Educational Robotics as a Teaching tool in higher education institutions: A bibliographical analysis

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Educational Robotics as a Teaching tool in higher education institutions: A bibliographical analysis

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Abstract. The incorporation of robotics as an educational tool in higher education institutions has represented in recent years an innovative mechanism towards improving the teaching of mathematics, physics, and development of control software. This work shows our research about the use of efficient robotics in educational processes in higher education institutions and their perspectives of new innovations towards teaching in engineering, health sciences, biology, chemistry, physics, etc. Bibliometric tools were used to analyze the evolution of educational robotics as an element that contributes to the improvement of teaching and involvement in teaching methods used by teachers.

1. Introduction
In recent years, robots have been considered as a complementary tool to improve the motivation and academic performance of students, which has generated a technological development that is increasingly incorporated into our daily lives for the many purposes: Education, industry and military science, but above all it has generated great interest in researchers, professors and professionals as support in learning in different fields of knowledge [1].

Studies indicate that robotics is venturing into education in an accelerated manner which is providing benefits as a teaching tool, performing repetitive tasks with great precision, flexibility, human-robot hyperactivity, since these devices are presented with various characteristics providing to student’s fun, motivating activities and real experiences, creating interactive and attractive learning environments [2].

Teaching-learning activities in the classrooms of the 21st century are being complemented and supported with the help of robotics, that is, in science, technology, engineering and mathematics, in addition, with project-based courses which challenge the creativity of students, improving their cognitive skills and motivating them to be active learners [2].

Researchers in educational robotics have stressed that this technology has great potential as a tool in educational activities, which invites them to raise many questions: is it important to incorporate this type of tools in educational activities? At what ages is it allowed? incorporate these devices ?, does it help to develop cognitive skills in students ?, what is the purpose of the use of educational robotics in this context? While educators are becoming idea generators, developing pedagogical activities aimed at incorporating and developing educational robotics in the teaching of science, mathematics and engineering, but still without significant evidence to support the direct impact on academic performance of the students [3].
Existing studies on educational robotics have had two important aspects: the technical and its applicability. In the technical aspect they have focused on the user’s perception and physical appearance (the size of the robot, the shape of the body, gender, the upper and lower extremities, hands and general movements) of the robots and the possible human interrelationships -robots (topics such as natural language, affective computing and long-term memory), in terms of perception, issues such as face detection, semantic interpretation, ergonomic and posture recognition and background noise filtering are addressed. Regarding the application of educational robots, several ways of using robots in education have been proposed, especially in language learning, being the second most popular in the application of educational robots, after programming activities. This ensures that there are important criteria to involve young people with diverse interests and learning styles, so that they are attracted and interested in different types of robot activities [2, 3].

The purpose of this study is to perform a bibliometry in the databases of the University of Magdalena on the use of educational robotics, in order to: (a) identify the potential benefits of incorporating robotics as an educational tool in different areas of knowledge, (b) present a synthesis of the empirical evidence available so far on the educational effectiveness of robotics, (c) define future research perspectives on the educational use of robotics based on the revised literature [2].

2. Context of educational robotics

The 21st century has unleashed a series of scientific and technological advances that have changed the way of life of human beings in their homes and therefore socially. The dependence of human beings on technology from the Internet to a simple mobile phone is increasingly evident. The invention of intelligent technological devices with human forms has acquired such importance that it has resulted in multitudes of applications that previously only existed in science fiction books and films. These devices called robot are acquiring an unquestionable role in society and in the lives of humans, their contributions and advantages in any field from medicine to military science being indisputable. Following the same path but without finding science and technology, the level of responsibility that stems from the use of these devices has increased dramatically, especially in areas that represent a great commitment to safeguard human lives such as control of unmanned flights, automation in amusement parks, control of food products, etc.

Current technologies have made human/machine interaction increasingly friendly to the point that little by little they have been incorporated into the field of education from the initial grades to higher education, called educational robotics, which has led to develop devices only for this type of activities, which has its own characteristics of each area taught, becoming an nondisciplinary discipline that involves knowledge and problems from the recreational to the purely scientific in a dynamic and easy to understand way, starting from the previous knowledge of preconceptions to the theoretical support of a physical phenomenon, that is to say, it allows to establish links between different areas of knowledge that is often difficult to express on the board. The incorporation of new technologies in the classroom and educational robotics seek to improve interdisciplinary learning environments where students and teachers can structure their research and solve problem situations in a concrete way; developing new skills and abilities in people, giving positive responses to the changing environments of a world impregnated with a lot of technology, contributing to the development of student’s creativity and cognitive capacity.

In order to provide an overview of educational robotics in higher education students, the review was carried out in the SCOPUS and Web of Science database of the Magdalena University library using the descriptors education AND robot AND review to search for articles published between 2009 and 2019, and limiting educational research.
3. Results and discussion

In Fig. 1 (left), we can see that the university or institute to which the most published articles belong are two (2) the University Degli studi Palemo and followed by the Aristotle university of thessaloniki among them add up to 25% of the publications and the remaining 75% distributed in 13 institutes. Fig. 2 (left) shows the analysis in the case of authors who have a greater number of published articles, the topic is to approach from robotic knowledge, in general, what can be used as a guiding reference for researchers and consultants to have the opportunity to prioritize the review of works by authors who have a greater number of articles. It is also evidenced that the author with the highest number of registered articles is Demetriadis S, with high impact publications. The authors Atmatzidou s, Castro E, Cecchi F, Dario P, are unleashed because the content aimed at the study of robotic implementations in education. The other nine authors revolve around educational robotics with a great interest in the academic community for the subject of study. Now we present in Fig.1(right) the main countries where the greatest research in educational robotics is concentrated, of which the highest concentration of research production is in countries such as Italy, the United States and Greece and add two of the American countries (Brazil, Colombia). Italy is the country with the greatest contribution in publications, followed by the United States, Greece, Spain, Japan and the United Kingdom; Canada, Malaysia and Portugal, Austria, Brazil, France, Lithuania and Turkey and Colombia are also unleashed. It can be established that according to the country or territory and the
lowest academic production is in Colombia, Turkey, Lithuania, France, Brazil and Austria where the implementation of robotic systems for the development of educational processes is in the initial stage. In Fig.2(right) we show that there is a limited group of organizations that financially sponsor scientific production in the field of educational robotics, the most recognized is the National Science Foundation this American agency promotes research and education Fundamental in the fields of science and engineering, it currently has 10 sponsored research; followed by the College of Science Technology Engi, it is a university dedicated to STEM based on the development of Science, Technology, Engineering and Mathematics. The ditch faculty with academic experts that involve students in the study of robotics shows 4 funded research. The Foundation of the Ministry for Science and Technology in Brazil is also highlighted, with the financing of 2. The rest of the entities have a financing. In the present investigation we appropriate the terminology of information science in what is known as a defined document typology as the different documents that an academic community or specific entity develops and organizes, to be applied to the different types of scientific production in order to generate in turn a dynamic of identification of greater productivity in relation to educational robotics.
The type of document most used when publishing literature on educational robotics was the article with 94.8%.

Fig. 3 (left) shows the relationships of the main journals with the number of publications made per year, highlighting the highest productivity in the period 2015 - 2017 with 18 publications to the IEEE Robotic and Automation Magazine. Behind in the growth curve between 2010 and 2019; magazine such as International journal of technology and design Education, Journal of robotics and Mechatronics, International Journal of Advanced Robotics Systems, Advances in intelligent Systems and Computing. It is observed in Fig. 3 (right) that publications per year have a tendency to increase, that is, that educational robotics continues to be a current area of research. Regarding the production of documents per year, the information analyzed in the period 2010 to 2019 conserved a record of low productivity. In that sense, it is evident that the years with the highest number of published documents are the years 2016 and 2017, it is possible that these peaks can be explained by the periodicity of the published articles.

In Fig. 4 The area of Computer Science is the most concentrated research groups with 35.7% is the area with more research followed by the Engineering area; 31%, followed by Social Sciences, with 16.7%, mathematics with 6.3%, psychology with 2.8%, arts and humanities, medicine, neurosciences and others with 1.6%, environmental sciences and biochemistry with the 0.8% and 0.4% respectively. These data show the areas of knowledge in which there is a tendency to develop their research processes in the area of educational robotics.

4. Conclusions

This work summarizes the panorama of the implementation of educational robotics worldwide in higher education institutions, through the bibliometric analysis of information extraction from the Scopus database, such as: affiliation, sponsoring sources of the study, authors worldwide, documents by author and by year, type of publication, sources of publication, types of areas where these devices are used for teaching. A systematic method is used to search and analyze information, through the use of a series of search descriptors consisting of keywords and link terms that makes it possible to limit the scope of the investigation. It should be noted that some basic concepts have been excluded in the search for articles relevant to research. As evidenced, the results of articles related to educational robotics in higher education institutions worldwide have included other topics of relevant importance in the fields of health sciences, engineering, basic and computational sciences, distance learning and Virtual education widely used in these times. On the other hand, the importance of the entities and universities that favor the development in the educational field must be considered, making the greatest contribution in the field of learning in the area of robotics, another analysis criterion is the country of origin of the authors, where it was found that the contributions in the field of educational robotics came from different countries, it means in addition to being an index of growth, which is a topic of great global interest. Without neglecting that the countries that contribute most to research on educational robotics are, according to their contributions, the following countries: Italy, United States and Greece. In addition, research in Latin America on educational robotics has been identified as a problem that will be addressed in the near future being Colombia, and Brazil pioneers in these implementations. The study of advances in educational robotics in higher education institutions, which the present research develops has some limitations, including descriptors of the search and evolution of the same, the results showed us that great research is being carried out in This field of robotics, but also offers the opportunity to investigate in this area and this implies a more detailed review on this subject. Finally, the purpose of this work is to specify the contributions of educational robotics in terms of methods, models or methods that evaluate the implementation of learning in higher education. Therefore, an interesting task in this area would be to go to a deeper level and analyze the contributions of articles related to the implementation of robots in higher education.
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