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EDUCATIONAL ROBOTICS AND THE INTERDISCIPLINARY PROPOSAL FOR BASIC EDUCATION: A SYSTEMATIC MAPPING

LA ROBÓTICA EDUCATIVA Y LA PROPUESTA INTERDISCIPLINARIA PARA LA EDUCACIÓN BÁSICA: UN MAPEO SISTEMÁTICO

ROBÓTICA EDUCACIONAL E A PROPOSTA INTERDISCIPLINAR PARA A EDUCAÇÃO BÁSICA: UM MAPEAMENTO SISTEMÁTICO

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Abstract
This article presents a systematic mapping carried out with the aim of identifying articles that address Educational Robotics (ER) in a way that contributes to the learning of basic education subjects. The results show that there is little research involving ER in an interdisciplinary way. However, these few initiatives seem to present indicators that they can be carried out. The mapping was carried out using the papers available on the Google Scholar platform, from 2016 to 2020, and the initial result was 647 papers. After applying parametrization and establishing 4 descriptors, 13 papers remained that met the proposed theme.

Keywords: Basic Education; Educational Robotics; Mapping Systematic; Digital Technologies; Computational Thinking.

Resumen
Este artículo presenta un mapeo sistemático realizado con el objetivo de identificar artículos que aborden la Robótica Educativa (RE) de manera que contribuya al aprendizaje de materias de educación básica. Los resultados muestran que existen pocas investigaciones que involucren la ER de manera interdisciplinaria. Sin embargo, estas pocas iniciativas parecen

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presentar indicadores de que esas pocas iniciativas pueden ser realizadas. El mapeo se realizó utilizando los artículos disponibles en la plataforma Google Scholar, de 2016 a 2020, y el resultado inicial fue de 647 artículos. Luego de aplicar la parametrización y establecer 4 descriptores, quedaron 13 artículos que cumplieron con la temática propuesta.

Palabras clave: Educación Básica; Robótica Educativa; Cartografía Sistemático; Tecnologías digitales; Pensamiento computacional.

Resumo

Este artigo apresenta um mapeamento sistemático feito com o objetivo de identificar artigos que abordem a Robótica Educacional (RE) de maneira que esta contribua para a aprendizagem de disciplinas da educação básica. Resultados apontam que há pouca pesquisa envolvendo RE de forma interdisciplinar. No entanto, essas poucas iniciativas parecem apresentar indicadores de que essas podem ser realizadas. O mapeamento foi realizado pelos trabalhos disponibilizados na plataforma Google Acadêmico, no recorte temporal de 2016 a 2020 e apresentou como resultado inicial 647 trabalhos. Após aplicação da parametrização e estabelecidos de 4 descritores, sobraram 13 trabalhos que atendiam a temática proposta.

Palavras-chave: Educação Básica; Robótica Educacional; Mapeamento Sistemático; Tecnologias Digitais; Pensamento Computacional.

Introduction

The presence of a wide variety of technologies in the school environment that are being used as teaching resources leads us to reflect that we still have a lot to learn about their inclusion and potential in teaching and learning processes in basic education. Araújo and Mafra (2015) point to robotics as "one of the technological resources that are beginning to make their way into Brazilian school environments" and call this practice "Educational Robotics".

But before understanding what RE is, we believe it is important to understand what robotics is. This is not such a simple task, as it requires knowledge of areas such as computer science, automation and engineering. In this vein, we'll give a short introduction to the meaning of robotics and then move on to understanding educational robotics (ER).

The human desire to create an artificial being that comes to "life" has been with us since ancient times. Ancient peoples such as the Egyptians, Greeks and Jews already had the idea of producing a robot machine that could perform tasks that man,

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for whatever reason, was unable to do. A classic example is the mechanical arms produced by the Egyptians and placed on the gods in order to impress the people (Pazos, 2002).

However, it was only after the 20th century that the science of robotics began to consolidate and grow, and became associated with increasing industrial productivity and improving product quality. In other words, robotics initially appeared in the context of factories with the aim of improving production. Therefore, the industrialization process can be identified as one of the social phenomena responsible for the introduction and promotion of robotics in the social environment and, therefore, its consequent growth is configured as a result of the increase in industrial production since the work carried out by a machine (robot) not only replaces the labour of several employees but also guarantees greater production in a short space of time. The term "robot" was first used by the Czech Karel Capek (1890-1938) in the play Rossum's Universal Robots. The writer called the characters in his play roboti, plural of robot, which has its origins in the Czech word robota, meaning forced labor, servitude. However, the writer Isaac Asimov was responsible for popularizing the word robotics in his 1950 work I, robot. As for the definition, although this is not the objective of this work; among the definitions of the term "robot", we highlight that of the Infopédia Dictionary of the Portuguese Language (2018), which states that:

> A robot is an automatic mechanism, sometimes shaped like a human being, capable of making movements and performing certain jobs in place of a human being.

Educational Robotics is a pedagogical approach that uses robotics as a tool to promote learning in different areas of knowledge. It is based on the idea that building and programming robots can stimulate logical reasoning, critical thinking, creativity, collaboration and other important skills for success at school and in life.

The use of robotics for teaching purposes is not new. This technology was introduced to education in the 1980s by scientist Seymour Papert, from the Massachusetts Institute of Technology (MIT) in the USA, with research into the Logo

programming language (Papert, 1985). The creation of this software was a milestone in the implementation of robotics in schools because, according to the author, this program is capable of strengthening intellectual activities in children.

In Brazil, the first kit marketed for assembling robotics was the Lego kit, made up of sensors, motors and gears. With the passage of time and the popularization of personal computers (PCs), robotics also became more accessible and Lego kits gained more national and international visibility and, following the implementation of robotics in education from the 1980s onwards, Lego-Logo kits began to be marketed.

Educational Robotics (ER) can be explored as a resource for teaching content in different areas of knowledge, as stated by Felcher, Pinto and Folmer (2019). In the same work, they also point out that ER is an option with interesting perspectives, although it has not been explored much. In this direction, Campos (2019) states that the search for information on RE has increased and that a large number of attempts have been made to introduce the topic in schools, from early childhood education to high school.

RE is considered to be an essentially interdisciplinary practice (Francisco Junior; Vasques; Franscisco, 2010). In a pedagogical environment made up of robotic devices, there is a constant dialog between various disciplines such as mathematics, physics, psychology, medicine, computing, among others. The task of programming a robot requires the learner to develop an integrated and broad knowledge of the task to be carried out, such as the mechanical structure of the robot, the sensors it has for carrying out some specific demands on its physical functioning. By integrating these concepts, the student needs to develop algorithms that solve the problems encountered in programming the robot in a structured and logical way. Often, the solution involves math or physics concepts directly (such as calculating the distance to the obstacle based on the measurements of the ultrasonic sensor, for example).

In this sense, the term Educational Robotics, used in this text, refers to the practice in educational contexts, usually in school environments, involving the activity of building, manipulating and programming robots, providing a learning

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environment that fosters reasoning, creativity, the construction of knowledge in different areas and the experience of living together in groups. Papert (2008) states that robotics at school serves as a platform for making connections between areas of knowledge, thus presenting a close relationship with the concept of interdisciplinarity established by Fazenda (1994), where the author states that the greatest characteristic of interdisciplinarity is the conception of knowledge without the existence of hierarchies, considering possibilities of concomitant and harmonious overlapping and juxtaposition, not being a simple interaction between the knowledge of different areas.

In terms of learning itself, Alves and Lopes (2019) point out that Educational Robotics can be an effective tool for stimulating students' logical reasoning and critical thinking. Building and programming robots requires students to think logically and critically in order to solve problems. According to the authors' study, students need to analyze the problem, identify the components needed to solve it, and develop a plan of action. They also need to test and debug their programs to ensure that the robots work correctly, which makes error analysis part of the learning process.

Also in this direction, the study by Chou and Lin (2019) states that Educational Robotics can have a positive impact on students' performance in math and science. The authors conducted a study with 120 elementary school students, who were divided into two groups: a group that participated in a robotics program and a control group. After the robotics program, the students in the experimental group obtained better results in math and science tests than the students in the control group.

The authors of the study attributed the positive results to the fact that Educational Robotics requires students to think logically and critically in order to solve problems. Building and programming robots also requires students to apply mathematical and scientific concepts, which can help improve their performance in these areas.

Although Chou and Lin's study is a pilot study, it provides promising evidence that Educational Robotics can be an effective tool for improving student

performance in math and science. The authors state that students who participated in a robotics program obtained better results in math and science tests than students who did not participate in the program. The authors of the study attributed the positive results to the fact that Educational Robotics requires students to think logically and critically in order to solve problems, and that it also requires students to apply mathematical and scientific concepts.

It is also important to mention the teacher's view of learning through RE. A study by Fernandes and Silva (2020) interviewed 12 teachers who taught robotics classes to children aged 7 to 10. The teachers were interviewed about their experiences with teaching robotics and the benefits they observed in the students' learning. The authors of the study concluded that Educational Robotics is a promising tool for promoting children's learning. They recommend that Educational Robotics be incorporated into school curricula as a way of stimulating the development of important skills for success in school and in life.

Given this scenario, and in an effort to contribute to understanding of the subject, our aim in this study is to look at the possibilities of using ER as a tool for interdisciplinary practices in basic education. A systematic mapping (MS) will be used to show what research reveals about the different approaches used in the use of ER in the search for interdisciplinarity. The strategy used to carry out the work will be through mapping the research, categorizing it and, finally, describing the results found.

Material and methods

In accordance with the aim of the study, which is to investigate research that addresses ER as an interdisciplinary resource in teaching and learning processes in Basic Education, we used the mapping methodology to present the methodological approaches and theoretical aspects that are revealed in the mapped works. Thus, this study was based on Fiorentini, Passos & Lima (2016), who define research mapping

as "a systematic process of gathering and describing information about the research produced on a specific field of study, covering a certain space (place) and period of time" (p. 18).

To carry out this MS, the Google Scholar database was selected, as it is a free search platform and brings together articles from important journals in the fields of education and computing. We used a time parameter of texts published between 2016 and 2020.

The searches took place in July 2022, using the Boolean operators "AND" and "OR" to organize the search strings. It is worth explaining here that these operators are possible on Google Scholar because the platform has a direct translation mechanism (which differentiates it, for example, from the Capes Catalogue of Dissertations and Theses, which requires Boolean operators in English ("AND" and "OR"). The search strings were then established as follows: ("interdisciplinaridade" OR "interdisciplinar") AND "Educação Básica" and "robótica-educativa" AND ("interdisciplinaridade" OR "interdisciplinar") AND "Educação Básica".

These search strings were chosen on the basis of the nomenclatures (Educational Robotics, Pedagogical Robotics and Educational Robotics) that were most commonly used by ER authors and researchers in preliminary searches and readings. In order to select research that addressed content related to interdisciplinarity, we composed the words "interdisciplinarity" and "interdisciplinary".

A total of 647 articles were found, making up all the texts identified through the strings used. We then applied the inclusion and exclusion criteria to the selected papers and then parameterized the research focusing on Basic Education, as shown in the flowchart of the mapping paths (Figure 1).

We then arrived at a portfolio of 13 articles. We then collected the data for categorization.

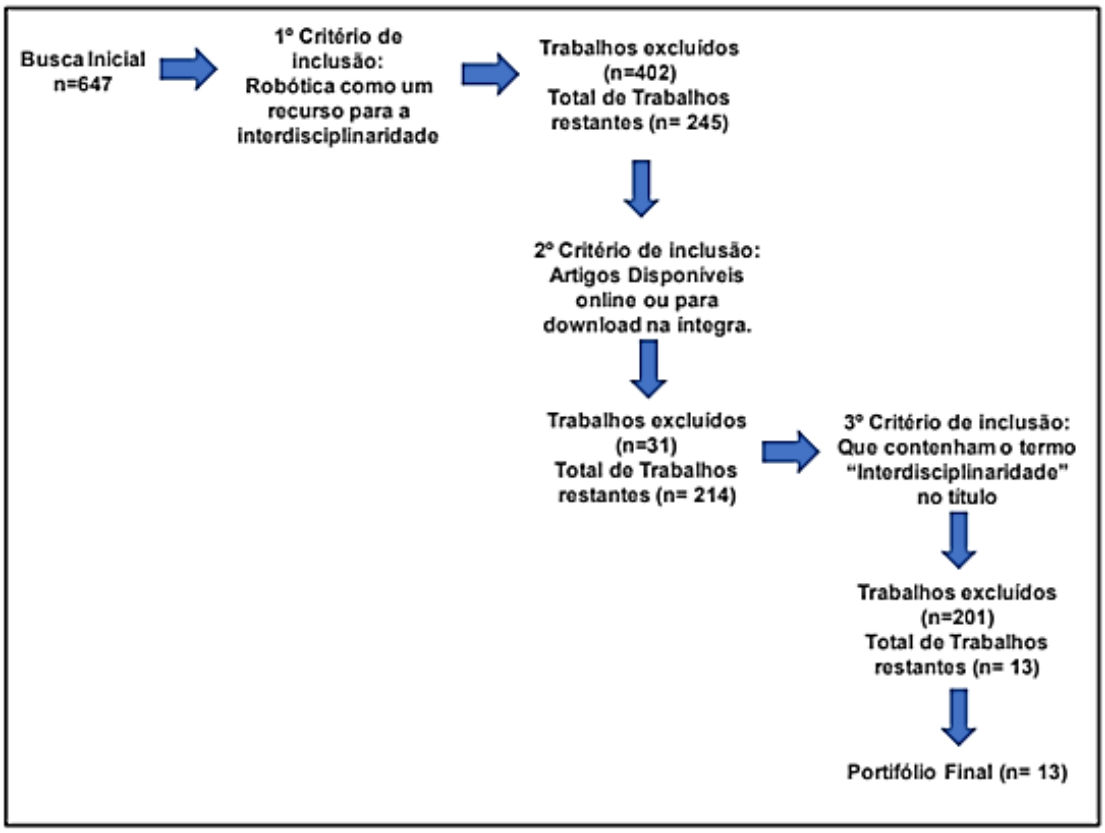

Figure 1 (Source: Authors, 2022)

The jobs identified

Chart 1 lists the 13 studies identified in the MS, organized by title and author. We have not characterized the database in the table because it is a single database.

	TITLE	AUTHOR
1	Robótica Educativa e interdisciplinaridade: o OzoBot como ferramenta de aprendizagem na Educação Infantil e nos anos iniciais do Ensino Fundamental.	Ribeiro et al. (2020)
2	A robótica na escola como postura pedagógica interdisciplinar: o futuro chegou para a Educação Básica?	Peralta, D. A.; Guimarães, E. C. (2018)
3	O Ensino de Linguagem de Programação na Educação Básica Através da Robótica Educacional: Práticas e a Interdisciplinaridade.	Costa, T. et al. (2017)
4	GEORobótica-Uma proposta lúdica interdisciplinar para Ensino de Geografia no Ensino Médio: um relato de experiência da robótica educacional com alunos de escola pública.	De Oliveira Farias, et al. (2019)
5	A robótica como um caminho para a interdisciplinaridade.	De Matos (2019)
6	Robótica educacional: desafios/possibilidades no trabalho interdisciplinar entre matemática e física.	Brito, et al. (2018)

7	Uso da plataforma ARDUINO na interdisciplinaridade do Ensino Fundamental I: Relato extensionista em uma escola pública.	Ramos; Ferreira; Magalhães (2018)
8	A robótica como ferramenta facilitadora e interdisciplinar no processo educacional de pessoas com neurodiversidade.	Miranda (2018)
9	A plataforma Arduído no apoio ao desenvolvimento dos projetos interdisciplinares dos cursos profissionais	Rocha (2020)
10	Linha de montagem: projeto interdisciplinar relacionando robótica com o estudo de funções matemáticas.	Aureliano, et al. (2020)
11	Robótica e Interdisciplinaridade: Aprendizagem Criativa Atraindo Meninas para a Tecnologia.	Santos; Da Costa Oliveira Filho (2020)
12	A Robótica no Ensino de Física: Uma Saudável Relação Interdisciplinar.	Braz; Oliveira (20216)
13	Robótica livre como instrumento educacional interdisciplinar	Pereira; Nunes; Santos (2018)

Table 1 (Source: Authors, 2022)

The abstracts of the articles were considered for reading. While reading the studies, we found that the focus on researching the contributions of the use of robotics due to its interdisciplinary nature was present in 46% of them.

To categorize the data collected, we adopted a model also used in a study by Albertoni et al. (2020) in which the ideas of Fiorentini and Lorenzato (2006) are considered to determine the meaning of categorization, which according to the authors "means a process of classifying or organizing information into categories, that is, into classes or sets that contain common elements or characteristics" (FIORENTINI; LORENZATO, 2006, p. 134). In this sense, to establish the categories, we will follow the proposal of using thematic focuses and sub-focuses. We established the possibilities of using robotics and interdisciplinarity as thematic focuses, and their ramifications as sub-focuses. The sub-focuses identified in relation to the possibilities and listed in the categorization use the disciplines in question to promote the proposed interdisciplinary relationships**.**

Figure 2 shows a word cloud with the main terms present in the abstracts of each of the research papers. The intention was to see which words refer to the possibilities of using robotics as an interdisciplinary practice. These were: robotics, teaching, interdisciplinary, student, knowledge and school. With regard to the theoretical aspects, we observed that Papert's constructionism is present.

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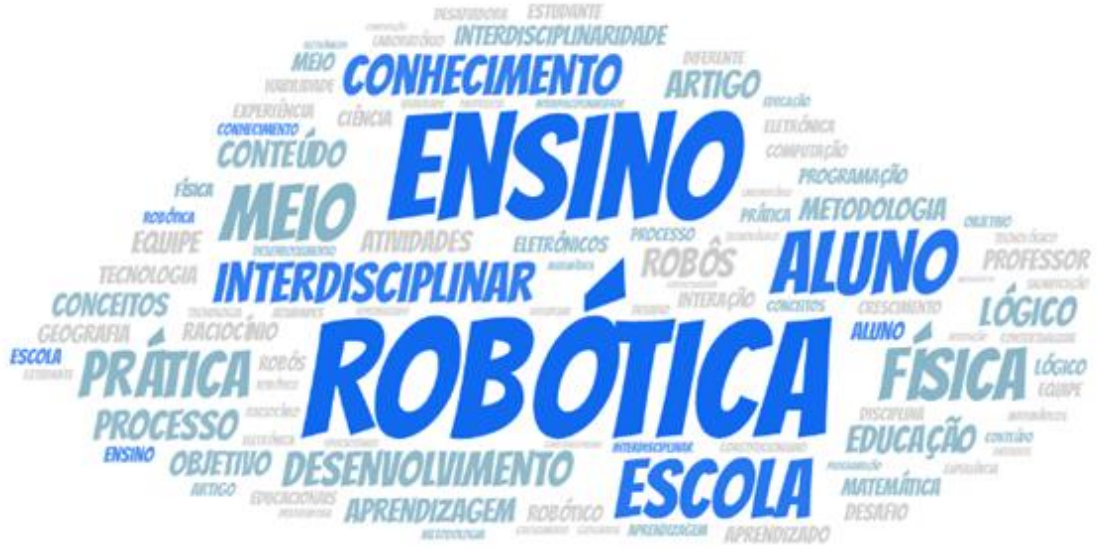

Figure 2 (Source: Authors, 2022)

Discussion of the results

The bibliographic portfolio was created based on the focuses and sub-focuses presented above, so we present the two categories that made up this research: (1) "Robotics as an interdisciplinary pedagogical possibility", (2) "Robotics and Interdisciplinarity as a facilitator of social inclusion".

Let's start with the category of "Robotics as an interdisciplinary possibility", which encompasses the vast majority of the studies researched here, and thus becomes a more relevant topic since the methodological procedure most used in classes that make use of RE as a resource for teaching and learning processes considers that RE is a potential element for promoting interdisciplinarity. We can highlight here the studies by DE MATOS (2019), whose proposal is direct and explicit in a study divided into 4 parts. The first part provides a brief history from antiquity to the present day. The second part explains the concepts and relationship between robotics and education. The third part aims to address the interdisciplinary nature of robotics and the fourth part presents teaching strategies for working with robotics in constant dialogue with the various areas of knowledge.

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In this direction, other works in the same category, such as RIBEIRO et al. (2020), aim to bring Geography and Robotics closer together, highlighting interdisciplinarity as a bridge. PEREIRA et al. (2018) and BRAZ and OLIVEIRA (2016) put forward similar proposals, but with Physics as an element that seeks to bridge RE as an interdisciplinary relationship.

Another very interesting study due to its explicit proposal to use robotics as an interdisciplinary pedagogical possibility is that of PERALTA and GUIMARÃES (2018). The authors propose a study guided by the proposition of robotics as an interdisciplinary pedagogical practice alternative to traditional teaching of curricular content, including understanding educational robotics as a potential element to make the student a producer and not just a consumer of digital technology, and the teacher a protagonist in processes of (re) construction of their own practice. According to the abstract, the research relied on a bibliographical survey and also a field survey obtained through experience in the school and teachers' reports, and the data allows us to affirm that ER can be accepted as an interdisciplinary practice.

In the second category, only one work, by SANTOS (2020), has the main objective of showing that girls can work in different areas of knowledge, including RE. Although the abstract proposes "a project to teach robotics and creative learning in an interdisciplinary methodology", the main objective is not to discuss the approach of CR as an interdisciplinary possibility.

Furthermore, it is possible to understand that, although there is still little material related to CR as an interdisciplinary possibility, it is possible to glimpse a perspective to overcome abstract knowledge and interact with other areas of knowledge, which can converge to broaden the world view, motivate students and, above all, contextualize the social function of science.

Considerations

The MS presented here resulted in 13 studies. In order to identify the information that would make it possible to categorize the studies, we read the

abstracts in order to identify the relevant data for this study, which we considered sufficient to identify and achieve our objective. Based on this, we sought to identify information that would make it possible to categorize this research.

During the composition of the categorization, which we separated into two categories, we pointed out that the two focuses apparently did not complement each other, since one of them dealt with the possibilities of using robotics as an interdisciplinary pedagogical practice, while the other used the approach of robotics and interdisciplinarity to achieve other (social) objectives that were not pedagogical in origin.

The question raised in the MS was answered with the steps presented in the research mapping. In this way, it was possible to identify that RE has been seen and used as a proposal for carrying out and promoting interdisciplinary practices.

Finally, we hope that this mapping can contribute to future studies on the use of ER as a possibility for interdisciplinary practice. In this way, given the current scenario, we are inspired to present research aimed at the use of ER and its relationship with interdisciplinarity, since the school context can be inserted alongside this technology, thus highlighting the importance of work on the use of this resource and interdisciplinarity in the educational context

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