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ROBOTICS AS A TEACHING STRATEGY FOR PROFESSIONAL AND TECHNOLOGICAL EDUCATION SUBJECTS IN BRAZIL BETWEEN 2017 AND 2022: AN INTEGRATIVE REVIEW

INTEGRATIVE REVIEW

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ABSTRACT

There are various ways to teach different subjects at any educational level. Through robotics, various formal components can be understood. Mathematics, physics, and programming languages are often the areas where robotics has the greatest impact. However, this does not prevent subjects like geography, arts, Portuguese language, and biology, among others, from using this tool. The aim of this article is to identify how educational robotics is used as a teaching tool in core subjects, with an emphasis on Professional and Technological Education (PTE) in Brazil, from 2017 to 2022. For this purpose, an integrative review was conducted on the influence of robotics as a supportive element in the teaching methodology of professional education subjects in Brazil, with a focus on Amapá, using the Google Scholar database for the specified period. It is concluded that when used correctly, robotics applied to education is a technological tool that provides students with meaningful learning, allowing them to be active participants in the process. The alignment between theory and practice in contextualized classes allows students to engage in challenging experiments that enrich their knowledge and overall education.

Keywords: Professional and Technological Education, Robotics, Teaching, Active Methodology.

INTRODUCTION

Teaching can be considered as the education an individual receives in a school environment (LDB, 2017). It can be defined as the ability to collectively construct knowledge through the learning of different contents. Currently, it can take place formally in specialized classrooms or through new technologies (active methodologies) (ARAÚJO *et al.,* 2021). In Brazil, education aims to form concepts in the so-called "fundamental" part (up to the 9th year). In the following years, called "high school," it is assumed that there is a consolidation of this content and the comprehensive education of the student to work and coexist in society (FAVACHO *et al.,* 2020).

There is a type of education focused on work and initially based on an observation and repetition methodology (COSTA; COUTINHO, 2018). Nowadays, this type of education is called Professional and Technological Education (PTE). It proposes learning focused on preparing the individual for the world of work and for active participation in the society in which they live (MARIN *et al.*, 2019).

The use of discarded electronic equipment, such as computers, tablets, smartphones, remote-controlled cars, in the teaching and learning process, is also known as educational robotics. Through this tool, different formal components can be understood. Mathematics, physics, and programming languages are often the areas where robotics has the most impact. However, this does not prevent subjects like geography, arts, Portuguese language, and biology, among others, from using this tool (DE SOUZA *et al.,* 2018; CAMPOS, 2019).

Educational or pedagogical robotics is a teaching methodology used in Brazil since 1994. Designed for students to build new knowledge, with or without electronic devices, it is a tool where the student's prior knowledge can be enhanced with an academic-scientific basis (PARREIRA *et al.*, 2022).

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OBJECTIVE

To identify how educational robotics is used as a teaching tool in core subjects, with an emphasis on Professional and Technological Education (PTE) in Brazil, between 2017 and 2022.

METHOD

Integrative review is a methodology whose proposal is to provide a synthesis of knowledge incorporating the applicability of significant results. In this sense, articles were searched in the main Brazilian journal databases: Google Scholar and Observatory of the *Programa de Pós-Graduação em Educação Profissional e Tecnológica* (ProfEPT). The inclusion criteria were: I) a time frame in the last five years (at the time of the research), from 2017 to 2022; II) full text available in electronic format, free of charge, and written in Portuguese; III) the presence of search terms "*robótica educacional*" in the title; IV) the presence of terms such as "*Robótica Educacional*," "*Robótica Educacional e Língua Portuguesa*," "*Robótica Educacional e Química*," "*Robótica Educacional e Arte*," "*Robótica Educacional e Geografia*," "Robótica Educacional e *Matemática,"* "*Robótica Educacional e Física*," "*Robótica Educacional no Estado do Amapá*," "*Robótica Educacional e a Educação Profissional e Tecnológica (EPT)*" in the abstract; and V) compatibility with at least one of the research objectives, that is, to contemplate the scenarios of educational robotics use and identify the importance of a differentiated active methodology in learning basic concepts in common curriculum components. Articles that did not meet the research proposal were excluded.

RESULTS AND DISCUSSION

Table 1 below presents the number of articles used for each descriptor, along with their respective authors and years.

In the descriptors *"robótica," "ensino,"* and "*língua portuguesa*," 162 articles were found on Google Scholar, and three articles were selected for analysis. For *"robótica,"*

"*ensino*," and *"química,"* 44 articles were found, and three articles were chosen. In *"robótica," "ensino,"* and *"artes,"* three articles were used out of the 300 found. Using the keywords "*robótica*," "*ensino*," and *"geografia,"* three articles were selected out of the 219 found. In *"robótica," "ensino,"* and *"matemática,"* four were chosen out of the 590 articles. In the descriptors "*robótica*," "*ensino*," and *"física,"* 128 were found, and three articles were analyzed. Regarding "*robótica*," "*ensino*," and *"Amapá,"* three articles were used out of the 12 found. In the descriptor "*robótica*," "*ensino*," and *"EPT,"* there were five articles that did not meet the search criteria, requiring a search in the Observatory of the *Programa de Pós-Graduação em Educação Profissional e Tecnológica* (ProfEPT), using the descriptor "*robótica*," three dissertations were selected from the seven found

Table 1. Number of articles used, according to each descriptor, and their respective authors and years

Base de Dados	Descritores	Número de artigos encontrados	Número de artigos utilizados	Autor, Ano dos artigos utilizados
Google Acadêmico	"Robótica", "Ensino" E "Língua Portuguesa"	162	3	SANTOS et al., 2018 LIMA *et al.* , 2019 SILVA e MORAES, 2020
	"Robótica", "Ensino" E "Química"	44	3	ALBUQUERQUE, 2018 JUNIOR *et al.* , 2020 GRAHALL *et al.* , 2021
	"Robótica", "Ensino" e "Artes"	300	3	SANTOS *et al.* , 2018 GODIN *et al.* , 2022 MORAES, 2018
	"Robótica", "Ensino" e "Geografia"	219	3	SOUSA, 2017 ARAÚJO *et al.* , 2019 FARIAS *et al.* , 2019
	"Robótica", "Ensino" , e "Matemática"	590	4	ARAÚJO *et al.* , 2017 MESQUITA *et al.* , 2018 ALBERTONI *et al.* , 2021 SILVA e OLIVEIRA, 2022
	"Robótica", "Ensino" e "Física"	128	3	LOPES *et al.* , 2018 LIMA e FERREIRA, 2020 MATOS, 2021
	"Robótica", "Ensino" e "Amapá"	12	3	MAHMUD, 2017 BRITO *et al.* , 2020 SOUZA *et al.* , 2021
Observatório ProfEPT	"Robótica"	7	3	RAMOS e MORAES, 2020 PONTES, 2021 ROCHA 2021

Source: Prepared by the authors, 2022.

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According to the authors Santos *et al.* (2018); Lima *et al.* (2019); Silva and Moraes (2020), who address the use of robotics in the Portuguese Language component, it is possible to develop differentiated activities, with previously presented texts, building prototypes to foster everything from word formation to poem and verse production, which led the participants to act actively, facilitating interpersonal relationships, creativity, cooperativism, making learning meaningful for them.

The National Common Curricular Base (BNCC) defined Portuguese Language and Mathematics as mandatory curriculum components. Aligned with these components, educational technologies with their competencies aim to make students protagonists in this process. The Portuguese Language assimilates new literacies, such as digital ones. The use of new educational tools can make the teaching and learning process effective and positive. It is necessary for technologies to be allies in this teaching and learning process, developed as teaching strategies in a contextualized way for meaningful learning (COELHO *et al.* 2020; REGNER *et al.*, 2022).

When addressing articles related to the descriptors robotics, teaching, and chemistry, it was noticed that, by using robotics in this context (chemistry), it facilitated the understanding of concepts, construction, and even the use of low-cost equipment for measuring solution variables. Robotics can easily be used both in basic education and in higher education, and the teacher ceases to be a transmitter of knowledge to become a mediator in the teaching-learning process (ALBUQUERQUE, 2018; JUNIOR, 2020; GRAHALL, 2021).

Robotics in the context of the chemistry curriculum component offers students an education centered on their direct participation. The teacher as a mediator in the teaching-learning process allows the student to express themselves freely, questioning and discussing possibilities in collaborative work, ranging from the reuse of various materials to the construction of prototypes, sharpening their curiosity and creativity. The presence of robotics in the classroom favors meaningful learning for the student, allowing them to seek other alternative methods and materials where they can develop and improve their knowledge in a contextualized way (PEREIRA JÚNIOR, 2014; PINHEIRO; SOARES, 2022).

In the arts curriculum component, authors Santos *et al.* (2018); Godin *et al.* (2022); Moraes (2018) observed that robotics can be used as a facilitating tool for teaching various curriculum components, with a focus on the arts. One of the difficulties in its use was the lack of physical structure (laboratories, for example), which did not prevent the execution of activities with this tool, as well as the possibility of carrying out a transdisciplinary approach.

In the articles that used the descriptors robotics, teaching, and geography, it was possible to see that the use of robotics promoted greater interaction, detachment, and engagement among students. It also provided them with the possibility of being protagonists of their learning in this curriculum component. As an innovative and differentiated practice, it is endorsed by the authors, who also comment on the importance of teachers' constant improvement in the face of new methodologies (SOUSA, 2017; ARAÚJO *et al.*, 2019; FARIAS *et al.*, 2019; RAMOS; REIS, 2021).

In articles related to Educational Robotics and Physics, it was observed that the authors mention the use of robotics as a concrete element contributing significantly to students' learning, where they showed greater participation and motivation in the classes of this curriculum component (LOPES *et al.*, 2018; LIMA; FERREIRA, 2020; MATOS, 2021).

The use of technologies as a tool in the teaching and learning process has been more frequently employed in education, leading to a change in the educational environment, providing a creative and collaborative atmosphere, facilitating and strengthening the relationship among students, demonstrating that robotics and computational thinking are common to all and favoring experimentation as a form of learning (MIRANDA *et al.,* 2019).

Digital technologies are increasingly integrated into society, allowing easy access to various information. The teaching and learning process is not an isolated act from the reality of its teachers and students. They are directly related, and the use of a methodology that takes this into account can spark the interest of those involved in the

process. The success of truly meaningful learning for all hinges on this consideration (SANTOS, 2020).

According to Batista and Assis (2019), digital technologies, as well as robotics, offer a variety of possibilities in the teaching and learning process and can contribute to effective student engagement. The teacher, as a guide, can provide more suitable and efficient learning.

Despite the ease of accessing information, this does not mean that students can truly understand problems in the society in which they are immersed because the quantity of information is not a guarantee of knowledge production. The teacher needs to be the mediator, aiming to develop critical thinking in the students so that the available information can become useful to them and have meaning (COSTA, 2018).

This wide variety of technologies available to society, with rapid access to information and knowledge produced, is one of the allies in the educational process. The teacher should mediate the process of knowledge acquisition to make it meaningful and contextual, within the students' reality (VENÂNCIO *et al.*, 2018).

According to the authors Araújo *et al.* (2017); Mesquita *et al.* (2018); Albertoni *et al.* (2020); Silva and Oliveira (2022), there is a consensus among them that robotics can be used to assist classroom activities through the contextualization, incorporation, and understanding of mathematical curriculum content. The methodology brings students closer to the world of technologies, where they are the protagonists of their learning.

Some students, referred to as Generation Z, do not adapt to traditional teaching, as they consider this methodology outdated or inadequate (BATISTA; ASSIS, 2019). Three generations of people can be defined as Generation X (born in the 60s and 70s), Generation Y (born between the 80s and the mid-90s), and Generation Z (born from the mid-90s onwards). The latter was born in a digital (or cybernetic) age. It is the responsibility of teachers from this generation to seek and adopt methodologies to facilitate knowledge transmission to these students (ZOMER *et al.*, 2018).

The teaching model still practiced views students as passive beings in the teaching and learning process, making it boring and unattractive. Educational robotics is a strategic alternative that can involve and make the student the protagonist of this process (BATISTA; ASSIS, 2019; ZILIO, 2020).

Considering that students already possess prior knowledge and that being in school implies a predisposition for learning, the teacher needs to carry out organized planning that will help students build meaningful learning. This way, students can make sense of and reframe their knowledge, connecting the formal content taught in schools with their own knowledge, which can make them more aware of their reality and capable of effecting change (FRASSON *et al.*, 2019).

In articles related to the descriptors Robotics, Teaching, and Amapá, the authors agree that the implementation of educational robotics in schools is a viable and positive alternative, as it can significantly contribute to improved student performance. The absence of a proposal in the pedagogical political project of school units is what sometimes hinders its spread: (MAHMUD, 2017; BRITO *et al.,* 2020; SOUZA *et al.*, 2021).

The Pedagogical Political Project (PPP) of schools is a document that organizes and guides pedagogical practices, their teaching philosophy, and concrete educational actions. It outlines means and strategies to develop the teaching and learning process, at least on paper. In practice, the implementation of these guidelines appears to depend on the commitment and engagement of the staff. The PPP needs to be prepared considering the community's reality and aims to guide and mediate the comprehensive education and formation of its students.

Educational robotics, in this scenario, plays a role in training students in the context of technology use, as this is already a reality. Therefore, it promotes the responsible and independent development of learners, encourages cooperation, and aligns knowledge production more coherently with the current reality. Education is not neutral when it aims to create citizens who are aware of their reality (SANTOS, 2020; RIBEIRO; FALEIRO, 2021).

In Federal Institutions of Education, Science, and Technology (IFs), the Institutional Development Plan (PDI) is a key document for strategic planning and management efficiency. Its periodic updating serves to reflect the changes and challenges faced by the institution, as well as the environment in which it is used (IFAP, 2019). Its goal is to define the institution's identity, mission, and vision, as well as establish the objectives, goals, and actions that will be used to pursue its development (IFAP, 2019).

For Ramos and Moraes (2020), educational practice using robotics allowed students to enhance their reflections, interaction, and learning. Robotics is presented as an effective facilitating tool in the teaching and learning process, which promotes reflection, interaction, and learning of the contents developed through it, providing comprehensive student development.

The interaction of theory with practice during the teaching and learning process encourages students to develop their skills, cooperation among them, planning, dialogue, as well as their competencies, valuing their prior knowledge. Educational robotics presents itself as a playful activity. The teacher reappears as the mediator in this process, providing students with autonomy to explore what is presented, constructing new concepts through the use of educational robotics. It also provides the possibility of breaking down barriers between curriculum components. At the end of this process, the student can give new meaning to the situation presented to them, reframing it. Robotics is seen as a facilitating activity that allows students to explore and develop their creativity (ROCHA; GOMES, 2019; RIBEIRO *et al.*, 2020).

CONCLUSIONS

In this sense, the teacher, as the facilitator of the teaching-learning process, sometimes seeks and appropriates methodologies that can assist in their action, enabling the student to become the protagonist of this teaching and learning process. Aligned with this context, robotics is a technological tool that can transform the classroom environment, making it creative, collaborative, and even exciting, and it can be used in various curricular components.

Educational robotics is considered an important teaching and learning tool for individual development, and it should be integrated into all curricular components from basic education to higher education. It is a technological tool that facilitates the understanding of concepts and the construction or prototyping of low-cost equipment, allowing students to enhance their reflective action, integration, and interaction for meaningful learning. The student as the protagonist of the educational process has the opportunity to develop their integral formation critically, potentially transforming their environment.

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