Circuit of Computer Science Unplugged activities based on the life of Ada Lovelace

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***Abstract*—Ada Lovelace's life is a source of inspiration for women and men of all ages, for being a bright-minded and visionary person. Her greatest achievement was that she wrote the first computer program in history. Thus, this work presents an alternative didactic use of a teen book about Ada Lovelace´s life by proposing a circuit of computer science (cs) unplugged activities in order to refine the computational thinking (CT) and promoting peer socialization of gender in young people, boys and girls. This didactic circuit was applied in a workshop held during the X Latin American Women in Computing Congress (LAWCC) in the XLIV Latin American Computing Conference (CLEI 2018). A quali-quantitative analysis performed with participants indicates the suitability of the proposed circuit of cs unplugged activities.**

***Index Terms*—Ceasar cipher, computational thinking, cs unplugged, hanoi tower,stem, women in computing.**

I. Introduction

In general, history is told from the standpoint of prevailing cultural traditions and those who occupy command and leadership posts, who have been eminently composed of men. The feats of women, in general, do not appear in history as attributed to them, always having a man to assume the deed and place in history. A rare exception is the mathematician Ada Lovelace, by many known as the daughter of the famous English poet Lord Byron, but who was responsible for developing the first computer program.

A computer program is a set of instructions that describe a task to be performed by an electronic deterministic machine, a computer. And the interesting thing is that the program came before even the development of the electronic computer itself. It was precisely Ada Lovelace, a brilliant mathematician who, with great creativity, curiosity and imagination, developed the sequence of steps and formulas, a pseudo-code algorithm, to calculate Bernoulli's numbers through Charles Babbage's analytical machine, publishing the work in 1843 [2].

There are many books that tell the beautiful life story of Ada Lovelace and her achievements. In this work, we used one of these books written by Bim [2] as a reference narrative for planning the didactic activities in order to develop the computational thinking and to promote the learning of computer science (cs) concepts, without necessarily having to use the computer. This is known in the literature by unplugged computing. Much has been discussed about computational thinking (CT). For Wing [20], CT refers to a set of human skills essential to the problem-solving proposition, involving: i) reformulating a problem through division and conquest strategies, ii) thinking recursively, iii) defining what are the highest priority tasks and iv) create algorithms to solve them.

Based on these assumptions, this work describe a workshop proposal of a circuit of unplugged computer science activities, inspired by the Ada Lovelace's life, to aid in the development of computational thinking in young people, pre-teen and teenagers, and promoting gender interaction and analysis. This didactic circuit was applied in a workshop held during the *X Latin American Women in Computing Congress* (LAWCC) in the *XLIV Latin American Computing Conference* (CLEI 2018).

Unplugged computing occurs through playful activities, group dynamics, and material elaboration. Bell *et al.* [**?**]ave been concerned with solving issues that can arise as soon as we are introduced to computing: how do computers work and what do computers solve? The book of such authors, titled "CS unplugged: Computer Science without a Computer", has many activities that can be reproduced with children in an easy and intuitive way. Despite the playful nature, the activities do not fail to pass the knowledge of the world of Computing, eliminating the initial difficulty that the computer can cause

in learning.

The holding of workshops and events for the purpose of working computational thinking with playful and creative activities plugged and unplugged has been happening in various spheres, such as these examples below. The Brazilian Creative Learning Network (based on the Lifelong Kindergarten Group of the MIT Media Lab) (RBAC, 2019), which involves educators, artists, entrepreneurs and public and private entities, fosters such actions. Scratch Day (proposed by MIT for use of the Scratch block visual programming environment) has one of these. The BEPECO (Playing on Computational Thinking) event organized by IComp / UFAM (de Freitas, Gadelha., 2017), for children and adolescents, involves disconnected activities, robotics and a circuit of steps involving computational problems, in open space and material. such as a giant Hanoi Tower game, colorful bit dice/boards, sack race, etc.

Based on these assumptions, this study examines an activity performed in a workshop for (pre-)teen, during a computer conference. Activities have been structured that refer since the childhood of Ada Lovelace, through family issues and their motherhood and scientific achievements in computing.

II. The Ada Lovelace´s life at a glance

Ada Lovelace was born on the 10th December 1815 in London, England. She married William King who became Earl Lovelace in 1938. Consequently, Ada - who was born Augusta Ada Gordon known by her relatives as Ada Byron - became Countess of Lovelace. They had three children: two boys and a girl.

Although Ada Lovelace is well-known as the Lord Byron's (a British poet - a leading figure in the Romantic movement) daughter in fact the responsible for the development of her mathematicians' abilities was her mother Anne Isabella Milbanke (a British mathematician nicknamed by her husband as "princess of parallelograms"). Ada's parents split up when she was only one month old. Ada never saw or met her father.

Afraid of her daughter would develop an inappropriate behavior (scandalous, imaginative, reckless) like her father, Anne Isabella hired tutors to teach her daughter numerous subjects except for poetry. Poetry was not allowed. Ada's math tutor was Mary Sommerville, the well-known scientist, and mathematician. So, during her childhood, Ada Lovelace´s day was full of classes. She was a lonely child, and her only friend was her cat Puff.

When Ada was seventeen years old, she met Charles Babbage and some years later their friendship and shared passion for innovation had produced a significant contribution to the computing area: the world's first algorithm.

The first algorithm was created because Ada Lovelace was invited by Charles Babbage to translate Menabrea´s article [17]. Charles Babbage looking for financial support to build his Analytical Engine traveled to Turin to present his project. Luigi Federico Menabrea, one of the people in the audience, wrote an article in French about the innovative project. Probably, looking for more possibilities of financial support Charles Babbage invited Ada Lovelace to translate the paper from French to English. As Ada was fluent in French because for her robust studies during her childhood, a passion for maths and an enthusiast of Babbage's work when she did the translation she wrote some notes to explain how the machine would work. Note G explains how the Bernoulli´s number would be calculated by the Analytical Engine and is considered the world's first algorithm.

In 1843 when the translation was published Ada Lovelace signed it as A.A.L. In that time a woman's work would not be recognized as a piece of solid knowledge, and consequently, it would be better to sign anonymously. More than a hundred years after that many books are talking about Ada Lovelace's life. Most of them were written and illustrated by women. One of them, "La Vida de Ada Lovelace" [2] written by Sílvia Amélia Bim and illustrated by Kiara Cabral, two Brazilian women, was used as inspiration for the workshop described in this paper (see Figure 1).

Fig. 1. Illustrations from the book "La Vida de Ada Lovelace" [2].

III. The proposed circuit of unplugged activities

Playful activities help in learning processes and stimulate the creativity and involvement of children, young people, and even adults. In this context, we propose a circuit of unplugged activities as a way of developing the innate ability of computational thinking. The unplugged activities of the circuit follow much the one proposed in the unplugged CS, being 4 stations defined according to the phases of Ada Lovelace's life and how she was also stimulated by her parents and became a brilliant problem solver while creativity and imagination fertile, their math skills.

A. Childhood station and the Hanoi Tower logic puzzle game

The Childhood station consists of using a playful puzzle game of mathematical logic, the classical Tower of Hanoi. It consists of three pins or rods, and a number of disks of different sizes, which can slide onto any rod, called source. The other two act as an auxiliary rod and a target one. The puzzle starts with the disks in a neat stack in ascending order of size on the source rod, the smallest at the top, thus making a conical shape. The objective of the puzzle is to move the entire stack to the target rod, obeying the two following simple rules:

1 only one disk can be moved at a time;
2 no larger disk may be placed on top of a smaller disk.

Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack or on an empty rod. The minimum number of movements required

by the following mathematical expression, $2^n - 1$, where n corresponds to the number of disks. The computational complexity to solve this problem is, therefore, $O(2^n)$,

Figure 2 presents a Hanoi Tower with three disks int the source rod A. The other two rods are the auxiliar rod B and the target rod C. The minimum number of moves to transfer the tower with three disks from the source rod A to the target rod C is 7.

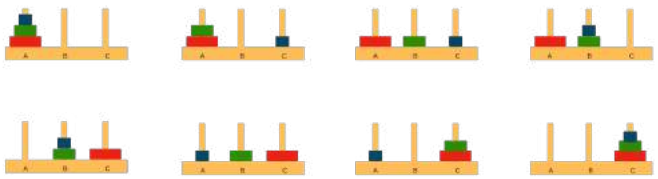

Fig. 2. Example of a Hanoi Tower with three disks and a total of seven moviments.

The Hanoi Tower constitutes a strategic game capable of contributing to the development of computational thinking and related capabilities such as the ability to memorize, logical reasoning, abstraction, decomposition, planning and problem solving through strategic techniques, here involving the algorithmic structuring of thinking step-by-step approach to solving the problem.

This logic puzzle was invented by the French mathematician Eduoard Lucas in 1883. The puzzle, also called "the Tower of Brahma" or "End of the World Puzzle", was created out of an old Hindu legend. The story tells of a Hindu temple at the center of the world where priests were given a stack of 64 golden disks of decreasing size. The priests were to transfer the stack of disks from the starting or source place to another one. The priests, tasked by God to complete the game, were to work diligently. It was said that when they completed their task, the temple would crumble to dust and the world would come to an end. Since the disks were made by gold and very heavy, if they placed a larger disk on top of a smaller one, the smaller one would break. Likewise, it was impractical to move more than one disk at a time. Thus, to carry the whole tower from the place of origin to the destination indicated by God, without breaking any disk, it was necessary to use an auxiliary rod.

This game can be used from the initial grades of Elementary School, in order to improve the motor coordination, identification of colors, notion of increasing and decreasing order. In the most advanced series, the game will be used in order to establish strategies for transferring pieces, counting movements and logical reasoning. Many properties and mathematical concepts can be explored through the manipulation of this game. Computationally, the Tower of Hanoi game is an excellent example for teaching recursive and recursive algorithms as well as iteration and iterative algorithms, stack-like data structures (a list that adopts the "Last In First Out"-LIFO policy) and a circular list (a list where the next element after the last is the first in the list). Also, it is an example of a computational problem that has a solution with exponential complexity, and can not have a better one.

B. Puff Cat station and the binary numbers

The Puff Cat station is intended to teach mathematical concepts of binary conversion. With illustrations and a playful story about Ada Lovelace's cat "counting" the world around her, binary numbers are taught gradually and easily understood.

As the theme is addressed in a simple way, the children's audience becomes a strong target to carry out the activity. However, the pre-teens were also interested in the activity and the engagement was great. Throughout the activity, challenges are proposed to transform binary numbers into letters and numbers, making basically sums. A text phrase, built to be decoded using binary conversion, was proposed as part of the challenge.

The first steps of the Puff Cat station demonstrate the exponentiation of numbers with the power of two. The kitten checks that the flowers in her yard double in comparison to the day before. For example, the day after she checks for two flowers in her garden, there are four flowers that grew at night. The next day, there will be eight flowers. To stimulate flower counts, the days are portrayed in pictures and participants must draw the missing flowers.

In the continuation of the activity, it is requested the conversion of binary numbers to decimals. Since binary numbers consist of 0 and 1, the logic for summing the values that result in the decimal number is explained. From the right to the left, the values that each field receives are, respectively, $1, 2, 4, 8, 16, 32$, and so on. This step ends up performing a continuity of the content learned in the previous step.

When presenting the information 11111, it is expected that the values of each field are added together, ie: $16+8+4+2+1$, result in 31. When informing that a certain field is null, value 0, its value is disregarded. That is 11011, in the sum of content, translates into $16 + 8 + 0 + 2 + 1 = 27$.

At the end of the activity, a table containing the letters of the alphabet and their respective decimal number is displayed for the last step, which is the discovery of a cipher phrase message using binary numbers. The decimal sequence for the alphabetical order is assigned as follows: $1 = A, 2 = B, 3 = C$, and so on up to the value $26 = Z$.

As an example the value 01100 must be summed such that $0 + 8 + 4 + 0 + 0 = 12$. In the conversion, the number 12 becomes the letter L.

C. Friendship station and image representation

The aim of the Friendship station was to present basic concepts of image representation. Considering that computers store photos on web pages and icons on buttons, this activity explores how images are displayed, based on the pixel as a building block. The main activity is based on coloring a few dozen black pixels with a pencil and it was inspired by the material available at the Computer Science Unplugged site [4].

To contextualize the activity with Ada Lovelace´s life the following scenario was present to the students:

"When Charles Babbage explain to Ada Lovelace how the Analytical Engine would work she went beyond the numbers and imagined that the engine could produce images. But how the computers store photos if they can only use numbers? Let´s try? Discover the image following the rule: The first number always relates to the number of white pixels. If the first pixel is black the line will begin with a zero."

In order to understand the rule, a simple example was presented to the participants as shown in Figure 3. The result expected in this activity was the image of a cat (the Ada Lovelace´s cat whose name is Puff). The template was chosen from a video on YouTube.

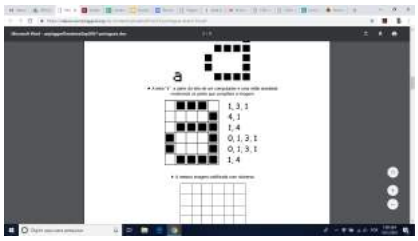

Fig. 3. Example of the image representation rules.

D. Family station, criptography and the Lord Byron's poem

The family station consists of the use of ***Cipher of Caesar*** to translate a *Lord Byron's Poem*. The Cipher of Caesar uses each letter of the message of an open text (or source text) and replacing it with the k-sequential letter of the alphabet, allowing for the rotation of this alphabet. In summary, the letter Z is followed by the letter A. For example, if $k = 3$, then the letter A of the open text becomes D in the encrypted text (ciohertext); B in the open text becomes E in the encrypted one, and so on, as shown in Figure 4 and Figure 5.

Although the current ciphertext appears to be non-existent, it would not long to crack the code if it was known that it was used the Cipher of Caesar. There are only 25 possible values for keys. The encryption process of the alphabet in the Cipher of Caesar with displacement equal 3, would be given according to Figure 6.

The Cesar cryptography equation is given by (1), where C is the ciphertext, k is the scroll key, and n is the source or open text. The mod operator is the remainder of the division by 26, which is the number of letters in our alphabet.

$$C = (k + n) mod 26 \quad (1)$$

The equation of Cesar's decryption is given by (2), where D is the ciphertext, k is the scroll key, and n is the text clear.

$$D = (k - n) mod 26 \quad (2)$$

In the activity of the family station, each team received a page with the message to be decrypted in 15 minutes. This message contained some verses from *Song I* of Lord Byron's Poem using Cipher of Caesar. The activity was based on the

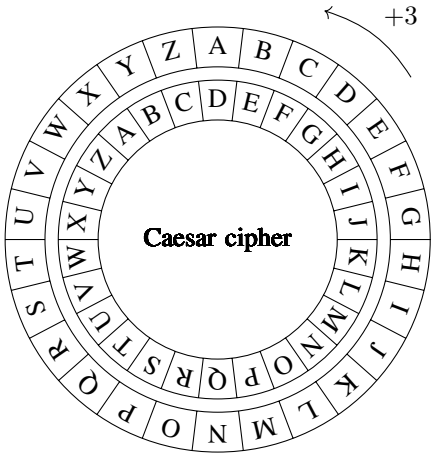

Fig. 4. César's encrypted disk is used to show how the letters of the open alphabet (outermost disk) are related to the letters of the encryptedCip alphabet (innermost disk), where given a shift key k the disk more anticlockwise k times.

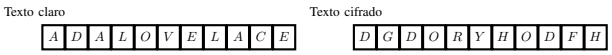

Fig. 5. Example of transcription using the key equal 3.

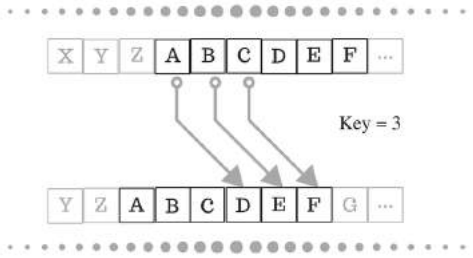

Fig. 6. Example of the encryption process using the Cesar Cipher with displacement equal 3.

context of Ada Lovelace who never lived with her father, but one day found one of her poems, *Don Juan*, a satirical poem. His mother could not even suspect that her daughter was reading Lord Byron's poems. Ada then encrypted a few verses from Song I of the poem using the Cesar Cipher using a three-position left rotation decode the following text, as shown in Figure 7.

E. Maternity station and the pillars of the computational thinking

Learning how to code the real world in different languages is one of the defining characteristics of how humans solve problems, from the simplest to the daily routine, to the more complex ones like the process of photographing a black hole. These skills today are popularly linked to the term "Computational Thinking".

Although the same features have already been termed algorithmic thinking, logical reasoning, the term gains a new outfit through Jeanneat Wing's speech in 2006 that drew attention to the importance of developing problem-solving skills, he said.

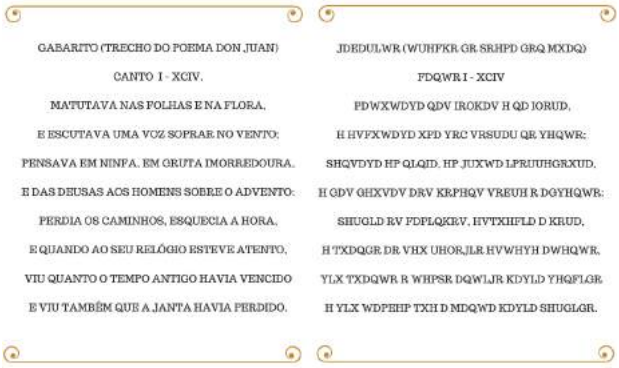

Fig. 7. The *Don Juan* poem: (a) to the right, the source/open text; and, (b) to the left, the same poem in a encrypted way.

including that the topic is so important that it should be part of the school curriculum, such as mathematics and mother tongue.

For Wing [20], Computational Thinking refers to a set of abilities, which may be innate to humans, which allow solving problems in the best possible way, in any area of knowledge, and not only in the areas related to computing. Unplugged activities allow the exploration of computer concepts, without the use of computers, some experiments have been used to promote the development of Computational Thinking, including through narratives, that put users as part of the scenario [3] [5] [20].

The maternity station, as well as the others, used ludification requirements [11], through problem-solving in a proposal to develop computational Thinking in a disengaged way. The objective of the activity was to work the concept of computational functions in a contextualized and ludified way. According to the sequence proposed by the proposed Algorithmic circuit, whose seasons contextualize episodes of the life of Ada Lovelace. See Figure 8.

The action was based on exercising logic through the application of the four pillars of computational thinking [3] aimed at the making of cupcakes. The four pillars are defined as:

- **Decomposition:** it is possible to divide the problem into smaller and simpler parts, improving the understanding of the problem;
- **Pattern Recognition:** with the problem decomposed, the parts are examined in order to find patterns between them;
- **Abstraction:** identifies and highlights the most relevant activities within a problem;
- **Algorithm:** develops a logical sequence to solve the problem.

The activity had a narrative, which proposed the solution of a problem, in the specific case, the participants of the action should play the role of the children of Ada Lovelace and were learning how to make cupcakes. The process of solving the problem allowed the learning of the concept of computational functions, in a playful way. Whose immersion was provided by

Fig. 8. Definition of computational thinking used in dynamics.

the plot proposed by the activity? For Kapp [11], immersion is very important for the promotion of engagement.

IV. Workshop: methodology, execution process and analysis of results

The proposed CS unplugged activity was conducted based on an applied research methodology, with an exploratory character and a qualitative-quantitative analysis, seeking arguments to reinforce the answer to the question about the suitability of performing playful activities, addressing problems and logical games that incorporate concepts to develop and refine the skills related to computational thinking and its four already classical pillars: abstraction, decomposition, pattern recognition and algorithms.

The unplugged activity was planned in five stations, each exploring a different moment in the life of Ada Lovelace and relating, at each stage of life, a concept or set of computational concepts and tangible unplugged tools.

Students from a public school were invited to attend the workshop. Participants were selected on the basis of their interest and availability. Considering that at the time of the activity there were no regular classes in the school, the availability for displacement was lower. In this way, the workshop was offered for boys and girls.

In total 10 students between 13 and 15 years participated: 4 boys and 6 girls. The workshop was held at a University that was hosting an event from the area of computing and technology a few miles away from the students' school. In this way, it was necessary to move the bus with a teacher accompanying the school. Participation in the workshop was an extra-class and optional activity.

At the beginning of the activities, 15 minutes were dedicated to the reception of the participants. Subsequently, each of the young people received a copy of the book that guided the work methodology and contextualized the subject matter. One of the people in charge of a workstation read the book to everyone out loud.

Each station had an activity time of 15 minutes for each group. The students were arranged in tables according to the affinity between them, where each student chose his work table. Each table had approximately 6 seats. One of the tables was with only one student, male, diagnosed with an autism spectrum disorder. Therefore, the groups of students seated at the tables did not obey age, sex or class criteria, occurring the distribution almost in a random manner. All groups would ideally pass through all the workstations. Therefore, all students would see all content.

At the end of the activity, the students participated in a coffee break together with the general public of the event, mainly students of higher education and teachers or researchers College students.

A. Execution and analysis of the Childhood station

The activity was intended to move all the discs of the Tower of Hanoi to the pin of the other end and also to verify how many movements the participants would do in this procedure. As a rule, participants could only move one disk at a time if the disk below is larger than the moving disk.

In the bases of the operant stimuli [13], the learning movement observed in this circuit attenuate the concepts of concentration, movement, motor coordination, laterality, and temporal space. In this sense Vygotsky [19] traces these concepts by bringing the exploration of different bodily postures while performing activities, progressive expansion of dexterity to move in space through constant possibility organized with thought with force, speed, endurance and flexibility, improvement gestures related to apprehension, fitting, drawing in the drawing, launching through experimentation and use of his manual skills in various everyday situations.

In this way the execution of the activity was divided into three stages: i) three disks; ii) four discs; iii) five discs that required seven, fifteen and thirty-one movements respectively.

The first pair consisted of female participants with a 13-year age group. One of the members had already solved the Tower of Hanoi and led the strategy of solving the problem. At the beginning of the activity, both did not demonstrate a motivation to perform the task. However, the degree of complexity increased and they began to train by demonstrating that to the extent that the challenges increased in the degree of complexity proposed were greater the operant stimuli in the development of the activity. To this movement [19], it will be called a creative exercise that enables the mind to compose a structure with variations and alterations by the challenge, moving active learning.

The participant who did not know the Torre assigned a certain complexity in the movement of the discs. However, he exercised very often the mobility of the pieces and at the end, he managed along with the other participant to carry out the activity, as shown in Table I. This movement is attributed to skills built by operant stimuli in which cognitive development is constituted by proximal causes in the case presented here in the frequency of exercises by the movement of the discs. The number of movements in the first two stages was the same indicated by Portal Mathematics Only. The second team consisted of two participants with a 15-year age group. One of the members had already heard about the Tower of Hanoi but had never met the challenge. She started the drive and explained to the other colleague. In this pair, the leadership was shared and both initiated strategic questions about the problem. We observe in this movement excitement and even upset because they can not perform the activity optimally, according to data in Table I.

TABLE I
PERFORMANCE, BY TIME AND NUMBER OF MOVEMENTS, OF EACH OF THE 2 TEAMS, IN PAIRS, IN THE RESOLUTION OF THE GAME OF TOWER OF HANOI.

	Time	Num. Moves
Pair 1	112 s	07
	250 s	15
	301 min e 20 s	38
Pair 2	115 s	09
	201 min	31
	305 min	98

To this movement of learning collaborative inferences of organic collectivity are observed to the extent that the knowledge was used as systems of exchange enabling this shared leadership (Gardner, 2005).

Regarding the result of the doubles, the performance of the first is directly related to the experience that one of the members already had. Unlike the second pair who claimed to have no previous knowledge and performed the third stage with more than 200

The relationship between the two learning movements will occur in what Gardner [8] calls the ability to generate products defined in the field of cognition in which this way of conceiving the neural organization implies in the recognition of different ways of information processing.

B. Execution and analysis of the Cat Puff station

At this station, the purpose of the activity was to present the binary numbers in a playful way. In all, six young people participated in the activity: three 12-year-old boys, one boy, and one girl were 13 years old, and one girl was 15 years old. The activity was developed in a group and the members helped themselves and commented on the proposed challenges.

According to Piaget [16]. the process of development in the work with numbers will require the coordination of the perceptions by which the formal Operative Intelligence will move to the construction of reflection and abstraction of thought. The plot of the activity was the story of the cat of Ada Lovelace and through it was reported on the binary order of numbers and how to count the elements in the computational pattern.

After the texts presented basic concepts, calculations were proposed for young people to discover which decimal number represented a certain sequence of binary numbers. At the end of the activity, a binary number sequence represented some letter and, by joining several sequences, students discovered the phrase “Fight like a girl”. See Figure 9.

The learning movement undertaken in this activity determines the important role of the symbolic game of numbers because in addition to interactivity caused individual situations that cognitively and affectively the action represented by the scenario of the game caused evoked situations, a characteristic of representation that occurred independently of language [15].

Predominantly, young people are most likely to be socialized by peers of the same gender. This also means that boys and girls achieve different experiences and learn skills,

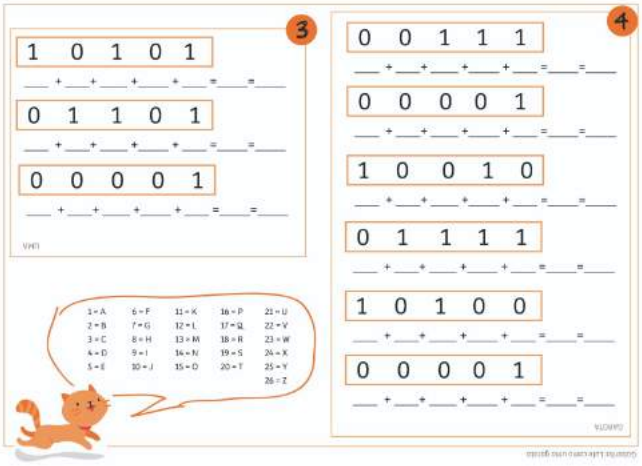

Fig. 9. Example of the activity in the Cat Puff station.

competencies, and interests in their interactions with perrs from the same sex [9]. This was actually observed in our experiments, where groups were allowed to be formed freely according to their affinities and interests. And, there were groupings of girls and boys. Even when the team got mixed up, the same-sex peers interacted more.

The students took about twenty minutes to complete the activity. The girls performed slightly better than the boys, watching the time elapsed to finish the challenges of the activity. Throughout the work, no comments or sexist or prejudiced behaviors were observed on the part of the young men. At times, boys and girls talked to each other to help the group unravel the calculations.

All students completed the challenge, with one kid taking more time than the rest of the group and needing help from the coordinators of the activity. One of the factors that may have led to the best female performance in the activity was the older age of most boys.

According to Piaget [16], behavior in the learning process seeks to maintain balance in the internal and external factors or the delay in performing the activity calls this balanced search to organize the thought and adapt in the relationship with the objects that are part of the construction of knowledge by which the subject that best organized in the motor sensory phases independent of sex, female or male, will gain the highest speed of action, since it is a construction process.

In this sense, it is concluded that the activity applied in this study is in line with what Piaget [14] will call adaptation to the environment, since in the course of the development of the activity there was the mobilization of several cognitive processes, such as reasoning, attention and thought were used to solve the activity implying organized constructions regardless of the time they took to complete.

C. Execution and analysis of the Friendship station

When the students arrived at the station, they received a worksheet with a list of numbers in each line. After 15 minutes the group was invited to give their response and go to the next station.

Only to groups of students arrived at this station. One of them took 9 minutes and 45 seconds to complete the activity. The other one took 9 minutes to fill all the black squares. It was composed by two female students of 14 years old (see Figure 10.

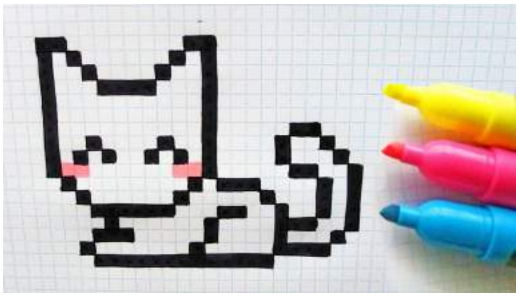

Fig. 10. Example of the image of a cat in reference to the cat of Ada, whose name is PUFF) to the representation image activity in Friendship station.

D. Execution and analysis of the Family station

To understand the learning process with the pre-teens who participated in the circuit, it is necessary to map the bases in the operant stimuli worked by Vigotsky in the learning movement [13]. In this sense, the observations during the application of the cryptographic activity enabled the comprehension of the language and objectives of the encrypted information as well as the pedagogical action guided in this process of learning in the visual field to the cognitive plane that directed forms of communication between the doubles in the development of the activity.

Considering this mapping, the first pedagogical aspect observed was the paths taken by each pair for the cryptographic reading by which they developed different modes by changing the reader and recorder position by which each pair carried out its autonomy. Another aspect observed was the characterization of the learning movement given to three stages of development by which in the first stage we observed the projection of the expectations contained in the text as for example words not common in the Brazilian vocabulary observed by two pairs.

In the second stage, this movement was due to the integrating recognition of the participants that the pedagogy calls multimodal reading and writing contributing to changes of postures in the process of literacy in trying to complete the text before finishing the decoding and in the third stage the lesson of otherness that is learned by the cognitive modifiability that is the overcoming of fragility presented in the course of the activity as: reflexes, mirror movement, motor coordination and laterality.

In the process of learning mediated in Feuerstein's theory, the stimuli occupy spaces full of symbologies imbued with important meanings in direct learning in which the interaction as an act of cultural transmission of values, attitudes, and intention, moves specific information and determines the

cognitive development by the in the case, mediated learning experience and the endogenous and exogenous causes that are the genetic and cultural factors [13].

The analyses carried out in the cryptography activity are not unrelated to the universe of subjective values and the positions taken in front of the course made by the participants, which does not diminish the beauty and importance of this learning dynamic, understanding that, in this sense, nothing more liberating than this challenging movement begins with the playful form.

E. Execution and analysis of the Maternity station

Complying with the Circuit, the maternity season has the following narrative "Ada is promoting a party, and decided to use the making of cupcakes to explain algorithms and functions for the children". With the help of the children, you can optimize the process of confection of the cookies, finishing the work more quickly.

Circuit participants received lists of cupcakes in different states (full, cover and mass+cover) and should create functions that would leave all cupcakes in the "full" state. The mission of each of the participants was to create the largest number of cupcakes through the design of functions that mechanized the process. The more optimized the functions, the greater the number of cupcakes produced.

As described in Figure 11, the cupcake could have three possible states. If the cupcake was complete, nothing could be done, but it could only have the shape, needing mass and filling, or could have the shape the mass needing the cover, as described in the algorithm in Figure 13.

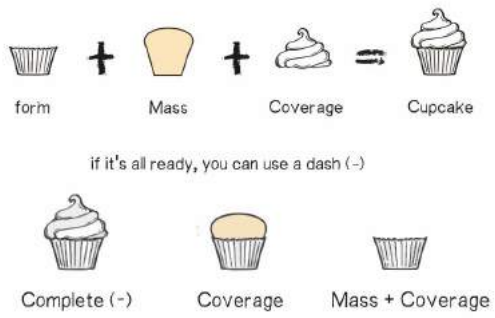

Fig. 11. Demonstration of the composition of the cupcakes and each of the possible states.

Each team received a sheet containing examples of how to solve the task and a list of problems to be solved, as shown in Figure 12. In addition to the written instructions, the participants were instructed by monitors to remove doubts as they came.

The activity was based on the tacit knowledge of each of the participants, on the components of cupcakes and attributes, process and identity of variables and implicit form. Although at no time did they receive as a hint the mathematical concepts of functions, variables or order, they followed standards in

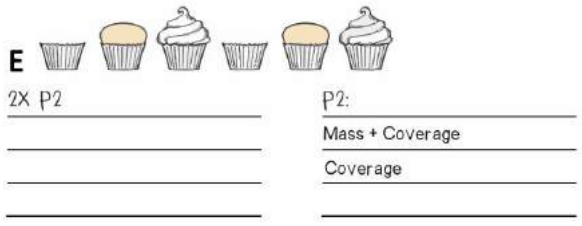

Fig. 12. Example of problem solving presented through a function.

solving what was proposed to them, clearly following an algorithmic process, demonstrating the application of the pillars of computational thinking. In Figure 13 it is possible to see the algorithm of basic resolution of the task.

```
Home_algorithm
        Read quantity_cupcakes // enter the amount of cupcakes
        while quantity_cupcakes> 0
                if cupcake == complete
                    So quantity_cupcakes--;
                if else cupcake == shape + mass
                    Then add coverage
                    quantity_cupcakes--;
                if else cupcake == shape
                    Then add mass + coating
                    quantity_cupcakes--;
End_algorithm
```

Fig. 13. Example of problem solving presented as an algorithm (pseudo-code).

The workshop participants had the function of creating the largest number of cupcakes by designing functions that mechanized the process. The teams were engaged in solving the problems presented, taking an average of 15 minutes to complete the activity. The girls were slightly faster in performing the activities than the boys.

In the purely feminine teams, the prevalence of leadership positions was not noticed. They discussed and worked hard to solve problems presented without competitiveness. In the purely boys' teams, there was a small "dispute" and haste in resolving the proposed issues. During the execution of the tasks, there were no comments of a sexist nature nor "jokes" that could be misinterpreted. In general, everyone was challenged and willing to participate in the proposed circuit.

It can be observed in the application of this activity that the central aspect was the development of the mathematical language of greater strength in the measure that the proposed numerical schemes required cognitive processes of abstraction that favored a reconstruction processed by the symbolic thought of mental representativeness in which the space and time of each phase would require operational skills based on mental representations favoring greater objectivity in the processes and phases of knowledge construction [16].

In this sense, the playful way of contextualizing the activity made possible the socialization and the movement of the exchange system, consolidating the collective work that Feuerstein (1990, ibid Meir and Garcia 20117) [13] emphasizes the

construction of relations that sediment the capacity, participation, affective bonds, cooperation and respect in relationships, establishing in these processes mediated learning.

Fig. 14. Some moments of the Workshop, with the teams executing the actions of the activities proposed in each station.

V. Gender analysis: behaviors and performances

In general, throughout the accomplishment of the activities in the stations, the teams showed themselves engaged in solving the presented problems, were able to solve the challenges within the proposed time limit. During the execution of the tasks, there were no comments or behaviors that were sexist, or even "jokes" that could be misinterpreted, neither by the male nor the female. In general, everyone was challenged and willing to participate in the proposed circuit.

At various times, boys and girls interacted to help the group solve problems and perform calculations (Figure 14). Predominantly, young people tended to talk and interact more with people of the same sex. Overall, all students completed the challenge, some of them receiving more support than others. In the purely feminine teams, the prevalence of leadership positions was not noticed. The girls discussed and worked hard to solve the problems presented without competitiveness. In the purely boys' teams, there was a small "dispute" and haste in resolving the proposed issues. In one case, a boy took more time than the rest of the group and needed special help from the coordinators of the activity. Overall, girls were slightly faster in performing activities than boys. One of the factors that may have led to the best female performance in the activity was that, on average, the girls' age was higher than the average age of the boys.

VI. Concluding Remarks

The workshop showed that it is an interesting strategy to use CS unplugged activities to bring students closer to computational concepts and techniques, and to develop computational thinking skills in general. Also, due to the independence of the use of computers and places with special infrastructure for their realization, such activities are suitable for accomplishment in events and schools.

Also, such unplugged computing activities allow the theme of gender equity to be worked on with girls and boys, making it possible to analyze gender in the face of behavior, skills, and performance. Thus, such activities and event proposals are appropriate and have been stimulated in engagement projects such as those of the Digital Girls Program and in events focused on the theme of women in computing, as was the case of this Workshop, which was carried out during the 10th edition of the (BLIND) event.

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