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TEACHING USING THE ARDUINO PLATFORM APPLIED TO THE CONCEPT Of IoT AS SUPPORT TO MICROCONTROLLER CLASS

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Abstract

Resumo With the emergence of the concept of IoT - the Internet of Things, it has become virtually impossible not to contextualize it in programming classes of electronic devices, such as processors and microcontrollers today. Thus, this work shows the analysis of a teaching methodology aimed at including in one of these courses an introduction to IoT, not excluding traditional hardware clarifications, such as the use of old microcontrollers such as 8051 (INTEL) and/or PIC (Microchip), thus not impairing, initial objectives proposed.

The ARDUINO Platform, a powerful and free development tool, was used to support the implementation of this proposal. This system allows a hardware abstraction through modules called Shields for industrial applications and can run communication algorithms in real-time, allowing to embark as a product some of the concepts of IoT. This article discusses the experience obtained with the use of such methodology applied to the microcontrollers class in a Course Technology in Industrial Automation of a Federal School, synthesized after the analysis of questionnaires to teachers and students involved in this course. The results of this methodology were positive, motivating the desire to better understand new hardware devices and how to program them, besides creating an innovative spirit in the projects of the graduates of this course concerning previous classes.

Keywords: Teaching Methodology; Microcontrollers; IoT; Arduino; Programming; Language c/c++.

1 Introduction

In Brazil, there is a very great demand for professionals for industrial activity. There are automation and control area has been growing for more than twenty years and in parallel, there is a constant technological evolution and. Because of this many interested parties of the current generation dazzled by the power of the internet and social networks easily delight in the possibilities of this career, including tied to the career of IT - Information Technology. Specifically, in this niche technological equipment such as sensors and microprocessor communication systems are ore able to communicate with telemetry immersed in the range and speed that the current Internet can offer.

In this interim arises the IoT - Internet of Things, which has the power to connect, also through the Internet, several technological devices very common nowadays, such as appliances of a future home full of Home Automation, associated with information on your smartphone-related to the current state of your home.

Inevitably technology is everywhere and for there to be this intelligence in this new universe, it then requires the updated professional to know a basis about the concept of IoT.

Industrial Automation courses traditionally include hardware disciplines for processors and microcontrollers, and some time in the course is presented to the student some programming language, be it Assembly, Basic, C, or the latest Python.

The problem lies when that student who does well in disciplines such as digital electronics, for example, comes across these microprocessor systems were knowing how to program is mandatory, and not always all students have enough abstraction to create an algorithm with traditional programming language classes.

Seeking to solve these two paradigms, one technological, from student access to IoT, and another cognitive, from the difficulty in programming by these future Automation professionals, the present work aims to investigate the contributions of the use of a methodology of teaching microcontroller programming by adding an introduction to the new concept of IoT, creating a technological motivator with this new technology, closer to the "connected" reality of the students of the current generation, where effects of this teaching practice are analyzed, without colliding with the expected course plan for such a discipline.

2 Bibliographic review

Upon entering higher education, most students opt for courses that are in tune with their interests and skills, as well as training professional skills to ensure better performance in the labor market (Soares and Carvalho 2017).

According to Facó, et al (2016), the courses that are on the rise for more than a decade are the courses of Automation and Control and their relative, always sought-after, are aimed at automatic systems, where they require a versatility of the professional future, which should get used to a constant professional update, given the speed of the novelties of the technological market that are already quite natural for young people of the current generations.

For Andrade, et al (2020), higher education courses in this area, more advanced computational skills are needed, and this is where some of this public encounter's difficulties in assimilation and learning of content because, for the vast majority, the initial disciplines related to computing focus on computer programming.

These disciplines offer students skills to solve problems, obtain logical reasoning, the ability to abstract solutions, and apply methods of using a programming language. In this context, many students conclude with a poor performance in these disciplines, leading to failure or even eventually to drop out of the course (GOMES, 2010).

In the disciplines related to the teaching of microprocessors and microcontrollers, it is traditionally adopted the teaching of hardware sequentially to those of more basic digital circuits, where its association and creation of internships culminated in a basic model of the processor.

By tradition, and even didactic facility, the teaching of hardware is given in older processors and /or microcontrollers such as Z80, 8051, and PIC, being evolutionarily the latter more complete of internal peripherals that facilitate the implementation of a micro processed circuit on a reduced electronic board.

According to Souza, et al (2018), for years the purchase or manufacture of device programming kits by schools and students was necessary for technical and higher courses for this type of teaching-learning.

At the same time, the technological world of software has emerged as never before, where the number of careers related to these segments grows every day.

Over time, low-cost development boards designed at universities around the world fell into the taste of the more engaged software staff and then began to be massively produced, mainly in China, examples of these are the platforms ARDUINO, ESP32, Raspberry, Beaglebone, among others and their use was intensified by the number of videos and online classes involving such subjects including arousing interest to IT staff and other relative areas where the abstraction of hardware is necessary.

The idea of ARDUINO came up in the city of Ivrea, Italy, in 2005, to interact in school projects to have a smaller budget than other prototyping systems available at that time. The success was signaled with the achievement of an honorable mention in the Digital

Communities category in 2006 by Prix Ars Electronica, in addition to the mark of more than 700,000 original plates sold until 2013, according to Quora.com. Being acquired from professional projects to prototypes for teaching, by graduate students to hobbyists interested in DIY – do it yourself.

ARDUINO consists of a single-board open hardware electronic platform based on MCUs (microcontrollers) Atmel AVR that has a standard programming language, based on C/C++ ANSI, low cost, flexible, and easy to use by beginners and professionals. Such a device allows very introductory classes such as an LED flasher, such as being an Internet server or 3D printer driver, essential requirements for the constantly expanding technology market.

Having these flexible features in hand, connected devices have emerged that allow you to build applications by taking advantage of the benefits of connectivity, a trend commonly known as the Internet of Things - IoT. Connectivity between devices occupies a central place in the current technological development. Much found in projects related to home automation among others.

Figure 01 - Universe of possibilities of connection between devices made possible by IoT

A survey was conducted (CHANDRASEKARAN et al, 2013) to investigate how to better equip academic teaching for students who require software development skills and still meet the needs of the industry. The most interesting finding was that academics and professionals agreed that students lacked motivation due to teaching style. Besides, results clearly showed that students are more interested in learning when presented to "hands-on" situations found in project situations and technical applications. It was

concluded that educators should focus more on practice rather than theory in the classroom.

A challenge faced by collaboration between industry and academia was highlighted, where the authors pointed out that today the technology cycle is shorter than the time of technology and engineering education, which means that what the industry needs now should have been provided by education in the past.

The authors pointed out that a solution could be the initial teaching of engineering/technology starting from primary and secondary schools (MACBRIDE et al, 2010; Santos et al, 2019). Several other challenges identified by the authors included: the incorporation of concepts such as systems integration, testing, and verification, the learning platform used, the educational methodology adopted the types of classes and laboratories, the methodology and evaluation system employed.

A challenge is the methodologies and tools for education, which highlight the need to carefully design the course structure and select the appropriate learning platform. Note that platform selection may also be linked to the hardware-software compatibility challenge. The second challenge is the evaluation procedure adopted by the course teacher.

For this, it is important to analyze the effectiveness of teaching by adopting these resources for this professional practice; therefore, a good way to guide the direction of this practice is by applying a questionnaire to the people involved.

When the first evaluations of research courses and teachers began to emerge, their results were mainly used by school administrators to assess the quality of teaching and teachers to improve teaching methodology. Currently, the market also wants to know the efficiency of these processes.

Teaching assessment questionnaires should be able to provide results, regardless of any correlation with external factors not related to the content of the subject or the teacher's ability to transmit to students the items mentioned in the course objectives. The teaching method should be treated in a multidimensional universe and, therefore, an appropriate evaluation questionnaire should have questions that address this multidisciplinary (MARSH, 1987).

With this in mind, it becomes very difficult to define a single parameter to assess the quality of a teacher or course based on the analysis of the answers to the questionnaire. In this case, the best approach is to compare different multidimensional factors, which can, for example, be evaluated by the questionnaire: about the teacher/clarity, enthusiasm, mastery of the subject, teaching material, teaching method, availability, size/content of the course, bibliographic references, evaluation method, Track the correlations between the different characteristics evaluated and how they affect the performance of the student in the discipline.

For the results of the questionnaires answered by the students about the subjects and the teachers to be reliable, it is necessary to obtain a considerable number of answers, the more students involved, the greater the reliability of the research (MARSH & ROCHE, 1997).

3 Method - information about the research subjects

The research was conducted with two classes in the fifth semester of the Courses of Technology in Industrial Automation of a federal school, all participants of discipline: Programming language, with an average number of 20 students per semester aged between 19 and 43 years, and two teachers.

This discipline is module 2 of the software part of processed electronic devices, and the classes have also seen two disciplines of hardware related to the subject.

The Course runs in four hours per week, which took place in sixteen weeks, totaling a minimum hourly load of sixty-four hours of course, where the principalities of hardware and software have already seen previously are reviewed and focusing on a professional practical application of the use of these systems where the principles of the IoT concept were included.

The selection of qualitative methodology is justified by the characteristics of the dimensions and nature of the sample. A questionnaire was conducted, the choice of the class occurred due to the easy access of the researcher and the approximation between the content to be worked with the students and the concepts developed in the experimental activities.

3.1 Questionnaire

A questionnaire was created with quantitative and qualitative questions. The questionnaire was modeled on Google Forms and sent by e-mail to members of two sequential fifth-semester classes who were exposed to such teaching practice.

This questionnaire consists of 20 questions among them data about the student to try to trace the context of the audience involved. Technical and training issues, about the experience, programming, and their difficulties were also included.

Finally, the questionnaire analyzes the teaching method including this concept, seeking to verify the impact of this proposed insertion, in addition to analyzing the teaching dynamics and quality of teaching of the two teachers involved in this proposal.

Teachers are given a questionnaire that monitors the profile of the class, its difficulties and seeks to trace the results obtained with this new insertion of content, seeking to capture its impact with such suggested practice.

4 Preliminary Results

A version of the questionnaire was applied to students of the Automation and Control Technology course of a Federal school of two different classes.

It was noticed that the vast majority of the class (80%) are young students (22 years on average) from the middle and lower classes, were about (50%) working in the area or some related activity.

It was perceived through the questionnaire answers that (86.6%) believes that content is important, although about (43.3%) prefer other subjects of the course, it is also noted that (63.3%) not so much intimacy in programming although they have seen this type of subject in two moments of the course, finding the hardware part easier.

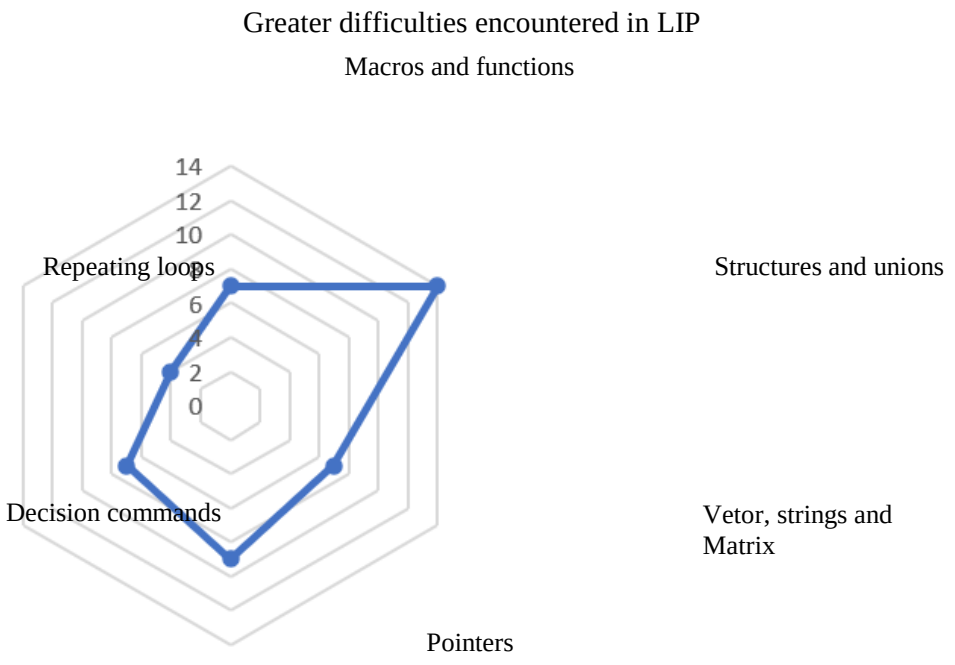
About teachers (90%) students believe that teachers have a high degree of experience regarding the discipline in question, (76.6%) believe that teachers are very interested and attentive to students, (63.3%) I would like to have a new discipline with these

teachers. IoT (80%) were more motivated when it came to involving technology with their smartphone, for example, (93.3%) believe this to be a trend, (63.6%) said more interested after inserting these concepts into the classes. (63.6%) would like to have a sequential mode to this course, (63.6%) want to involve in your CBT some concept related to IoT.

Regarding the greatest difficulties in programming on the part of the students, it was believed to be more interesting to demonstrate these difficulties in the form of a polar graph, seen in graph 1.

In graph 1 it is possible to see that the concepts of structures and unions were the ones that brought the most difficulties, followed by pointers and vector, matrix, and string. The best-absorbed concepts were decision structure and repetition bonds. Perhaps this is due to the greater applicability of these last two concepts.

As for the results from the teachers' questionnaires, more effort was noticed by the students about previous semesters, they felt more motivated given the interest of the vast majority. It is noticed that the approach of proposals for course work suggested by the students exposed to this discipline, which also happens in the fifth semester of the course, tended to be influenced by 80% to the concept of IoT.



Graph 1 - Graph of the greatest difficulties encountered by programming students

5 Conclusions

After the analysis, we noticed that the students studied in this discipline showed great interest, not only for the specific knowledge but also for the didactic development of lip activities. Since most students are professionals or trainees in a relative field, their motivations for diversified teaching activities are justified by the need for greater knowledge in the field of teaching strategies. Especially those related to applications of Science and Technology in society. From the students' reports, it was clear that they learned concepts related to the operation of the equipment used in the experiments and the observed phenomena.

The work in question also contributed to the production of easy-to-access didactic material, detailing the principles of operation. So that other teachers can use the material to adapt it to their specific teaching needs. Finally, we realized that, with undergraduate students, differentiated teaching methodologies, in addition to bringing gain and conceptual motivation, we are still contributing to a professional in this area more up-to-date and according to market trends.

The evaluation of students by teachers is a subject that always causes controversy, mainly because teachers generally have a defensive attitude in this regard. However, as much proven scientific research is applied, this is an appropriate method for assessing the quality of teaching.

Also, if possible, the preparation of the questionnaires and the analysis of the results should be done by a specialist in the area, together with the teacher. Therefore, they are more likely to accept the search results and use them to improve their teaching methods. The questionnaire was applied in experimental characters and the partial results identified that students have difficulty with this type of programming of technology courses, although an average of them like so many disciplines, others considered important, the difficulty in this type of abstraction causes the public to move away.

It can be seen that adopting a theme closer to the reality of the student, as Paulo Freire would say, as the IoT facilitates acceptance and the willingness to be a more important part of the process.

Something notorious is also to know that if the teacher is an expert in the subject and dedicated to the class, topics of greater difficulty can become more digestible and perhaps incur an important competence to the technology professional that is the Programming Language.

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