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Science and technology research group Moralba
Semillero de investigación en ciencia y tecnología Moralba

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ABSTRACT

The Moralba Science and Technology Seedbed is an educational project that aims to deepen the concepts of science and technology in STEM areas (Science, Technology, Engineering and Mathematics) for elementary, high school and middle school students. In the technological field, the RobótiKa Moralba project and the Robotics interest center stand out. In this space, students work on projects related to STEM Olympics and programming with Arduino, which gives them the opportunity to apply theoretical knowledge in concrete projects. On the scientific side, the Semillero includes the Antares club and the Astronomy interest center. These programs focus on theoretical-practical activities related to astronomy, which reinforces curricular knowledge of natural sciences and mathematics. These activities foster the scientific abstraction necessary to thoroughly understand the topics in this field, promoting curiosity and passion for science, providing an enriching educational environment that combines technological and scientific aspects. Students have the opportunity to participate in hands-on projects, olympiads and astronomy-related activities, which helps them develop skills in science and technology, as well as fostering their interest in STEM disciplines. This comprehensive approach seeks to prepare students for future challenges and opportunities in the field of science and technology.

Palabras clave:
Ciencia, Tecnología, Astronomía, Robótica, Enfoque STEM, ABP

RESUMEN

El Semillero de Ciencia y Tecnología Moralba es un proyecto educativo que tiene como objetivo profundizar en los conceptos de ciencia y tecnología en áreas STEM (Ciencia, Tecnología, Ingeniería y Matemáticas) para estudiantes de primaria, bachillerato y educación media. En el ámbito tecnológico, se destaca el proyecto RobótiKa Moralba y el centro de interés de Robótica. En este espacio, los estudiantes trabajan en proyectos relacionados con olimpiadas STEM y programación con Arduino, lo que les brinda la oportunidad de aplicar conocimientos teóricos en proyectos concretos. En el ámbito científico, el Semillero incluye el club Antares y el centro de interés de Astronomía. Estos programas se centran en actividades teórico-prácticas relacionadas con la astronomía, lo que refuerza los conocimientos curriculares de ciencias naturales y matemáticas. Estas actividades fomentan la abstracción científica necesaria para comprender a fondo los temas en este campo, promoviendo la curiosidad y la pasión por la ciencia, proporcionando un entorno educativo enriquecedor que combina aspectos tecnológicos y científicos. Los estudiantes tienen la oportunidad de participar en proyectos prácticos, olimpiadas y actividades relacionadas con la astronomía, lo que les ayuda a desarrollar habilidades en ciencia y

Tecnología, así como a fomentar su interés en las disciplinas STEM.	Este enfoque integral busca preparar a los estudiantes para futuros desafíos y oportunidades en el campo de la ciencia y la tecnología.

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Introduction

Colegio Moralba Suroriental IED is located in the southeast of the city of Bogotá, in a vulnerable socioeconomic area very close to the eastern hills. The educational community is characterized by its limited interests in science and technology, only focused on supplying basic needs in their homes and personal needs, very few have a defined life project. It is in this scenario where the project plays a fundamental role, in which students who have a taste for science and technology topics have the possibility to focus their life projects, thus the Moralba Science and Technology Semillero.

It is presented as a classroom project and aims to deepen science and technology concepts in STEM areas using the ABP (Project Based Learning) methodology for elementary, high school and middle school students. In turn, it arises as an initiative to promote learning and interest in these fundamental fields. This is divided into 5 strategies, three of technology and two of astronomy, which are addressed together, in the strengthening and deepening of the themes that are cross-cutting in natural sciences, mathematics and technology.

On the technology side, there is the robotics project "RobótiKa Moralba", the Robotics Center of Interest and the participation of two teams in the STEM Olympics, one in the Junior category and the other in the Juvenile category. In the scientific field, there is the astronomy group "Antares" and the astronomy interest center. These strategies as a whole make up the seedbed, which, in a complementary manner, are part of the curricular alternatives for students in extra-class hours.

In each strategy, theoretical-practical activities are carried out, where audiovisual media such as video clips, documentaries and films are used, as well as practical workshops with consumable material or digital tools such as computers, tablets or cell phones in the use of software, topics and problem situations are addressed through project-based learning, i.e., a proposal is proposed that will be developed during the year.

During its development, in each stage, it is evaluated, not with a class grade, but as an activity of each strategy, with the evolution of the students in the work groups, carrying out an audiovisual show each semester and, at the end, an exhibition of each final product obtained. As a pedagogical proposal that integrates technology and science to provide students with an enriching experience in the learning of STEM areas, it seeks to stimulate students' interest and understanding of science and technology, providing them with tools and opportunities to explore and apply this knowledge in a practical way.

Conceptual Framework

STEM FOCUS

The STEM approach is the acronym for Science, Technology, Engineering and Mathematics (Ramos-Lizcano et al., 2022). It is a combination of the sciences in a teaching approach based on interdisciplinarity and applicability of science and mathematics knowledge (Perales Palacios & Aguilera, 2020), it is an

educational methodology that integrates these disciplines in an interdisciplinary approach. According to Bybee (2019(Bybee, 2019)), the STEM approach seeks to develop key skills and competencies, such as critical thinking, problem solving, and collaboration, through hands-on projects and activities. It encourages inquiry-based learning and promotes the connection between theoretical knowledge and its application in real-world situations.

In the context of classroom projects, the STEM approach allows students to tackle complex challenges using an integrated approach. According to (Allodi et al., 2019) classroom projects based on the STEM approach engage students in authentic problem solving, where they apply the principles of science, technology, engineering, and mathematics to design innovative solutions. These projects encourage creativity, experimentation and teamwork, providing students with hands-on experience that helps them understand the relevance and impact of STEM disciplines in their daily lives.

In interest centers, the STEM approach also finds application by allowing students to explore topics related to science, technology, engineering and mathematics that spark their curiosity. According to (Knowles et al., 2018) this fosters intrinsic motivation and student engagement in learning. By tackling projects related to their insights, students become active researchers, applying the scientific method, using advanced technology and developing mathematical skills to understand and solve complex problems.

Applying the STEM approach in these settings also has long-term benefits for students. According to (Bybee, 2019), this approach promotes the development of skills and competencies that are highly valued in today's labor market, such as critical thinking, collaboration and adaptability. In addition, the STEM approach fosters interest in these areas, thus contributing to closing the gender and diversity gap in these fields.

PROJECT-BASED LEARNING (PBL)

Project-Based Learning (PBL) is a pedagogical approach that focuses on project-based learning as the primary means of learning. This approach encourages student participation, promoting the acquisition of knowledge, skills and competencies through practical problem solving and the creation of tangible products. According to (Mutakinati et al., 2018), PBL involves designing challenging and authentic projects, where students take active and collaborative roles, investigating, planning, solving problems, and presenting results.

In the context of classroom projects, PBL provides students with the opportunity to apply the knowledge acquired in a real-world environment. According to (Edelson et al., 2021) PBL-based classroom projects engage students in exploring and understanding concepts through hands-on problem solving. These projects can address topics relevant to students, awakening their interest and intrinsic motivation for learning. In addition, PBA fosters teamwork, effective communication and the development of socioemotional skills, thus strengthening the competencies necessary for the 21st century.

As for the centers of interest, PBL also finds application in this educational approach. According to (Mergendoller, 2018), it involves creating learning environments that reflect students' interests and needs. These provide a meaningful context for learning, where students can explore topics that are relevant and motivating to them. Students can develop research, problem-solving and decision-making skills while actively engaging in the learning process.

The use of simulators in theoretical and practical laboratories has proven to be a valuable tool in the teaching of physics and mathematics (Molina Molina, 2021). These simulators allow students to explore and experiment with key robotics concepts in a controlled virtual environment. According to previous studies, the use of simulators can improve the understanding of scientific principles and promote practical skills in the field of robotics (Sánchez-Caballé & Esteve- Mon, 2023; Sánchez-Otero et al., 2019).

Seedbed

From the particular interests of the students and their due characterization, the socioeconomic context of the educational institution (Colegio Moralba Suroriental, located in the district of San Cristobal, southeast of the city of Bogota) and the low academic results of students in areas such as natural sciences, mathematics and technology, the need arises, initially, to strengthen the fundamental concepts for the understanding of the scientific context, the difficulties in their understanding, and then to deepen their understanding.

The idea of the project arose a few years ago, after several attempts to gather some high school and middle school students, since they participated in an institutional way in events with the business emphasis of the school in some entrepreneurship exhibition in the afternoon. The club was born in the year 2021 as a classroom project, and in turn participating in "planetarium for teachers" of the district planetarium linked for some years in the activities and workshops for teachers, initially a weekly extra-classroom session, virtual modality of two hours, aimed at high school students from sixth to eleventh grade during August to November of the same year.

Subsequently, a proposal was made for the following year, in a 100% face-to-face manner, for the creation of the Astronomy center of interest, a center of interest specific to the educational institution, which would work against the school day, for now, only directed to students from sixth to ninth grade in the afternoon in a two-hour session. Theoretical and practical activities are carried out on different astronomy topics that attract the students' attention. In each session they not only satisfy their curiosity, but also reinforce their knowledge in natural sciences and mathematics through the scientific abstraction required by the topics in this field.

During the same year, other classroom projects were initiated, which are part of strategies other than astronomy, such as RobótiKa Moralba and STEM Olympics, initially with tenth and eleventh grade students in the subjects of Physics and Technology, where the curriculum is complemented with the use of simulators and STEM resources. On the one hand, there are the simulators in theoretical-practical physics laboratories and on the other hand, the use of programming software such as Scratch and Mblock to bring the students closer to the

students to programming through the use of blocks and later the use of the Arduino board (and the electronics kit) for the control of external objects, with the purpose of bringing them closer to Robotics. Programming has been recognized as an important skill in the 21st century, and its application in robotics can spark students' interest and promote cognitive and problem-solving skills (Bers, 2018; Katterfeldt & Shilling, 2019).

In 2023, the Robotics center of interest was opened, which, together with the other two technology strategies (RobótiKa Moralba and STEM Olympics), will work transversally as projects with a STEM focus, which seek to work together to solve a problem, either institutional or local (specific to the sector, for example, mobility, pollution in the area, inadequate use of waste, etc.). In this way, it is possible to carry out workshops or school activities in projects such as ICT and risk management.

This is based on educational approaches supported by research, where the use of simulators, programming and the study of astronomy through theoretical and practical activities are effective strategies to deepen the concepts of science and technology in STEM areas. These promote student interest and understanding, providing them with tools and opportunities to explore and apply knowledge in meaningful contexts.

It is an educational project that has been developed with the purpose of deepening the concepts of science and technology in STEM areas (Science, Technology, Engineering and Mathematics) for students of different educational levels. This pedagogical approach seeks to stimulate young people's interest and learning through two key educational methodologies: the STEM approach and project-based learning (PBL). This article explores in detail this educational project, its relevance in the context of STEM education, and the contribution of the use of technologies and simulators, with a special focus on the teacher's experience as a learning facilitator.

It emerges as an innovative educational initiative that seeks to provide students with the opportunity to explore and understand concepts in STEM areas, such as natural sciences, mathematics and technology. This approach has become a fundamental pillar of contemporary education, as it is recognized that STEM training is essential to prepare young people to meet the challenges of the 21st century, both in their future careers and in their understanding of the world around them.

It is based on the interconnection of the aforementioned disciplines to address real-world problems and foster problem-solving skills, critical thinking and creativity. This approach seeks not only to impart theoretical knowledge, but also to apply this knowledge in practical and real situations. In addition, project-based learning (PBL) is a methodology that promotes active learning and student participation in projects with clear objectives and practical applications.

Technology Integration in STEM Education:

The use of technology plays a crucial role in the effective implementation of the STEM and PBL approach in education. The teacher, in this context, plays a fundamental role in incorporating technological resources to improve the quality of teaching and learning. In the case of the teacher behind the Semillero de Ciencia y Tecnología

Moralba, his experience and commitment to teaching physics and mathematics have led to an evolution in his pedagogical approach.

Initially, the teacher introduced Web 2.0 and 3.0 technologies in his classes. These technologies provided assessment tools, such as online questionnaires and interactive assessments, as well as online resources for consultation. Over time, this experience expanded to the integration of simulators and STEM resources with programming in the classroom. This allowed for a more hands-on and engaging approach for students, who were able to interact with cutting-edge educational technology.

Experience with PhET Simulators

A particular highlight of the teacher's experience has been his work with the PhET simulators in the classroom. PhET Interactive Simulations is a collection of interactive simulators developed by the University of Colorado Boulder, designed specifically for teaching science and mathematics. These simulators offer students the opportunity to explore and experiment with scientific and mathematical concepts in a virtual environment, which facilitates the understanding of abstract and complex topics.

The teacher has used PhET simulators in a variety of educational contexts. First, it has incorporated them into the design of laboratory activities in physics and mathematics. Simulators allow students to conduct virtual experiments in a safe and controlled environment, eliminating the logistical and equipment limitations associated with traditional experiments. This expands access to laboratory experiences in resource-limited settings.

In addition, the teacher has integrated the PhET simulators in different moments of a class session. These simulators have been used at the beginning of a lesson as a way to explore concepts and preconceptions. This strategy helps to arouse students' curiosity and build a solid foundation of knowledge before delving into more complex topics.

PhET simulators have also been used at the end of the exploratory or preconcept phase, allowing students to apply what they have learned and observe how scientific principles manifest themselves in practice. Finally, PhET simulators have been used after the explanations in the practical phase, allowing students to consolidate their knowledge and reinforce their understanding through hands-on activities.

The Benefits of Technology and Simulators in STEM Education:

- The integration of technology, and in particular educational simulators such as PhET, into the classroom offers a number of significant benefits in the context of STEM education. Some of these benefits include:

- Interactivity and Virtual Experimentation: Simulators allow students to interact with scientific concepts and principles in a safe and practical way. They can perform virtual experiments, modify parameters and observe results, which facilitates experimentation and understanding of complex phenomena.

- Access to Laboratory Experiences: Simulators eliminate the physical and logistical resource constraints in traditional laboratories. This broadens the access of

students to laboratory experiences, regardless of the availability of equipment and materials.

- Focus on Active Learning: Simulators encourage active learning as students actively participate in exploration and experimentation. This promotes critical thinking and problem solving.
- Personalization of Learning: The simulators allow students to advance at their own pace and explore concepts in depth. This facilitates the personalization of learning and adaptation to the individual needs of students.
- Visualization of Abstract Concepts: Many concepts in science and mathematics are abstract and difficult to visualize. Simulators provide visual representations that make these concepts more accessible and understandable.
- Motivation and Commitment: Technology, in the form of simulators and interactive resources, is often highly attractive to students. This increases motivation and commitment to the learning process.
- Formative Evaluation: Simulators can also be used for formative assessment, allowing teachers to track student progress and adapt their teaching accordingly.

The Teacher's Experience as a Learning Facilitator:

The teacher behind the Semillero de Ciencia y Tecnología Moralba plays a fundamental role as a learning facilitator. His experience in teaching physics and mathematics, as well as his commitment to educational innovation, have enabled him to take full advantage of technologies and simulators in the classroom.

It has shown the importance of adapting its pedagogical approach as educational technology evolves. It began with the incorporation of Web 2.0 and 3.0 tools, which led to a significant improvement in online interaction and evaluation. As he progressed, he delved into the world of simulators and STEM resources with programming, allowing students to experiment with concepts in a more hands-on and visual way.

The use of PhET simulators in their teaching has demonstrated their ability to provide high quality virtual laboratory experiences. This is especially relevant in a context where physical laboratories often present logistical and budgetary challenges. The ability to use simulators to provide hands-on experiences is one way to overcome these barriers and ensure that students have access to a better quality education.

They have applied these simulators at different times in their classes, which shows a deep understanding of how to integrate technology into the teaching and learning process. By using simulators at the beginning of a lesson, it creates a solid foundation for concept exploration. Used at the end of the exploratory phase, they allow students to apply what they have learned. In addition, PhET simulators were used after the explanations in the practical phase, consolidating learning by verifying the concepts.

In addition to his experience with educational technology, he has demonstrated a commitment to STEM education and project-based learning. The Moralba Science and Technology Seminar is a manifestation of this commitment, as it provides students with the opportunity to participate in projects that challenge them to apply their knowledge to real-world situations. The combination of technology and innovative educational methodologies has led to an enriching learning experience for students.

Relevance in the Context of STEM Education:

The STEM approach and project-based learning have gained prominence in the field of education in recent years. This is due in part to the growing demand for professionals in STEM areas and the need to prepare students for future careers and challenges that will require strong foundations in science, technology, engineering and mathematics. STEM education has become an essential approach to promote scientific and technological literacy in society. This includes not only the acquisition of knowledge, but also the development of critical skills, such as logical thinking, problem solving and creativity. The integration of technology, as seen in the case of the seedbed, complements this approach by providing tools and resources for learning.

Project-based learning, on the other hand, emphasizes the practical application of knowledge and skills. Challenging, problem-oriented projects allow students to work in teams, investigate, collaborate and solve real problems. This fosters critical thinking and prepares students to face complex situations in their future careers and lives. The combination of STEM and PBL creates a comprehensive educational approach that prepares students for success in the 21st century. In an ever-evolving world where technology plays a central role, the ability to understand and apply STEM concepts is essential. STEM education also fosters scientific and technological thinking, which is fundamental to problem solving in various disciplines and contexts.

It is an outstanding example of how STEM education and project-based learning can stimulate student interest and learning. The combination of educational technology, in particular the use of PhET simulators, with innovative pedagogical methods, has enabled the teacher behind this project to provide enriching learning experiences. The integration of technology, such as PhET simulators, into the classroom has proven to be an effective strategy for addressing physical and logistical resource constraints in science and mathematics education. In addition, teachers have adapted their approach over time, incorporating increasingly advanced technological tools to enhance the teaching and learning process.

It highlights the importance of preparing students to face real-world challenges through STEM education and project-based learning. This approach not only provides them with theoretical knowledge, but also with practical and applicable skills in a wide variety of fields. Ultimately, it exemplifies how the combination of a committed teacher, advanced educational technology and innovative pedagogical approaches can have a significant impact on students' education and prepare them for a knowledge and technology-based future.

Method

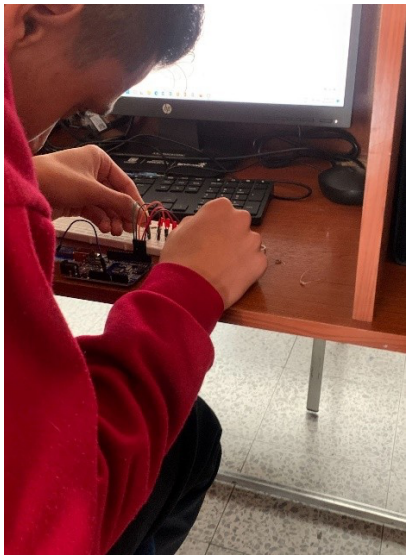
The seedbed consists of 5 strategies that comprise two lines of work, on the one hand, the technological part based on the "RobótiKa Moralba" project, the Robotics Interest Center and participation in STEM Olympics and, on the other hand, the scientific part, where the Antares Astronomy Club and the Astronomy Interest Center are located. Both currents focus on the same goal, which is the strengthening and deepening of concepts through the design and execution of PBL projects, in terms of the STEM approach, as will be seen below:

Moralba RobotiKa Project:

On the technological side, there is the RobótiKa Moralba project, which uses simulators in theoretical and practical physics and mathematics laboratories. These simulators allow students to explore and experiment with key robotics concepts in a virtual environment. In addition, students are introduced to basic notions of programming using the Arduino board, giving them the opportunity to enter the world of programming and electronics.

Figure 1

Middle school student developing a practical activity with the Arduino board



Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

Robotics Interest Center:

Since 2023, it has been open to students from 5 to 9 as part of the extended day, as well as Astronomy. It addresses some basic topics related to the introduction to programming and the use of devices such as Arduino are effective strategies to bring students closer to the world of technology and electronics, in addition to the formation of two teams, one junior (students from 5 to 8) and one youth (9 to 11) for participation in the STEM Olympics. Its objective is to strengthen concepts in STEM areas, but also to teach them other uses of some electromechanical devices, which, together with programming software, are important for the execution of tasks, using knowledge of mathematics, natural sciences and technology.

Figure 2

Students attending the robotics center of interest

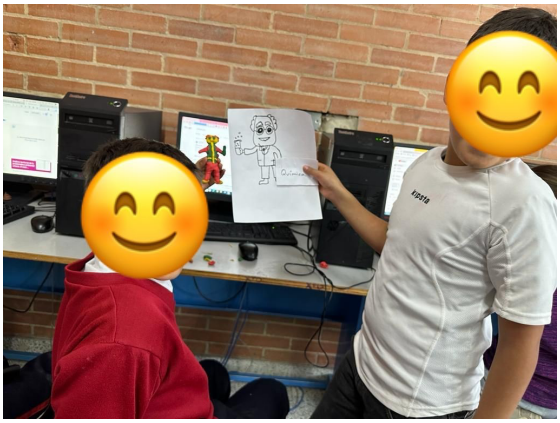
Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

STEM Olympics:

Since 2022 we have participated in the STEM olympics, forming the youth team QUARK TEAM MORALBA, with students in grades 10 and 11, with whom we reached the challenge 4 out of a possible 5. In the year 2023, two teams will be formed, one junior and one youth, whose base are the students of the robotics center of interest and are intended to continue advancing sustainability projects, on the one hand, sustainable production, and on the other, climate change.

Figure 3

Junior Quark Team Moralba STEM Olympiads students



Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

Antares Astronomy Club:

As for the scientific part, the seedbed has the ANTARES Astronomy Club, which has the support of the District Planetarium. This club focuses on theoretical and practical activities related to astronomy, allowing students to deepen their curricular knowledge of natural sciences and mathematics. These activities, which range from astronomical observations to conducting scientific experiments, foster the scientific abstraction necessary to

understand astronomical phenomena and apply mathematical concepts in this field.

Figure 4

Students starting the astronomy club, year 2021

Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

Astronomy Interest Center

It begins in 2022 as part of the astronomy club of the educational institution and the astronomy seedbed that had previously worked from the District Planetarium. With the approval of the Board of Directors, the call for applications was made in February for students from sixth to ninth grade in the morning session, as shown in the advertisement. The schedule is against the clock (in the afternoon) in a two-hour session on Thursdays from 2:20 pm to 4:10 pm, are theoretical and practical sessions, which address topics of interest in astronomy, such as: Planet Earth, Moon, Sun, Solar System, Planetary Systems, Exoplanets, Galaxies, Milky Way, Constellations, Astronomical Coordinate Systems, Telescopes, etc. In the year 2023, the program continues on Friday afternoons, in the same modality as the previous year, and two guests have been invited to talk with the students.

Figure 5

Students attending the Astronomy interest center

Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

Publication of scientific articles on the pedagogical practice carried out in physics classes with PhET simulators, as a product of the seedbed. The idea is to continue writing about the experiences and results obtained in each strategy. The site https://sites.google.com/view/cienciaytecnologamoralba/inicio contains the different projects of the seedbed, which are permanently updated, according to the activities that are being developed on a permanent basis.

Figure 6

Screenshot of the seedbed website

Note. Retrieved from: https://sites.google.com/view/cienciaytecnologamoralba/

Results

Throughout several years of teaching practice, the Moralba Science and Technology Semillero has demonstrated a significant impact on the teaching-learning process. This educational project has employed a combination of educational technology, in particular, simulators and innovative pedagogical strategies to provide students with enriching learning experiences in STEM areas. In this article, we will explore in depth the positive results obtained and their relevance in the development of STEM skills.

Simulators: Effective Tools for Understanding Concepts

Simulators have played a prominent role in the success of the Moralba Science and Technology Seedbed. These interactive tools have proven to be effective in explaining abstract and complex concepts in the natural sciences and mathematics. Through the simulation of scientific and mathematical phenomena, simulators provide students with a hands-on experience that allows them to understand and visualize concepts that might otherwise be difficult to assimilate.

The usefulness of simulators lies in their ability to simplify and clarify concepts, making them more accessible and understandable to students. These

virtual environments allow students to explore variables, perform experiments and observe results interactively. Rather than relying solely on theoretical explanations, the simulators offer a hands-on experience that encourages active, participatory learning.

The application of simulators in physics and mathematics teaching has had a particularly positive impact. Students can perform virtual laboratory practices, which eliminates the logistical and budgetary constraints associated with traditional laboratories. This flexibility has enriched the learning experience by giving students the opportunity to experiment without limitations, which has stimulated their curiosity and participation in the classes. Simulation technology not only simplifies concepts, but also facilitates the process of experimentation and analysis. Students can test hypotheses, modify parameters and observe how results change, which promotes critical thinking and problem solving. This practice is fundamental in the formation of essential scientific and mathematical skills.

The Impact on Robotics and Programming

In addition to its effectiveness in teaching natural sciences and mathematics, the Moralba Science and Technology Semillero has had a significant impact on student interest and participation in the field of robotics and programming. The introduction of basic notions using the Arduino board has proved to be an enriching experience.

Robotics and programming are growing areas that are fundamental to STEM education. The Semillero has acted as a bridge to these fields by fostering students' curiosity and motivation to explore technology and electronics. The use of the Arduino board as a pedagogical tool has allowed students to understand the concepts of programming and electronics in a practical way. The Arduino board is known for its versatility and ease of use, making it an ideal platform for teaching programming and electronics. Students can create interactive projects and explore a variety of applications, which stimulates their creativity and desire to learn. This experience also has the potential to awaken vocations in fields related to technology and engineering.

The Robotics Interest Center at the Semillero has been particularly effective in bringing students closer to the world of technology and electronics. Forming teams to participate in STEM Olympiads has promoted collaboration and healthy competition among students. Competition in these Olympiads allows students to apply their knowledge in real-world situations, which reinforces their understanding of STEM concepts and problem-solving skills. The connection between technology and robotics is also critical for the future, as robotics and automation play an increasingly important role in industry and society in general. The Semillero has prepared students for future opportunities in these fields while enhancing their understanding of STEM concepts.

Deepening of Curricular Knowledge

The Antares Astronomy Club has been a valuable addition to the Moralba Science and Technology Semillero. This club focuses on theoretical and practical activities related to astronomy, which has led to a deepening of curricular knowledge in natural sciences and mathematics. Astronomy is a discipline that combines aspects of natural science and mathematics, and requires scientific abstraction skills to understand astronomical phenomena. Hands-on activities, such as star and planet observations, allow students to apply mathematical concepts to the understanding of these phenomena.

It has not only enriched curricular education, but also stimulated students' curiosity about the universe and the mysteries of the cosmos. Astronomy is a discipline that has fascinated mankind for centuries, and this club has allowed students to explore and appreciate the beauty of space.

Discussion and conclusions

The experience with the different strategies of the seedbed has proven to be highly positive and enriching. Its integration with the science, mathematics and technology curricula has facilitated the explanation of complex concepts and increased students' level of understanding. The possibility of virtual laboratory practices has provided flexibility and variety in the learning activities, which has boosted student interest and participation. The RobótiKa Moralba project has been a great success in introducing students to the world of robotics and programming. The use of simulators in theoretical and practical laboratories has allowed an interactive and safe exploration of key concepts in robotics. Participation in the STEM Olympiads has motivated students to excel and engage in learning in STEM areas.

The Antares Astronomy Club has been a valuable experience to deepen the curricular knowledge of natural sciences and mathematics. Theoretical and practical activities related to astronomy have stimulated the students' scientific abstraction and logical reasoning. In conclusion, the use of PhET simulators and ICT resources in the teaching of physics, as well as the implementation of the RobótiKa Moralba project and the Antares Astronomy Club, have had a positive impact on the educational process. These experiences demonstrate that the appropriate use of technologies and the promotion of hands-on, playful activities can enhance student learning in STEM areas. We will continue to explore and expand the use of ICT resources in teaching to improve teacher training and learning of physics in the future, continuing with the social projection, that the educational community continues to recognize our work and effort through its dissemination, and increasingly students show greater interest in these areas and forge a future studying careers related to the STEM approach, but above all, see a whole life project that allows them to grow integrally from the scientific and technological training.

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