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ROBOTICS APPLIED TO HISTORY TEACHING: STEAH METHODOLOGY

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ABSTRACT

Educational robotics requires the use of active methodologies such as STEM, STEAM and Design Thinking articulated to the development of computational thinking. In this sense, the teaching of History, by reinterpreting previous experiences and recreating its own STEAH methodology, seeks dialogue and integration with multiple scientific knowledge in the field of Engineering, Arts and Technology. To demonstrate this journey through the Programming and Gamification Language, it presents the Tecnogame as a teaching proposal for the Cultural Heritage of the city of São Cristóvão, Sergipe, Brazil.

General Terms: Active Methodology, Computational Thinking, Digital Humanities.

Keywords: Educational robotics; Lego We Do; Game; History teaching; Scratch.

1. INTRODUCTION

And in addition to being a student able to think critically, make decisions autonomously, with ethical and solidary responsibility, everyday life demands that its workforce have sufficient information and training to develop skills for handl ing digital technologies and robotics in an increasingly automated world.

The integration of knowledge appears strongly in the Engineering area, where its graduate needs to work in multidisciplinary teams, with professionals from other areas, such as architecture, design, and administration, for example, to solve complex problems.

In a world, knowledge needs to be integrated, in a multiplicity of areas, to bring solutions to socioeconomic, environmental, cultural, and political problems, Education has been dedicated to the development of active methodologies that place the student as the protagonist of their learning and seek their integral development.

One of these methodologies is STEM, an acronym in English for "Science, Technology, Engineering and Mathematics", which means "Science, Technology, Engineering and Mathematics". Thus, STEM education is associated with innovative and exciting real-world learning experiences that require interdisciplinary approaches. Thus, an interdisciplinary approach focuses on establishing explicit connections between relevant disciplines by juxtaposing and integrating two or more disciplines so that the potential of each field of knowledge awakens each student's own creativity and talents in a collaborative work (Arifin; Mahmud, 2021, p.1558-1559).

In a context that requires a worker at the same pace as technological modernity, creative ideas, humanist leadership, collaborative action and a sensitive eye are also essential. The concern with the formation of these skills and competences in Basic

Education is in the Common National Curriculum Base (BNCC, 2018), in Brazil. Therefore, both the humanities needed to turn to computational thinking when the exact areas of knowledge approached the humanities. An example of this meeting was the incorporation of the Arts into the STEM methodology, which became STEAM (Science, Technology, Engineering, Arts, and Mathematics).

The History we are dealing with here is part of the perspective of Digital Humanities, whose premise is the search for an effective transdisciplinarity by incorporating traditional knowledge into computational technologies; and at the same time, carry out the incursion of traditional knowledge in the field of technological knowledge. For the participation of a historian (professor of History) in the creation of digital technological tools permeates the understanding of how they work (Sousa, 2010).

It is not about ordering a database, a platform, a visualization design from a “computing specialist” – it is, in effect, about designing classifications, indicators and ways of reading together with computer professionals. These projects thus demand a deep intercomprehension between these researchers, all of them, in this movement, becoming subjects of technology – in the case of humanists, effectively learning to "think like their computers." (Sousa, 2010).

In this regard, History needs to read, understand, dialogue with the theoretical and practical productions of Computer Engineering, Production Engineering, Electronic Engineering, as these areas provide knowledge for the development of educational applications and the generation of robots and robotic models to be used as technological pedagogical tools in teaching the historical context of various temporalities.

In this article, we seek to bring the possibilities of a reinterpretation of STEM and STEAM methodologies, to insert History as one of the protagonists in this interdisciplinary and transdisciplinary path. For this, when working with the teaching of Cultural Heritage in Sergipe, Brazil, we propose the STEAH methodology (Science, Technology, Engineering, Arts, and History).

2. STATEMENT OF THE PROBLEM

In the first two decades of the 21st century, there was an acceleration in the development of digital technologies, which changed the way human beings deal with themselves, with the environment and with machines (Nóbrega; Maia, 2020). The issue of production time, recording information and health expectations are seen in a different way.

Communication via messaging applications has almost completely extinguished fixed telephony. Smartphones connected to the Internet allow the storage and sharing of information, the production of professional audiovisuals (discarding video-camcorders and audio recorders), allow the execution of text editors and digitized documents (dispensing the use of desktop computers), as well as apps such as monitor heart rate, calories consumed, and mileage of fitness walking and jogging routes. Mobile telephone devices connected to the internet have become fundamental parts of the course of life in society (Frey; Xu; Ilic, 2017).

In addition to being used for photographic-digital mapping of urban and rural spaces, drones have also provided delivery services and monitored the application of fertilizers and pesticides on plantations. These drones, controlled by cell phones, as well as tractors, also under the command of smartphones, plow the field without the need for a human driver (Wynsberghe; Comes, 2020).

Artificial intelligence is already in homes, in sensors that initiate the heating or cooling of environments according to temperature, just as the Internet of Things establishes communication between the refrigerator and MP4 music or even games programmed to be watched on the Smart TV.

If the world of the future of the animated series The Jetsons, produced from 1962 by the American Broadcasting Company, was not completely realized with flying cars and the robot Rosie, who takes care of the house cleaning, came awfully close. Electric cars and autonomous car projects are already a reality, as are robot vacuum cleaners and pizza chefs. Automated work quickly advances in daily life, impacting the economy and the lives of human workers (Lacerda, 2013).

The presentation of the “Manifesto of the Digital Humanities”, in 2010, during THATCamp, in Paris, emphasized that the digital humanities refer to the set of Human and Social Sciences, Arts and Letters that seek to learn, incorporate, create, and teach the from digital technologies. Digital humanities do not deny the past; on the contrary, they are supported by the set of paradigms, know-how and knowledge of these disciplines, simultaneously mobilizing the instruments and unique perspectives of the digital world. They aim to build evolving cyber-infrastructures that respond to real needs.

According to Chaves & Fernandes (2021, p.7), the use of technological resources can enable interest in learning; that is, the educational process through films, videos, games and with gamification produces positive effects by taking students to a learning mode that transforms the student into an active member of their learning process. Therefore, the fluidity and dynamism, which are the result of the implementation of technologies in the classroom, generate a differentiated teaching method that maintains the student's permanence in the classroom, reducing truancy and, consequently, with the training of students completely, with a possible reduction of social inequalities in the Brazilian reality.

Therefore, we are interested in the studies, research and products arising from the alliance between educational robotics, the use of STEM and STEAM methodologies in education, the joining of robotics with STEM, STEAM and other methodologies that consider the teaching of current generations to the present and the future.

The articulation of different methods has been a solution to enrich teaching proposals and make learning more dynamic. Thus, the use of design thinking combined with STEM has provided good experiences in the classroom. Inaugurated by David Kelly, design thinking has solved problems and presented a better image for business objects. However, its use is not limited to business and has extended to various fields such as Administration, Tourism, Production Engineering and History teaching (Arifin; Mahmud, 2021, p.1560).

For Plaza, Carro and Castro (2017, p.132) Robotic Education is becoming extremely popular these days. Simple robots are being used within STEM (Science, Technology, Engineering and Mathematics) Education as a powerful tool which eases the way to teach STEM knowledge. Additionally, Robotics also provide an attractive manner to transform boring concepts into an amusing learning process. Robotic kits facilitate the ease with which students can make connections among STEM disciplines.

Kopcha et al. (2017, p.32) justify that while the robot serves as a concrete external representation incorporated into students' thinking, students must also engage in abstraction while thinking and programming the robot's physical movement. These activities are important to STEM education because they help students develop the confidence and persistence needed to deal with ambiguous issues and to collaborate and engage in rigorous academic discussions with peers.

As Jung and Won (2018) state, robotics education offers students practical experiences to understand language and technological and mechanical systems. From this contact, students begin to accept and adapt to constant changes driven by complex environments. Knowledge leaves the classroom and is applied in real situations or across time, space, and contexts.

Allowing students to engage in robotics process-oriented learning experiences makes young students assume roles of initiative as co-constructors of learning, not just passive recipients of knowledge or consumers of ready-made technologies (Jung; Wo, 2018).

The studies by Guedes & Kerber (2010, p.202-203) listed among the systems available that offer a robotics kit for the classroom the “Lego Mindstorms” formed by four types of sensors, three motors and a central controller, where each one performs a specific function, namely: 1) the motors are responsible for moving the assembly structure; 2) sensors, by collecting information in the external environment; 3) the central controller is responsible for the intelligent part, where the software that manages the system resides.

Alves et. al (2011) when developing the Michelangelo robot, they show the step by step of their work, as they follow a basic architecture based on a Personal Computer (PC), a communication system and a robot. The PC is responsible for controlling the robot and carries out the planning of tasks that the robot must perform. The robot performs the tasks sent by the PC that define it s performance on the environment. At the same time, it senses the state of the environment and the modifications caused by the actuators and sends sensory data to the PC to ensure that planning is carried out with up-to-date data. Communication between the PC and the robot is carried out through the communication system, which is wired or wireless.

Silva's most recent work (2017, p.34-37) presents ideas for the development of a platform for multi team robots from a central core, also using Lego Mindstorms. For the researcher, communication between the components and the core is important for managing the events.

Games, nowadays, are no longer used only as a form of leisure or detachment from the real world, but also as a way of extending reality. In the last decade, games have become increasingly immersive through visual identity, aesthetic mechanics, dense characters, and plots, thus attracting a large and diverse audience. In this sense, games take on various guises, stories, and purposes, being used not only the entertainment industry uses this tool, but also the educational environment, that is, recently the number of educational games has grown, whether virtual or physical games (Chaves; Fernandes, 2020, p.318-319).

Our proposal is guided by the development of techno game, that is, analog board game with a digital interface and coupled robotics, creating the STEAH methodology to historically contextualize time and space in Sergipe, Brazil.

The game takes the student to the rivers and lakes of the fourth oldest city in Brazil, São Cristóvão, with a motorized boat that runs along wires presenting the natural heritage composed of vegetation and hydrography, the local history of the village the space, the construction of São Francisco Square (recognized by Unesco as a world heritage site) with its architecture of Portuguese and Spanish origin, the traditional sweets (cheese sweet, bricelets and fruit jams), the cultural events of groups and dances, traditions African traditions and religiosity present in the processions of Senhor dos Passos and Fogaréu the protection of Iphan and Unesco (Mello, 2020, p.578).

3. RESEARCH METHODOLOGY

3.1 The STEAH Methodology

The STEAH methodology (Science, Technology, Arts, Engineering and History) (Fig. 1) developed arises to implement the historical discourse in Sergipe within the educational environment in a playful, interactive, and immersive way. It turns out to be one of the ways to produce engagement and direction within the teaching of History in a differentiated and innovative way, observing the educational peculiarities that the 21st century presents to education.

STEAH is applied in the gamification process of teaching History, to promote a scenario that enables the use of technological tools in games in a productive way. The main objective is linked to the creation and development of a board game, in which it is possible to visualize the main cultural heritage of the city of São Cristóvão, Sergipe (Brazil), covering material, immaterial and environmental aspects. In turn, on the board, the importance of using basic robotics in the gamification project is highlighted, with the development of tracks and electronic pieces of dynamic movement.

In this respect, the use of Design Thinking as a method of elaborating solutions for the identified problems, allows idealizing, creating in 2D, prototyping in 3D and testing. As it is about creating new technologies and methods, it also involves researching intellectual property and copyright.

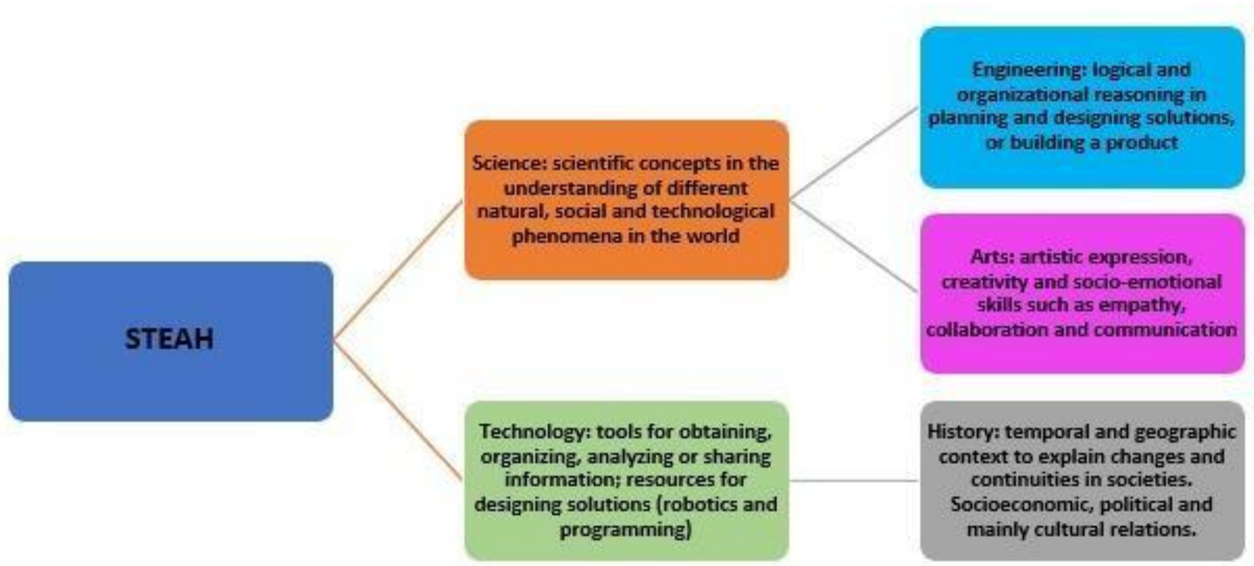


Fig. 1. STEAH Diagram Font: Self elaboration (2021)

3.2 Use of Design Thinking + STEAH

The design thinking method uses a Value Propositions Canvas model adapted to a Historical version of Cultural Heritage (Fig.2). The model is divided into a square (left) and a circle (right).

In the square there are three subdivisions: a) Problem (with a question that will guide the research); b) Context (which must bring the historical content); b) Geography (which must contain data on cartography, demography, climate, and hydrography). Filling in this information occurs through the input (Design Thinking + STEM/STEAM = STEAH).

In the circle there are also three subdivisions: a) Ideas (which must contain proposals to answer the question in the square); b) Impact (which must bring the "value proposition", that is, social impact, meeting the demands of society); c) Solution (which must contain a clean and accurate answer about a technological educational service or product). Filling in these data generates the output (Robotics + Programming Language + 3D Printing).

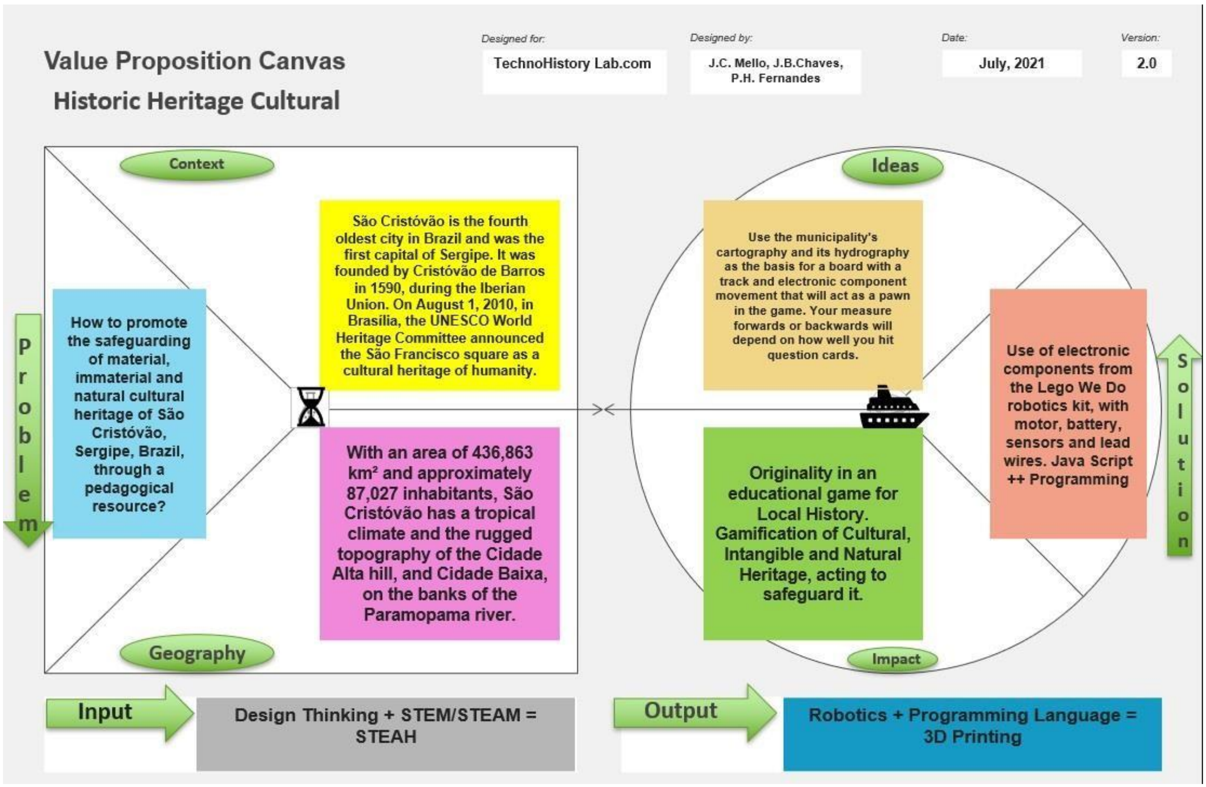


Fig. 2. Value Propositions Canvas HHC model (Design Thinking) Font: Self elaboration (2021)

3.3 Motorized Vectors: 2D and 3D Design

For the 2D drawing of the game's engine (Fig.2), research was carried out on the shape and style of motorized vectors (boats) on the Vexels platform (https://br.vexels.com/). With the variety of offers, it was possible to choose a model that could integrate the analogue board.

Fig. 3-4. Boats 2D drawing and 3D visualization Font: Self elaboration (2021)

From the 2D visualization experience, there was a search for a 3D visualization (Fig.4) with a vessel made with Lego blocks. A rough layout of the game's powerhouse was found on the Gratispng platform (https://www.gratispng.com/png-87huro/download.html).

3.4 Use Robotics + Programming Language

The prototype of the motorized vector was designed based on the Lego We Do 2.0 educational robotics kit, with pieces in the form of snap-on blocks made of resistant plastic, movement and inclination sensors, motor, battery, smarthubs and connection cables (LEGO, 2018) (Fig. 5-6).

Fig. 5-6. Kit robotics Lego We Do 2.0 and electronic motor

3.5 Analog Game Board Design

The game's analogue board project surveyed the images of the historic center of the city of São Cristóvão, SE, Brazil (Fig.7 - 8), with a view of buildings and an aerial view containing vegetation and hydrography. In parallel activity, the research cartography (Fig. 9-10) was collected.

Fig. 7,8,9,10. São Cristóvão's images and maps Font: Photos by research archive (2019) and Maps from Wikipedia (2021)

With these data in hand, the analogue board was elaborated (Fig.11), and a prospection research was carried out in the information banks of intellectual property registration at INPI, Brazil. The design of the board was inspired by the city with its shapes and colors. The flag and coat of arms of the place also helped in this part. The tracks run through the delimited space and the game is governed by the definitions and inquiries of cards with historical and environmental content.

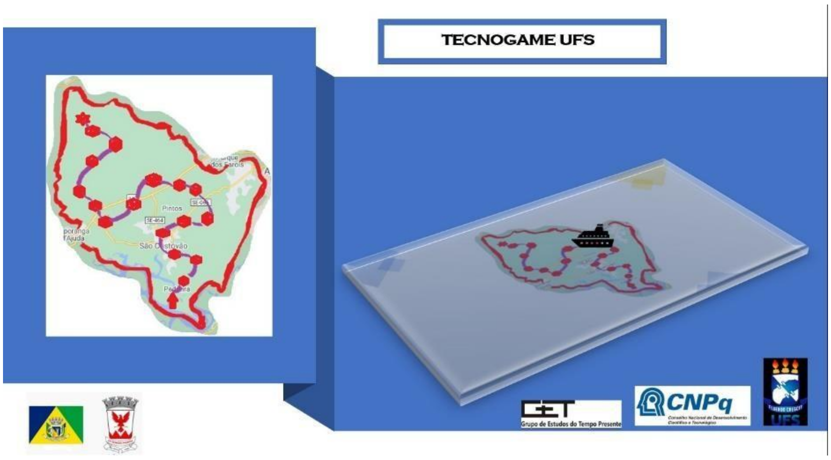


Fig. 11. First prototype of the game board Font: Self elaboration (2021)

3.6 Robotics Architecture + Programming Language

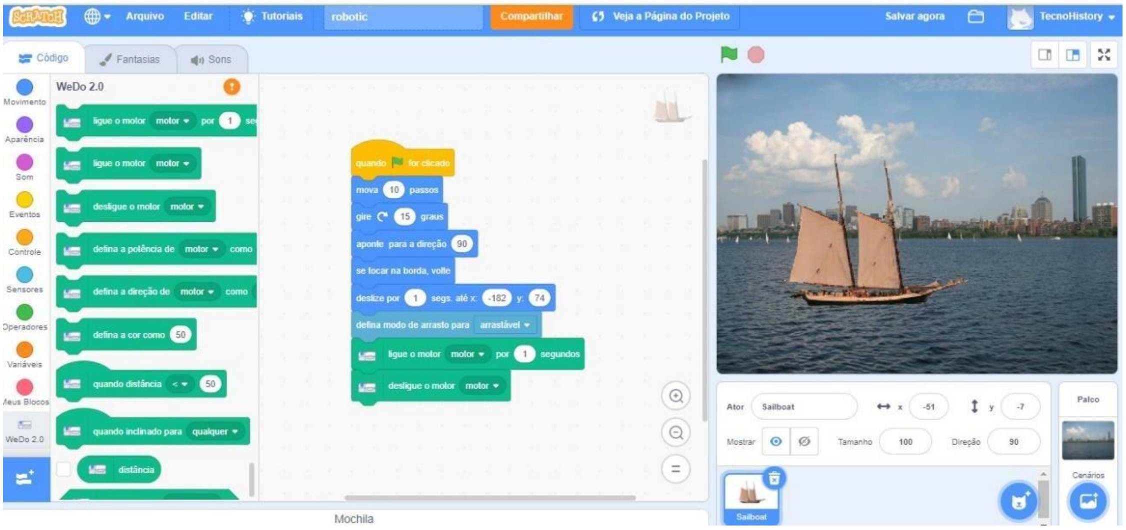
The motorized vector (boat) that serves as the top of the game carries a supervisory system responsible for activating the actuators and reading the sensors, upon computer request. On the computer is the Scratch development environment, which provides the software interface that promotes communication between the computer and the vector.

WeDo 2.0 uses National Instruments LabVIEW technology, the interface presents multicolored icons with figures that, using drag and drop, line up in a linear sequence (LEGO, 2018).

The use of Scratch enhances We Do operations, because through colored graphic blocks it is possible to control graphic objects (sprites) and carry out the communication of the virtual element with the physical vector. Commands enable motion, events, control, sensors, operators, and variables. These are structural, object- and event-oriented programming concepts, introduce loops, variables, and logical expressions.

Created by Mitchel Resnick in the MIT environment, the Scratch Programming Language consists of an online platform that integrates several resources, is accessible for online operation or downloadable for offline execution. It is related to constructionist digital learning environments, based on the 4P's (Think at play, Creative potential, Pairs and Passion) (Resnick, 2020).

The Scratch programming language uses Java and C++, however, in the creation and sharing of projects, as it operates with open source, it allows a variety of other coded creations, through remix (change, suppress or add) (Resnick, 2009). Available for operating systems: Windows, Android, Mac OS, and Chrome OS.



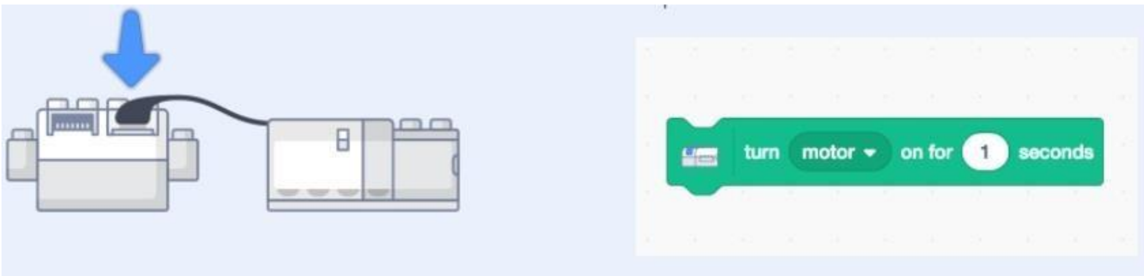


Fig. 12. Scratch 3.0 + Lego We Do 2.0

With the Scratch 3.0 version (Scratch Link) it is possible to connect a motor to We Do and program its operation over time. The communication between the vector and the computer is used a Bluetooth Communication System, configuring the Internet of Things (IoT) in the communication between notebook/smartphone > robot (boat)> sensors> game (Fig.12).

The project architecture represented by the diagram shows the programming in the Scratch environment that communicates with the Lego We Do robotics kit to make the Tecnogame work and promote interaction with the user (Fig. 13).

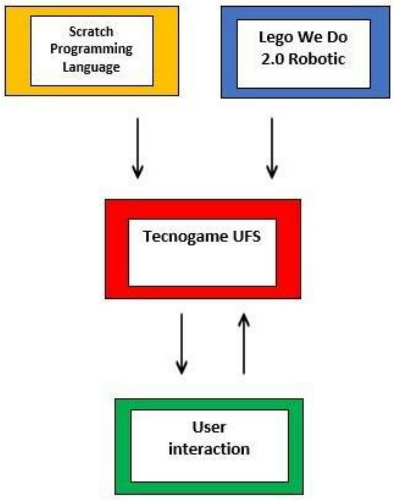


Fig 13: Working architectureFont: Self elaboration (2021)

The Scratch team seeks to develop collaborative potential through online communities (clubhouse) that allow creative learning, diversified by different interests, oriented by design, with work by peers (doing together), with shared knowledge and products, thus creating personal connections, enhancing imagination and artistic expression. Process that also involves the development of concentration, attention, perception, and fine motor coordination (Equipe Scratch, 2019).

4. CONCLUSION AND RECOMMENDATION

This model of pedagogy that uses educational robotics is inspired by Vygotsky's constructivism where there are dialectical interactions between students at different stages of learning and skills, as well as with more experienced people (teachers, instructors, or an intelligent system) acting as mediators of a project-oriented, autonomous learning that involves theoretical understanding, skills, and application. (Tang; Tung; Cheng, 2020, p.2).

It is recommended the combined use of active methodologies such as STEAM/STEAM, Design Thinking and creative computing articulated with the development of school and citizen skills such as: computing and programming (use of digital tools, multimedia production and programming language), computational thinking, insertion in culture and the digital world with reflective, critical, ethical, and inventive bases (BNCC, 2018)

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