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# INTRODUCTION TO COMPUTER SCIENCE WITH UNPLUGGED COMPUTING AT DIFFERENT TEACHING LEVELS

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**ABSTRACT**

This work focused on the development of a methodological proposal based on the principles and foundations of Unplugged Computing (CD), in order to develop playful activities related to the introduction of computer science without using the computer and outdoors. The proposal was applied to two different classes, one from the 9th grade of elementary school at Escola Comunitária de Augustinópolis (ESCA) and the other from the 2nd year of high school at Colégio Estadual Manoel Vicente de Souza (CEMVS), both in Augustinópolis-TO. After the realization of the workshops, a significant improvement was observed in the perception of the students involved with the basic concepts of computing, demonstrating that unplugged computing can serve as a cheap alternative for teaching basic informatics in environments with low technological infrastructure.



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## INTRODUCTION

Digital information and communication technologies (TDIC`s) are tools that assist in study and facilitate learning in a creative and stimulating way. In this sense, the introduction of TDIC`s in the context of teaching and learning is of paramount importance. However, due to the lack of resources for the acquisition and maintenance of computer equipment, in some cases, the use of these technologies becomes deficient [Sousa 2013]. The Community School of Augustinopolis is included in this reality since it does not have a computational technological infrastructure for the development of classes in the area of information technology. Faced with this scenario, the idealization of this work was born, presenting unplugged computing as an alternative for carrying out activities related to computing and the development of computational thinking (PC), without the use of computers, enabling the planning of differentiated and playful classes. , these classes were also developed at the Manoel Vicente de Souza State College (CEMVS), which has the computational infrastructure, but unplugged computing was used as an introductory character. In this sense, activities from the book Computer Science Unplugged were used to develop the PC, proposed by Wing (2006), as a problem-solving process based on computer science techniques, defending the implementation of the PC since basic education, because, for he, this is a skill of equal importance to reading and the ability to solve mathematical calculations, the PC also encourages the development of skills such as decomposition¸ abstraction, generalization, and algorithmic reasoning. The importance attributed to the use of playfulness in class can be seen in the ideas of Verêda and Panta (2017), when the authors state that through playful activities children demonstrate pleasure in learning, acting, in addition to generating self-confidence, such reasoning is ratified in the work of Vygotsky: a historical-cultural perspective of education, where he argues that learning arises from the interaction between individuals, aiming that the playful activities have as their main basis the interaction of students [Rego 2013]. In this perspective, this work resulted in the development of Computational Thinking and the sharing of knowledge between students, based on the activities developed. These activities were part of an introductory computer course, in which it was considered the recognition of the main technologies present in the students' daily lives, as it was found that knowledge deficiency in the area of computer science through diagnostic activity. In section 2 we have the theoretical framework with concepts that give theoretical support to the work, in section 3 the methodological trail of the project is presented, in section 4 a discussion of the results obtained with the project and in section 5 the final considerations of the project are presented. job.

**Theoretical Reference:** Unplugged computing consists of teaching the introductory fundamentals to computer science with playful activities, without using computational resources, thus avoiding possible distractions from the computing environment. As these are simple activities and it is not necessary to explain technical details of the computers' operation, the method can be developed for different audiences, from children to adults, regardless of their level of education. The highlight is that unplugged computing does not require any electronic device, students learn in practice and have fun while learning and cooperating with each other when developing computational thinking. Based on the work of Rodrigues et al. (2018), which presents a systematic review on the subject, it was possible to access the literature that emphasizes the use of unplugged computing, providing this work with a view of the changes that unplugged computing can offer in the environment where it is applied. In the book Computer Science Unplugged, we find activities that the PC develops through unplugged methodology, these activities are separated into three groups: "Representing Information", "Algorithms" and "Representing Procedures". Thus, in each one, specific computer content is developed, based on the use of playful materials, such as cards, magnets, boxes, images, paper clipping, among others. Bell et al. (2011) suggest several alternatives for the application of activities, giving tips on how to apply them to more advanced students, highlights the skills developed and subjects to be used. All these activities are found, these, in turn, are being used in different disciplines as an example we mention the use of computing unplugged by Cunha and Nascimento (2018) in the development of computational thinking in the discipline of robotics. The diversity of adaptation of activities is noted through the work of Sousa and Lopes (2018), where they demonstrate in their article, the process of stimulating the construction of computational thinking and logical reasoning, with themes and simulations of the Brazilian Informatics Olympiad (OBI), with emphasis on the use of unplugged computing, when they did not have a computer lab. The Ministry of Education (MEC) through the National Common Curricular Base (BNCC) deals with PC development in the area of mathematics, also emphasizing the importance of algorithms and their flowcharts so that they can be objects of study in Mathematics classes. The Brazilian Computer Society (SBC) in its guidelines for teaching computer in basic education defines the PC as "the ability to understand, define, model, compare, solve, automate and analyze problems (and solutions) in a methodical and systematic way, through the construction of algorithms "(SBC 2019).

## METHODOLOGY

The present work was developed in two classes and in different schools. The first class with 34 students of the 9th grade, at the Escola Comunitária de Augustinópolis (ESCA), in which they had no computer discipline, not even a laboratory, used unplugged computing in order to demonstrate the operation of computers always exemplifying with equipment present in their daily lives in order to make them capable of identifying them and knowing how they work. The second class had 17 students from the 2nd year of high school at Colégio Estadual Manoel Vicente de Souza (CEMVS), in this class the proposal was to teach the introductory classes to the content of the technical course in computer science using CP as a methodological proposal to promote different classes, using non-computational materials presenting them with the basic functioning of electronic devices in a playful way. At first, a diagnostic activity was carried out with students in both classes to measure the level of knowledge related to computing. The activity included the application of a questionnaire containing 12 (twelve) questions covering different topics of computing. From obtaining the answers to this questionnaire, a deficiency in basic computer knowledge was identified in both groups. As an example, we can mention the difficulty that most had in identifying a monitor or a laptop. In the diagnostic activity, students from both classes answered the test with 12 (twelve) questions. Of the 12 questions presented, 35.3% of correct answers and 64.7% of errors were obtained. The alternatives that had the most errors were related to the nomenclatures of technologies and devices, evidencing the lack of knowledge of students related to basic subjects related to computing, based on this activity, classes were developed to suit the students' level of knowledge. Having the diagnosis of the classes that would be assisted, activities were elaborated that could contribute to resolving the deficiencies found with respect to knowledge about computing. During the project, different spaces were explored, such as the playground area, which had trees and shade, the use of this environment allowed outdoor activities to be carried out with students. It is worth mentioning that the application of diagnostic tests and final tests and some activities took place in the classroom. In order to assess the efficiency of the intervention proposed by the project, a survey was carried out with its participants, in both classes, with the objective of ascertaining their level of learning with regard to information technology, through activities with the use of computing. unplugged. In the high school class, a different qualitative test was applied in order to verify the acceptance of the methodology used.

**Activities:** As previously said, the activities are structured in three groups: "Representing Information" this brings us activities that illustrate the functioning of computers when representing data (binary numbers, text, and images), data storage, and compression. In the second group, the book deals with the "Algorithms" most frequently used in computers, such as the ordering and information search algorithms. In the group “Representing Procedures”, the book presents concepts about finite state automata, graphs, and programming languages.

**Representing information:** In this group of activities it was demonstrated with the computers it stores the text and images since its language is summarized in only zeros and ones. Where it is possible to work on contents related to the discipline of mathematics such as sequences, patterns, and representation of numbers in bases other than decimal, developing skills such as counting, correlation, and order.

The activities related to binary numbers require a set of cards shown in figure 1, to solve the proposed problems.

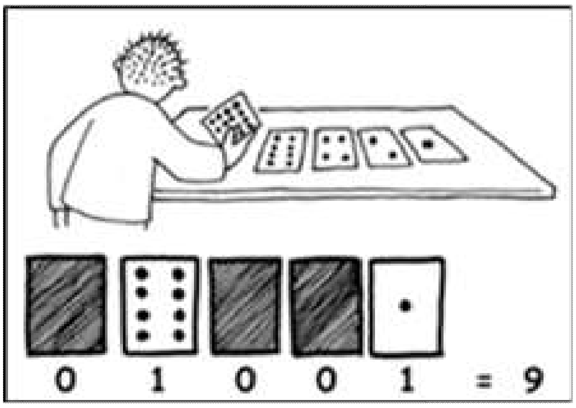


**Figure 1. Card Illustrations**

These cards are used to form numbers from binary codes, where 1 represents the card to be used and 0 the card to be ignored thus forming a number, later we worked on the concept of decoding with figures, then we used Figure 2 as an activity, students should write down the binary code, transform it into a natural number and then transform it into a letter, thus deciphering which message the man trapped in the building was sending.

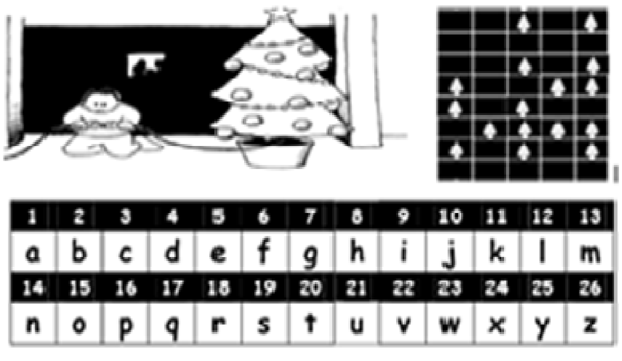


**Figure 2. SOS Message**


**Figure 3. Printing Images**

These cards are used to form numbers from binary codes, where 1 represents the card to be used and 0 the card to be ignored thus forming a number, later we worked on the concept of decoding with figures, then we used Figure 2 as an activity, students should write down the binary code, transform it into a natural number and then transform it into a letter, thus deciphering which message the man trapped in the building was sending. After the activities on binaries were completed, we moved on to the activities related to image representation, where students were introduced to the concepts that make images appear on computer screens.

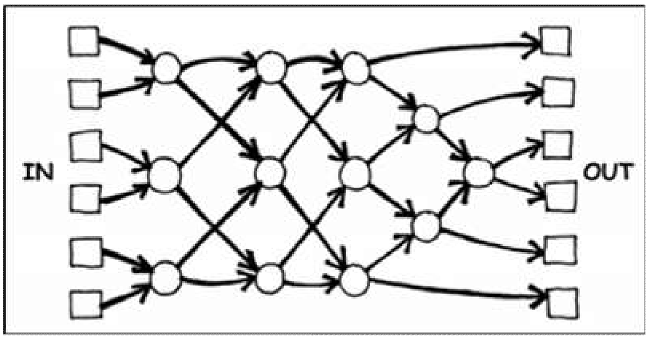


**Figure 4. Ordering Network**

Bell et al. 2011 show in Figure 3 how an image can be represented by numbers in a playful way, where the first line represented by 1, 3, 1 translates into a white pixel, followed by three black pixels and at the end a white pixel. From this introduction and having answered questions about it, it was proposed that students generate the codes and another student tried to decipher and reproduce the image, thus working on the concept of fax operation.

**Algorithms:** In the second group of activities, we apply only the activity “Sorting Network”, this exemplifies how computers sort the numbers in ascending or descending order represented in Figure 4. The students organize themselves in groups, one group positioned itself at the entrance and the other in the circles, each student at the entrance represents a number, the objective as already mentioned is to make sure that in the area of the exit, they are in order, this activity was developed with different variations using letters also.

**Representing Procedures:** At first, students, carrying a pen and A4 sheet, should hear and draw pictures according to the instructions given by the teacher shown in Figure 5, students should not see what their colleague was doing, it was proposed in this way to find out individual interpretation based on the result of the activity.

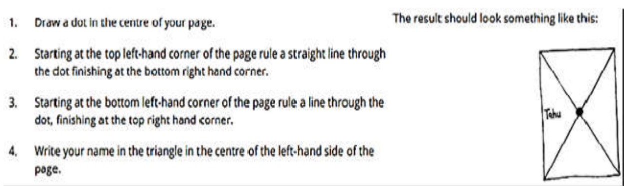


**Figure 5. Drawing**

Thus it was possible to demonstrate that each computer follows a basic language or binary, which is a machine language (low-level language), however, when we use high-level languages (which is close in which we use to communicate on a daily basis), each machine or system can understand differently and bring us different results, which was the varied designs obtained through this activity.

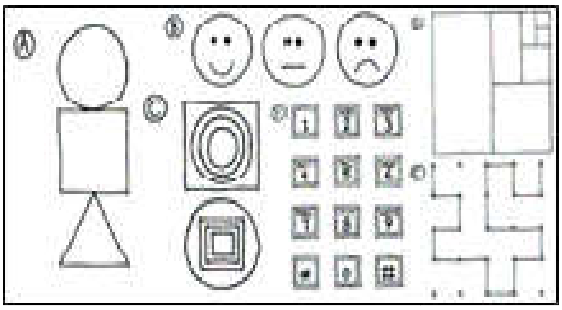

Figure 6. Executing commands

Figure 7. Maze

Subsequently, it was proposed that the students should be divided into pairs, we divided figures exemplified in figure 6, so that each member would use commands as in figure 5, so their colleague interpreted the commands and would draw, in the end, the figure and the result that the student had drawn. We had bulky moments because the result was not always identical or approximate to the figure that the colleague was describing. The last activity shown in Figure 7, developed was to make a labyrinth in the schoolyard and make a blindfolded student go through it until he reached the end to receive chocolate as a prize, he would reach the end of the labyrinth blindly obeying command previously done by another student, exemplifying how programming is done and how the computer interprets commands.

## RESULTS AND DISCUSSION

At the end of the proposed problems, we started with the qualitative activity in order to verify the opinion of high school students on the methodology used and we obtained the following results.

**High school:** It was found that the present work was successful in its objectives since 100% of the students answered that the activities are interesting, 88.2% managed to understand the content as shown in Figure 8.

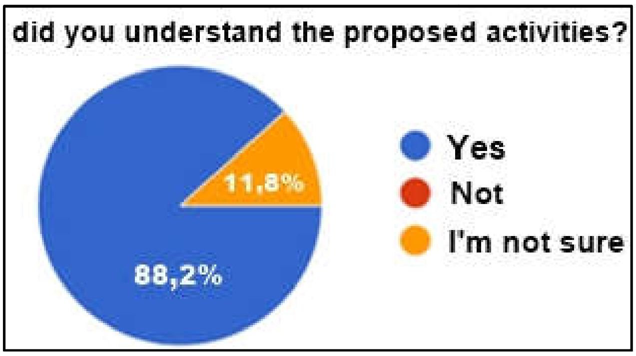


Figure 8. Understanding Activities

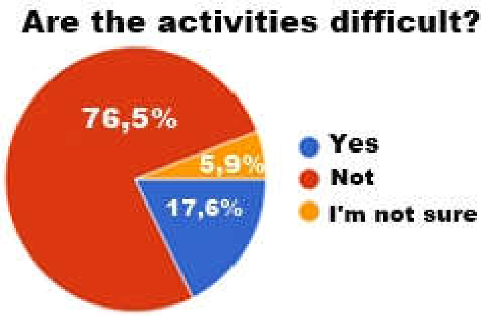


Figure 9. Difficulty of Activities

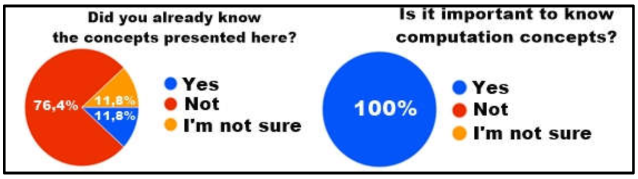


Figure 10. Computing Concepts

Of the participants, 76.5% had no difficulty in solving the proposed problems, and only 17.6% answered that the activities were difficult, Figure 9. 76% of students did not know the concepts treated during classes as shown in Figure 10, but all recognize the importance of understanding the concepts of computing, with the methodology unplugged the students were able to understand the concept of how computers work, even if superficially students' interest in having this class format in other subjects was identified as it would be easier to understand the content before using the technical terms.

**Elementary School:** After carrying out the activities foreseen by the present work with the 9th year, a final activity was carried out, used as an assessment tool for the knowledge obtained by the students, in Figure 11 their performance is shown in the final test. This test was based on the same content of the diagnostic activity, but with fewer questions and different questions, trying to find out if they learned or just memorized the answers. When comparing Figures 11 and 12, it is possible to identify a greater number of correct answers in the final activity, taking into account that both shared the same content as a basis. During the classes, with the use of unplugged computing techniques it was possible to verify, still, a greater interest of the students in participating in the proposed activities, different from what was noticed in the initial period, proving, in this way, that it is possible to hold their attention and awaken your interest by introducing playful activities into the teaching environment.

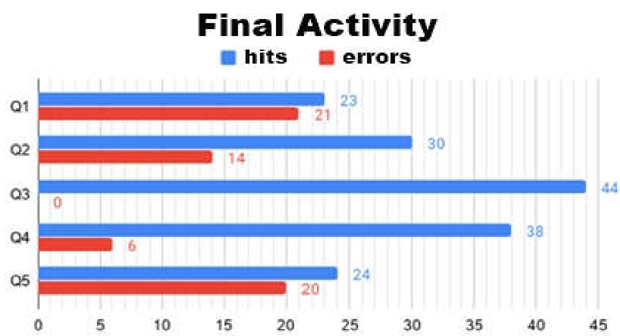


Figure 11. Final Activity

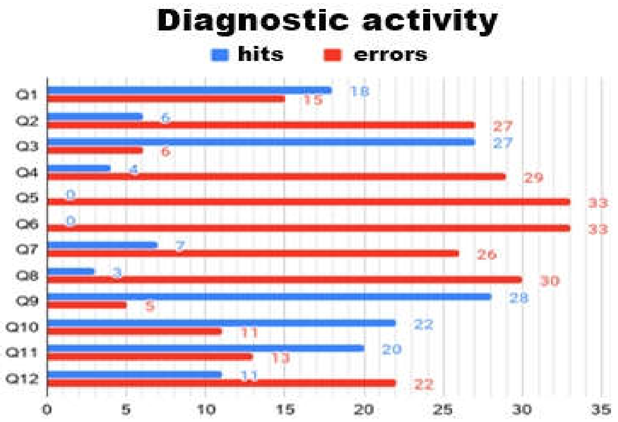


**Figure 12. Diagnostic Activity**

**Classes:** The assumption of the application of the project in different classes was to validate which changes should be made in the methodology applied at different levels of education, considering that the objective is the same regardless of the level of education, in fact, some changes were necessary and what these changes imply is that one class had computer classes and the other did not. It was noted in common among the classes the interest of students in carrying out activities, inside or outside the classroom, the good level of adaptation in raising the level of difficulty of each activity developed, the difference in age and maturity did not bring any negative characteristics during classes, reinforcing that the use of unplugged methodology is a great alternative to introduce concepts of computing regardless of age or level of education.

### Final considerations

This work proposed the development of activities in the school context with the adoption of practices that involved concepts of unplugged computing in order to develop computational thinking. Based on the data obtained, it was possible to conclude that the initiative achieved its objective, considering that students who initially had no knowledge of basic subjects related to information technology, at the end of this study, the students already knew how to differentiate CPU (Central Unit of Processing) of the casing, common mouse gamer, understand the definition of programming language, computational and non-computational algorithms, differentiate the types of storage that the computer uses. It was also possible to disseminate among other teachers information from sites that offer various content that involves educational games so that they could also use in the classroom, making their classes playful and we also obtained feedback from the students easier to solve problems following the steps of computational thinking.

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