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TRADITIONAL STORIES AND THE INTEGRATION OF PROGRAMMING AND ROBOTICS WITH THE KIBO ROBOT

LOS CUENTOS TRADICIONALES Y LA INTEGRACIÓN DE LA PROGRAMACIÓN Y LA ROBÓTICA CON EL ROBOT KIBO

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ABSTRACT

This research emerged from the implementation in kindergarten context of the curriculum "Powerful Ideas And The KIBO Robot Curriculum: The Traditional Children's Stories, for The Integration Of Programming And Robotics" developed by (Miranda-Pinto, 2021) in a perspective of replicating this previously designed curriculum. Case study was usedto observe skills associated with computational thinking, in a specific group of pre-school children, having been implemented in June/July 2021, with a duration of 20 hours. The main data collection tool, Positive Technological Development framework (Bers, 2018); (Bers, 2012) was used to observe children's behavior in their activities with the KIBO robot. The results reveal maximum levels of the indicators of the various dimensions (6 «C´s»), which in preschool represents engagement and significant learning. However, this work would have had more consistent results if it had been developed during the whole school year, which is an ideal situation when integrating robotics into preschool curricular activities. Previous research (Miranda-Pinto *et al.*, 2021) allowed us to understand that the most complex programming concepts can be worked on when the work progresses at a playful pace, parallel to the children's learning and gradually throughout the school year.

KEYWORDS

Computational Thinking; Programming; Robotics; Preschool; Positive Technology Development; KIBO Robot; Curriculum.

RESUMEN

La investigación que presentamos surgió a partir de la implementación en el contexto del jardín de infantes del currículo "Ideas Poderosas y el Currículo del Robot KIBO: Los Cuentos Tradicionales para Niños, para la Integración de la Programación y la Robótica" desarrollado por (Miranda-Pinto, 2021) en una perspectiva de replicar este currículo previamente diseñado. Se utilizó la metodología de estudio de caso para observar las habilidades asociadas al pensamiento computacional, en un grupo específico de niños de preescolar, habiéndose implementado en junio/julio de 2021, con una duración de 20 horas. Utilizamos el marco de Desarrollo Tecnológico Positivo (Bers, 2018); (Bers, 2012) como principal herramienta de recolección de datos para observar los comportamientos de los niños, en las actividades con el robot KIBO. Los resultados revelan niveles máximos de los indicadores de las distintas dimensiones (6 «C´s»), lo que en preescolar es sinónimo de engagement y aprendizaje significativo. Sin embargo, este trabajo habría tenido los resultados más constantes si se hubiera desarrollado durante todo el año escolar, situación ideal cuando se integra la robótica en las actividades curriculares de preescolar. Investigaciones anteriores (Miranda-Pinto *et al.*, 2021) permitieron entender que los conceptos de programación más complejos pueden ser trabajados cuando el trabajo avanza a un ritmo lúdico, paralelo al aprendizaje de los niños y de forma gradual a lo largo del año escolar.

PALABRAS CLAVE

Pensamiento computacional; programación; robótica; preescolar; desarrollo tecnológico positivo; robot KIBO; Curriculum.

1. INTRODUCTION

The principal aim of this research was to replicate the KIBO robot curriculum, for the integration of robotics in a pre-school context, which was previously developed in an academic context by (Miranda-Pinto, 2021). The central theme of the curriculum can always be variable as long as the concepts associated with programming can be developed. The advantage of integrating the KIBO robot kit is that it is a robot that is programmed with tangible blocks and allows the child to be free from screens for its use (Bers, 2018). To develop this curriculum, the guidelines of all the work conducted by Bers (2018), Sullivan *et al.* (2015), Rosenberg & Bers (2014), Elkin, Sullivan, & Bers (2014); Bers & Horn (2010), but also of what it has been developing in Portugal in kindergartens within the scope of programming and robotics, including the KIBO robot, which allowed to design this curriculum for a preschool educational context (Pinto *et al.*, 2021); (Miranda Pinto, 2019); (Miranda-Pinto & Osório, 2019); (Miranda-Pinto *et al.*, 2017).

What defines this work as different is the work with the KIBO robot, which is the only robot we have worked with programmed with tangible blocks and integrating different components, such as sensors and actuators, concepts that provide programming levels that can go from the simplest to the most complex, when it introduces the "Repeats" or "Ifs". To understand the potential of the KIBO Robot and how we can observe the children's behaviors in a technological environment suitable for preschool age, a theoretical framework divided into two points - Integration of the KIBO Robot in Preschool and Theoretical perspective of 6 C's of the PTD (Positive Technological Development) framework – is outlined. This background will allow to understand the construction and development of the curriculum for kindergarten context. The methodological design, the results, the discussion and the conclusions will follow the background theoretical framework.

1.1. INTEGRATION OF THE KIBO ROBOT IN PRESCHOOL

Research into the integration of the KIBO robot in preschool education is evident, mainly in the United States, where this robot was developed (Rosenberg & Bers, 2014), but also in some other countries that are beginning to develop a research and integration of programming and robotics from preschool onwards and are eventually including KIBO in their activities. This educational robotics kit was designed in 2011, tested with groups of children and commercialized for educational purposes in recent years, with the aim of filling a gap in this area dedicated to children's early years. It is important to say that, «the concept, prototypes, and research for KIBO were born in (...) DevTech research group in 2011 through generous funding from the National Science Foundation (...). KIBO became commercially avaliable worldwide in 2014 through Kinderlab Robotics» (Bers, 2018, p. 138). It is important to highlight that KIBO is not simply to be commercialized, but rather to be integrated in an educational context and with a playful purpose. Its development involved a research team that understood that programming and robotics can be part of preschool and that "this is possible when children are given tools that are developmentally appropriate, that encourage open-ended play, and that allow the integration of technical skills with expressive arts, math, and literacy. The KIBO kit «was developed collaboratively with teachers, children, and a research team consisting of designers, engineers, and child development specialists» (Sullivan *et al.*, 2015, p. 421). As mentioned by (Sullivan

et al., 2015) «The KIBO robot (...) was developed in order to fill this gap in the availability of engineering tools for young children» (p. 418).

KIBO is a very complete kit for preschoolers, which allows a very comprehensive integration of programming and robotics in the concepts that we intend to integrate in the area of computational thinking. According to (Sullivan & Umaschi, 2018) «KIBO is a robotics construction kit that involves hardware (the robot itself) and software (tangible programming blocks) used to make the robot move (Sullivan & Bers 2015). KIBO is unique because it is explicitly designed to meet the developmental needs of young children. The kit contains easy to connect construction materials including: wheels, motors, light output, and a variety of sensors» (p. 331). This educational resource designed especially for preschool age and with the advantage of integrating components that can be worked on in the future, programming concepts make the difference with this robotics kit. Furthermore, it places the child in a more interactive role in its use, because it implies that they assemble the robot with its components and manipulate the tangible blocks for its programming. For (Elkin *et al.*, 2016) «although there are now many commercially available robotic kits that teach about programming, (...) are «pre-built» in the sense that children are not involved in any of the construction or design aspects of building a robot» (p. 171).

The potential for integration of programming and robotics for preschool and early primary school children in the Portuguese context became evident from the first educational conext applications (Miranda-Pinto *et al.*, 2021); (Miranda-Pinto, 2021); The programming concepts that can be worked on with KIBO are extensive because of the curricular areas that can be integrated, the creativity, the collaborative learning that can be developed, as well as the concepts associated with computational thinking that can be developed. As defined by (Bers, 2018), «Designed with a playground approach, KIBO supports children in making almost anything: a carácter from a story, a carousel, a dancer, a dog sled. The possibilities are endles, as wide as children´s own imaginations. The child puts together a sequence of instructions (a program) using the wooden KIBO blocks. Then, they scan the blocks with the KIBO body to tell the robot what to do. Finally, they press a button and the robot comes «alive». KIBO engages children in becoming programmers, engineers, problln solvers, designers, artists, dancers, choreographers, and writers» (p. 138).

1.2. THEORETICAL PERSPECTIVE OF 6 C'S OF THE PTD (POSITIVE TECHNOLOGICAL DEVELOPMENT) FRAMEWORK

It´s possible to understand that the six C's are interconnected and can be worked through the different areas of knowledge and allow moments of great involvement in activities by children. Kindergarten is undoubtedly a privileged education context that can promote all the behaviors of the PTD Framework (Bers, 2012, p.13) considering that this is inspired by Constructionism, developed by Seymour Papert and Positive Youth Development, because it puts the child in the central place of the learning process. The PTD Framework clearly studied and validated in kindergarten contexts, in several research projects (Bers, 2012); (Bers, 2018); (Strawhacker & Bers, 2018) allows us to support our research in this observation framework. When we analyse the perspective of the 6 C's we realise that in a preschool environment Communication is obsevable in all learning processes with technologies and «programs informed by PTD must welcome the enormous possibilities for sharing ideas, thoughts, and feelings, for forming new social relation-

ships and maintaining old ones, offered by our technological landscape» (Bers, 2012, p.101). According to (Bers, 2022), «In the playground, there is conversation. Language socialization plays a key role in cognitive development as well as personal, social, and emotional growth. A healthy playground is not a quiet place». (p. 142).

Regarding Collaboration (Bers, 2012) «is the willingness to respond to the needs of others. To assist others, and to use technology as a means to help others», (p.111), this being a key skill that we must promote in the development of the child since preschool and that transversal to all areas of knowledge. For (Bers, 2022), «For collaboration to happen, there is a need for a share goal and cooperation on a common task. This can be challenging in early childhood; for a typically developing young child, the turn-taking, self-control, and self-regulation required to effectively collaborate on a Project is difficult. Coding provide another opportunity to practice these skills (…)». (p. 142 & 143). The exchange of knowledge with the Community is another learning moment, in which the child feels recognised throughout the process of creating a project. According to Bers, (2012) «All six C´s are interrelated, but according to Lerner, the C of contribution makes thIn all come together and is «the glue that creates healthy human development» (2007, p. 183), cit in (Bers, 2012, p. 119). In the perspective of (Bers, 2022), «Community building takes this a step further by offering mechanisms for giving back to others and contribuiting to our communities» (p. 143).

Content Creation, «is the most powerful of all: our technological landscape must provide opportunities for children to create their own projects» (Bers, 2012). It is more important than ever that children have the possibility to become producers of their own contents, resources, games, activities and not merely consumers of the information that surrounds them. For (Bers, 2022), «The activity of coding involves using an artificial language to create. (…). To create her own Project, she learns to ask questions, identify a goal, formulate an action plan, make an initial attempt, test, evaluate, and revise her ideas by assesing what went wrong and what could be done better». (p. 141).

Creativity is, undoubtedly, a fundamental pillar of learning, which we wish to see in multiple ways in our educational contexts and with technology we can expand these possibilities. To Bers (2012), «One of the potentials of our digital landscape is that it can offer Creative technologies that can be programmed to take on a «thousand forms» for a «thousand functions» and appeal to «thousand tastes» (Papert, 1980) cit in (Bers, 2012), p. 85. From a more recent perspective (Bers, 2022), adds that, «creativity requires training and hard work. Contradicting some popular myths, the creative child is not necessarily the one who wake up one morning saying «Eureka!» but the one who is disciplined in her work, takes risks, and can find new connections» (p. 142). Finally, we have Choice of Conduct which provides that «The process of making choices is an important aspect of building a strong sense of character» (Bers, 2012, p. 91), in order to give the child, the opportunity to be empowered in the learning process with technologies and, in turn, to promote their responsible use. As Bers tells us »anytime we do something, we make choices and must asume consequences. This process, when authentic, builds character» (Bers, 2022, p. 142).

Recent research reveals that «It makes sense that children's learning environments, too, should be equally intentional and supportive of children's developing skills» (Strawhacker & Bers, 2018, p.

15), therefore, preparing an environment that involves all the dimensions foreseen in the Positive Technological Development framework can provide enriching experiences at various levels for children and kindergarten teachers. The possibility of combining the 6 C's is also in line with the most recent perspective of (Bers, 2022), when the author proposes a different metaphor that does not focus only on the knowledge that can be built when we work with technologies in kindergarten. It is important to value other dimensions and as Bers states: «A coding playgroung needs guiding values and not only behaviors. While different cultural in which the act of creative production is rewarded lends itself to values such as curiosity, determination, and persistence (Bers, 2022, p. 143).

2. DESIGN AND METHOD

This research aims to:

- Replicate the previously designed KIBO Robot curriculum (Miranda-Pinto, 2021) "The Traditional Children's Stories, for The Integration Of Programming And Robotics"
- To understand how more complex programming concepts can be worked at a playful pace, in parallel with children's learning, and the presence of the 6 C's of the Positive Technological Development framework (Bers, 2012), in these activities.

The research is approached from a qualitative perspective based on the case study (Yin, 2014), providing an interpretive and descriptive approach to the data obtained through the development of the KIBO Robot curriculum. For the observation of the activities, the Positive Technological Development framework (Bers, 2012) was used as it allows us to give a direct response to the established objectives.

2.1. RESEARCH DESIGN

All the lessons revolve around the big "Powerful Idea", which is to tell the story of the "Three Little Pigs". The subject units presented in this research have been developed for a specific curriculum, which was implemented in a kindergarten with 11 children as a pilot study, but it is important not to forget that educators who want to introduce coding in the context of early childhood education need not only knowledge of programming languages, but also of how to work the curriculum of the KIBO robot for its development. The chosen theme does not limit the work of the curriculum and therefore it is possible to develop other themes, which are of interest to the children. Even within the theme of traditional stories we can choose multiple themes. The important thing is that the child is invited to explore programming and robotics in themes that happen in the family or in the educational context. The intention is always to realize the advantages of the "Powerful Ideas" advocated by (Papert & Harel, 1991) that make sense for children and their learning process.

The development of this curriculum foresees a total of 20 hours of work with children, preferably children who have already had contact with computational thinking, programming or robotics activities during a school year. The design of the curriculum may be initiated by the educator or built together with the children, in a more comprehensive process that allows flexibility at various levels. In this specific case, the collaborating teacher carried out the activities with the group of 11 children.

The intention was to replicate the design of the KIBO Robot curriculum previously designed "The Traditional Children's Stories, for The Integration Of Programming And Robotics" (Miranda-Pinto, 2021), with the same story of the "3 Little Pigs and the Big Bad Wolf" (Table 1), adjusting only details, according to the group of children. The purpose was to test the curriculum and understand its validity for integration into pre-school, since it was designed in an academic context. To observe the activities, the Positive Technological Development framework (Bers, 2012) was usedin order to understand the presence of the 6 C's during the activities developed. The example of a robotics curriculum framework with KIBO was initially designed and evaluated in a higher education context at Tufts University, in the context of the curricular unit «Online Seminar in Technological Tools for Playful Learning» - Tufts Early Childhood Technology (ECT) certificate program (Miranda-Pinto, 2021). Therefore we replicate the proposal of this curricular structure (Miranda-Pinto, 2021, p. 3598):

Table 1 - The KIBO Robot curriculum "The Traditional Children's Stories, for The Integration Of Programming And Robotics" (Miranda-Pinto, 2021)

Lesson Topic	Children will be able to…
1- The Enginee-ring Design Process	• Plan a project from a traditional story, through group work, promoting collaboration among children • Idealize how to put the previously built scenery in 3D and the paths, for the robot to follow • Designing robot prototypes for the realization of the project • Using "The Engineering Design Process" will allow the group of children to conceptualize the various phases to build their robot (engines and sensors needed for each of the lessons) and decorate KIBO as the main character, the "Bad Wolf"
2- Robotics	• Define the character that will later be programmed to retell the story with the Robot • Know What Is A Robot? • Know and be able to identify all parts of the KIBO Robot • Try to assemble the KIBO robot and realize how it works (place motors, wheels, turn on, scan the blocks), so that the robot moves • Program the robot in several steps, with the simplest programming blocks (front, back, right and left), allowing the child to see how the robot moves and executes a sequence of actions
3- Progra-mming	• Define routes that the robot will have to take to get to the house of each one of the little pigs • Program the robot with a complete sequence (go through all the houses) • Understand what errors they encounter in programming, but also how they can simplify the algorithm and thus work on debugging
4- Sensors	• Use the "Sound" sensor and the "Wait For A Clap" block at the beginning of the programming sequence • Use the "Light Output" actuator every time the Robot ("Bad Wolf") passes in front of a House. The Child realizes that the KIBO robot has completed one stage of the programming.
5 - Repeat Loops	• Use the "Repeat Loops" blocks in programming situations that need to be simplified, for example, in the sequences where the "Bad Wolf" goes to each one of the houses • Understand the advantages of using the loop blocks and a number of repetitions, so that the Robot ("Bad Wolf") is able to go from the Forest and go to each one of the “3 Little Pigs” houses.
6 – Conditio-nals	• Use the "Light" actuator after completing the sequence, as a way to perceive the end of the whole journey through the forest and passing through the houses of the "3 Little Pigs" • Realize that when the robot arrives at a house, it needs to identify this situation as a condition to be evaluated by the robot. For example, the robot when finding the first house turns around and continues the route. Here you can use the "If" and also the "Distance Sensor".
7- Final Project	• In the final project the child will be able to retell the story of the "3 Little Pigs", with the KIBO robot as the main character, the "Bad Wolf" • To expand the Project, the Child can integrate one or three more robots, which would play the role of the "3 Little Pigs" and they would have to have a program to escape from the "Bad Wolf" • Children can also explore the dance choreography, presented in the musical video • Use the Robot ("Bad Wolf") as a character of other traditional stories, that the children know and here work the curriculum unit.

Source: Own elaboration

2.2. SAMPLE

This research was carried out in a kindergarten in the interior of Portugal, with a group of 11 children, in June and July 2021. The sessions organized by the curriculum lessons were previously designed and adapted to the educational context and children. The learning rhythm of the children was respected, as well as the initiation to the integration of the robot KIBO, as it had not been worked during the school year due to the great period of isolation and closing of schools because of the pandemic.

2.3 PROCEDURE

Data collection focused mainly on the criteria of the Positive Technological Development framework and videos and photographs were used to support the analysis after the implementation of the activities. The activities were carried out at the end of the 2020/2021 school year, following the time distribution, as presented in Table 2.

Table 2. Scheduling of Activities

JUNE								JULY	
02 / 06	**09 / 06**	**11 / 06**	**16/06**	**17 /06**	**23 / 06**	**24 / 06**	**30 / 06**	**01/07**	**06/07**
L1	**L2**	**L3**	**L4**	**L5**	**L6**	**L6**	**L7**	**L7**	**L7**
120′ (30′+ 60′ + 30′)	120′ (30′ + 60′ + 30′)	120′ (30′ + 60′ + 30′)	120′ (15′ + 90′ + 15′)	180′ (30′ + 120′ + 30′)	180′ (30′ + 120′ +30′)	180′ (30′ + 120′ +30′)	120′	120′	120′

Source: Own elaboration

In each of the sessions, the respective activities were organized with the aim of meeting the objectives set out in the curriculum but considering the development of this specific group of children. Thus, their initial skills, their interests, and the learning they were developing during the process of integrating the KIBO robot curriculum were considered, in order to adjust the curriculum and its different stages. The kindergarten teacher prepared the general planning and went on to fill in the gaps in the curriculum as learning was achieved.

3. FIELDWORK AND DATA ANALYSIS

The implementation of the KIBO Robot curriculum gave rise to the development of seven previously proposed lessons which, with varying degrees of development, the teacher who collaborated in the research was able to develop with the group of 11 children. It is important to refer that the total number of hours of the curriculum was about 20 hours and over 6 weeks, thus allowing a gradual approach to the concepts that each lesson provided. In the results section,

we present each of the lessons descriptively, in order to exemplify how it is possible to work with this curriculum in pre-school. In the discussion of the results, we will analyse the results of each lesson, both with the observations of the teacher, as well as the results obtained through the Positive Technological Development framework.

3.1. LESSON 1 - THE ENGINEERING DESIGN PROCESS IN THE TRADITIONAL STORY OF THE 3 LITTLE PIGS

Powerful Idea: Traditional stories for children and the Choice of the story the 3 Little Pigs - Robotics with the KIBO Robot. The Engineering Design Process is a process used by engineers to help thIn create new things. It consists of 6 steps: QUESTION, IMAGINE, PLAN, CREATE, TEST AND IMPROVE, and SHARE.

Overview: In lesson 1, the Educator knows that students are interested in the theme of traditional stories and every day they like to hear a story. In these ages (4 to 6 years old), the 3 Little Pigs' Story is always one of the favorites, because they have to deal with the "Fear" they have of the wolf and manage to put themselves in the role of the 3 Little Pigs that always end up getting out of every situation well. The children in this curriculum have the opportunity to experience the whole process of engineering design, to explore how to build and organize the elements of the scenario, and to program KIBO. In this process children can imagine and define which or which paths "Wolf", who will be the main character of Robot KIBO, will take. It is possible that children need to test the sequence of actions with their own body and thus experience the notions of space and sequence, through what I consider to be important, that is, the computational thinking without technologies.

Time: 120 minutes. No. of participants (Children) in kindergarten: 11 children (4 years old = 9, 5 years old = 2).

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in making projects based on traditional stories, which promote the knowledge of different curricular areas and the use of different materials.
- Students have previous experience in the area of computational thinking without technologies and that involves the programming concepts that are expected for these ages.

Students Will Understand That:

- The engineering design process is useful for planning and guiding the creation of artifacts.
- There are many different kinds of engineers.
- The creation of a project integrates several parts and different work teams, to achieve a common goal.

Students Will Be Able To:

- Plan a project from a traditional story, through group work, promoting collaboration among children.

- Idealize how to put the previously built scenery in 3D and the paths, for the robot to follow.
- Designing robot prototypes for the realization of the project.
- Using «The Engineering Design Process» will allow the group of children to conceptualize the various phases to build their robot (engines and sensors needed for each of the lessons) and decorate KIBO as the main character, the "Bad Wolf".

Materials Needed:

- Story Book «The 3 Little Pigs».
- Musical Video «The 3 Little Pigs»: https://www.youtube.com/watch?v=KL5-wzi1Mpw
- Engineering Design Process poster.
- Pictures of different parts of the story.
- White sheets, pencils and colored pencils.
- Parts of the 3D Scenario of the Story of the 3 Little Pigs to be set up in the kindergarten room.

ACTIVITY DESCRIPTION

Warm-Up Activity (Time: 30 minutes)

The Educator tells the story of the "3 Little Pigs" and then shows the Musical Film of the story in order to involve children in a Multimedia dimension and encourage the next phase of work. This warm-up time serves as Motivation and Engagement and will provide children with the necessary basis to develop their own powerful ideas.

Main Activity (Time: 60 minutes)

Introduce the concepts and the task to be developed, following the inspiration of the Engineering Design Process. In large group talk about the story and the film. Show the different parts of the story scenarios and promote discussion about each character and their role in the story. Question the children how we will create the scenario of the story in our room to tell the story? Share ideas and introduce the stages of the engineering design process. Divide the children into 4 working groups. Each group identifies the concepts associated with the part of the story they have to develop. The children draw the elements to be built or reused available in the room, thus creating a conceptual map of the story and promoting the development of Powerful Ideas. The Children build with recyclable materials or reuse objects, for each part of the story. Example of dialogue with the Children: «In Lesson Number 1 we will learn how to develop our Powerful Idea, with the help of engineering design process. So, it's important to understand that, when you do a project, you do it because you have questions you would like to answer. You will be able to imagine how to answer those questions. You will be able to plan solutions! You will be able to create your solutions, test and improvise your creations. If in the end you feel that new questions have come up, don't forget that it's important to go through all the phases of the engineering design process again.»

Concluding Activity (Time: 30 minutes)

Share the results of Main Activity with the large group and experiment with the placement of the various scenarios in the room. Children play freely to experience how the characters move in the story, thus promoting the retelling of the story without technologies and with the possibility of experiencing the sequential movements with their own body.

Lesson 1 Vocabulary

- Design - a plan for a building or invention. Children experience the role of managers of a great project
- Engineer - someone who invents or improves things. Children build and experiment with what they develop
- Story's - Traditional stories and their narrative, which allow the development of language, imagination and creativity
- Story Characters - Identification of characters and their characteristics
- Action/Sequence - Children are able to describe the actions and sequences of each of the characters.

Assessments To Be Used:

- Photos and Video
- Designs
- PTD Checklist

Results:

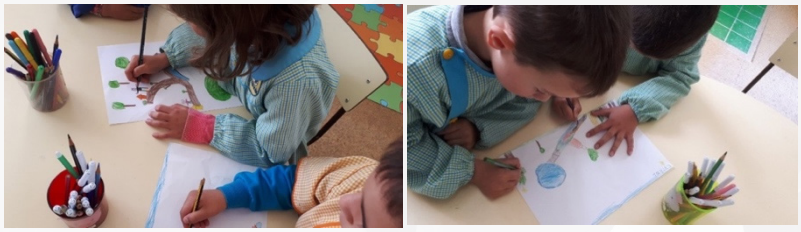
Image 2 - Inspiration on the Engineering Design Process (Bers, 2012, p. 142)
Visualization of the Story of the "3 Little Pigs"

Source: Own elaboration

Image 3 - Sequence of the story of the "3 Little Pigs

Source: Own elaboration

Image 4 - Drawing the Story



Source: Own elaboration

3.2. LESSON 2 - WHAT IS A ROBOT?

Powerful Idea: What is the character of the story that can be programmed in the Robot? - Robotics with the KIBO Robot. Robots have special parts that enable thIn to follow instructions. They need moving parts, such as motors, to be able to perform behaviors specified by a program. The robotic 'brain' has programmed instructions that make the robot perform its behaviors.

Overview: In Lesson 2 we will discover the one that in the story of the 3 Little Pigs, one of the characters can help us to recount the complete story. This discussion of ideas with the group of children is essential so that after understanding what a Robot is, the child can decorate and program the robot to tell the story. It is important that the children understand what a Robot is, what its parts are, how it can be programmed and how it moves. It is also important that children realize that they have an important role in programming the robot and that it is they who introduce the instructions (algorithms), which allow it to execute a sequence of actions. In this lesson we present the KIBO Robot, all its components and the children try to assemble some of its parts, digitalize blocks and create a small program to perceive the movements of the robot.

Time: 120 minutes. No. of participants: 13 children (4 years old = 10, 5 years old = 3)

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in the area of computational thinking without technologies and involving the programming concepts that are expected for these ages.

Students Will Understand That:

- What is a robot and which robots do they know?
- Are able to identify the parts of the KIBO Robot and how all the parts are assembled for its functioning.
- It is necessary to create an algorithm (sequence of simple actions), scan and then the robot execute the actions. It is important to highlight the start, end and motion blocks (right, left, front, back).

Students Will Be Able To:

- Define the character that will later be programmed to retell the story with the Robot.
- Know What Is A Robot?

- Know and be able to identify all parts of the KIBO Robot.
- Try to assemble the KIBO robot and realize how it works (place motors, wheels, turn on, scan the blocks), so that the robot moves.
- Program the robot in several steps, with the simplest programming blocks (front, back, right and left), allowing the child to see how the robot moves and executes a sequence of actions.

Materials Needed:

- Stories for children about robots, for example, "The Robot Book" or "No-Bot, the Robot with No Bottom" or videos about Robots.
- KIBO Robotic Kit.
- Pictures of different part of the story.
- White sheets, pencils and colored pencils.
- 3D Scenario of the Story of the 3 Little Pigs.

ACTIVITY DESCRIPTION

Warm-Up Activity (Time: 30 minutes): It is important to start with a dialogue about what robots are and what robots' children already know. The Educator can show photos of some robots and talk about their characteristics. If the Educator has some story or short film about Robots he/she can be part of this introduction moment. However, this activity should not take more than 15 minutes. This warm-up time will give the children motivation to gain access tothe concepts more associated with Robotics. Children can design their idea about Robots.

Main Activity (Time: 60 minutes): Main Activity is with the KIBO Robotic Kit and initially we let the children open the box and discover all the parts they find of the KIBO. The Educator must question all the parts they find out and understand if all the children follow these learnings. It is important that the child recognizes the components of KIBO and can describe the functionality of each one, always keeping in mind the age of the children. Children should recognize the main blocks and start by creating a small program with the movement blocks. It is important to emphasize the beginning and end blocks and allow the child to experiment with digitizing the blocks as well. After this experimentation, the child assembles the robot with the main parts that allow it to move. Example of questions with the Children: Can you design me a robot?; What can a robot do?; Do you Know what part of a robot are?; Can robots tell stories?; What robots do you know?; Can you build the KIBO robot?; Tell me, what you are putting on your robot?; Do you know how a robot works?

Concluding Activity (Time: 30 minutes): Children share their doubts about the components of the KIBO robot and the programming blocks. The children share their ideas for future programming and discuss how they can program the "Wolf" robot to go to the 3 little pigs' houses. It is important to associate to this moment of knowledge of what a Robot is to the Curriculum Unit we are working on. The intention is, at the end of this lesson, that the child starts to think about the intentionality that the Educator intends to give to this curriculum, which is to learn to program through the retelling of a story, in this case, the 3 Little Pigs.

Lesson 2 Vocabulary:

- Robot - a machine that can be programmed to do different things.
- KIBO Body - the central part of the Robot where all the other components are connected.
- Motor - the part of a robot that makes it move.
- Wheels - the importance of the wheels for the robot to move on the ground.
- Power button - the importance of recognizing when the robot is on and off.
- Batteries - Necessary for the functioning of the robot and that children realize that they are the source of energy of the robot.

Assessments To Be Used:

- Photos and Video
- PTD Checklist

Results:

Image 5 - What are robots for? What types of robots exist?

Source: Own elaboration

Image 6 - Meet the KIBO robot and learn how to assemble it

Source: Own elaboration

3.3. LESSON 3 - WHAT IS A PROGRAM?

Powerful Idea: The 3 Little Pigs story, with The KIBO Robot (the "Bad Wolf") – Programming: Control Flow by Sequencing and Instructions to program.

Overview: In Lesson 3, children will learn What Is a Program? It is important that the initial exploration that was given in Lesson 2 moves to a consolidated learning about what the movement of the robot represents. The child in this lesson will understand that the movement of the robot is a sequence of instructions that determine its action. This learning about what is a program is associated to the retelling of the story of the 3 little pigs. After the children have the scenario of the story completed (the Forest and the 3 little houses of the 3 little pigs) it is important to define the paths that the robot will do. Considering the global route that the Robot will have to travel, the Educator should encourage the children to divide the route into parts, for example, that the Robot (the "Bad Wolf") go to one little house at a time. The children should look for the programming blocks necessary to create the program that allows the robot to reach each of the little houses. In the experimentation phase of the program, the children try to digitalize the blocks and test the program. In case the program doesn't work and the robot doesn't reach its destination it is important to debug the program to detect the error and it is important to experiment again.

Time: 120 minutes. No. of participants: 13 children (4 years old = 10, 5 years old = 1)

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in the area of computational thinking without technologies and that involves the programming concepts that are predicted for these ages.
- The students have already explored the KIBO Robot, its components and programming blocks.
- The students know well the story of the 3 little pigs and can define the path of the Robot (the "Bad Wolf") to recount the story.

Students Will Understand That:

- Before programming the robot, it is important to understand which path they intend to program (computational thinking without technologies).
- Each block represents an instruction and should be introduced gradually, considering the age of the children and prior knowledge in the programming area.
- A program is a sequence of instructions that is followed by a robot.
- Mistakes when creating a program can happen and that these should be viewed as another learning opportunity.

Students Will Be Able To:

- Define routes that the robot will have to take to get to the house of each one of the little pigs.
- Program the robot with a complete sequence (go through all the houses).

- Understand what errors they encounter in programming, but also how they can simplify the algorithm and thus work on debugging.

Materials Needed:

- Stories for children about robots, for example, «The Robot Book» or «No-Bot, the Robot with No Bottom» or videos about Robots.
- KIBO Robotic Kit.
- Pictures of different part of the story.
- White sheets, pencils, and colored pencils.
- 3D Scenario of the Story of the 3 Little Pigs.

ACTIVITY DESCRIPTION

Warm-Up Activity (Time: 30 minutes): It is important that the children organize the scenario of the story of the 3 little pigs and in a large group define which routes the Robot must take, so that the story can be told. Each child, working individually or in a group, can draw on the sheet of paper the scenario they built in the room and with the help of the pencil make a kind of journey on paper. This procedure can help the child to internalize the spatial notion that he or she will later represent in the program he or she will create. The Educator can help to remember the directions and here we have an opportunity to learn the spatial-temporal notion that can be worked on, because the path is divided into different parts and moments of the story. If the Educator prints the "icons" of the programming blocks in the size of an A4 sheet it can be important for discussion, with the group of children, to know the blocks better and to use thIn even on a table or wall to be more easily visible by all children. This warm-up time will provide the children with knowledge about the programming blocks and feel safer to explain the program you are creating for the Robot.

Main Activity (Time: 60 minutes): Main Activity is with KIBO Robotic Kit and the character (the Bad Wolf) who will go through the forest looking for the houses and the 3 little pigs. The children will try to create the various programs for the robot (the Bad Wolf) to reach each of the houses. It is important to divide the program by parts, like this: 1. The children use the directional blocks of movement (front, back, right and left) to leave the forest and reach the first house (the Straw). 2. The second program is the sequence of actions that the robot will have to perform to move from the first house (the Straw one) to the second house (the Wood one). 3. The third program will be the sequence of actions that the robot will have to execute to move from the second house (Wood house) to the third house (Brick house). 4. The fourth program will allow the Robot (the Bad Wolf) to escape to the forest, after not being able to "catch" any of the 3 little pigs. At the end of trying to create these 4 programs it is important to put the image of the program of each of the parts posted on a wall. This way the large group of children can discuss and collaborate to find new ways to simplify the program. It is important to bear in mind that all this activity has to be developed and always take the age of the children, their previous knowledge about programming and their maturity to understand more complex levels of programming into consideration. If the Educator thinks that he/she can make this part of the activity even more complex, then he/she can propose to the children that they try to create the

complete program, so that the robot (the Bad Wolf) can go through all the houses, programmed with a single program. Example of questions with the Children: Do you know well the story of the 3 little pigs, which I just narrated?; Can you imagine the main parts of the story and create the scenario with these objects?; Which of the actors of the story will your robot be? Why?; Which is the path of your robot, the Bad Wolf, so that you can tell the story?; Can you plan your route on this sheet?; Can you create a program for the robot with the programming blocks?; Can you test the robot's programming and see if he was able to leave the Forest, go to all the houses and go back to the forest?

Concluding Activity (Time: 30 minutes): The children share their doubts, about the programming blocks and the action sequence of the Robot (the Bad Wolf) identifying the mistakes and what they can do best in the next lesson. It is important to give the children a voice and that they discuss and present their achievements and difficulties in a large group, providing one of the important parts The Engineering Design Process, which is "Share".

Lesson 3 Vocabulary

- Route - the path you take to get to a certain place.
- Programming Blocks - physical representation of an instruction.
- Program – a set of instructions for a robot.
- Sequence – the order of instructions that a robot will follow exactly.

Assessments To Be Used:

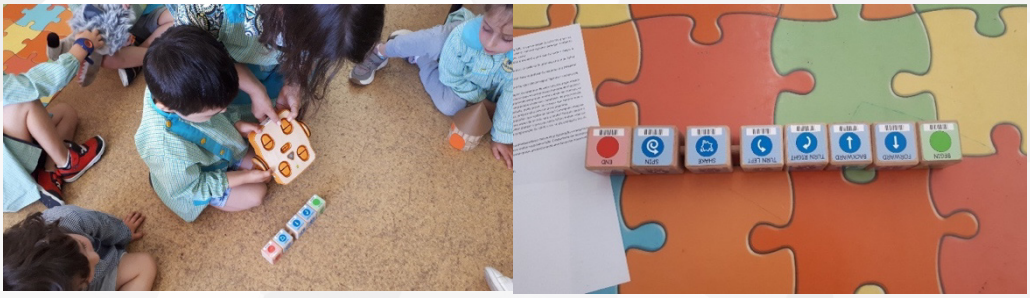
- Photos and Video.
- PTD Checklist.

RESULTS

Image 7 - Story of the 3 Little Pigs & Scenario development

Source: Own elaboration

Image 8 - First programming steps



Source: Own elaboration

3.4. LESSON 4 - WHAT ARE SENSORS?

Powerful Idea: What are the 3 Little Pigs' Moments of Story? - Learning with Sensors and Actuators. A robot can sense and see around it with a sensor. A robot can react to the information it receives by changing its behavior.

Overview: In Lesson 4, children will have the opportunity to learn how to use the Sensor and the "Light Output" actuator. It is important to come to this lesson with learning from previous lessons consolidated. The age range of pre-school children (4 to 6 years old) is a conditioning factor for the way all the components of robotics are worked at different ages. In this lesson, we begin the discussion of ideas with the whole group of children in order to analyze the programming that was done previously in lesson 3 and how we can introduce the Sensors. The child needs to learn that the Sensors are components of the Robot and that it can react to an external action, in a simpler way, the Robot feels something if it has sensors.

The activity can startwith the simplest sensors and the "Light Output" actuator: 1. "Sound" sensor and the block "Wait For A Clap" for example, so that the robot starts the action (The Wolf enters the Forest). 2. The "Light Output" actuator with the blocks of white, blue and red light, to mark each time the Robot arrives at each of the Little Houses. 3. In the following lessons we can introduce the remaining sensors. If the Educator considers it important to divide the children by working group, either by age or by mixed to carry out this lesson it is up to each one. It is important to look at what the children have already learned and provide new challenges in this lesson.

Time: 120 minutes. No. of participants: 12 children (4 years old = 9, 5 years old = 3)

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in the area of computational thinking acquired prior to curriculum development and previous lessons.
- Students have already tried programming the KIBO Robot, with several programming blocks.
- Students know the story of the 3 little pigs well and can define at what moment the "Sound Sensor" and the "Light Output" actuator can be introduced to mark important moments in the story.

Students Will Understand That:

- The "Sound" sensor and the "Wait for A Clap" block can allow you to mark an important moment in the retelling of the story.
- A robot can feel and see its surroundings with a sensor.
- The robot can react when reaching a stage by showing a signal that marks the same stage, for example with the "Light Output" actuator.

Students Will Be Able To:

- Use the "Sound" sensor and the "Wait for A Clap" block at the beginning of the programming sequence.

- Use the "Light Output" actuator every time the Robot ("Bad Wolf") passes in front of a House. The Child realizes that the KIBO robot has completed one stage of the programming.

Materials Needed:

- KIBO Robotic Kit.
- 3D Scenario of the Story of the 3 Little Pigs.
- White sheets, pencils, and colored pencils.

ACTIVITY DESCRIPTION

A Warm-Up Activity (Time: 15 minutes): In the first part of the activity, it is important to remember the concepts associated with the components of the KIBO Robot and present the two sensors that are defined for this activity. The discussion in large group about what is a Sensor is fundamental and if possible, the Educator can demonstrate its functioning, so that later the children develop their ideas on how to use these sensors in the recounting of the story of the 3 Little Pigs.

At Main Activity (Time: 90 minutes): In Main Activity the child proposes different ways to use the sensors and it is important to test all the possibilities. If there is more than one KIBO Robotic Kit in the room, the idea is to divide the group of children according to the number of Kits and allow new ways of programming with the sensors to be explored. We should promote discussion every time a group of children tests a program with the sensors and record, for example, on a sheet or whiteboard the programs that are tested. In this way, the children visualize the program and adjust to new tests until they are satisfied with the programming and integration of the sensors. As I mentioned before, the "Sound" sensor and the "Light Output" can serve to mark important moments in story, such as the beginning with the "Sound" sensor and the "Wait For A Clap" block and the "Light Output" actuator every time the Robot ("Bad Wolf") passes in front of a house, of the 3 little pigs. Example of questions with the Children: Do you know what a Sensor is?; How does the Robot know when the story begins?; Can you program the beginning of the story with a Sensor?; What programming block do you need when you are using that Sensor?; Do you want to create the program and test it?; How do I know that the Bad Wolf (your robot) has passed in each of the houses and has reached the end of its path?; Can you mark these passages with some actuator?; How is the programming with the actuators? Can you do and test?

Concluding Activity (Time: 15 minutes): After the activity, it is important to reflect with the children. This lesson on sensors can take more or less time than expected and it is important that these adjustments take place so that there is no learning left to consolidate. At this point of completion, it is equally important to motivate yourself for the next lesson on Repeats- Loops & Number Parameters. Children should create the foundation to pursue the curriculum and be motivated for new challenges.

Lesson 4 Vocabulary:

Sensor - The child is able to describe a "Sound" sensor when receiving a stimulus reacts and performs an action.

Actuators - The actuators emit a signal, such as the "Ligth Output", when the programming is set to do this and you want to mark a moment.

Assessments To Be Used:

- Photos and Video.
- PTD Checklist.

RESULTS

Image 10 - Discovering the sensors

Source: Own elaboration

Image 11 - The surprise of the discovery

Source: Own elaboration

3.5. LESSON 5 - WHAT ARE REPEATS?

Powerful Idea: What does the Bad Wolf do? - Recount the entire story of the 3 little pigs using the Repeats- Loops & Number Parameters. An instruction or sequence of instructions can be modified to repeat a certain number of times (or forever) using Repeaters, Repeater Ends, and Numerical Parameters.

Overview: In Lesson 5, after children have learned to use a Sensor and an actuator, we move on to a more advanced level of programming. We began this lesson with a discussion of ideas with the entire group of children to analyze the programming that was done earlier in Lesson 4 and how we can simplify and clarify the programming that the children did. We consider that these learnings should be for older children or children with previous knowledge of programming and robotics, even before this curriculum. However, it is always important to explore these programming blocks and understand how children deal with these learnings, whether simple or complex. If the group of children has advanced in previous learnings and are prepared to learn

new concepts, these learnings can be introduced gradually. It is important that the child understands that the use of the Repeats - Loops & Number Parameters blocks will allow thIn to simplify the programming sequence and structure their computational thinking with another maturity. To retell the story the child may concluded that the first sequence of the Robot can be repeated, for example, when the Robot goes from one house to the other and then should define the number of times it repeats the movement.

Time: 180 minutes. No. of participants: 12 children (4 years old = 9, 5 years old = 3)

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students will have previous experience in the area of computational thinking acquired prior to curriculum development and previous lessons.
- The students have already tried programming the KIBO Robot, with several programming blocks, with sensors and actuators.
- Students know the story of the 3 little pigs well and are able to define at what point they can repeat sequences.

Students Will Understand That:

- The program they initially created for the Robot to retell the story can be simplified.
- The introduction of "Repeat" in programming is an additional information that can clarify the algorithm.

Students Will Be Able To:

- Use the "Repeat Loops" blocks in programming situations that need to be simplified, for example, in the sequences where the "Bad Wolf" goes to each one of the houses.
- Understand the advantages of using the loop blocks and several repetitions, so that the Robot ("Bad Wolf") is able to go from the Forest and go to each one of the "3 Little Pigs" houses.

Materials Needed:

- KIBO Robotic Kit.
- 3D Scenario of the Story of the 3 Little Pigs.
- White sheets, pencils, and colored pencils.

ACTIVITY DESCRIPTION

Warm-Up Activity (Time: 30 minutes): To begin this lesson, it is important that the Educator dedicates the first part to reviewing the programs that the children have previously created, to program the robot to tell the story. As such, it is suggested that: 1. the Educator uses the white board to draw or paste the programming blocks of each of the sequences that the robot performs to leave the Forest, then to go to the house of Straw, then to go to the house of Wood, go to the house of Bricks and finally go to the Forest. 2. The visualization of each of the programs and the

discussion with the group of children may allow thIn to reach the conclusions necessary so that they understand the sense of using the Repeats- Loops & Number Parameters

Main Activity (Time: 120 minutes): The start of Main Activity is dependent on Warm-Up Activity and must also be worked on by parties: 1. The children will define the 5 paths of the Robot and identify in each one of thIn which parts repeat (try to discover the pattern that repeats): Leave the Forest; Go to the house of Straw; Go to the house of Wood; Go to the house of Brick; Go to the Forest. 2. Children introduce Repeats - Loops & Number Parameters into various programs to simplify them. 3. Children test the modified program(s), which may have been reduced to a single program in general, depending on the number of Repeats - Loops & Number Parameters. This procedure should be gradual so as not to make the learning too complex the first time. 4. After testing it is important that the child shares his ideas and has the opportunity to "debug" the program until he achieves the goal of this lesson which is to retell the story of the 3 Little Pigs and that the Wolf (Robot) goes through all the parts of the story.

This lesson, because it has a higher level of complexity in the learning intended to develop, can be accomplished in 2 or 3 days and devote more or less time than is suggested, because it is dependent on the development of each child and their maturity for the acquisition of these concepts. Example of questions with the Children: Do you know what repeats are?; Can you remember what the Robot's schedule was to go to all the houses?; Can we repeat some of the actions in this program you initially created?; Can the algorithm get smaller and simpler?; Do you understand why you are using the repeats?; Can you create a program using the repeats where you told me it was possible to do?

Concluding Activity (Time: 30 minutes): The concluding activity should always promote dialogue, encouraging children to share their achievements and difficulties. On the other hand, the Educator should understand if the concepts acquired in this lesson have been consolidated or if he/she needs to revisit these lessons before introducing the next lesson. In this curriculum, lesson number 6 is more complex and may or may not be carried out at preschool, as it is aimed at older children who master the concepts learned from lessons number 1 to 5. In this curriculum it is possible to go from lesson 5 to 7. This lesson is different because it includes new perspectives of the curriculum, so it can be said that, if an Educator considers moving from lesson 5 to 7 without performing lesson 6, it is because their group of children is not mature enough to understand the concepts that will be worked on in lesson number 6.

Lesson 5 Vocabulary:

- Loop – something that repeats over and over again.
- Parameter – a limit that a robot will follow.
- Pattern – a design or sequence that repeats.
- Repeat – to do something more than once.

Assessments To Be Used:

- Photos and Video.
- PTD Checklist.

RESULTS

Image 12 - Repeats

Source: Own elaboration

3.6. LESSON 6 - WHAT ARE IFS?

Powerful Idea: Where is the Bad Wolf going? - Ifs- Sensors & Branches. A robot can "choose" between two sequences of instructions depending on the state of a sensor using ifs (and ifs nots).

Overview: Lesson 6 only makes sense for children who already have previous knowledge in computer thinking, programming and robotics, and even then, to work with older children. This lesson no longer tells the story of the 3 Little Pigs, because it is told until lesson 5, however, in this lesson we can take the opportunity to introduce advanced programming concepts such as conditional. As mentioned previously it is possible to go from lesson 5 to 7. This lesson 6 is different because it includes new perspectives of the curriculum, so I would say that if an Educator considers moving from lesson 5 to 7, without performing lesson 6 is because his/her group of children is not mature enough to understand the concepts that will be worked here. The intention of this lesson is to review all the Robot programs from the previous lessons and see in each one how it is possible to introduce the distance or light sensors and that the Robot makes a choice, creating a non-linear sequence. For example, in the story of the 3 Little Pigs the Wolf in the previous lessons was able to go to all the houses of the 3 Little Pigs and go to the Forest. The programming was done in a sequential and complete way, without ever considering "obstacles" that prevented the Robot from continuing its' action. In this lesson we can question the children about this problIn of the robot finding obstacles and having to decide. Here we can see when the Robot reaches a house and goes against it. If the child has to program the robot, he/she will have to make the logical decision that "if the robot goes against the house, he goes back and follows the path".

Time: 180 minutes. Number of participants: 9 children (4 years old = 6, 5 years old= 3)

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in the area of computational thinking acquired prior to curriculum development and previous lessons.
- Students have already tried programming the KIBO Robot, with several programming blocks, with sensors, actuators and using Repeats - Loops & Number Parameters.
- The students know well the story of the 3 little pigs and are able to define at what moment the robot may need to complete a sequence and go back to follow the path.

Students Will Understand That:

- The robot when arriving to a certain place that was programmed by the child may have to opt for two situations, for example, stop or continue to another sequence of actions.
- That there are sensors of the robot, which are used to establish a choice (Ifs and If Nots), during the sequence that the robot performs.

Students Will Be Able To:

- Use the "Light" actuator after completing the sequence, as a way to perceive the end of the whole journey through the forest and passing through the houses of the "3 Little Pigs".
- Realize that when the robot arrives at a house, it needs to identify this situation as a condition to be evaluated by the robot. For example, the robot when finding the first house turns around and continues the route. Here you can use the "If" and also the "Distance Sensor".

Materials Needed:

- KIBO Robotic Kit.
- 3D Scenario of the Story of the 3 Little Pigs.
- White sheets, pencils, and colored pencils.

ACTIVITY DESCRIPTION

Warm-Up Activity (Time: 30 minutes): To begin this lesson, it is important that the Educator dedicates the first part to reviewing the programs that the children have previously created, to program the robot to tell the story. As such, it is suggested that: 1. The Educator uses the white board to draw or paste the programming blocks of each of the sequences that the robot performs to leave the Forest, then to go to the house of Straw, then to go to the house of Wood, go to the house of Bricks and finally back to the Forest. 2. The visualization of each of the programs and the discussion with the group of children may allow thIn to reach the conclusions we need, so that they realize the sense of using the distance sensors, light and learn the blocks of conditional "Ifs» and «If Nots».

Main Activity (Time: 120 minutes): The Main Activity can be divided into 2 parts which can be done on different days. The important thing is that the children understand the logical condition that is implicit in the programming of the robot. The first part can be dedicated to the

Distance Sensor (telescope) trying to improve the program that the child has already done in previous lessons, to program the robot when it arrives at the Pigs' homes.

In this part it is important to test the program several times, with the blocks "Ifs and If Nots" and the Distance Sensor to reach the final program that corresponds to the retelling of the story of the 3 Little Pigs, passing through the 3 houses and leaving, finally, for the forest. The second part of this activity can be dedicated to the Light Sensor (Eye), with the objective of explaining to the child that the Robot can walk the path until it reaches a dark place (which in this case can be the Forest), thus escaping the path to the forest. These challenges can be worked as examples, but it is also important to listen to the ideas and imagination of children. It is important to take the time to test the ideas and explain to the children what is happening. In this lesson we can always prolong the main activity, depending on the motivation of the children, the difficulties and what we want thIn to learn, considering their age and maturity. Example of questions with the Children: Do you know what an "If" is? Imagine that your robot arrives at a place that is very dark and doesn´t want to enter. Can you program it so that the robot will stop when it reaches a dark place?; What programming blocks do you need?; What sensor do you use with those programming blocks?; Do you want to create the program and test it?. Imagine that your Robot arrives at a house and needs to decide where to go next. Does the robot need a sensor to feel that it has reached the first house, turned around, followed its path and so on?. What programming blocks do you need to program the robot?; Do you want to test it?

Concluding Activity (Time: 30 minutes): This activity can be concluded with a conversation with all the children realizing if they were able to perceive the story of the 3 Little Pigs when it was the Robot to tell, through the programming that they made. It is important that the Educator encourages the debate about what they could not do, but also about what they want to do next and here we can always ask as a question: Do you want to program the Dance of the 3 Little Pigs, that after getting rid of the Wolf they celebrate in the Forest? And additionally, for example, What other stories do you know that have "Wolves" and that the scenario is in the Forest? From these two proposals the debate can be extended to the robot dance or to retell another story, enlarging scenery objects and new characters. Some stories that can be developed with a similar curriculum are: "Little Red Riding Hood", "the Wolf and the Seven Little Goats", "Peter and the Wolf", "Let's Play In The Forest While The Wolf Is Not Around". Lesson 7 is dependent on the conclusion of this activity; however, we can always conclude the project with a Dance of the Story of the "3 Little Pigs" and this is Lesson 7.

Lesson 6 Vocabulary:

- If- Used for introducing a situation that may happen.
- Distance sensor (telescope) - allows to feel the distance the robot is in relation to an object.
- Light Sensor (Eye) - allows to feel/see the Light in a certain space.

Assessments To Be Used:

- Photos and Video.
- PTD Checklist.

RESULTS

Image 13 - "Ifs"

Source: Own elaboration

3.7. LESSON 7 - CULMINATING PROJECT

Powerful Idea: "The Story and Dance of the 3 Little Pigs" and Other Stories of Wolf in the Forest. The final project covers all the previous learning and presents new challenges for the children, namely sharing the constructed learning with the whole school community. It is from this perspective that the development of the final project will be approached.

Overview: In this lesson we relive all the «Powerful Ideas from computational thinking and how they align with traditional early childhood concepts and skills» (Bers, 2018, p. 78), that is, Algorithm, Modularity, Control structures, Representation, Hardware/Software, Design Process and Debugging. Lesson 7 is the conclusion of a whole project developed through the previous lessons, but with a special closing, which includes the Storyand Dance of the "3 Little Pigs". This lesson, as a culmination of the project, should be shared with the local community (school community, family, friends, etc.). For this lesson, the Educator should encourage the children to prepare the final version of the presentation of the story, for a wider audience. And, also, add new elements such as the Dance that can be done with the Robot and the Children together. Some more time should be devoted to this lesson, so that the children can re-enter the Engineering Design Process and feel confident before the final presentation. Beyond this moment, which includes what was experienced in the previous lessons and the dance, the intention of this curriculum is to leave open the possibility of working on other stories, similar or not, with lessons as proposed here. This curriculum is easily adaptable to other stories and that the objective is also to learn how to program to tell a story.

Time: 6 hours. No. of participants: 1st session: 11 children (4 years old = 8,5 years old=3). 2nd session: 10 children (4 years old =7, 5 years old=3). 3rd session: 10 children (4 years old=7, 5 years old=3).

KNOWLEDGE & OBJECTIVES

Prior Knowledge:

- Students have previous experience in the area of computational thinking acquired prior to curriculum development and previous lessons.

- The students have already tried programming the KIBO Robot, with several programming blocks, with sensors, actuators, using Repeats - Loops & Number Parameters and Ifs and If Nots.
- The students know well the story of the 3 Little Pigs and are able to define at what moment the robot may need to complete a sequence and go back to follow the path.

Students Will Understand That:

- It is important to organize the ideas through Engineering Design Process and reach the last phase of sharing not only with your peers, but also with the community.
- Through programming and robotics, it is possible to tell a story and make a dance with the Robot.
- Programming and Robotics is also for preschool children and Coding as Literacy is possible" (Bers, 2028).

Students Will Be Able To:

- In the final project the child will be able to retell the story of the "3 Little Pigs", with the KIBO robot as the main character, the "Bad Wolf».
- To expand the Project, the Child can integrate one or three more robots, which would play the role of the "3 Little Pigs" and they would have to have a program to escape from the "Bad Wolf».
- Children can also explore the dance choreography, presented in the musical video.
- Use the Robot ("Bad Wolf") as a character of other traditional stories, that the children know and here work the curriculum unit.

Materials Needed:

- KIBO Robotic Kit.
- Engineering Design Process poster.
- 3D objects that can be built with recyclable materials or others for each of the stories you want to work on.
- White sheets, pencils, and colored pencils.

Final Project Activity - (6 hours): The final activity should be divided into several parts, according to what was defined as the main theme of this lesson. If the goal is to create a presentation of the story to the community and a dance, then the process should be to organize how to do it and an example of this could be this division of work: 1. The educator should organize what will be presented from the story and remember the concepts from the previous lessons for the presentation (2 hours). 2. The educator should prepare the Robot dance together with the children to end the story retelling (2 hours). 3. Final presentation of the story and dance for the Local Community (Family School, Friends). If the objective is to retell another story of Wolf in the Forest, as examples given in the previous lesson, it is important to consider the previous knowledge of the children. The Educator can dedicate this lesson to work with the children the lessons he/she considers necessary to retell another story. The 6 hours of Final Project should be

divided by the lessons that the Educator considers should be worked with the children, given the motivation and maturity of the children. Example of questions with the Children: Do you know how this story ends?; Would you like to create the Dance of the 3 Little Pigs to celebrate the end of the story?; Do you know other stories that have a wolf?; Would you like to do another project with the robot with another story?

Vocabulary:

All the vocabulary used in the previous lessons and new suggestions from the children.

Assessments To Be Used:

- Photos and Video.
- PTD Checklist.

RESULTS

Image 14 - The performance outside the kindergarten

Source: Own elaboration

Image 15 - Exploration, try/error, until we get the algorithm to follow the dance of the big bad wolf and the 3 little pigs

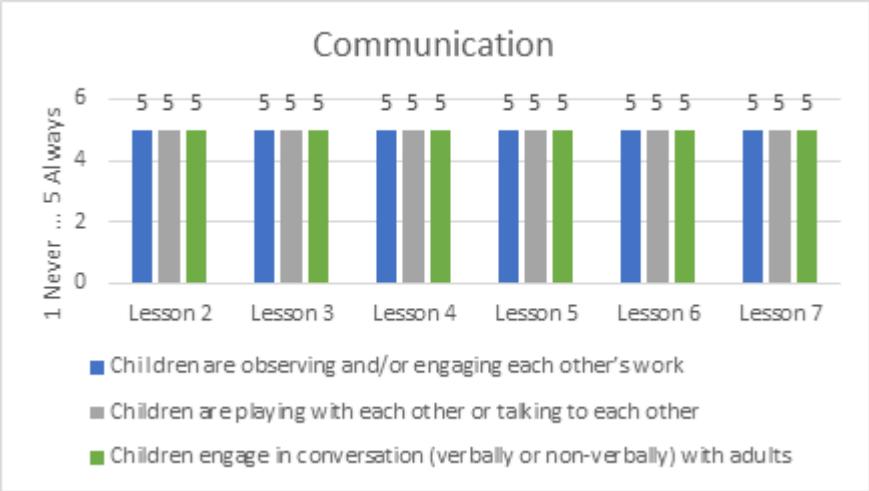
Source: Own elaboration

4. RESULTS

The KIBO robot curriculum that was replicated in a kindergarten context used the various lessons for its development, as presented in the fieldwork and data analysis of this work. However, we

highlight that the second objective of this research was the observation of the activities taking into account the Positive Technological Development framework (Bers, 2012) and understanding the presence of the 6 C's (Communication; Collaboration; Community Building; Content Creation; Creativity; Choice of Conduct) that constitute it. Through these indicators we have the possibility to observe positive contexts of learning with technologies (Bers, 2018), whether with the KIBO robot or with other programming languages. With regard to Communication (Bers, 2018), we noticed that in all lessons the educator observed, rated on a Likert scale from 1 to 5, that all lessons scored 5 in all indicators. Regarding «Children are observing and/or engaging each other's work» was considered: - Children watch as others work on a Project - Children express themselves through their projects; - Children touch or play with each other's projects while they work». Concerning the «Children are playing with each other or talking to each other»: The Educator observed: - Children speak or sign to each other; - Children ask each other what they are doing, request tools to be passed, etc.; - Children share ideas with one another. And finally, «Children engage in conversation (verbally or non-verbally) with adults» was possible to observe: - Children speak, nod their head, etc. when adults pause to let thIn respond.

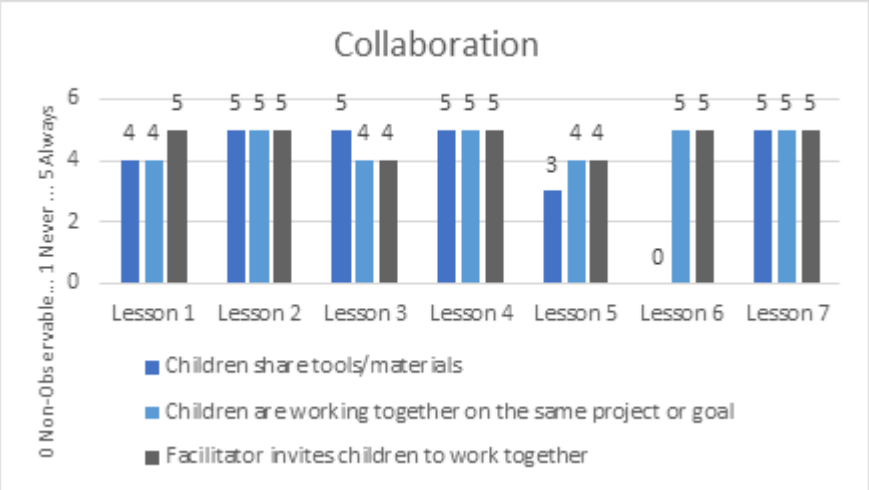
Graphic 1 - Communication



Source: Own elaboration

With regard to Collaboration (Bers, 2018), we noticed that during the seven lessons on a Likert scale from 1 to 5, the observation made by the Educator differs between 3 and 5, with Collaboration mostly at 5 in most of the indicators. It is noteworthy that in order to observe, the Kindergarten teacher took into consideration: «Children share tools/materials» if: -Children use materials and return thIn when done; -Children do not «collect» tools that they are; not using; many children touch and use the same materials at once. When he/she observed if «Children are working together on the same project or goal», he/she registered if: - Children are actively engaged in the same play/work activity - Children are adding elements to the same project; - Children take on different roles as they work together. Finally, to register how «Facilitator invites children to work together» it was necessary to observe: Facilitator suggests that children seek help from peers.

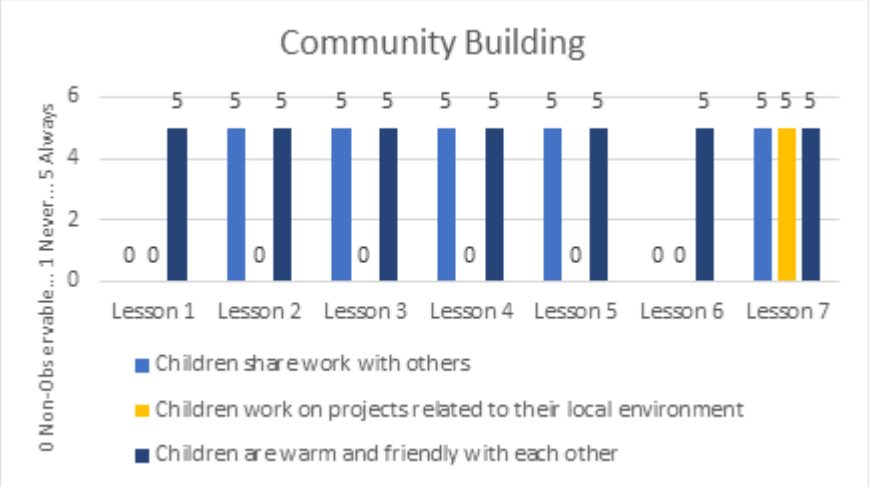
Graphic 2 - Collaboration



Source: Own elaboration

Regarding the Community Building (Bers, 2018), throughout the seven lessons on a Likert scale from 1 to 5, the observation made by the educator reveals that one of the indicators was only observable in Lesson 7, while the other indicators were observable in almost all the lessons with the exception of Lesson 6, in which only one indicator was identified «Children are warm and friendly with each other». Thus, we have that the perception of «Children share work with others» by the Educator which implied understanding: -Children show work to peers, community members, or facilitators; -Children place work on display somewhere in the space (or, they request/allow facilitators display their work). As regards the «Children work on projects related to their local environment» it was necessary to identify: -Children use technology in projects that relate to their school, home, or local environment; -Children read books, ask questions, or role play about local holidays, events, or locations; -Children create projects that help others. And finally, observe whether «Children are warm and friendly with each other»: -Children ask each other about home, or speak about each other's personal details (e.g. «I saw your sister in the hallway»); - Children laugh and play together.

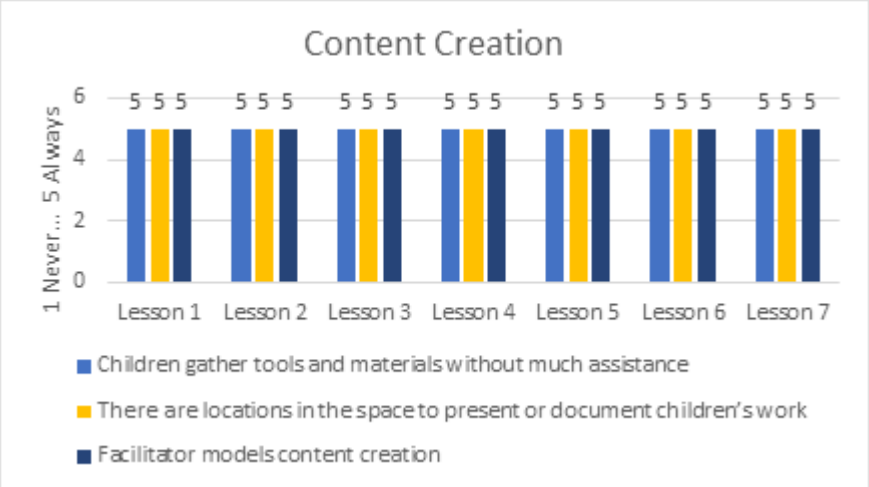
Graphic 3 - Community Building



Source: Own elaboration

As for Content Creation (Bers, 2018), the observation of the Kindergarten teacher ranked the seven lessons on a Likert scale from 1 to 5, at a frequency of 5 in all indicators, thus revealing that, «Children gather tools and materials without much assistance», because: - Children reach for crafts or turn on computers without needing help; - Children open boxes or bring tools out on their own-Children use the technology in a playground way (child directed and open ended) as opposed to a playpen (adult-directed and close-ended) way. Moreover, «There are locations in the space to present or document children's work» and it can be observed when: - There are pictures and explanations of their work; - There is a space for ongoing work to stay. Finally, «Facilitator models content creation» and this can be observed when: - Facilitator works on projects alongside children, or assists when asked; - Facilitator shares mistakes openly and models how to cope with them; - Facilitator encourages children to focus on the process rather than the product of their work.

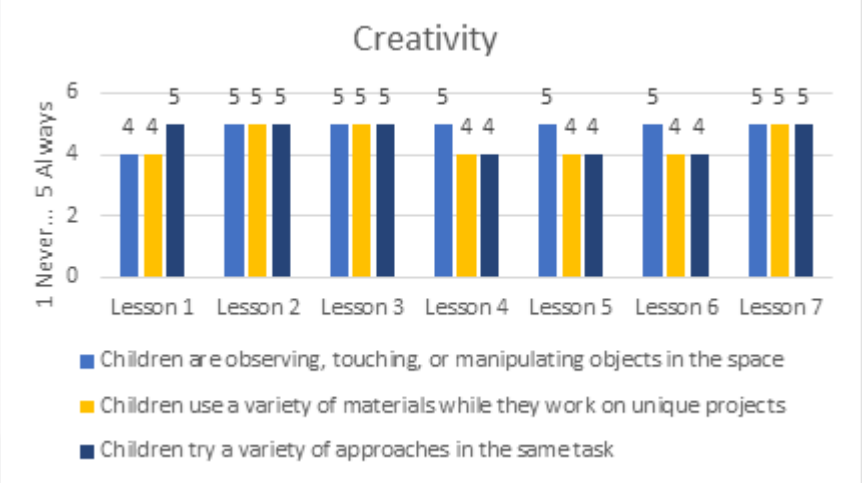
Graphic 4 - Content Creation



Source: Own elaboration

Creativity (Bers, 2018), had a presence between 4 and 5 on a Likert scale from 1 to 5 in the seven lessons that were developed. Considering the indicators observed, the Kindergarten teacher had the opportunity to understand how the «Children are observing, touching, or manipulating objects in the space», through: - Children run their fingers over a plush cushion or hold glass beads up to the light - Children comment about the properties of an object (e.g. «this wood is rough»). But also, if «Children use a variety of materials while they work on unique projects», when: - Children use wires, glitter, and cloth in a collage; - Children mix materials from different areas (e.g. blocks with crafts). And, furthermore, when the «Children try a variety of approaches in the same task», this when: - Children try tape, paper clips, and hot glue guns to attach paper; - Children try building a tower on a table, a chair, and a cushion.

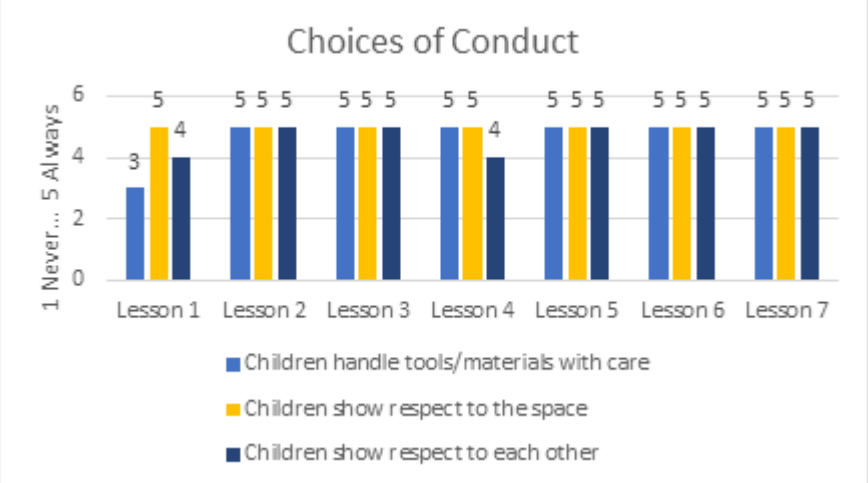
Graphic 5 - Creativity



Source: Own elaboration

The last "C" Choice of Conduct (Bers, 2018), allowed us to see that although most of the Kindergarten Educator's observations scored 5 on a Likert scale from 1 to 5, we found some lessons that had some variation of scores on their indicators, revealing behaviour that should be worked on in groups whenever we develop work with technologies. In this way, we were able to observe how the «Children handle tools/materials with care», through: - Children carefully hold/use scissors, glass, etc.; - Children return dangerous tools safely after using them. But also, how do the «Children show respect to the space», this when: - Children clean up materials after they are done working; - children take risks but use furniture, technology, etc in safe ways. However, how is it that «Children show respect to each other» easily understandable when: - Children take turns, share materials, and give each other space; - Children show signs of character (e.g. hugging someone who is crying, helping someone else clean up a mess).

Graphic 6 - Choices of Conduct



Source: Own elaboration

5. DISCUSSION AND CONCLUSIONS

One of the objectives of this research was to replicate the curriculum previously designed in an academic context (Miranda-Pinto, 2021), with the aim of understanding its effective validity and interest in curriculum integration, at the level of programming and robotics in preschool, with the KIBO robot. Similarly to previous research (Miranda-Pinto *et al.*, 2021) we worked in a kindergarten context in Portugal, with the kindergarten teacher, children and educational team to carry out the activities. It is important to highlight that this work was developed at the end of the 2020/2021 school year, i.e. in June and July 2021 when the children returned to the classroom, after months of school closure due to the pandemic. These limitations were taken into account in the lack of some skills that we should have worked initially with this group of children, namely, computational thinking activities without technologies (Miranda Pinto, 2019); (Bers, 2018); (Resnick, 2017); (Miranda-Pinto & Osório, 2016); (CSTA, 2016); (Bers *et al.*, 2014); (Wing, 2006). Furthermore, another objective of this research was to observe the children when they performed the activities included in the curriculum, in each of the lessons, taking into account the Positive Technological Development framework (Bers, 2012), in order to understand how it is possible to work on programming concepts with the KIBO robot, in a preschool context, by promoting the development of the 6 Cs skills (Communication; Collaboration; Community Building; Content Creation; Creativity; Choices of Conduct). Each of the lessons focused on a different unit of analysis, which allowed for adjustment and gradualincrease both of the challenges and the levels of complexity in the proposed activities.

In Lesson 1, the children were very receptive and interested in this new activity. Initially they did not have high expectations, since the steps taken correspond to the routine adopted for the motivating and/or integrating stories of new themes and classroom projects. The Engineering Design Process is based on the premise used daily in the educational context: "see, listen, think and only then act...". The only change to the usual work plan was the creation of the concept map which became the sequenced graphic record of the story. We believe that with the group being mainly 4 years old, this was the easiest way for thIn to implement ideas and achieve the objectives set for the first lesson, in a perspective of computational thinking activities without technology.

In Lesson 2, the degree of motivation increased substantially when perceiving the presence of KIBO in the room. The presence of a robot that does not look like a toy, but rather like a "real robot" as some defined it, quickly caused curiosity and interest in exploration. However, even at a preliminary stage of the presentation of KIBO the children got stuck on the images of the different types of robots, their usefulness, and the essential help they provide to society. In the development phase, the idea they had, until now, of a robot as a toy like others they already knew, changed completely. After all, in lesson 2, which was about talking about what a robot is, the children were involved in a dialogue about the purposes of robots for different areas of our life. In the case of education, robots serve to help thinking and learning. In this lesson it was noticeable that the children had the idea that robots have a humanoid figure, with a digital voice and rigid and limited movements: front, back, right, left, this is by the way they described it in their drawings and exemplified it with movements. However, Kibo is the opposite of this whole idea because you need to know how to assemble it and it forces you to think what needs to be done to make it work well. It does not have buttons and it doesn't speak automatically. It has blocks that

look like building blocks and some other objects (the sensors, which they have not yet been able to decipher in this lesson) that, although they have been introduced, have only remained in the imagination until the respective lesson. At the end of this lesson the expectation was raised and without a doubt the interest in continuing the development of the curriculum was not abandoned.

Lesson 3 was another day of great engagement due to the expectations formed in the previous lesson. The story of the '3 Little Pigs' was recalled and the participants set off to create the story's scenarios and the respective characters. However, the free exploration of KIBO was essential to fulfil the aim of this lesson, which was to find out what is a program. The children were completely involved in the project, from the creation of the scenarios, the characters, but never forgetting the moment to see, touch and experiment with KIBO. In this lesson the dialogue about the end of year virtual party was important. After talking, listening to opinions and ideas, the children decided that it made sense to play the "3 Little Pigs", outdoors and suggested a performance with KIBO, the robot being the "Big Bad Wolf" of the story. They also realized that to be a theatre made with robots they needed three more robots to be the "3 Little Pigs" and among the resources of the room it was easy to have these resources available. Regarding the discovery of programming by tangible blocks, this was another point in favour of KIBO, because it was easy to organise the ideas and the sequence of actions. However, due to the long route they wanted to take in the story they began to realise that this process was going to have some difficulties.

In Lesson 4 the degree of involvement increased significantly. This fourth lesson was the culmination of excitement and discovery, as it was the time to get to know the sensors and actuators. The first reaction was a spontaneous and genuine "I love it". There were mouths open in surprise, hands covering the mouth, hands clenched in a "what's this" gesture and some immediately said: "I'm going to ask my mum to buy a robot like this". Becoming aware that an object has actions, that despite needing to be programmed, seIn to give it intelligence was something that shook everything the children had known until now. Time flew by in a series of experiments with the sensors. The 'ear' was the favourite as its coding was almost, a mere note, giving the children the perception that the order is with the clap regardless of whether they must use the CLAP block. The work with the remaining sensors was merely experimental and allowed the children to understand how they work, not having used all ofthese for the development of the final project of this curriculum.

In the 5th lesson it is clear that the children are fully involved in the elaboration of the project and it was time to create other programming hypotheses. Programming with tangible blocks is appealing, not only for the construction of algorithms in a concrete way, but also because the use of "REPEATS" gives thIn a more complex way of thinking. This characteristic allows the adult to see the maturity of the child's thinking. It is not just a question of seeing how the child solves a problIn using the chosen route, but of seeing what their choices are in writing the algorithm. The lesson went well and the children assimilated the concepts quickly, in a quest to simplify the actions. However, although everyone understood and tried it at least once, in practice and autonomously only the 5-year-olds and the older 4-year olds chose to use the REPEAT blocks. At the end of this lesson, it was ensured that the development of the curriculum was on track as originally designed and with the conditions necessary to create a final project.

When we got to lesson 6, with the introduction of the "Ifs" the complexity of the programming evidently became more difficult and ended up discouraging most of the children. Verbally they seemed to understand the concept: "If the big bad wolf finds the straw house, dance!", but then reproducing it in algorithm and making it concrete in the blocks was much harder, with this group of children who had little work of computational thinking activities or robotics this school year 2020/2021. The Kindergarten teacher's experience in developing the KIBO curriculum was not initial, because in the previous school year (2019/2020), with another group of children the integration experience had been longer and she herself mentioned that in this other group this problIn of integrating programming with "Ifs" was possible, in fact, the results of this other research were also published and show this experience (Miranda-Pinto *et al.*, 2021). It is important to highlight that it is necessary to give the child time to assimilate learning, which in this case, in a post-lockdown context and the use of the KIBO robot for the first time in this curriculum, which was planned for a total of twenty hours, turned out to be insufficient for the acquisition of this learning.

In lesson 7 the intention was the culmination of the project, with the presentation of the work developed in the previous lessons, even if not using all the programming blocks and the complexity in the creation of algorithms. It was important to notice that in this stage, children were autonomous and collaborative in the execution of the proposed tasks. The culminating stage was the presentation to the community, but as the sanitary situation and lockdown rules didn't allow face-to-face parties we decided to divide the project in two stages. The first one was to make a dramatization, outdoors, of the story of the "3 Little Pigs", the second one was to use the soundtrack accompanying the dramatization to retell the same story with KIBO and three other robots (DOC and SUPERDOC). Although the development of the curriculum took place at the end of the school year, this lesson summarizes well the great involvement of the children in all the planned stages and the learning achieved in each one of them. Programming by tangible blocks with the KIBO robot was appealing not only because of the construction of algorithms in a concrete way, but also because this construction can be done with a greater or lesser degree of difficulty, allowing the adult to see the evolution of the child's thinking. It was not just a question of solving problems for the chosen routes, but rather of seeing the complexity of algorithms used for the final dramatisation. The knowledge of the extra blocks: "SPIN", "SHAKE" allowed humanising the robot and the "SING" block gave it a low, pleasant voice that the children did not expect. In short, it was noticed that the children had a great receptivity to this new robot, they were able to learn concepts so different from those they were used to and enthusiastically embarked on a final project that had visible results and the educator herself revealed that she was surprised by the success achieved, in developing the curriculum without ever having worked with KIBO before with this group of children.

During the development of the 7 lessons of this curriculum the whole educational environment was prepared in order to allow the children to develop the behaviors connected to the 6 C's (Communication; Collaboration; Community Building; Content Creation; Creativity; Choice of Conduct) inspired by the Positive Technological Development (PTD) framework (Bers, 2012). The results show high levels in each of these dimensions when the observation was carried out. It was possible to document thatthe indicators for each of these dimensions of the 6 C's were actually

happening in a curriculum activity development environment with the KIBO robot and the theme of the "3 Little Pigs" stories.

The integration of robotics in preschool contexts is, as we can see, an increasingly common reality in educational contexts in Portugal. Even though there is no defined training program for early childhood educators in this area of digital, programming and robotics, we know that some research projects have addressed these gaps (Miranda-Pinto & Osório, 2020); (Miranda-Pinto, et.al., 2017); (Miranda-Pinto & Osório, 2015); (Miranda-Pinto, 2016). By referring to our particular projects, we only do so in order to also highlight the work that we have developed with the KIBO robot and, for this reason, it was possible to replicate the curriculum that we previously outlined in an academic context. During the process of observing children's behavior in interaction with technology and their learning with programming concepts, the use of the PTD framework allowed reflection that the potential to develop with this type of work is not only focused on learning programming skills. There is a whole work at the level of values that this type of activity allows us to work with children in the search for thIn to develop as complete human beings, in a perspective as (Bers, 2022), «(...) an educator can intentionally choose the values to put into practice in her lessons and incorpórate new values: curiosity, open-mindedness, perserverance, patience, optimism, honsty, fairness, generosity, gratitude, and forgiveness» (p. 146). It also refers that «in the coding playgroung, the child is the artist who learns to code, and the paintbrush is the programming language that supports creativity» (p. 146).

During the development of the curriculum with the KIBO robot it was evident that all the behaviours of the PTD framework were present in a very positive way, allowing collaborative activities to be developed among the children, for example, to create different algorithms for the final project, find solutions, test and do it all over again, several times until the final programming of KIBO was achieved. And in this collaborative process, communication and creativity took part. However, with 3 and 4-year-old children, where concentration time is shorter and their interests are more immediate, we tried to avoid demotivation by setting smaller, achievable challenges. This factor made us realize that the integration of the robot KIBO requires a longer process in preschool contexts, to achieve a real appropriation of learning. In the future, it will be advisable to work with KIBO throughout the year and to have more autonomous and spontaneous explorations, before going on to work on a curriculum with a specific theme. We recognise that time was lacking to mature, explore and see, in the children, the spontaneity and acquisition of linguistic competences at the level of coding with tangible blocks. The difficulty with more complex programming, either with "Repeat" or "Ifs" demonstrates this. However, we understand that the knowledge built gradually through various forms of questioning and collaborative work between children and the educator, allowed the integration of activities of computational thinking, programming and robotics in pre-school context, with the robot KIBO, as has been happening in investigations already carried out (Monteiro *et al.*, 2021); (Miranda-Pinto & Osório, 2019); (Miranda-Pinto *et al.*, 2017); (Miranda-Pinto *et al.*, 2017); (Miranda-Pinto, 2016).

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