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IMPACT PERCEPTION IN EDUCATIONAL ROBOTS IN THE DEVELOPMENT OF PHYSIC EDUCATION

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ABSTRACT.
Educational robots are collaborative robots designed to work with students and teachers to enhance learning. They can develop skills, such as problem solving, collaboration, interactivity and creativity. This study was applied to 72 physical education teachers in the department of Sucre, Colombia and 118 scientific articles. By working with these robots, students can learn teamwork, innovation and effective communication. The aim of this scientific article is to analyze bibliometric the research concerning educational robots in the development of physical education. The methodology used for the systematic analysis through bibliometric review and digital search of experiences on the application of educational robots in physical education, allowing to implement the system of analysis of authors, journals and contributions. The methodology promotes theoretical and practical contributions that demonstrate the need for the implementation of educational robots to achieve better learning outcomes in environments such as physical education. It is a current topic, led by authors and journals from developed countries. The main results show the need to update classroom plans, curricula, and educational systems for the development of learning based on these new technologies. In addition, smart classrooms are a reality and educational robots are an example of this.

Keywords: Educational robots, learning activities, cognitive adaptation, curricular adaptation, technological adaptation, physical education, artificial intelligence

1 INTRODUCTION

In the context of recent concerns about online education and a growing pedagogical gap in terms of unequal access to qualified teachers, the use of social robots in education is considered timely (Constantinescu et al., 2023). The above develops the institutionally anchored role of pedagogues in antiquity, apart from contemporary enquiries. The advancement of information technologies and breakthroughs in artificial intelligence are leading to a level of automation that has never been reached before.

Collaborative robots can help prepare students for the future and improve their ability to face real-world challenges. In this sense, designing collaborative friendly robots for a Smart Factory can serve as an enabling technology for teaching, allowing students to work together, learn and develop important learning skills that would not be acquired during a traditional classroom lecture (Heredia-Marin et al., 2022).

Promoting the child-robot interaction aspect through multiplayer games where a team of robots and humans collaborate to compete with another team of humans and robots (Merkouris et al., 2021), makes cooperative or competitive game-based robotic activities an effective approach to exploit the child-robot interaction and learning perspective.

Much of this level of automation is due to the use of robotics, which in turn ends up hindering or accelerating the educational process (Ananías & Gaspar, 2022). Due to the need for robots to work in collaboration with humans simultaneously or in parallel, a new generation of robots known as robots or collaborative robots are gaining importance to address these challenges.

Artificial intelligence is increasingly being used in education around the world, especially in today's digital age. In this context, teachers play a key role in this process, using various educational methodologies and tools including educational Robots. These resources positively impact educational curricula and are being implemented by schools and universities seeking to adopt new educational technology models (Sanabria-Navarro et al., 2023).

Creating algorithms is eminent to enable educational robots to adapt to new environments intuitively, learning robotic paths demonstrated by humans (El Zaatari et al., 2021), based on educational interests and achievement of learning outcomes. Digital games with educational robots are a better model for thinking about computational agents, working directly with humans and not establishing distances to them (Higashi et al., 2021). The above is explained in three lines of research: current thinking about robots, plans for further research on robot game design in the future and its impact on learning development in education.

However, an applicative example is how direct and inverse kinematic control of a 6-DOF collaborative robot for an augmented reality educational system (Islas et al., 2021), ensures the development of student learning through robotics, augmented virtual reality technologies and artificial intelligence. Kobots are robots designed for more collaborative operations with humans. In this way, they enable new methods of task instruction (programming) through direct interaction between the operator and the robot (Canfield et al., 2021), which means that students can work alongside them safely, enabling them to develop collaborative skills and teamwork, important resources in the physical education classroom.

Collaborative robots, or robots, represent an innovative technology designed for high-level collaborative interactions (Michaelis et al., 2020), these relationships are between teachers and robots or between robots and students and between teachers and students using the robot. In this way, a number of flexible capabilities for school learning are deployed, catering to every need of subjects and educational institutions at different levels.

Examples of robots used in physical education include the RoboCup Junior, Nao, Beebot robot (Kalaitzidou and Pachidis, 2023) and Pepper (Blindheim et al, 2023) (Figure 1). These collaborative robots are used to teach movement concepts, promote physical activity and provide feedback to students in educational settings action in human and robot tasks, adaptively assessing learning (Figure 2). It has the same methodology and techniques as the previous case. They also develop educational competences with storage and retrieval systems with the same methodologies.

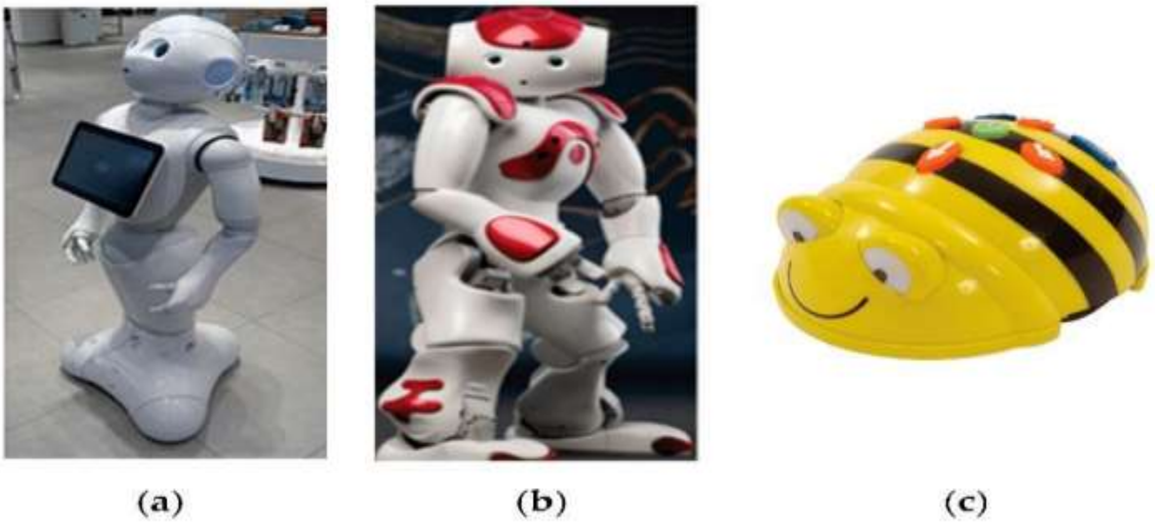


Fig 1. (a) Pepper robot; (b) NAO robot; (c) Beebot robot
Source: Kalaitzidou and Pachidis (2023)

NAO6 Developer		https://www.aldebaran.com/es/pepper-and-nao-robots-education

Fig 2. NAO6 Developer

Preparing future professionals to work in highly automated production requires adequate education in the theory and applications of robots (Djuric et al., 2017). Therefore, teachers need to be trained in the following topics: Introduction to the concepts of collaborative robotics. Mechanisms and controls of collaborative robots. Safety considerations for collaborative robotics. Operations and programming of collaborative robots. Collaborative robot kinematics and validation. These are elements that, although they seem futuristic, are already being applied in education in several countries and are becoming more and more real every day.

Educational robots are being employed more frequently in smart classrooms (Timms,2016), thus aiming to create technologies designed specifically for teaching and learning by combining the power of artificial intelligence and educational systems with advances in the field of robotics and the progressive use of sensor devices to monitor the environment and make educational decisions.

Digital teaching supported by ICT technologies in universities serves as a focal point for the advancement of modern education; and has become a mode of instruction and an approach to teaching (Li & Wang, 2023). The term "Smart Classroom" has evolved over time and now reflects the technological advances incorporated into educational spaces. Rapid advances in technology and the need to create more efficient and creative classrooms that support both face-to-face and remote activities have led to the integration of artificial intelligence, smart technologies and educational robots into smart classrooms (Dimitriadou & Lanitis, 2023).

Innovative educational programmes power a supportive virtual learning environment, combining pedagogical theories, gender-inclusive instructional strategies, scientific principles and practices, gamification methods, computational thinking, and real-world problem solving through educational robots (Casey et al., 2023).

In the era of information explosion, modern education is developing towards an intelligent system approach (Gao & Cheng, 2023), where technologies play a key role and educational Robots are increasingly inserted as teachers' assistants. The development of a voice recognition system for distance music teaching based on a model that introduces educational robots (Xu & Xia, 2023), contributes to the improvement of the teaching-learning process and enhances the impact of smart classrooms even outside educational institutions.

The generation of an environmentally aware system for learning through educational cobot technology (Tabuenca et al., 2023), powers a growing availability of sensors, networks and cloud services that can facilitate real-time measurements to perform data analysis on plants and the environment in which they coexist with students and teachers.

The Internet of Things is creating enormous opportunities for education in general, and these opportunities need to be quickly harnessed to enhance interaction between students and teachers (Kommula et al., 2023), which enhances learning remotely through E-learning and educational robots. Academics can develop animated lessons; tutorials based on online delivery and can share study materials through smart virtual classrooms.

Taking into account all of the above, the conceptual categories of the object of study of the research are established through a bibliometric analysis using the VosViewer software where from 15 articles (Scopus), 100 (Science Direct) and 10 (Mendeley) 139 key words are established, of which with the use of the co-occurrence method with an average repetition of 5 words and 6 fundamental terms, which boosts a 95% of feasibility of the procedure used and only a 5% margin of error. The conceptual categories obtained can be identified as variables, dimensions and indicators from different research studies, which are defined below, establishing their relationship with the object of research:

Robotics: Artificial intelligence, intellectual property, cyber risk and robotics leading to the emergence of a new digital age (Taplin, 2023).

Robot programming: A versatile interaction framework for robot programming based on hand gestures and poses (Sun et al., 2023).

Robotic education: Design and piloting of intervention proposals with educational robotics for the development of lexical relations in early childhood education (Campos & Muñoz, 2023).

Robot collaboration: The human-centred collaborative architecture of Industry 5.0 (Toth et al., 2023).

Robots: Collaborative robot interactions, control technologies and market impact, ensuring flexible applications, resource efficiency and safety (Taesi et al., 2023).

Machine design: Automatic machine interpretation of drawings as a common means to codify design and manufacturing requirements (Zhang et al., 2024).

Smart classrooms: Artificial intelligence and edge computing for teaching quality assessment based on 5G-enabled wireless communication technology (Li & Wang, 2023).

For all of the above reasons, it is necessary to establish the research question: What are the incidences of educational robots in the development of physical education through a bibliometric analysis? Establishing as general objective to analyse bibliometrically the incidences of educational robots in the development of physical education.

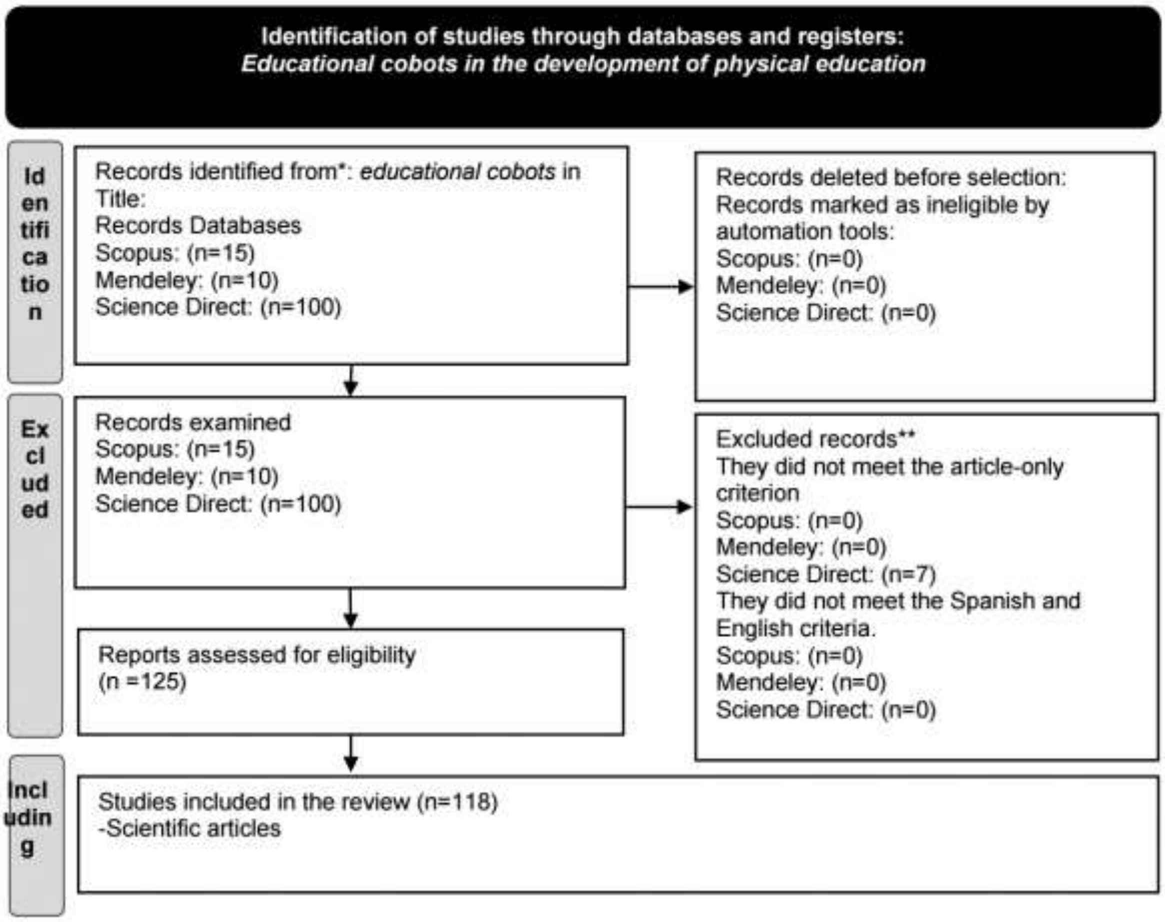
2 MATERIALS AND METHODS

The study leads to two steps. The first step is the bibliometric analysis, and the second step is the statistical analysis of the measurement instrument. The latter consists of surveying 72 teachers from the department of Sucre about their perception of what an educational robot will allow them to do in classes, in favor of learning results.

This study conducted a retrospective and descriptive bibliometric analysis of the impact of educational Robots on the development of physical education. An adaptation of Matthew et al. (2021) was used and the PRISMA methodology was applied to support the systematic review. This adopted a mixed approach combining qualitative and quantitative research as well as the critical theory paradigm. In addition, the constructivist paradigm was used, as the referenced articles were based on research constructed from socially tested realities in different contexts and times, including diverse countries and situations.

For the research, the conceptual categories are established considering the impact of the educational Robots on the development of physical education, which define the dimensions (D) and indicators (I) that lead the research and which are based on the analysis of the information previously established through a methodology of results by phases of the authors of the research and which group together three categories: Authors, Journals and Contributions (ARA).

Therefore, the steps performed for the visual design of the PRISMA diagram are described below. 118 scientific articles related to educational Robots in the development of physical education were considered. The above publications are from three fundamental databases 15 articles (Scopus), 93 (Science Direct) and 10 (Mendeley), the inclusion criteria were: Only scientific articles, Language (Spanish or English), from the above databases, all from the last decade (Figure 3).



Note: Adapted from Matthew et al. (2021).
Fig. 3. Prism for Identification of studies through databases and registers

Identifying the key steps of the systematic review: Systematic review usually involves includes sub-steps such as:

- Search for studies: We used the search equation: title ("educational robots") and limit-to (language, "English") or limit-to (language, "Spanish").
- Selection of studies: In order to obtain the best results in the exploration carried out, the following studies were conducted applied search strategies to all the literature indexed in Scopus, Mendeley and Science Direct in relation to this issue until 2023.

- Data extraction: We used the tools of the Bibliometrix package of the programme R statistic (Aria & Cuccurullo, 2017), for the extraction of the information of the variables to analysed according to the dimensions explained above.
- Assessment of the quality of the evidence: Following the previous steps, we analysed the results in a descriptive way and based on this information, tables and graphs were drawn up.

3 RESULTS

First step

The analysis of the results was guided by the ARA methodology proposed by the authors for the development of the research, as this structurally organizes the processes carried out in the bibliometric review. The ARA methodology establishes three moments of analysis in the research, enhancing the systematic study of the incidence of educational robots in the development of physical education.
The historical evolution of research related to educational Robots according to the Scopus database began in 2016 and has had its highest performance in terms of publications in the year 2021, however, until now the increase of the subject of study continues, from which the above theories are justified as theoretical contributions of the research and all the results shown below (Figure 2).

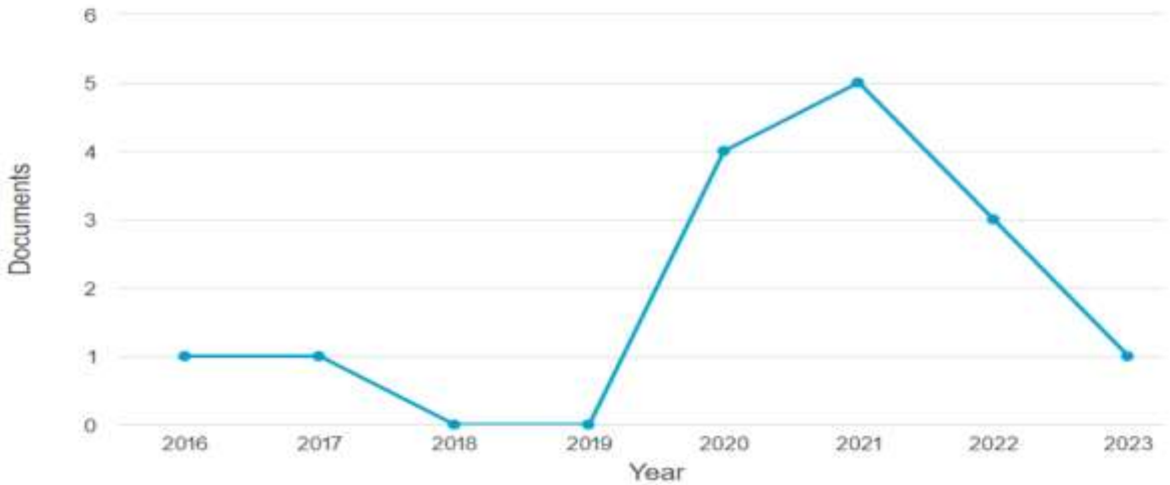


Fig. 2. Historical development of research on educational robots (Scopus, 2023).

The results of 10 authors related to the topic of educational robots in the development of physical education from the Science Direct, Scopus and Mendeley databases are presented in order to analyze the main trends of the object of the research:

1. Among the most cited authors we have Yang with one article in 2023, who has a total of 124 citations of which 99 in scientific articles and obtains an h-index of 6. His affiliation is Aarhus University in Denmark and of the conceptual categories identified in this research through the bibliometric analysis by the Vos Viewer software, he is directly related to robots.
2. Schmidbauer, with one article in 2020, is one of the main authors related to the subject under study. He has a total of 58 citations in 10 articles and an h-index of 4. He belongs to the Institute for Management Science in Austria and is directly related to the conceptual category of Robot collaboration:
3. Emma-Ikata in 2022 makes her contributions to the subject related to educational robots in the development of physical education through a scientific article, this author has 1 citation in the article, she is a researcher at the South East Technological University of Ireland and is identified with the conceptual category of machine design.
4. Pinto publishes a scientific article in 2023, has 55 citations in 53 scientific articles, index h=3, his affiliation is the Ruhr University Bochum in Germany and he identifies himself with the conceptual category of smart classrooms.

5. Canfield makes his contribution to the researched topic through a scientific article in 2021. He has 388 citations in 322 scientific articles and an h-index of 9. He is affiliated with the Tennessee Technological University in the United States and is identified with the conceptual category of robotic education.
6. Likewise, Ananías in 2022 publishes an article that is registered in the research as avant-garde in terms of the topic and methodologies worked on. It has 7 citations in 2 scientific articles and an h-index of 1. It belongs to the *Universidade da Beira Interior*, Portugal and is related to the conceptual category of robotics education.
7. Constantinescu (2023) published a high impact scientific paper. His affiliation is with the Applied Ethics Research Center in the United States, and he works directly with robots as a conceptual category.
8. Timms since 2016 visualized the importance of the topic through his scientific article. He has 1212 citations in 842 scientific articles and an h-index of 16. From the Consultant at EdTech Evaluation in Australia he makes his scientific communications and relates directly to smart classrooms as a main conceptual category.
9. Komenda (2021) with 184 citations in 165 scientific articles, h-index of 8, is from Fraunhofer Austria Research and is related to robotics education.
10. Heredia in 2022 makes his scientific communication related to the topic of study. He has 127 citations in 115 scientific articles and an h-index of 3. He is from *Tecnológico de Monterrey*, Mexico and works in the same conceptual category as the previous author.

This explains why most of the citations and h-indexes still do not reach high values in terms of citations since, as could be seen in the sample, there are few studies related to educational Robots in the development of education and learning. In general, most of the countries in the selected sample, and of which contributions have already been established, coincide with the best educational systems according to the Programme for International Student Assessment (PISA, 2022).
An articulation is achieved between the authors and the conceptual categories established in the research through bibliometric analysis. On the other hand, in terms of production by country, it is observed how the United States is the greatest exponent in terms of scientific productivity with 548 contributions, followed by China with 518, Spain with 399, the United Kingdom with 148, Mexico with 83, Brazil with 71, Canada with 67, Australia with 66, Colombia with 66, Portugal with 64, among others. Publications from the United States represent 20% of the publications found (Table 2).

Table 2*Scientific production by magazines*

Magazines	Main publications	Quartiles	Impact factor	Index h	Countries	Databases
Robotics and Computer-Integrated Manufacturing	Cobot driven by a vision based on learning	Q-1	10.4	111	United Kingdom	Scienci Direct
Procedia Manufacturing	Computer Science Artificial Intelligence	Q-2	2.3	69	Netherlands	Scienci Direct
IFAC papersonline	Control and systems engineering	Q-3	1.8	86	Austria	Scienci Direct
Heliyon	Multidisciplinary	Q-1	0.61	69	Netherlands	Scienci Direct
Journal of Mechanisms and Robotics	Mechanical Engineering	Q-1	0.76	55	United States	Scopus
Applied System Innovation	Artificial intelligence and information systems	Q-2	0.63	19	Suisa	Scopus
Frontiers in artificial intelligence and applications	Artificial intelligence	Q-4	0.25	61	Netherlands	Scopus
International Journal of Artificial Intelligence in Education	Social sciences and education	Q-1	1.11	56	United States	Mendeley
Tasks in human-cobot teams	Economics, Econometrics and Finance	Q-1	0.76	44	Austria	Mendeley
EDUNINE 2022	Artificial intelligence	Q-2	0.65	37	United States	Mendeley

Note. Authors' elaboration.

Source: author based on information from Scopus (2024).

The table above shows the main journals that have published scientific articles related to educational Robots in physical education development. The Journal Robotics and Computer-Integrated Manufacturing publishes an article related to Robots driven by a learning-based vision. This journal is in quartile 1 of the Scimago Journal & Country Rank (Q-1), has an impact factor of 10.4, an h-index of 11, is from the UK and is in the Scienci Direct database.

Likewise, we also have the journal Procedia Manufacturing, which presents a scientific communication related to the object of study of the research from the area of Computer Science and Artificial Intelligence. This journal is Scimafo (Q-2), impact factor 2.3, index h 69, is from the Netherlands and is in the Science Direct database.

The Journal IFAC papersonline deals with control and systems engineering, from there it raises the importance of educational Robots in the development of physical education. This journal is Q-3, has an impact factor of 1.8, h-index of 86, is from Austria and can also be found in Scienci Direct. Heliyon is a multidisciplinary journal that makes significant contributions to the subject matter under study, with its Q-1 in the Scimago Journal & Country Rank, impact factor of 0.61 and an h-index of 69, it is a scientific publication from the Netherlands and is listed in Scienci Direct, making it one of the best in the world.

Journal of Mechanisms and Robotics specialises in mechanical engineering topics and from these areas it is committed to the improvement of educational Robots for the improvement of physical education. It is Q-1, has an impact factor of 0.76 and an h-index of 55. It is published in the United States and is in the Scpus database. Applied System Innovation enhances thematic areas related to artificial intelligence and information systems, which are directly related to the quality of the subject matter under study. With an impact factor of 0.63, an h-index of 19, ranked Q-2, this publication from Switzerland is in the Scopus database. Frontiers in artificial intelligence and applications, which is directly related to areas of artificial intelligence, is very well integrated with the subject matter under study. It is Q-4, its impact factor is 0.25 and its h-index is 61, it is published in the Netherlands and is listed in Scopus.

International Journal of Artificial Intelligence in Education has areas of work related to the social sciences and education, from where it makes significant contributions to educational development and learning through Robots. It is Q-1, has an impact factor of 1.11, h-index of 56, is from the United States and is in the Menndeley database. Tasks inhuman-cobot teams discusses the importance of educational Robots in the development of economics, econometrics and finance, where the subject matter under study provides educational and learning outcomes. It is Q-1, impact factor 0.76, h-index 44, is from Austria and is in the Mendeley database. EDUNINE 2022, is a conference that published its proceedings directly in thematic areas related to Artificial Intelligence and the role of educational Robots. Q-2, impact factor of 0.65, h-index of 37, United States and is listed in Mendeley.

In a general sense, we can say that the journals mentioned above coincide with the statements made in the previous dimension. They are all from developed countries, mainly European, countries that are at the forefront of education worldwide; no underdeveloped country appears. As far as the impact of these journals is concerned, most of them are new or have been founded only a few years ago, so they have not yet reached the desired levels. We are in the presence of a subject that has been in existence since 2016 and will be at its peak from 2020 onwards. All the journals are in the first quartiles of the Scimago Journal & Country Rank and all are perfectly aligned with the established conceptual categories.

Once the main authors (D1) and journals (D2) have been established, it is necessary to establish the main contributions of the first two dimensions, continuing with the analysis provided by the ARA methodology established by the authors. Cobot systems driven by a learning approach is a topic that provides an insight into how robots contribute to the automated production process in a correct and accurate way. Using a learning methodology based on vision-based detection and inspection, analysis techniques through pinhole camera models with distortion and a sample of 10 randomly selected images using the CNN-SVM and Non-ML method. It makes it possible to see that the development of educational Robots is a rising trend and is here to stay in our daily lives.

Teaching robots in learning factories makes different contributions to different levels of robot interaction and control. Using a methodology of intuitive interfaces to modify existing execution programmes, it leverages comparative system analysis techniques with 36 participants. Preparing for Industry 5.0, the contribution of intelligent curricula. Mix methodology with surveys and file analysis of 13 people make visible the importance of the topic in question. Collaborative robots produce higher user confidence. An experiment with informed consent, a socio-demographic questionnaire and 38 people demonstrate the acceptability of the users of educational Robots in the development of physical education. Direct teaching programming and monitoring of a robot's process. Using a methodology of task instruction and direct observation with 1 Robots makes a contribution related to assisting in teaching and monitoring.

The robot-education and the pedagogical gap, uses methodologies of conceptual philosophical contribution, through systematic reviews of 50 papers that make contributions related to Robots for the enhancement of the virtues of the educational process. Low-cost collaborative robots for scientific and educational purposes enhance effective educational approaches used in robot development. User interface methodology, with sizing and selection of circuits, contributes to educational approaches used in the development of robots. Educational robots and intelligent classrooms are a trend that from methodologies of integration of artificial intelligence make contributions where Robots help teachers in the classroom.

This research is based on a systematic review of documents. Human-robot team tasks propose self-organism If we analyses the table above, we can refer that for this research, twice as many documents were analyzed as the majority of the samples expressed in the table above, which demonstrates the depth of analysis, the seriousness of the treatment of theories and methodologies. The ARA system enhances deep bibliometric analysis capabilities by establishing analytical capacity through its dimensions.

It can also be established that there are many scientific areas working together in the development of educational Robots for the development of physical education. Intelligent classrooms, human-robot collaborative systems, Robots as assistants to teachers, the confinement of users in them and the incidence of artificial intelligence, means that education systems worldwide must consider in the immediate future (short term), the adaptation of school curricula, teaching strategies, teachers with mastery of new information technologies and knowledge, more virtual learning environments and more Robots as assistants to teachers and students in achieving better results and learning skills.

First step: Statistic analysis

This study was applied to 72 physical education teachers in the department of Sucre, Colombia, who have not previously had contact with educational robots to know their perception about whether they will use cobosts how they believe it would help the physical education process. The overall reliability, as indicated by Cronbach's Alpha, is 0.712, and there are 8 items in the analysis, the following factors: Perception variables of possible impact of educational robots (Educational Quality, Learning Improvement, Innovation, Creativity, Competencies) and Learning results (Problem-based Learning results, Project-based Learning results, Challenge-based Learning results). Using the likert scale to 1-Completely disagree; 2-Disagree; 3-Neither agree nor disagree; 4-Agree; 5-Completely agree.

Table 3 *Reliability Statistics*

Cronbach's Alpha		**Number of items**	
,712		8	
Items	**Mean**	**Std. Deviation**	**Qualitative assessment**
P1=Educational Quality	4,29	,638	Agree
P2=Learning Improvement	4,14	,718	Agree
P3=Innovation	4,46	,502	Completely agree
P4=Creativity	4,14	,635	Agree
P5=Competencies	4,24	,617	Agree

LR1=Problem-based Learning results	3,50	1,210	Agree
LR2=Project-based Learning results	3,65	,937	Agree
LR3=Challenge-based Learning results	4,29	,638	Agree
Valid N (per list)	72		

Source: SPSS, 28.0

The analysis of teachers' perception of using educational robots was based on the following hypotheses:
H_1: The integration of educational robots in the learning environment positively correlates with improvements in Educational Quality.
H_2: The utilization of educational robots in educational settings is associated with increased Learning Improvement.
H_3: Educational robots contribute to fostering a culture of Innovation.
H_4: The incorporation of educational robots in the curriculum is positively associated with the development of Creativity among students.
H_5: The use of educational robots is linked to the development of specific Competencies among students.
H_6: Educational robots support positive Problem-based Learning results.
H_7: The integration of educational robots in educational settings is associated with successful Project-based Learning results.
H_8: Educational robots contribute to positive Challenge-based Learning results.
The linear regression equation provides a predictive model for understanding how the perception about educational robots (PER) is influenced by different factors, allowing for insights into which factors have a stronger or weaker impact on this perception. The model summary (Table 4) shows significant R and R squared, so the models are likely.

Table 4*Summary model*

Resumo model

Model	R	Adjusted R	Squared R Standard	Error of the estimate
1	,853[b]	,727	,719	,20711
2	,917[c]	,841	,834	,15918
3	,953[d]	,907	,902	,12250
4	,972[e]	,944	,940	,09557
5	,982[f]	,965	,962	,07649
6	,992[g]	,983	,982	,05310
7	1,000[h]	1,000	1,000	,00000

Although Innovation obtained a higher score in the descriptive statistics, it is the only hypothesis (H_3) that is not met because the variable did not enter the model (Table 5):

$$PER=0.350+0.134LR_1 +0.164P_4+0.165P_1 +0.118LR_2 +0.126P_5 +0.117LR_3 +0.100P_2 \quad (1)$$

H_6 H_4 H_1 H_7 H_5 H_8 H_2

Table 5*Linear regression models summary*

Model				**Standardized coefficients**	**t**	**Sig.**
				Beta		
5	(Constant)	0,965	0,106		9,120	0,000
	Problem-based Learning results	0,124	0,011	0,385	11,518	0,000

	Creativity	0,182	0,022	0,295	8,095	0,000
	Educational Quality	0,193	0,020	0,315	9,826	0,000
	Project-based Learning results	0,131	0,014	0,314	9,304	0,000
	Competencies	0,148	0,022	0,234	6,638	0,000
6	(Constant)	0,548	0,108		5,049	0,000
	Problem-based Learning results	0,119	0,009	0,369	13,742	0,000
	Creativity	0,192	0,018	0,312	10,637	0,000
	Educational Quality	0,214	0,016	0,348	13,285	0,000
	Project-based Learning results	0,126	0,011	0,302	11,164	0,000
	Competencies	0,132	0,018	0,208	7,323	0,000
	Challenge-based Learning results	0,091	0,015	0,149	6,168	0,000
7	(Constant)	0,350	0,079		4,438	0,000
	Problem-based Learning results	0,134	0,006	0,416	21,374	0,000
	Creativity	0,164	0,013	0,266	12,629	0,000
	Educational Quality	0,165	0,013	0,269	13,109	0,000
	Project-based Learning results	0,118	0,008	0,282	14,864	0,000
	Competencies	0,126	0,013	0,199	10,049	0,000
	Challenge-based Learning results	0,117	0,011	0,191	10,941	0,000
	Learning Improvement	0,100	0,012	0,184	8,417	0,000

Source: SPSS 28.0

CONCLUSIONS

Taking into account all the results of the research we can say that the use of educational Robots is very important for the development of modern education at all levels of studies, agreeing with Constantinescu et al. (2023) who considers the use of social robots in education to be opportune.Ananías & Gaspar (2022) refer to advances in information technologies and significant advances in artificial intelligence, which are leading to an unprecedented degree of automation. Educational Robots are therefore a reflection of this. The authors of the research agree on enhancing educational development and learning. The contributions identified in the research reviewed refer to the above, coinciding with Heredia-Marin et al. (2022), who state that the idea is to create friendly collaborative robots that act as assistive technology for teaching, helping undergraduate students to work together, learn and develop important learning skills that are not acquired during a traditional classroom lecture.

The child-robot interaction and learning perspective can be effectively harnessed through cooperative or competitive game-based robotic activities. This is in line with Merkouris et al. (2021), who propose to foster child-robot interaction through multiplayer games where a team of collaborative robots and humans work together to compete against another team of humans and robots. Sanabria-Navarro et al. (2023), discuss that educational robots are having a positive impact on educational curricula as schools and universities adopt new educational technology models, enabling more informed decision making. The above is identified with the concept of intelligent auas presented in the research from the perspectives of various authors across theories and conceptual categories. According to Zaatari et al. (2021), the creation of algorithms is crucial to enable the intuitive adaptation of educational robots to new environments, allowing them to learn from robotic paths demonstrated by humans. This is supported by the contributions made in the research under study from various categories such as AI, robotics, robotic education and smart classrooms.

Teachers and students must adapt to new trends in contemporary education based on digital assistants that facilitate and help to make fewer mistakes. Among these new application methodologies are robots that undoubtedly enhance the veracity and timeliness of the information requested in real time, which helps through interaction and play to achieve the learning results achieved. This is in line with

Higashi et al. (2021), who suggest that digital games with educational robots represent a more effective model for thinking about computational agents that work directly with humans, without establishing distances from them.Assisting teaching and supporting teachers is one of the aids in terms of self-organization of human and robot tasks that are adaptively evaluated and optimized, with points of agreement with Canfield et al. (2021), which highlights the importance of robots designed to operate more collaboratively with humans, enabling new methods of task instruction through direct teacher-student interaction. Robots are an innovative technology designed to enable high-level collaborative interactions according to Michaelis et al. (2020), these relationships can be between teachers and robots, between robots and students, or between teachers and students using the robot as a support tool.According to Djuric et al. (2017). Preparing future professionals to work in highly automated production requires adequate education in the theory and applications of robots. Educational robots and smart classrooms according to Timms (2016), are a combination of the power of artificial intelligence and advanced educational systems in the field of robotics, coupled with the increasing use of sensor devices to monitor our environment and actions, promises the creation of technologies designed specifically for learning and teaching. The above approaches are directly identified with the results obtained in the research since, educational robots are a complementary assistant to the educational system that by interacting with students and teachers makes the educational system more interactive and collaborative. Smart classrooms refer to an educational environment that uses advanced technology to improve the quality of education and the learning experience of students. This environment may include electronic devices, educational software, online collaboration tools, and student monitoring and tracking systems. A smart classroom is expected to enable students to learn in a more effective and personalised way, as well as allow teachers to monitor students' progress and adapt to their individual needs. In short, the term "Smart Classroom" refers to an educational environment that seeks to leverage technology to enhance the teaching and learning process. The above approach agrees with Li & Wang (2023), referring that the "Smart Classroom" has evolved over time and currently reflects the technological advances incorporated in educational spaces. The integration of artificial intelligence, smart technologies and educational robots in smart classrooms has become increasingly important due to rapid advances in technology and the need to create more efficient and creative classrooms that support both face-to-face and remote activities. Identifying with Dimitriadou & Lanitis. (2023), who refer that due to advances in technology and the need to create more efficient and creative classrooms that support both face-to-face and remote activities, there has been an increasing integration of artificial intelligence, smart technologies and educational robots in smart classrooms.According to Casey et al. (2023). Innovative educational programmes seek to enhance a supportive virtual learning environment, combining pedagogical theories, gender-inclusive instructional strategies, scientific principles and practices, gamification methods, computational thinking and real-world problem solving through the use of educational robots. This is evidenced by the topics and contributions shown in the research, which are also published in high-level journals and the authors have given vital importance to the topic in question. In the age of information and knowledge empowered by ICT and AI, technologies play a fundamental role and educational Robots are increasingly inserted as teachers' assistants, which is identified with Gao & Cheng (2023), who refer to the age of information explosion, modern education is evolving towards an intelligent system approach. According to Kommula et al. (2023), the Internet of Things is providing great opportunities for education in general, and it is important to quickly take advantage of these opportunities to enhance interaction between students and teachers, thus improving remote learning through E-learning and educational robots. Academics can develop animated lessons, tutorials based on online delivery and share study materials through smart virtual classrooms.The above can have a direct impact on the creation of social awareness, specifically in the generation of an environmental awareness system for learning through educational robots technology that seeks to promote environmental awareness in students through education and technology, an aspect highlighted by Tabuenca et al. (2023), the above power the increasing availability of sensors, networks and cloud services can facilitate real-time measurements to perform data analysis on plants and the environment in which students and teachers live.

We are in the presence of an extraordinarily topical research for the future of global education and the acquisition of knowledge through automated learning in any field. Educational Robots are a tool that is being perfected more and more every day and in a certain way will be putting faces to artificial intelligence. What is certain is that it can become a complementary tool that in real time provides you with real and reliable information that helps to prevent errors, to enhance the didactics of the class, to improve the dynamics of traditional classes and to help implement new educational strategies more in line with the students of this time.

Educational Robots for physical education are a collaborative assistant that has come to stay and that its acceptance provides a greater response to the needs of our times and even the future that it has bequeathed and that, if understood, could improve the learning results and the educational process of many institutions at different levels and in different countries.

The authors presented in the article are cutting-edge in terms of the methodologies they propose, the analyses they propose and the theoretical and practical contributions they have made. This historical, multidimensional and systemic research helps to empower modern education. Many of the results of the article may seem controversial for some Latin American countries, however, it does not detract from the importance of the viability, feasibility and potential of the results provided.

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