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Artículos científicos

Robótica educativa utilizando el mBot en estudiantes de educación básica

Educational robotics using the mBot in elementary school students

Robótica educacional usando o mBot em alunosEducação básica

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Resumen

Este documento muestra una experiencia de uso del robot mBot para efectos educativos, el cual puede implementarse como apoyo para el aprendizaje de la programación basado en bloques, lo que desde temprana edad sirve para fomentar el pensamiento computacional. Para ello, se diseñó un estudio cuya finalidad fue conocer la experiencia de un grupo de estudiantes de primaria que participaron en una clase en la que se utilizó el mBot. En concreto, se aplicó una metodología descriptiva de corte cualitativo. Los resultados de la observación muestran que los estudiantes han adquirido conocimiento tecnológico combinando un dispositivo móvil y usando bluetooh para conectarse y dar seguimiento al uso del robot.

Palabras clave: Arduino, Makeblock, mBot, programación por bloques, robótica educativa, STEM.

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Abstract

This paper shows an experience of using the mBot robot for educational purposes, which can be implemented as a support for learning block-based programming, which from an early age serves to promote computational thinking. For this purpose, a study was developed to learn about the experience of a group of elementary school students who participated in a class in which the mBot was used. Specifically, a qualitative descriptive methodology was applied. The results of the observation show that students have acquired technological knowledge by combining a mobile device and using Bluetooh to connect and follow up the use of the robot.

Key words: Arduino, Makeblock, mBot, block programming, educational robotics, STEM.

Resumo

Este documento mostra uma experiência de uso do robô mBot para fins educacionais, que pode ser implementado como suporte para o aprendizado de programação baseada em blocos, que desde cedo serve para promover o pensamento computacional. Para isso, foi desenhado um estudo cujo objetivo foi conhecer a experiência de um grupo de alunos do ensino fundamental que participaram de uma aula na qual o mBot foi utilizado. Especificamente, foi aplicada uma metodologia qualitativa descritiva. Os resultados da observação mostram que os alunos adquiriram conhecimento tecnológico combinando um dispositivo móvel e usando bluetooh para conectar e rastrear o uso do robô.

Palavras-chave: Arduino, Makeblock, mBot, programação em blocos, robótica educacional, STEM.

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Introduction

The appearance of information and communication technologies (ICT) have changed the unidirectional way in which students learn, as well as the methods that the teacher used for teaching. In particular, for "educational engineering", whose purpose is to find new ways to learn, various options and methodologies have been shown, one of which is called educational robotics, in which students can explore and manipulate what they want to understand in order to learn from their own experience (Barrera, 2015).

Currently, technological learning, such as robotics, is used in schools, since it awakens in students many skills necessary for daily life and work. The increase in technological

demand drives the application of this type of strategy, since the different options offered by these robots also simplify the way in which teachers can implement the variants and advantages of mBot v1.1 or educational robotics in the classroom (Román et al., 2017). According to Pittí et all. (2014) is a systematic and organized process to obtain learning in which technological elements interrelated with the robotics platform and programming software are involved.

Other authors are based on cybernetics, because —according to Papert (1993)— to say that a learning context uses digital technologies and pedagogical processes, students must build robotic prototypes or simulations based on their creativity and knowledge. (Castro *et al*., 2012).

To improve the results obtained, it is important that the teacher includes stages or phases for the project and roles for the team members. The stages facilitate the achievement of the objective because the work is distributed and it is known what to do in each one. The younger or younger the students, the greater the number of phases and the explanation of each one should be. The roles allow each student to have the responsibility of carrying out specific tasks, although she can participate in helping others. Roles should not be permanent, but rotating. Thus, students can practice in each one to discover their abilities, talents, limitations and aspects that can be improved (Pittí et al., 2014).

In a work proposal with educational robotics, it is always important to use a rubric to evaluate the students' work to know their performance in different areas addressed during the project, such as design, block programming, construction and communication of their ideas. This assessment must be done at the beginning and at the end to know the progress and learning of the students, or their weak points. From the beginning, a work plan must be in place to develop the different stages (which include conceptual and practical components); however, it should not be static, to adapt to changes based on the results of the evaluations: phases can be added to deepen topics in which students obtain low performances or lengthen the duration of each phase (Castro et al., 2012).

In particular, in primary education it is considered important to innovate, introduce and promote the teaching of robotics, because by using science, technology, engineering and mathematics (STEM), computational thinking and a range of possibilities and possibilities are promoted in the classroom. skills in the pedagogical space. In fact, in the area of technology and robotics, LEGO offers benefits to increase and improve skills and, above all, the potential of children who have access to the STEM line (Coxon, 2012). In this way, benefits are

achieved in the practices that are carried out within the classes, which allows students to learn to program and generate solutions and planning of opportunities and skills necessary for the future. (Wing, 2006).

Similarly, the use of digital tools combined with STEM teachings play an important role, which the teacher must take ownership of in order to later transmit knowledge and generate learning environments. In this context, educational robotics enters the classroom, a tool that can support teaching and learning; that is, it can be taken as a positive action to interact with primary and secondary school students during the practices established by the teacher in order to stimulate and awaken scientific and technological skills, as well as the curiosity to learn what will help them solve problems in your daily life. (López et al., 2020; Monsalves, 2011).

In accordance with this idea, Sanders (2009) recommends that it is essential to continue promoting programming, digital tools and the use of STEM methodologies, since there is concern that students do not opt for science, mathematics and technology courses, which generates a low performance index in these areas. For their part, educators should be interested in STEM education so that students learn how technological skills work, which will generate new vocations in the future (Sanders, 2009).

Previous studies have shown that the use of educational robotics can integrate knowledge from various areas to develop a project. In educational robotics workshops, students have the ability to conceive, design, develop and implement their own robots in order to solve problems; for example, creating a scenario to simulate the operation of a traffic light, etc. These workshops also encourage students to build and program their own robot. With these works, students can improve their performance, which can be evaluated through tests carried out a priori (Mancilla García et al., 2017).

Based on the above premises, it was decided to carry out the present study, which aims to learn about the experience of a group of primary school students who participated in a class in which the mBot was used; In addition, the way in which this initiative impacted learning about block-based programming is described.

Conceptual framework

Currently, technologies in the educational sector have been expanding, as they are becoming indispensable in both everyday life and work. For their part, educational institutions have been preparing academically to implement techniques through the tools offered by the different educational robots available in order to prepare students to enter the technological world (Fernández Panadero, 2020).

Now, to build an educational robot, different knowledge of certain learning areas is needed; for example, mechanics to build a robot, electricity to supply energy and make its parts work and, finally, computer science to program it and give it different functionalities. For this task, the student can carry out the learning of each of the robot structures through m-learning, since they use small devices such as tablets and smartphones (Ally et al., 2005), hence the teachers should also have that kind of knowledge (Monsalves, 2011).

Parts of the mBot

The use of the friendly educational mBot created by Makeblock (2020a) has a wide variety of projects to learn educational robotics and transmit block programming knowledge in a simple and fun way. It is ideal for children from 9 to 12 years old, since it allows to develop creativity and improve the knowledge of primary children through instructions that help them advance to the next level.

This section describes all the details of each of the components of the metal structure from which the mBot is created, easy to assemble to obtain maximum benefit, from the Arduino board, tires, sensors, cables, screws, motors to the batteries that allow the robot to power on.

Arduino boards

Arduino is a board designed with easy to use code. It is capable of receiving readings from light sensors and button presses, which it then transforms into an output (eg, activating a motor or turning on an LED). To tell the board what to do, a set of instructions must be sent to the microcontroller. The Arduino programming language was created in 2005 (Arduino, 2020).

mCore card

mCore is an Arduino electronic board specially designed to be used in the mBot that integrates various sensors, such as light sensor, LED, horn (buzzer) and RGB, included in the tools to learn electronics more easily. mCore comes with Arduino and Makeblock (based on Scratch 2.0) libraries for easier programming. The board also integrates a type B USB connector that guarantees prolonged use, as well as its resettable fuse, which prevents the board from burning out.

MBot v1.1 blue (Bluetooth version)

mBot is a STEAM educational robot based on Arduino and Scratch, designed in an intuitive way. It is mainly used by teachers as an innovative educational strategy. This type of robot has various learning options such as programming and the construction and assembly of materials. The graphical programming environment is based on Scratch and has Arduino compatibility (Fernández Panadero, 2020).

Table 1. mBot V1.1 Technical Specifications (Miguel, 7 de mayo de 2019)

Especificaciones técnicas	Características
Software	mBlock, mBlock Blockly para Mac, Windows, iPad mblocky y Arduino IDE
Pilas	4 pilas AA
Peso	400 gr
Placa	mCore (basada en Arduino)
Cantidad de piezas	800
Sensores	Seguidor de línea y ultrasónico,
App	mblocky Makeblock
Conexión	Serie inalámbrica 2.4G Bluetooth
Microcontrolador	Atmega328

Source: self made

Figure 1. mBot

Source: Makeblock (2020b)

RGB led

The RGB led module consists of four adjustable and panchromatic RGB leds. The colors of the led can change in different shades (red, green and blue), which adds different signals to each of the leds.

RJ25 port

The RJ25 module is a standard model that has an adapter, with 6 pins (VCC, GND, S1, S2, SDA and SCL) necessary to connect the different inputs of the mBot connectors.

Megaphone

The horn generates sounds according to the programming that is applied to the robot. It works by transforming electrical energy into sounds.

Light sensor

The light sensor is used to perform some practices where the mBot must detect the intensity of light found in the environment.

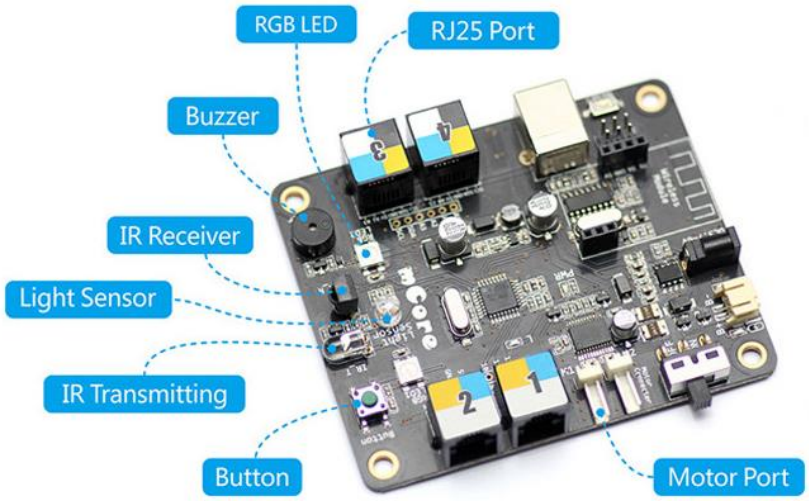
Button

The mBot has an integrated button with two programming sequences line following and obstacle detection, which can be used to show the operation of the robot.

Engine ports

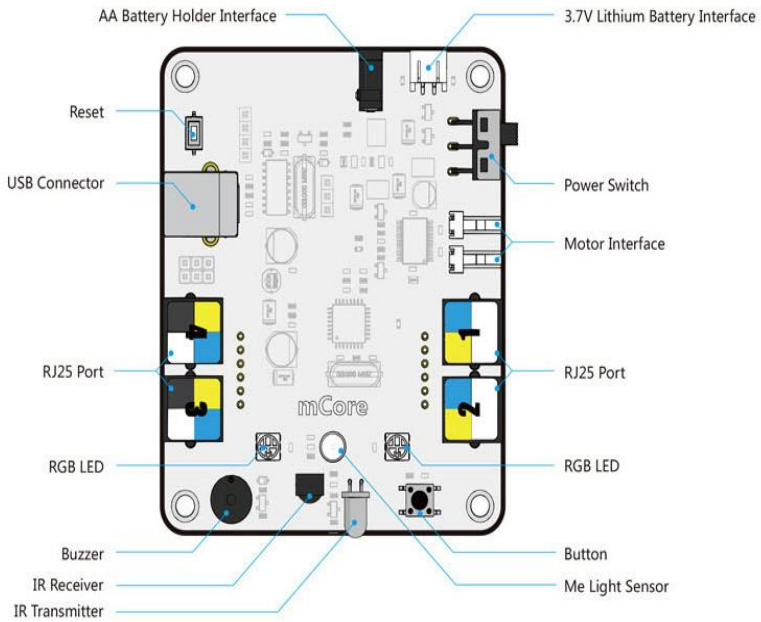
The mBot has two ports to connect the motors, necessary to move the wheels of the robot (Zambeca, August 6, 2017). Figure 3 shows the characteristics of each of the parts and the structure of the Arduino board.

Figure 2. mBot Arduino uno board



Source: Makeblock (2020b)

Figure 3. Structure of the mBot



Source: Mecatronicalab (2018)

Engines

The motors fulfill the functionality of turning the two wheels.

Sensors

Each one fulfills different functions such as detecting obstacles and also detecting the absence or presence of light.

Battery carrier

Here the necessary lithium or AA batteries will be placed to power the different parts of the robot. It is important to learn and know each of the parts by which the robot is formed, since in this way the teacher can explain its operation to the children. Also, in some cases, the mBot can be assembled to assess the advantages of Use these practices in class.

Methodology

To meet the objective of this study, a qualitative research was carried out, with a descriptive design. Specifically, we tried to analyze the experience of a group of primary school students who participated in a class in which the mBot was used, as well as its impact on learning block-based programming.

Primary school students (4th, 5th and 6th grade) from a public school in the community of San José de Gracia, municipality of Tepatitlán de Morelos, state of Jalisco (Mexico) participated in the study. It should be noted that students from lower grades were not considered because from the fourth year is when they can make better use of robots, especially with a view to implementing them as part of their classes.

Implementation of sessions with the use of mBot robot

In accordance with Álvarez-Herrero (2021), a review and validation of the mBot was carried out taking into account the instrument for the evaluation of the robot, which is based on the taxonomy of robots (its different characteristics and specifications can be observed, such as like how to program and configure it using apps like Makeblock and mBlock Blockly).

To carry out the research, 12 sessions were designed and implemented where they learned to manipulate and control the mBot robot in the classroom. The project began with the first practices to learn how to use the robots and relate them to the topics that were developed during or after the classes. In this way, it was sought to reinforce some skills and knowledge of the different subjects.

Mobile applications were found to program the mBot, which have several options that can be useful to detect sensors located in different parts of the robot; Similarly, students were shown that it is possible to generate other ways to assemble the mBot using additional parts. Likewise, they were taught how to use it through different devices (such as a tablet or a cell phone), with their instructions already recorded in blocks within the applications that served to work in story mode. Finally, the progress of each class was saved.

Research instrument

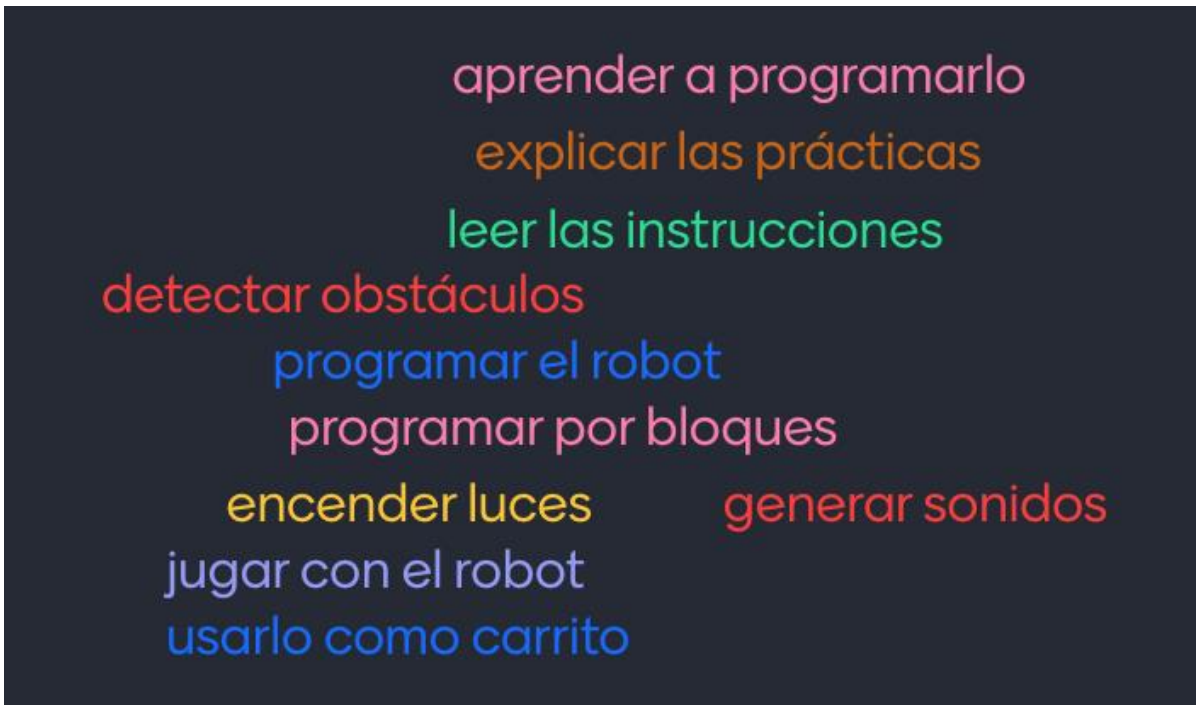
In order to know the experience of the students, a questionnaire was designed to carry out semi-structured interviews in which the children reported how they had felt when using the robot. In addition, they were questioned about their experience learning with this

technology in order to learn about the new concepts they had acquired. Finally, they were asked if they had learned more using the robot and how they felt about it.

Results

The interviews conducted with 12 elementary school children in San José de Gracia were analyzed using a content analysis methodology. The results of Figure 4 show the words with the highest number of mentions by children. In short, it can be said that the experience was positive, since the concepts they learned in robotics classes are demonstrated.

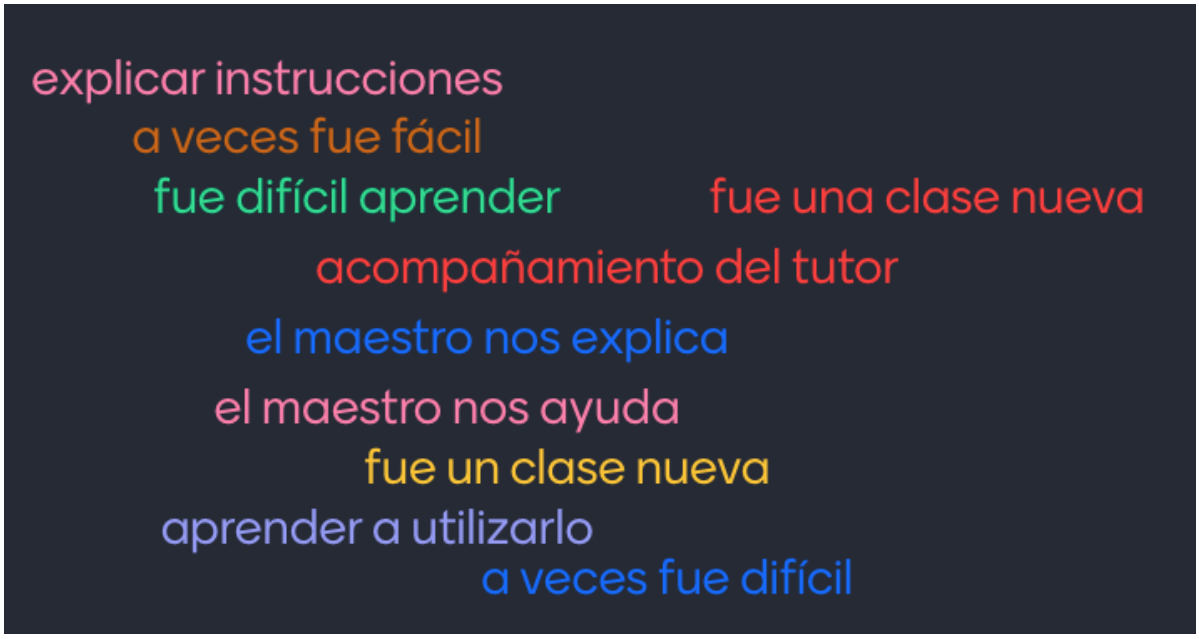
Figure 4. What did you learn in robotics classes?



Source: self made

On the other hand, after asking the students what they liked most about the robotics classes, the results show that the children liked that the teacher explained them and helped them with the instructions.

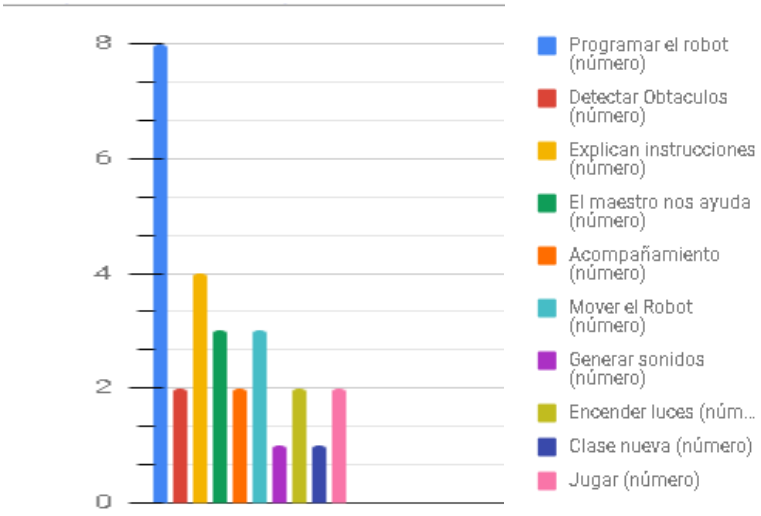
Figure 5. What did you like most about robotics classes?



Source: self made

Figure 6 shows that the students were struck by the programming of the robot, the teacher's explanation of the instructions, moving the robot, the teacher's accompaniment during classes, turning on the lights and generating sounds, as well as playing with the mBot.

Figure 6. Children's repeated activities



Source: self made

Discussion

According to the results presented, the mBot helps to improve the experience of the practices and more specifically in the application of Makeblock and mBlock Blockly. Thanks to the robot's bluetooth communication protocol, its use from different locations is facilitated. Likewise, the light and proximity sensors it has expand the number of practices. In addition, it is possible to use different colors and sounds to help in its configuration and to carry out some practice depending on the topics that you want to address in the classes. This coincides with what was expressed by Barrera (2015), who highlights the importance of educational robotics in student learning.

After the study, it is considered that the design of the mBot helps children to be interested in using robots as part of their academic activities, since they consider them as a toy. In this sense, as Román (2017) points out, depending on the type of learning that is to be achieved, some projects can be applied to develop certain skills, since robots encourage computational thinking due to the progressive exercises where the child goes reading the instructions for each of the activities.

Currently, educational robotics proposes new ways of learning and developing and integrating other skills and knowledge in students to apply them in some school projects and improve the teaching-learning process in the technological area.

The appearance of information and communication technologies came to improve the way of teaching and learning, and educational robotics allows you to explore and create your own experiences using robots to, for example, learn to program by blocks. By designing, building and programming their ideas, the student generates their knowledge (Castro et al., 2012).

Finally, when we talk about the characteristics of the different educational robots (such as the mBot), it is important to provide students with knowledge, programming skills and learning when interacting with sensors, motors, parts, blocks and programming. This produces in them a world of possibilities of different ways of learning, since they can enhance the students' reasoning (Coxon, 2012). Therefore, it is considered important to continue taking advantage of educational robotics in primary education through a club or workshop that is part of the curriculum.

Conclusions

Educational robotics and its inclusion in different activities within the classroom require the constant training of the teacher, because only in this way can better results be achieved. Therefore, it is transcendental that the teacher who is going to use this type of robot has a well-designed planning. Likewise, dialogue between teachers should be encouraged to identify specific learning units that can be developed by students through educational robotics. In this sense, you can consult articles that refer to the benefits offered by robotics, as well as the different applications that can be used and combined with the mBot.

Future lines of research

Among the benefits of the implementation of robots in different learning units, it is important to highlight the follow-up of research due to the relevance it gains in daily academic events. For example, you could start with the application of a study with children on Torrance's creative thinking ability, and continue with the use of the mBot for several sessions so that students learn to program using applications. For this, some tools can be implemented, such as markers, paper, cardboard boxes and necessary materials that the teacher considers for its development and implementation. Finally, the Torrance Creative Thinking Test can be used to show the results.

References

Álvarez-Herrero, J. F. (2021). Diseño y validación de un instrumento para la taxonomía de los robots de suelo en educación infantil. *Pixel-Bit. Revista de Medios y Educación*, *60*, 59-76. https://doi.org/10.12795/pixelbit.78475

Arduino (2020). *What is Arduino*. https://www.arduino.cc/en/Guide/Introduction

Barrera, N. (2015). Uso de la robótica educativa como estrategia didáctica en el aula. *Praxis & Saber*, *6*(11), 215-234.

Castro, M. D. y Acuña Zúñiga, A. L. (2012). Propuesta comunitaria con robótica educativa: valoración y resultados de aprendizaje. *Teoría de la Educación. Educación y Cultura en la Sociedad de la Información*, *13*(2), 91-119.

Coxon, S. (2012). The malleability of spatial ability under treatment of a first lego league-based Robotics simulation. *Journal for the Education of the Gifted*, *35*(3), 291–316.

Fernández Panadero, J. (2020). Prácticas mBot. Robot con mCore basado en Arduino uno usando mblock. *La ciencia para todos*. https://lacienciaparatodos.files.wordpress.com/2017/05/prc3a1cticas-mbot-javier-fernc3a1ndez-panadero-05-05-2017.pdf

López, V., Couso, D. y Simarro, C. (2020). Educación STEM en y para el mundo digital. *Revista de Educación a Distancia*, *20*(62).

Makeblock (2020a). *mCore*. https://www.makeblock.com/project/mcore

Makeblock (2020b). *mCore-Main Control Board for mBot*. http://docs.makeblock.com/diy-platform/en/electronic-modules/main-control-boards/mcore.html

Mancilla García, V. H., Aguilar Duron, R. E., Aguilera González, J. G., Subías Aguirre, K. y Ramírez Ramos, A. (2017). Robótica educativa para enseñanza de las ciencias. *Revista Electrónica sobre Tecnología, Educación y Sociedad*, *4*(7).

Mecatronicalab (2018). http://www.mecatronicalab.es/wp-content/uploads/2018/03/mcore_componentes-1.jpg

Miguel, R. (7 de mayo de 2019). *El País*. https://elpais.com/elpais/2019/05/06/escaparate/1557131651_822010.html

Monsalves, S. (2011). Estudio sobre la utilidad de la robótica educativa desde la perspectiva del docente. *Revista de Pedagogía*, *32*(90), 81-117. https://www.redalyc.org/articulo.oa?id=659/65920055004

Papert, S. (1993). The Children's Machine: Rethinking School in the Age of the Computer. *Technology Review-Manchester NH-*, *96*, 28-28.

Pastor, J. (4 de enero de 2017). Xataka. https://www.xataka.com/robotica-e-ia/lego-boost-es-el-sistema-de-motores-sensores-y-codigo-que-dotara-de-vida-a-tus-construcciones-lego

Román, P., Hervás, C. y Guisado, J. (2017). *Experiencia de innovación educativa con robótica en la Facultad de Ciencias de la Educación de la Universidad de Sevilla (España)*. Universidad de Sevilla (España). https://idus.us.es/bitstream/handle/11441/65614/2017%20Capitulo%20Libro%20-%20Buenas%20Practicas%20con%20TIC%20-%20Malaga%20Roman-Hervas-Guisado.pdf?sequence=1&isAllowed=y

Sanders, M. (2009). STEM, STEM education, STEM mania. *Technology Teacher*, *68*(4), 20-26.

Scratch (2022). Scratch. https://scratch.mit.edu/projects/editor/?tutorial=getStarted

Wing, J. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33-35.

Zambeca (6 de agosto de 2017). mBotV1.1, con conexión Bluetooth. *Zambeca*. https://www.zambeca.cl/tiendaOficial/documentos/MakeBlock/mBotV1.1Bluetooth.pdf