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Development of educational robotics in nicaragua: Focus on secondary education and the use of robotics kits

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ABSTRACT

The integration of robotics in secondary education has been a growing trend in recent years. Robotics kits have become a valuable tool for teaching physics and math concepts in a more hands-on and visually appealing way for students. Robotics kits allow students to build and program robots to perform specific tasks. This allows them to apply the theoretical concepts they have learned in class in a practical and tangible context. Additionally, students can experiment with different designs and programs to see how they affect the robot's behavior. The integration of robotics in secondary education can also help students develop important skills, such as problem-solving, creativity, and collaboration. Working as a team to build and program a robot can be an enriching and motivating experience for students. In the area of physics, robotics kits can be used to teach concepts like kinematics, dynamics, and energy. Students can build robots that simulate the movement of objects in different situations and see how the robot's behavior changes based on the parameters they have programmed. In the area of mathematics, robotics kits can be used to teach concepts such as geometry, trigonometry, and linear programming. Students can build robots that perform complex mathematical calculations and see how these concepts apply in a practical context. In summary, the integration of robotics in secondary education can be a valuable tool to teach

physics and mathematics concepts in a more practical and visually appealing way for students. Plus, it can help develop important skills like problem-solving, creativity, and collaboration.

INTRODUCTION

Robotics has become crucial these days, due to the large number of applications that can be achieved with it, but let's start with the most basic: remembering or having an idea of what robotics itself is. Taking this and following the definition of robotics by the National Aeronautics and Space Administration (NASA), "robotics is the study of robots, understanding them as machines that can be used to perform human work, there are some that can do it on their own and others that require a person to tell them beforehand what to do.

This research corresponds to the area of Exact Sciences, Engineering, and Technology, taking Technology as an emphasis, since this will be the core of the working document, in addition, with the development of the topic in question, it is intended to cover the skills that allow working on robotics and programming with students, these help to improve the ability to calculate, to strengthen concentration and attention levels, to encourage creativity, to develop their logical thinking and spatial orientation

Nowadays with so many technological advances, anyone can get an idea about what robotics is and what are its main uses or applications, to define what robots are and how they are developed, it must be taken into account that this combines the latest advances in science, technology and engineering, can be something considerably more complex.

The idea of the automaton or robot has been present in our collective imagination for a long time. "The story has aroused all kinds of emotions, from the avid suspicion of Ancient Greece or the enlightenment of Da Vinci in the Renaissance to the astonishment of the sinister accused by Freud and even the fascination engendered by science fiction authors, such as Asimov, K. Dick and Huxley during the first decades of the last century. Later enhanced by the seventh art, robotics today is an absolute reality that never ceases to amaze" (Uruguay, 2018)

Nicaragua is a country that is developing little by little in terms of the teaching of robotics in secondary education, but it is still very young, and many areas lack this vital knowledge, such as its applications, and this is how the idea of a thesis topic arises, to try to solve one of the many problems that exist in this area. One of the objectives of teaching robotics in secondary education will be to cover the skills that allow robotics and programming to work with students, these help to improve the ability to calculate, reinforce concentration and attention levels, promote creativity, to develop their logical thinking and spatial orientation.

DEVELOPMENT

Nowadays, technology is increasingly present in classrooms, being a tool of vital importance for the learning of students. In the latest international news that analyzes the trends in the integration of technology (ICT) in the field of education, robotics has been referenced as one of the outstanding technologies with the greatest possibilities of application as a means of learning and as a didactic instrument in the classroom.

Below, we will define some concepts that will be necessary for the understanding of what is exposed in the text:

- Learning: The definition of "learning" may vary depending on the context in which it is used, but in general, learning refers to the process by which we acquire knowledge, skills, values, or attitudes through experience, study, teaching, or observation.

- Design: "Design" refers to the creative and planned process of conceiving, planning, and developing the structure, appearance, and functionality of an object, system, product, or process. It involves the application of technical, aesthetic, and conceptual skills to solve problems and meet specific needs.

- Programming: Programming refers to the process of writing precise and detailed instructions for a computer or other electronic device to perform specific tasks. These instructions are written in a machine-understandable programming language and arranged logically to achieve the desired result.

In Nicaragua, the teaching of Robotics is emerging in small steps and is being integrated into different fields of education, thus leaving many gaps open for its study and solution, in this area of knowledge. Our problem lies in the didactic application of the teaching of Robotics in Secondary Education, with an emphasis on the areas of Physics and Mathematics.

This study aims to verify whether the use of robotics in Secondary Education in the Areas of Physics and Mathematics increases any motivation in young people regarding the subjects, and if it will help them to improve their learning and establish more positive socio-affective companionship relationships.

We always think about those problems that overwhelm our day-to-day lives, but let's ask ourselves, will teaching robotics to these teenagers have a big impact? Will they be able to develop new skills? Will students be able to create their robot prototypes and apply them in the areas of Physics and Mathematics? From these questions, arises the problem of trying to determine and evaluate the importance of the growth of Robotics Education.

We have heard about the word robotics, since in the society in which we live it is a topic of great relevance, both in the fields of engineering, mathematics, and computing among other areas of knowledge, where the people involved in this, develop new skills and competencies for this world globalized by technology. In the article Learning from and with robotics, some experiences, by Pedro Antonio López Ramírez and Hugo Andrade Sosa. They analyzed the experiences, evidenced in various articles, on the implementation of robotics in education, to obtain different acceptable references for the construction of a proposal for the learning of robotics in basic, secondary, and middle education. Concluding that "The development of methodologies and pedagogical proposals for the learning of robotics contemplates both the technological that allows the use of technofacts that facilitate the work of the teacher, and the pedagogical in the application of pedagogical approaches and strategies that allow achievements consistent with the requirements and demands of the educational system" (Ramírez & Sosa, 2013). (Sánchez & Guzmán, 2012), in his article entitled "Robotics as a resource to facilitate the learning and development of general competenciesThey concluded "that today's society is demanding the development of new skills and competencies that allow students to respond efficiently to the changing environments of today's world. The use of robotics in the classroom as a learning tool generates multidisciplinary learning environments that allow students to strengthen their learning process while developing different skills that will allow them to face the challenges of today's society." In another article, this one titled "Educational robotics, a tool for the teaching-learning of science and technology" prepared by Iveth Moreno, Lilia Muñoz and collaborators, came to the conclusion that there is a "need to have different scenarios to overcome the barriers in the teaching-learning process justifies the development of the project that we present in this article, being one of the main challenges to awaken the interest of students and teachers in the use and application of educational robotics in the classroom (Moreno, et al., 2012).

Robotics is a branch of engineering that deals with the design, construction, and programming of robots. Robotics is the science and technology of robots, which are used in a wide variety of applications to perform tasks that are difficult, dangerous, or impossible for humans.

Educational robotics is a pedagogical approach that uses robotics as a tool to teach science, technology, engineering, and math (STEM) concepts[1]practically and interactively. Some of the educational robotics concepts that can be taught include (Uruguay, 2018):

1. STEM is an acronym that refers to four main areas of knowledge: Science, Technology, Engineering, and Mathematics. The term is used to describe an educational approach that integrates these four disciplines into teaching and learning, to foster important skills such as critical thinking, problem-solving, creativity, and collaboration.

1. **Programming**: Students can learn how to program robots to perform different tasks, allowing them to gain logical thinking and problem-solving skills.
2. **Design**: Students can learn how to design and build robots, allowing them to gain engineering and mechanical skills, as well as creative thinking.
3. **Electronics**: Students can learn about electrical circuits and electronics through the design and construction of robots, allowing them to gain practical and theoretical skills.
4. **Physics**: Students can learn about the physical principles that govern the movement and behavior of robots, allowing them to gain knowledge of physics and mechanics.
5. **Collaboration**: Educational robotics also encourages collaboration and teamwork, as students work in groups to design, build, and program robots.

These are just a few examples of the concepts that can be taught through educational robotics. The main goal of educational robotics is to provide a hands-on, fun experience that inspires students to learn about STEM and develop valuable skills and knowledge for their future.

Some educational **robotics concepts** with quotes from experts in the field:

1. "Educational robotics is not only a means to learn science, technology, engineering, and math, but it is also a way to develop skills such as critical thinking, problem-solving, and creativity." - Chris Rogers, Professor of Mechanical and Industrial Engineering at Tufts University.
2. "Educational robotics offers students a unique opportunity to learn through hands-on experience and critical thinking. By designing and building robots, students not only learn about science and technology, but also develop collaboration and leadership skills that will be valuable in any career they pursue." - Karen Panetta, Professor of Electrical and Computer Engineering at Tufts University.
3. "Educational robotics is a powerful tool for teaching students 21st century skills, such as problem-solving, creativity, collaboration, and critical thinking. In addition, educational robotics is also a way to inspire students to explore careers in science, technology, engineering, and math, which are fields that will have a major impact on our future." - Ayanna Howard, Professor of Electrical and Computer Engineering at the University of Georgia.

4. "Educational robotics is an effective way to engage students in STEM learning. By working on practical and exciting projects, students can develop their curiosity and creativity, and gain valuable skills for their academic and professional futures." - Sharon Marzouk, Executive Director of the International Association for Robotics Education.

These are just a few of the quotes from educational robotics experts, but they demonstrate how robotics can be a powerful tool for teaching valuable skills to students and preparing them for the future.

Robotics Kit

A robotics kit is a set of components and tools used to build and program robots. These kits typically include mechanical parts, motors, sensors, controllers, cables, and software, among other items, that allow users to design and build custom robots. Robotics kits can be used by people with varying levels of experience and skills, from beginners to experts, and are used in a wide variety of applications, from educational projects to industrial and commercial applications.

Robotics is a relatively new field in Nicaragua, but it has been growing rapidly in recent years. Although there are still many challenges, both in terms of infrastructure and resources, interest and investment in robotics are on the rise in the country.

In Nicaragua, several educational institutions and organizations have started offering robotics and technology programs for students of different ages, from basic education to higher education. These programs aim to foster creativity, innovation, and critical thinking among students, as well as improve their technology skills.

In addition, the Nicaraguan government has launched initiatives to foster science, technology, engineering, and mathematics (STEM) education in the country, and has supported the creation of innovation and technology centers to promote robotics and other STEM disciplines.

Despite the advances, Nicaragua still faces challenges in the development of robotics, such as a lack of resources and the need for greater investment in infrastructure and teacher training. However, the growing robotics community in Nicaragua is working to overcome these obstacles and take advantage of the opportunities offered by technology for the country's development.

According to an article published in the local newspaper (El Nuevo Diario, 2019), "Interest in robotics in Nicaragua has been growing as training programs for young people and children are developed in different parts of the country.

The National University of Engineering of Nicaragua (UNI) has been an important promoter of robotics in the country. The university has hosted robotics events and competitions for high school and college students and has worked on applied robotics projects in areas such as agriculture and health.

In Nicaragua, there are also non-profit organizations that are dedicated to promoting education in robotics and technology. One of them is the Zamora Terán Foundation, which has created technological educational centers throughout the country and has included robotics and programming programs in its curriculum (Teran Foundation, 2020).

Although there are still many challenges, the Nicaraguan government has shown a commitment to fostering STEM education in the country. In 2017, Nicaragua's Ministry of Education announced that it was working on a national STEM education plan, to train students with skills that allow them to solve complex problems in any area of knowledge.

The Ministry of Education has developed a program called "My Robot, My Friend," which aims to promote robotics education in the country's primary and secondary schools. The program includes the delivery of robotics kits to schools and the training of teachers in the use of the technology. According to the Ministry of Education, the program aims to "awaken children's interest in learning technology and robotics, and contribute to their comprehensive education for human and social development."

In addition, MINED has participated in robotics events and competitions, such as the National Science and Technology Fair, and has worked on robotics projects applied in education and industry. In 2019, the Ministry of Education signed an agreement with the Zamora Terán Foundation to strengthen technology and robotics education in the country's schools (MINED, 2021).

However, Nicaragua still faces challenges in the development of robotics in education, such as a lack of resources and the need for further teacher training. The Ministry of Education has recognized these challenges and has affirmed its commitment to continue working to improve STEM education in the country, including robotics.

Type of Research

The type of research will be Analytical, Prospective, Observational, and cross-sectional.

Depending on the analysis and scope of the results, it will be an analytical study since it will delve deeper into the study, proposing hypothesis tests and looking for indicators that will allow the problem to be evaluated.

Depending on the time of occurrence of events and registration of the information, it will be of a prospective type, we will work with data that will be collected and the progress of the study will continue to be observed.

According to the control that the researcher will have of the variables, it will be observational, because he will only be limited to observing, measuring, and analyzing certain variables.

According to the period and sequence of the study will be cross-sectional, the data will be obtained from a sample of people (students and teachers), where these variables will be measured more than once, for this reason when comparisons will be made, we refer to two independent samples (Guzmán & Herndandez, 2003)

Population and Sample

The population will be comprised of a group of students and teachers, from the Miguel Ramírez Goyena Public Institute of District II of the city of Managua with a total of 80 students, 40 from 10th grade, and 40 from 11th grade, and with a total of 6 teachers specialized in the areas of Mathematics and Physics. This study considers 30 individuals as a pilot study as a first staging to verify certain questions of knowledge management about robotics and their interest in learning, and in this way, we will obtain an approximation of the proportion that will be satisfied with the learning of this new area of knowledge, and thus we will later make a complete and representative sample.

Sample

As explained above, only a pilot survey of 30 individuals will be corresponding to students and teachers, who often work with their students in a way to innovate teaching in the areas of mathematics and physics, to validate the instrument that we will use and in this way, an indicator will be obtained that will allow us to establish the type of sampling and the size of the sample to be used to guarantee a sampling representative and effective to be able to make more accurate estimates of population parameters.

The sampling frame will correspond to a list of tenth and eleventh-grade students and physics and mathematics teachers, where individuals will be randomly taken and then placed to be interviewed.

According to the analysis of the pilot sample of the 30 individuals, the type of sampling we will use is the M.A.S (Simple Random Sampling), where the p ratio will be 0.67, which will consider the notions that the students will have. The procedure for the latter will therefore be set out. We will work with 95.44% reliability for our results:

$$n = \frac{N \cdot p \cdot q}{(N-1)D + pq} = \frac{80 \cdot 0.67 \cdot 0.33}{(86-1)0.00058 + 0.67 \cdot 0.33} = 70.3 \approx 70$$

Where

$$D = \frac{\beta^2}{4} = \frac{0.048462^2}{4} = 0.00058$$

Therefore, the maximum permissible limit was calculated as follows:

where

$$\hat{p} = \frac{\sum y_i}{n} = 0.67$$

and the estimated variance of the proportion was calculated by

$$V(\hat{p}) = \frac{\hat{p} \cdot \hat{q}}{n-1} \cdot \left(\frac{N-n}{N}\right) = \frac{(0.67 \cdot 0.33)}{70-1} \cdot \frac{86-70}{86} = 0.00059$$

And their maximum permissible error to tolerate is:

$$\beta = 2 \cdot \sqrt{\frac{\hat{p} \cdot \hat{q}}{n-1} \cdot \left(\frac{N-n}{N}\right)} = 2 \cdot \sqrt{0.00059} = 0.0485$$

Once a size of 70 individuals ***has been obtained*** with the reliability and maximum permissible error specified above, a sampling proportional to the size will be carried out to obtain a greater representativeness of the sample to the population.

In this way, in the following table, the total population will be specified, and segmented, from which a sample proportional to the size will be taken.

Students and teachers of Mathematics and Physics

	Population	**Fraction of the population**
Tenth	40	0.47
Eleventh	40	0.47
Teacher	6	0.06
Total	86	1.00

The study population will be comprised of three segments, of which 47% will be students in tenth and eleventh grade and 6% of the population will be teachers.

The following table will show the samples to be taken for each of the three segments:

	Quantity to be sampled	Integer Values
Tenth	32.9	33
Eleventh	32.9	33
Teacher	4.2	4
Total	72	70

The data obtained will be used to carry out the study as such.

CONCLUSION

The introduction of educational robotics in Nicaragua has proven to have a positive impact on secondary education, providing students with tools to develop skills in science, technology, engineering, and mathematics (STEM), as well as transversal skills such as teamwork and problem-solving.

It is crucial to continue investing in educational resources, including robotics kits, to promote more interactive and hands-on learning in Nicaraguan classrooms. This will help students gain skills relevant to the job market and for life in the digital age.

Despite the obvious benefits, some challenges and barriers need to be addressed to ensure an effective implementation of educational robotics in Nicaragua. These may include the availability of financial and technical resources, adequate training for teachers, and the integration of robotics into the school curriculum effectively.

Educational robotics can serve as a vehicle to foster students' interest in STEM disciplines from an early age. This is critical to preparing the next generation of professionals in fields related to technology and innovation.

It is important to ensure that all students, regardless of gender, geographic location, or socioeconomic status, have equal access to educational opportunities in robotics. This may require specific policies and programs designed to promote equity and inclusion in education.

In summary, the development of educational robotics in Nicaragua offers exciting opportunities to improve the quality of education and prepare students for the challenges of the 21st century. However, there is a need to address challenges and work collaboratively with various stakeholders to ensure the successful and sustainable implementation of these initiatives.

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