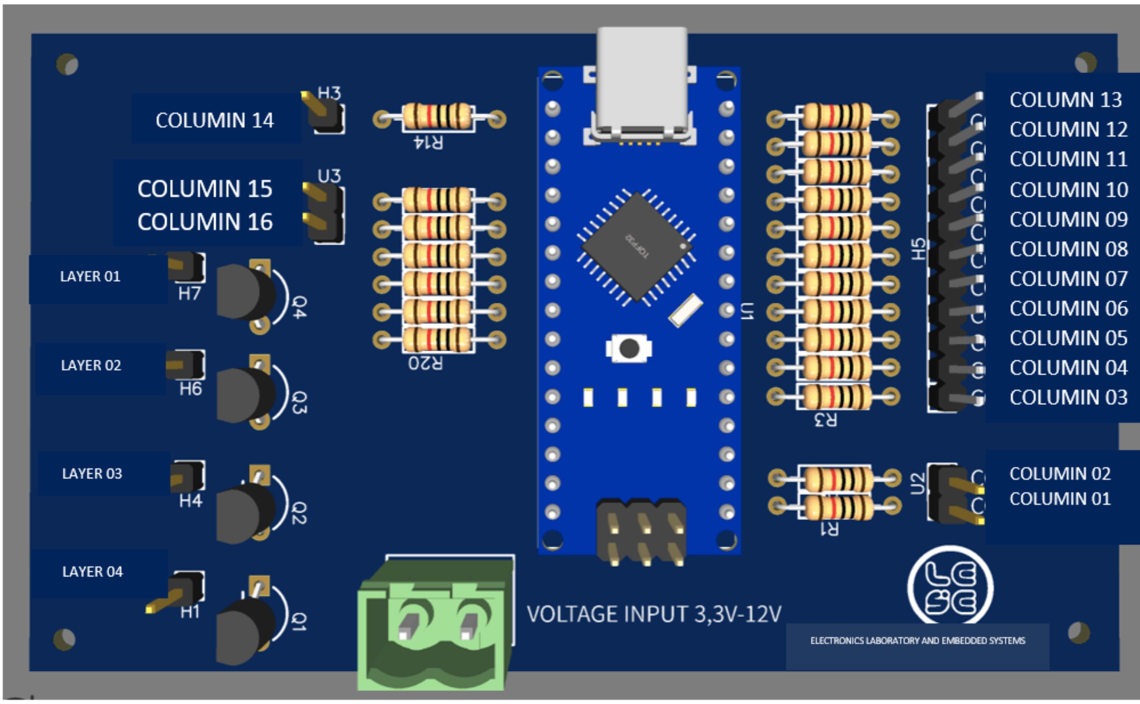
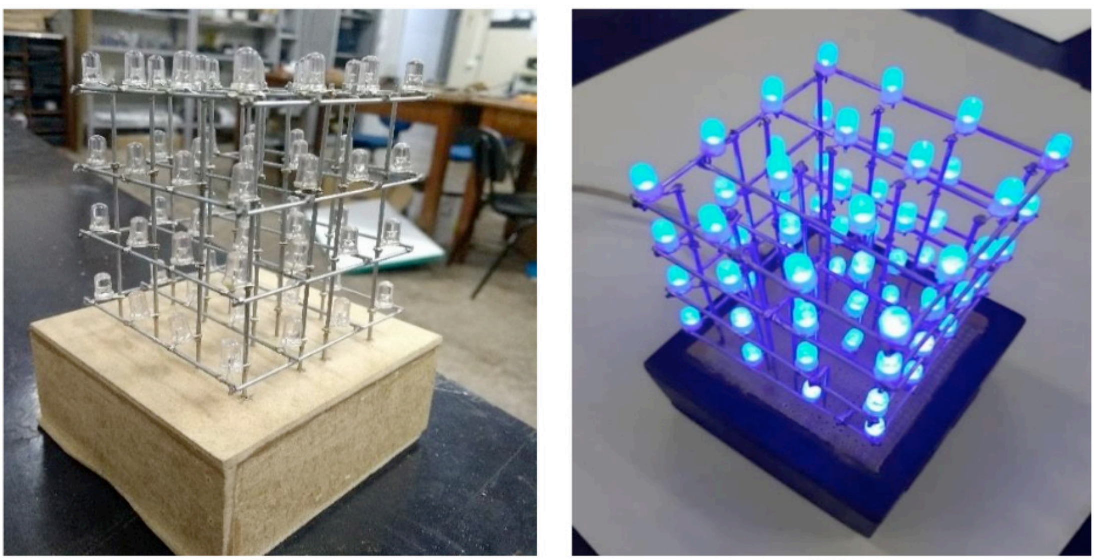


Figure 4. 3D model of the 4x4x4 LED Cube PCB

Source: author (2022).



(a) (b)

Figure 5. 4x4x4 LED Cube – (a) Inactive LED Cube, (b) Fully functional LED Cube.

Source: Author (2022).

the courses. It is worth mentioning that the teaching-learning method is not the only solution to reduce dropout from a course or subjects taught. Factors such as financial expenses, geographic location of students, social lives, among others, can be accounted for to reduce the dropout of students in the area of exact sciences.

The Fundamentals of Electronics (FE) course started in the first semester of 2015 (2015/1), but the insertion of the proposal to develop the ARC Reactor, with active teaching methodologies, started in 2017 (2017/ 1). Through access to data from the academic supervision of UNEMAT on the Campus de Alto Araguaia and by the Department of the bachelor's degree in computer science, the graph of dropouts and stays of students in the EF discipline was constructed from its beginning in 2015/1, until the last acquisition made in 2019/1 (Graph 1).

As shown in Graph 1 between the semesters 2015/1 to 2016/2, in which the present study had not been carried out, there was an average dropout rate between 51.57%, to 48.43% of the Elective of Fundamentals of electronics. After the insertion of the study and the application of active methodologies in teaching and learning between the semesters from 2017/1 to 2019/1, there was a decrease in the average dropout rate to 40%.

A motivating factor for carrying out this study was the large dropout rate in 2016 (2016/2) which reached above 80%, as well as the high dropout rate of courses in the area of exact sciences. It was also possible to observe that from the 2017/2 semester there was a gradual growth in the permanence of students in the Elective Fundamentals of Electronics, as well as a success in the application of active teaching-learning methodologies, also contributing to the reduction of dropouts from the course of Computer Science from UNEMAT, and a great performance of the students in the discipline.

Graph 2, on the other hand, depicts the permanence and dropout of students in the discipline of Embedded Systems. The course started in the 2016/2 semester, but the application of active methodologies and the present study started in the 2017/1 semester.

In this sense, it is possible to conclude that in the 2016/2 semester in which the study had not started, the average student dropout rate was 20%. After the insertion of the study between the semesters from 2017/1 to 2019/2, there was a decrease in the average dropout rate to 17.07%.

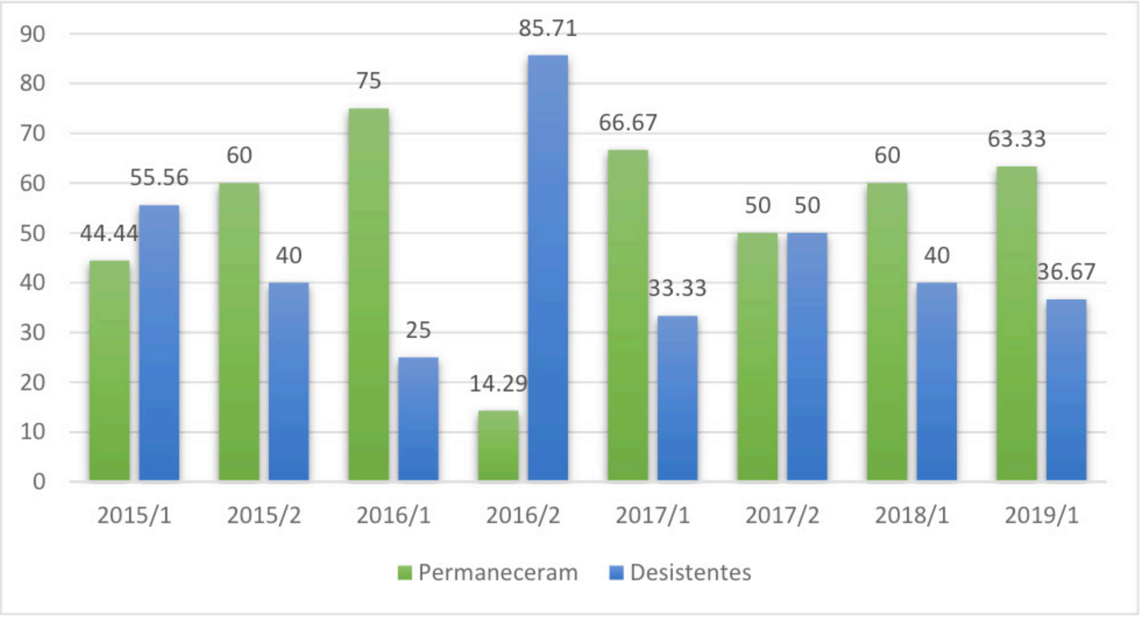
Graph 2 shows the large dropout in the Elective of Fundamentals of Electronics in the semester of 2016/2, which reached more than 80%, but the result of the elective of Embedded Systems from the semester of 2017/1 showed a gradual growth students' permanence in the discipline of Embedded Systems with the application of active teaching-learning methodologies and, also, an excellent performance of students in the discipline. It is important to highlight that there were some dropouts between the semesters from 2018/1 to 2019/1, but nothing that could impact the final results.

Graph 3 shows the results regarding dropouts and stays in the professional qualification course in Fundamentals of Electronics, which began in the 2018/1 semester, with a partnership between UNEMAT and CREAS.

This study had a great impact on the dropout rates between the semesters from 2018/1 to 2019/1 with a percentage of 25.56%. The permanence rate during the application of the study had an average rate of 74.44%. Graph 3 showed that the vocational course produced good results and that other methodologies can be applied in Universities and disciplines as a style of methodology in teaching and learning.

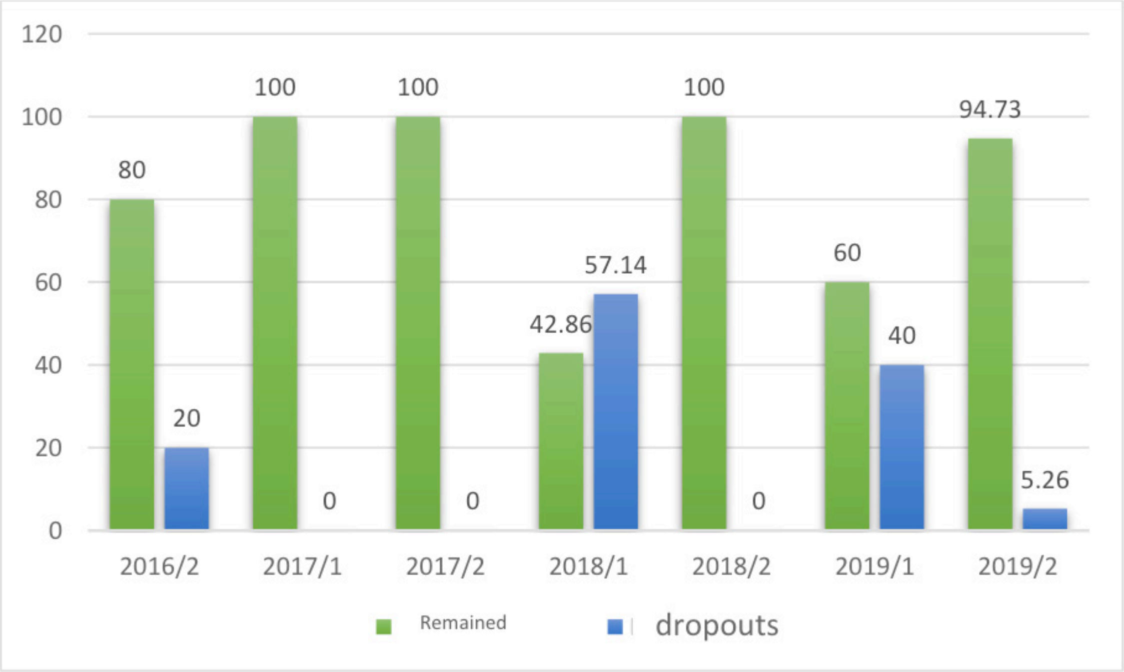
Figure 6. CREAS students during the course of Professional Qualification Fundamentals of Electronics.

Source: Author (2022).



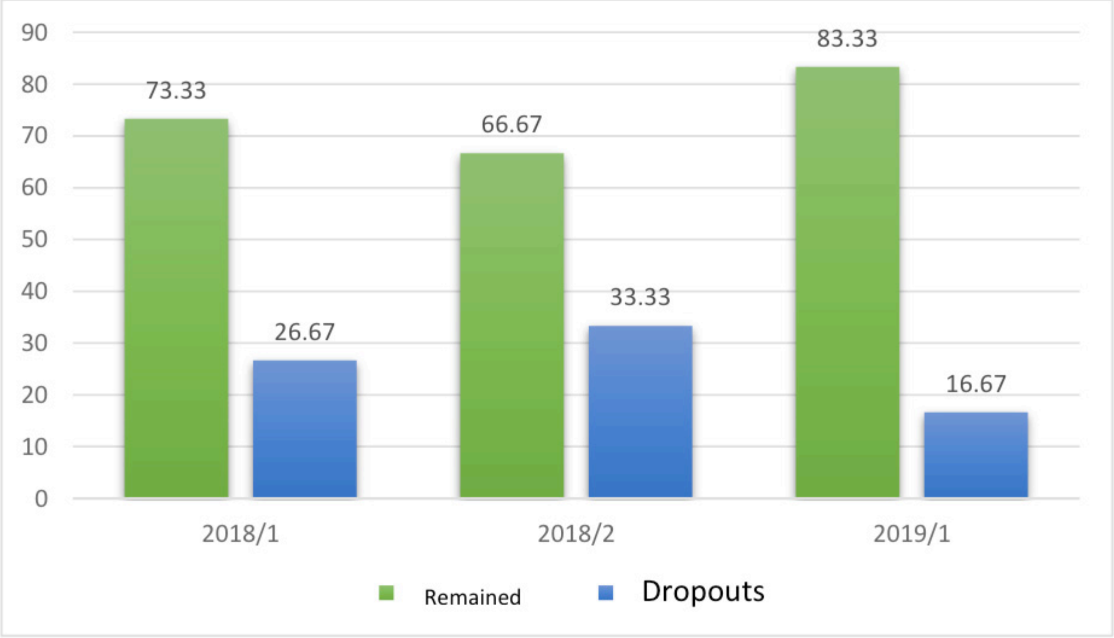
Graph 1. Permanence/withdrawal of students in the EF discipline

Source: Author (2022).



Graph 2. Permanence and dropout of students in the discipline of Embedded Systems

Source: Author (2022).



Graph 3. Permanence and Withdrawal of Students in the Professional Qualification Course in Fundamentals of Electronics

Source: Author (2022).

In the work by Carvalho et al., (2019), a very close evaluation was carried out. From 2012 to 2017, UFAM graduate students and students who dropped out of computer science, computer engineering and software engineering courses were evaluated. This number was shocking: the dropout rate for men is over 60% and the dropout rate for women is over 13%. Another interesting data provided by the author was the academic performance in the first semester with an estimate of the performance coefficient and approval rate of the following subjects. As mentioned earlier, the reasons for these numbers range from financial costs to university management and teaching methods applied. Following the same precepts (CARVALHO et al., 2019).

CONCLUSION

In view of the information mentioned above, it is possible to conclude that the active teaching-learning methodologies were applied in the elective subjects of Fundamentals of Electronics, Embedded Systems and in the Professional Qualification course in Fundamentals of Electronics with robust and assertive results. This new study approach brought better interaction and motivation for students, increasing the permanence rate in the disciplines and in the course of the exact sciences area, thus reducing the dropout rates and consequently increasing the permanence rates in the higher course. Another important point was the insertion of the professional qualification course in the menus of the disciplines, making the study attractive and consequently reducing the dropout rates and increasing the motivation for courses of this resourcefulness.

The studies produced in this work sought an evaluation of the period before the COVID-19 pandemic period. The period of the pandemic affected the way in which the disciplines were offered and taught at the university, making it difficult to administer several disciplines and limiting the way in which they were executed, so this study sought to evaluate only the period in which the disciplines were being arranged. in the face-to-face teaching model.

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