Chapter 53

The exercise of computational thinking with students of a public high school

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ABSTRACT
This article seeks to work on concepts and practices of computational thinking for problem solving by students at a high school in the municipality of Panambi, Rio Grande do Sul. They aim to operate the four pillars of computational thinking, which are abstraction, by encouraging students to read problems and identify what is important; decomposition, which allows students to divide the problem into smaller parts; pattern recognition, encouraging students to recognize patterns they have already used in similar problems, and algorithms, which seek to establish a set of steps to solve the problem. To complement the methodological path, the study relies on applied research, with a view to computational thinking learning. The research findings point to a qualified teaching and learning process, by presenting more than 50% of the activities carried out efficiently, contemplating the concepts presented, even if the students live with traditional methodologies, which glimpses the potential of computational thinking, in pedagogical practices, identifying the protagonism of the students.

Keywords: Teaching, Computational Thinking, Apprenticeship, Public school.

1 INTRODUCTION

Society in recent decades has achieved significant advances, a scientific and technological development, which has driven and transformed the way of teaching and learning. In addition, the increasing complexity of activities in all sectors required new knowledge from the educational process. It means that science in contemporary times has become part of all the environments of society.

Therefore, scientific and technological knowledge are key pieces in family life, at work, at school, at leisure, providing everything from face-to-face interaction, to sending messages and warnings. In all activities, this process of computerization, is in line with providing the facilitation of the execution of these activities. It is in this direction that the present study seeks the understanding of computational thinking, especially in the educational area, of how students can solve everyday problems, based on the teaching-learning process.

It is understood that, when developing the logical reasoning of the students, it is opportunistic to the possibilities of awakening a favorable environment, to effect concepts and practices fed by computational thinking. To Rocha, *et al.* (2010, p. 07), "programming logic is a fundamental requirement in computer courses, and is an important tool in the structuring of logical reasoning." It means, when the student starts

to assimilate the operation, allows the realization of the processing and execution of data, with the proper help, carried out by the computer processor, in the search for solutions, giving due treatment to problems much faster and more efficiently.

Attention is given to the search for problem solving, considering as a starting point, defragmentation, division smaller parts, which allows to reach a faster and more effective solution. This movement presents itself with several challenges, however it allows the search for solutions by way more reliable, by relying on the defragmentation of the problem, when thinking and planning the parts of the problems, especially the smaller ones, looking for similar or equal elements in each case, in this way, it is possible to find solutions in previous experiences, by logical knowledge, in the process of computational thinking.

Therefore, the methodological path allows filtering and classifying the data of each problem, to save time, avoiding unnecessary information, keeping focus on work, important topics, to create a representation, in the search for resolution in the face of problems. However, in order for this process to be executed successfully, it is necessary to locate the essential information, efficiently and effectively, so that the problem is solved competently, that is fast and efficient.

However, to perform the solutions of the problems encountered, in every methodological way, it is necessary to develop an algorithm, that is, a process of execution of the identified solutions. In this process, the execution instructions are described and ordered so that their purpose is achieved, in the form of a diagram or human language, and then encoded. It means, with the description and performance of the algorithm it is possible to conquer autonomy in the execution and realization of the problem

Finally, the teaching-learning process, by relying on the paths of logical reasoning, allows students to conquer their objectives, when solving daily problems, awakening the use of technologies to create and recreate forms of interaction, new forms of sociability.

In this sense, Ribeiro *et al* (2021) discusses the theme of the inclusion of people with disabilities and high skills or gifted care through computational thinking, as a strategy for improving and complementing cognoscent activities. Gomes, Rodrigues & Franco (2020) discuss the theme through the analysis of an experience in the integrated high school/technician used the Game TIS-100 from Zachtronics, where it was evidenced that gamification can be used as a powerful strategy to assist in the development of computational thinking.

2 METHODOLOGY

Research is a rational and systematic procedure, which aims to present answers to the proposed problems, which have insufficient information about reality (Gil, 2002). Thus, the research is classified, as nature, as applied, based on the teachings of Zamberlan *et al.* (2014), to generate knowledge in the area of computational thinking.

Therefore, the initial methodological paths were bibliographic in nature, collecting materials from authors who have worked on the subject in books, articles and thesis. Inaddition to applied research, it has a qualitative approach, which allows a broad dialogue, with a complex network of terms, concepts and assumptions, related to cultural and interpretative studies (Denzin; Lincoln, 2006). Minayo (1994), corroborates this line of investigation, stating that qualitative research responds to very particular questions, with a level of reality that cannot be quantified, but rather, exposed and interpreted by the researches themselves. Thus, for the authors it is necessary to keep in mind the social reality, which is richer than any theory, any thought and any discourse that can be elaborated about it.

However, it is important to be present, in qualitative approaches, studies that dive into epistemological research. According to González Rey, (2005), the path of epistemology makes us understand that research needs a permanent process of the production of ideas. This process is enriched by researchers, when organizing complex scenarios, by the historical dialogues of the objects of studies, to help in responses, facing the needs of research, not in a linear process, but in a process where the researcher and researched assume an active role in the development of research, in the paths of complexity, which are the elements for the elaboration of epistemological conceptions (González Rey, 2005).

Consequently, gonzález rey (2002) reinforces, qualitative studies operate the epistemological field, helping to understand the different subjective configurations of the subjects that influence the learning processes. It means the presence of the theory of subjectivity, in the interpretative constructive production, in the interactive character and in the historical context that the subjects are involved, to understand the unique and differentiated form of the subjective constitution.

Thus, Cardinali (2006) presents the need to understand subjectivity, which goes beyond the apparent issues, requires an investigation that does not allow direct access. It means to remember the reality of the subjects, where subjectivity manifests itself differently. Also, for the author, although hidden, the realities of subjectivities influence and are influenced by the school environment, and therefore should not be ignored by the professionals inserted in it and who commit themselves to the global education of their students.

Finally, the participants included in the research are high school students, who were in the context of the team of researchers, in the covid 19 pandemic, in 2020. In the opportunity was the interaction and dialogue possible, when relying on online communication tools, *by WhatsApp* to develop research activities.

The challenges faced by the online research, however, the research team, worked the guidelines for the participants to receive and understand the resolutions of the activities in a shared way and with the explanations inherent to the process, to face some difficulties, in the understanding of the utterances and mode of resolution. It means, with the help and exchange of ideas, the students were able to carry out the activities, by the paths pointed out by the research.

It is still worth noting that the students, contemplated in the research, are from the Poncho Verde State School, in the municipality of Panambi, in Rio Grande do Sul, being well-regarded among the

parameters of the Basic Education Development Index, created in 2007, by the National Institute of Educational Studies and Research Anísio Teixeira, to measure the quality of national learning and establish goals for the improvement of teaching, being 19 schools that exceeded the national and state goal and of these 9 schools have already reached the goal by 2021, the Poncho Verde School – Panambi, is in 6th place at the state level.

3 THEORETICAL FRAMEWORK

Society lives in a movement of great changes, of uncertainties, where collective and individual cognitive maps, go through enormous challenges, in the way of thinking and acting, which opportunities a fertile field for research, in the area of computational thinking. A process that relies on computational modeling techniques, essential to understand computing requirements, in a way that information is stored, accessed and manipulated by software at any location and time.

Para Morigi and Pavan (2004), the use of information technologies provides opportunities, creates and recreates several new forms of interaction, as well as enables the conquest of new identities, creates an environment for new social habits. Moran (2000) points out that new technologies enable the expansion of the concept of class, space and time, since it builds new bridges between face-to-face and virtual, between being together and being connected at a distance. It means that social relationships do not only occur by face-to-face contact between citizens, but can be mediated by the computer.

Therefore, in the opinion of Morigi and Pavan (2004), information, knowledge have become essential variables for citizens in contemporary society, because they establish the most varied forms, in the information age, in the post-industrial society, in the virtual era or information society.

In Giddens (1991), this process, of time and space, is no longer a barrier to establishcommunication, exchange of information. Today, a disconnection of social systems is established, that is, the displacement of social relations from local contexts, in indefinite extensions of time-space. However, says the author, that in this relationship, there is a game that includes both traditional forms of sociability and modern forms, which enables a tense, conflicting and sometimes contradictory relationship.

Consequently, this process impacts the educational field, which most of the time cultivates a good environment of cooperation between teachers and students, where students and educators relate to each other to provide the construction of knowledge. Through the active action of both parties in the process of learning construction, the quality of teaching advances at the levels.

However, for González Rey (2011), the learning process points to greater needs, in addition to cooperation, between educators and students, but needs to immerse themselves in a subjective process, which contemplates symbolic-emotional production. This path causes the student, leaves aside the passive field, engages in an active condition, which implies a proper and singular positioning in the learning process.

Thus, the construction of knowledge begins to rely on active action, the construction of their own spaces conquered by the students, in which subjective productions boost the confronting character of the subject before his experiences. This walk needs to rely on methodologies, guided by educators, to stimulate each individual, even if he does not construct knowledge in isolation, but receives a teaching and learning process that enables change in the search for knowledge.

According to Husserl (1980), the construction of knowledge is not free and random leading to incommunicability. It must correspond to a thought, to an agreement, to a universal consensus, with due mediation between educators and students. One cannot imagine that each one can "build" his knowledge individually and without ties to the scientific community, but this process must have a pedagogical process that allows the construction of knowledge, with the strong presence of the students.

Thus, in the mediation and construction of knowledge, the presence of new scientific and technological advances, materialized in technological equipment, begin to assist and improve the teaching and learning process. Therefore, the construction of knowledge together with the students, opportunities an attractive environment, by complementing a game with various dynamics to present the contents. This process has games, learning objects, virtual environment, communication tools, and various physical equipment. Thus, by uniting practice with theory, the contents are adequately and pleasantly fixed to the students.

For Santiago (2006, p.10) "technology in education requires new strategies, methodologies and attitudes that surpass traditional educational work". It means that it is not enough to have technology, a classroom suitable for new technologies, if it does not count as new pedagogical, with methodology that includes students in the teaching and learning process, in the search for computational thinking.

Therefore, with scientific and technological advances, it becomes possible to conquer changes in the way of building knowledge. In a way, although slowly, with little creativity and conviction, the Federal Government included with the National Common Curriculum Base (BNCC), from public schools, the concept of computational thinking in the Common Disciplines in the classroom.

It is in the case that computational thinking requires interdisciplinary guidance. A process that allows integrated actions in the activities of the Basic Disciplines and that can develop cognitive and socioeconomic skills, arousing intellectual curiosity and the use of technology. For illustration purposes, two competencies are cited below: the first general, and the second specific:

> Exercise intellectual curiosity [...] resort to research, reflection, critical analysis, imagination and creativity, to investigate causes, elaborate and test hypotheses, formulate and solve problems and create solutions (including technological) based on knowledge of different areas (BNCC, 2018, p. 11);
>
> Use mathematical processes and tools, including available digital technologies, to model and solve everyday, social and other areas of knowledge problems, validating strategies and results (BNCC, 2018, p. 269).

Analyzing the competencies, we perceive some difficulties that include traditional classes, because, the awakening of intellectual curiosity, the use of scientific strategy to formulate and solve problems, in a traditional class that uses chalk, slates, handouts and that is concerned with defining and formulating concepts, memorizing and executing algorithms for solving exercises, with the sole objective of allowing students to obtain satisfactory concepts in evaluations, will not develop the skills of intellectual curiosity, the use of digital technologies in the search for problem solving, especially computational thinking.

It is understood that computational thinking helps students in understanding how to use the computational devices that encode information and process it, which allows to execute complex processes quickly and efficiently, finding solutions through experiences experienced at other times of school, family and community life.

Therefore, computational thinking is a troubleshooting process that includes (but is not limited to) the following characteristics:

> • Formulation of problems in a way that allows us to use a computer and other tools to help us solve them;
> • Organization and logical analysis of data;
> • Representation of data through abstractions, such as models and simulations;
> • Automation of solutions through algorithmic thinking (a series of ordered steps);
> • Identification, analysis and implementation of possible solutions in order to achieve the most efficient and effective combination of steps and resources;
> • Generalization and transfer of this problem solving process to a wide variety of problems.
> These skills are supported and enhanced by a number of qualities or attitudes that are essential dimensions of the PC. These qualities or attitudes include:
> • Confidence in dealing with complexity;
> •Persistence when working with difficult problems;
> • Tolerance for ambiguities;
> • The ability to deal with open problems;
> • The ability to communicate and work with others to achieve a common goal or solution. (CSTA/ISTE, 2011)

Finally, through the process of acquiring skills, to solve problems quickly, the student can perform a set of activities in adulthood, achieving greater ease in communication, problem solving and teamwork. A journey, in which the student can be in search of his human emancipation, in the search for a more dignified work, in a society so unfair and unequal.

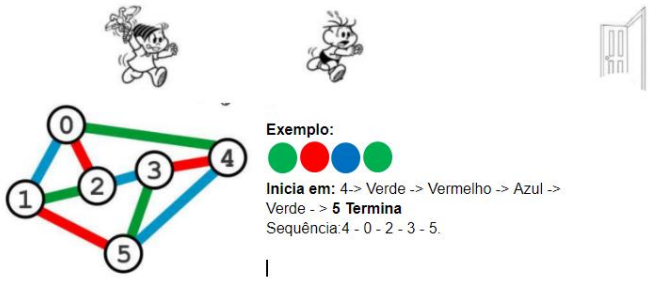
4 RESULTS AND DISCUSSIONS

It is understood that it is important, before the analysis of the results, to carry out a reflection, of the choice of activities applied during the research with the students. Initially, the work was read - Development of Computational Thinking - by the activities unplugged in basic education, elaborated by Professor Christian Puhlmann Brackmann (2017). Thus, in this walk, there are several different activities, however the research team chose to focus on the activities of Monica Automata and *Cupcakes.*

Therefore, attention is given to the choice of activity, Automata of Monica *and Cupcakes*, which needs previous knowledge, to awaken the performance of the daily tasks of the group of chosen students,

high school, a public school in Panambi. This process aims to solve the problems, by understanding the activity, the Automata of Monica, which deals with how students need to find the correct path by the provided clues, where they are guided the initial steps and at the end of the route. Thus, in the case of the activity, it is necessary to start and complete, according to the guidelines, following the steps of how to use all the colors described in the task. However, the color sequence was not always applied in the same way, that is, according to the guidelines indicated by the rule, however the task was performed correctly. Figure 1 shows the paths to be followed in the development of the activity.

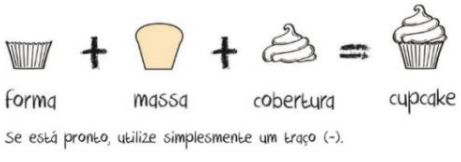
Figure 1: Monica Automata



Source: Brackmann (2017, p.217)

It is understood that *cupcake*, aims to create patterns, that is, to use the *cupcake construction pattern*, to guide / dictate a sequence of activities. Thus, the objective of the task became, the elaboration of a cookie completely, with pot, dough and topping. In this activity, function concepts were also implemented, so that code and fonts were used without being all described again. Thus, there were several ways of resolving each activity. It means that the students absorbed the concepts of functions, to give the answers, by various paths, however, the result was always the same. Thus, the students could visualize the advantages and disadvantages of this function of programming languages, using the concept of the construction of a *cupcake*, as shown2.

Figure 2 - Cupcakes



Função P1	Função P2
Massa + Cobertura	Massa + Cobertura Cobertura –

Source: Brackmann (2017, p.215)

Based on the above, before starting any of the activities, the title, description, objectives and main learning are included. Then, the instructions to be followed for students to perform the activity successfully were quoted as topics. This process, counted on the presentation of an image, which described the activity, at the same time, made the use of a practical example. After this walk, we sought the description of each task. This process had unplugged activities, which are the fastest and easiest way to teach computer programming in classrooms, as they are easy to apply in different economic and social realities in Brazil (Brackmann, 2017)

Therefore, the chosen activities have the four pillars of computational thinking, which are: (1) Decomposition that identifies complex problems, breaking them into small pieces, so that it is easier to manage. (2) Pattern Recognition - analyzes minor problems and tries to find the solution in activities already carried out, experiences already lived. (3) Abstraction - focuses only on the most important and relevant information; and (4) Algorithms - solves or creates the solution to the problem (Brackmann, 2017)

Therefore, in the automaton activities of Monica, the decomposition is carried out by analysis, that is, how the activity begins, which steps need to be followed, how the defragmenting of the major problem is performed, as well as the recognition of patterns that is carried out by analyzing the examples and comparing with the activities to be solved. Abstraction analyzes the relevant colors and steps to follow. Finally, the algorithm is carried out by constructing the activity response, including the numbers in the missing gaps.

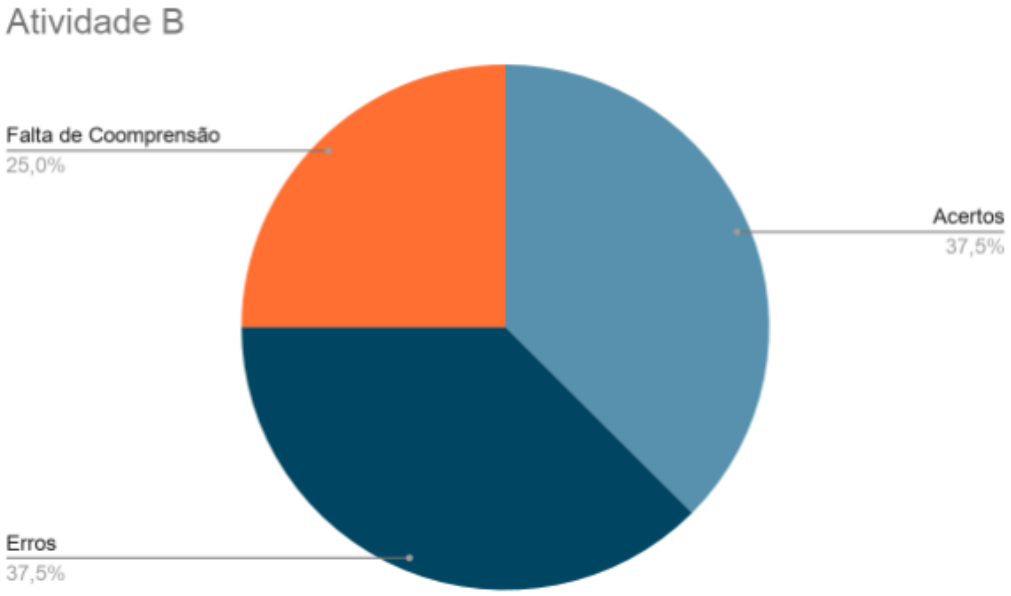
On the other hand, in *the Cupcakes activity*, the decomposition is performed at the moment when it is displayed cupcake by cupcake, to find and define the missing parts. Pattern recognition happens when analyzing the example and commnatowith the activities to be performed. Abstraction emphasizes the missing parts of the cake, according to previous experiences. The algorithm is carried out with the description of the missing steps of each cake, in this activity is also used a good programming practice that is of the functions, it was presented a function that should be used in the resolution of problems, to facilitate and reuse "source" codes.

Thus, the proposed activities present a main objective, which is the resolution of problems quickly and in practice, fixing the concept of the four pillars of computational thinking: abstraction (the student reads the problem and identifies what is important and what can be left aside); decomposition (the student divides the problem into smaller parts); pattern recognition (the learner recognizes the patterns he has already used in similar problems) and algorithms (establishing a set of steps to solve the problem). This process helps students to return skills in any circumstance of life to solve problems in a more agile way. Thus, the research had two stages: the first is composed of three exercises and the second is composed of four exercises. And the answers are presented in graphs 1 and 2 below.

The activity Automata of Monica, exercise A the errors and correct answers were equated, they both, having 37.5% of the answers with correct answers and 25% of the students did not understand the

activity, with this performed inadequately. Exercise B had the same percentage in all directions according to A.

Graph 1: Activity B Responses



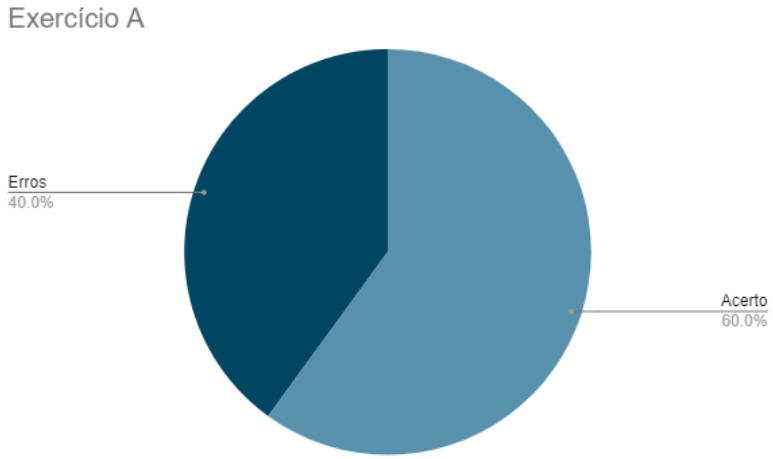
Source: elaborated by the research team, based on the research.

On the other hand, the 'C' exercise behaved differently with 25% of correct answers, 50% of errors and 25% of lack of understanding. This lack of understanding on the part of the students is justified for several reasons, among them, a certain lack of commitment to the activity, to the extent that the students did not request help, which could certainly be understood as a passive attitude, the result of traditional education. It means that the development of computational thinking needs to rely on the exercise of intellectual curiosity, with creativity, to formulate and elaborate problems and to seek solutions (Gonzáles Rey, 2011).

However, the objective of the Exercise Automata of Monica, which relied on the methodological paths, by indicating the beginning and the end, where it should cross, without defining the order, which should be evaluated by the student in order to achieve success in the activity, follows in a certain way the guidelines of Husserl (1980), when indicating that the construction of knowledge is not free and random, must correspond to a thought, to an agreement, with due mediation between teachers and students. It means that you cannot build knowledge individually without scientific knowledge.

On the other hand, the *Cupcakes exercise* in the 'A' activity had 60% of hits and 40% of errors. The activity 'D' with 80% hits and 20% errors. In the 'E' activity 60% of hits and 40% of errors. Then the activity 'F' with 60% of correct answers and 40% of errors and finally the activity 'I' 80% of correct answers and 20% of errors.

Graph 2: Exercise A Responses.



Source: elaborated by the research team, based on the research.

When reflecting this research walk, it was identified that there was no lack of understanding, as the students already sought to know the theme before performing the activities. But in the evaluation of the correct answers, it was found that many forgot only to end the function with the (-) or did not use the good programming practices that are related to the use of functions and reuse of codes.

Thus, the objective of the research was to verify how *the activity of Cupcakes*, allow the understanding of the process, step by step the construction of a cupcake and reuse this step so that it was not necessary every time to perform repeated procedures. An example, to build a complete cookie, needs form + dough + topping, so this sequence (shape + dough + topping) = P1, becomes a function, so every time you need to use it, you don't need to describe all the steps, it just includes 'P1'. In a way, this process became an interesting exercise for a group of students, from the Poncho Verde State School in Panambi. That, in Cardinali's view (2006), the research, through direct access, with the students, provides opportunities for the understanding of the subjectivity of the students, where the realities of subjectivities influence and are influenced by the school environment.

Finally, according to González Rey (2005), to understand the realities of subjectivities, it is important to take into account the studies of epistemology, which is a process enriched by researchers, when verifying reality, bearing in mind the historical movements of the objects of studies, which in this research permeates computational thinking, as a didactic way of working in activity and problem solving, bearing in mind the process of teaching essential learning, such as knowledge, skills, attitudes, values, for the full development of computational thinking.

5 FINAL CONSIDERATIONS

The article responds to its main objective, which was to work computational thinking, through the search for theoretical bases in order to supply the definition of the concept of the theme, still surrounded by doubts and inaccuracy, but which encompasses greater pertinence, by overcoming the practice of

memorization, causing students and educators to need to become aware of the new models of teaching and learning. To respond to this challenge, the research verifies the activities developed Monica Automata and *Cupcakes.*

Therefore, the study is attentive to the activity, Automata of Monica *and Cupcakes,* in a process that relies on previous knowledge, to awaken the conceptions and motivations in performing the tasks of a group of students, from high school, from a public school in Panambi, to put the hand-to-mass, in order to develop their own skills related to computational thinking. A rich experience that provided effective learning.

Thus, it is present, when presenting concepts of computational thinking, in a didactic way at work, the suggestion of problem solving in high schools, which can be facilitated, a promising process, with high expectations. In addition to their theories being related, the practice shows an attractive side for students, where they are encouraged to learn and seek knowledge, cognitive construction, and make problem solving less complex.

The study contemplated the four pillars of computational thinking: abstraction (the learner reads the problem and identifies what is important and what can be left aside); decomposition (the student divides the problem into smaller parts); pattern recognition (the learner recognizes the patterns he has already used in similar problems) and algorithms (establishing a set of steps to solve the problem). This process can help students to return skills in any circumstance of life, making solving problems more agile. In this sense, the research had two stages: the first is composed of three exercises and the second is composed of four exercises.

The activity Automata of Monica, exercise A the errors and correct answers were equated, they both, having 37.5% of the answers with correct answers and 25% of the students did not understand the activity, with this performed inadequately. Exercise B had the same percentage in all directions according to A.

It is recorded that in the 'C' exercise, the results present different forms, with 25% of correct answers, 50% of errors and 25% of lack of understanding. It is understood that this process presents a passive attitude, which may have suffered influences from traditional education. Thus, the proposed activities were developed and thought so that the students understood the request and fixed the concepts of computational thinking. The interaction with the students was online, but even so, they participated effectively and contributed to the solution of the problems. It is recorded that it was one of the possible paths in the pandemic.

Thus, it is highlighted that scientific and technological advances were very important in the communication process between the students and the research team, in the construction of knowledge. It is notorious that science and tools are on the list of skills and knowledge needed for the full exercise of citizenship in the 21st century.

From the point of view of computational thinking learning, the study qualifies the results, indicating as a teaching-learning process, pointing out that more than 50% of the activities were performed correctly and used the concepts presented, even if the students live with the traditional methodologies, which envisions the potential of computational thinking in solving the problems, in pedagogical practices, assisting in the protagonism of students and educators, in meaningful learning, in the formation of habilities, to deal with the tools and languages of digital culture, as well as, in the conquest of a work environment, which can provide a dignified life, in a permanent search for a sustainable society, from a social point of view, economic and environmental impact.

As a research does not run out in itself, futurework can be carried out using other parameters of computational thinking, such as the inclusion, whether of people with disabilities, or of young people or adults in the educational system of elementary and/or high school.

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