LEARNING ELECTRICITY AND MAGNETISM IN A RURAL CONTEXT THROUGH PBL

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Abstract

This article is based on the research named "aprendizaje de la electricidad y el magnetismo aplicando el aprendizaje basado en proyectos". this research set out a didactic strategy based on projects to teach physics to tenth an eleventh-grade students at Institucion educativa la Floresta in Sapuyes Nariño. For this, it makes an exhaustive analysis about official an institutional document, direct observation and surveys to students and teachers. As result, it demonstrated the lack of science syllabus which join the subjects and guide the teaching of physics from the transversality with the technical area. in the same way, it was found that the curriculum does not have concepts about electromagnetic events in biology and physics subjects. Therefore, this study aims to design support material based on project-based learning (ABP) which allow the student and teacher to follow step by step to help them to find a solution to a problem in their context.in this way, student achieve a meaningful learning about the concepts of electricity and magnetism which are stipulated in the basic learning standards and commit to the constructivist pedagogical model set out in the institution.

Key words: project-based learning, context, electricity, magnetism, strategy

Resumen

Este artículo se basa en la investigación realizada en el trabajo de maestría denominado "Aprendizaje de la electricidad y el magnetismo mediante la aplicación del aprendizaje basado en proyectos". La investigación plantea una estrategia didáctica basada en proyectos para enseñar física a los estudiantes de grados décimo y once en la Institución Educativa Agropecuaria La Floresta, en el municipio de Sapuyes; para ello se realizó un análisis exhaustivo de documentos oficiales e institucionales, observaciones directas y encuestas a estudiantes y docentes en donde se evidenció que la institución carece de un plan de área de ciencias naturales que unifique las asignaturas y guíe la enseñanza de la física desde la transversalidad con el área técnica. Del mismo modo, se encontró que en las mallas curriculares existentes no se abordan los conceptos de eventos electromagnéticos en las asignaturas de biología y física. Por consiguiente, este estudio diseñó guías de apoyo fundamentadas en el aprendizaje basado en proyectos las cuales permiten al estudiante y al docente encontrar solución a un problema de su entorno, en virtud del aprendizaje significativo de los conceptos de electricidad y magnetismo estipulados en los estándares básicos de aprendizaje, y como respuesta a las exigencias del modelo pedagógico constructivista planteado en la institución.

Palabras Clave- aprendizaje basado en proyecto, contexto, electricidad, magnetismo, estrategia

Introduction

Education plays an essential role in the progress of communities, and the teaching-learning process acquires crucial importance in this context. It is necessary to promote didactic strategies that foster meaningful learning and motivation in scientific education and training, particularly in rural environments, where students often lack a clear life project for their future. The objective of this research "Learning Electricity and Magnetism through Project-Based Learning" is to address the difficulties observed in teaching the concepts of electricity and magnetism in the tenth and eleventh grades of the Agricultural Educational Institution "La Floresta" (INEDAF) in the municipality of Sapuyes. A strategy supported by project-based learning (PBL) is proposed to fulfill the constructivist approach of the institution's pedagogical model. Therefore, the research question is: How does Project-Based Learning contribute to the learning of electricity and magnetism in the tenth and eleventh grade students of INEDAF? To provide an answer during the research, a learning strategy was developed and designed where the student has a guide to conduct small investigations related to problems in their environment, including topics of electricity and magnetism appropriate to their grade level.

Taking into account that the institution is located in a rural community dedicated to agriculture and livestock, it is essential to link the fundamental areas with the context and focus of the educational institution to promote meaningful learning and thus achieve the attention and active participation of the students. Consequently, an analysis of the context at the municipal level, of the village, and of the educational institution was initiated to understand the problems related to electromagnetism. Additionally, previous research on physics, electromagnetic events, and the implementation of strategies supported by project-based learning was reviewed.

The research is theoretically based on key concepts such as project-based learning and the teaching of physics in secondary education. It also addresses the complexity of learning electricity and magnetism in basic and secondary education, where the lack of presence of these concepts in the natural sciences work plans and in the teaching of physics in secondary education is observed.

The research was conducted with a qualitative approach, using a descriptive method to analyze and describe the collected information, which allowed for the development of a didactic proposal to address the identified problems. The proposal includes objectives, a general structure of PBL, and the roles that both the teacher and the student should play at each stage of the project's development. Lesson plans for the tenth and eleventh grades were also designed, along with guides and the evaluation of the learning process.

TEACHING ELECTROMAGNETIC EVENTS: CONTEXTUALIZATION.

Difficulties in the teaching of physics and student learning regarding the various topics covered by this discipline are varied. Some of these are unique cases, while others are common across different institutions. In the context of secondary education, students often face challenges in understanding and assimilating the various concepts of physics. Chacón identifies and highlights the following difficulties:

1. The lack of a didactic approach consistent with the nature of physics that facilitates and optimizes the teaching-learning processes of the conceptual foundations.
2. The decontextualization of acquired knowledge with respect to the historical framework and the application environment of the learned knowledge.
3. Repetitive failures in problem posing and solving (Chacón Cardona, 2008).

Thus, the theoretical work of the teacher does not allow the student to involve this area of knowledge with their context; learning must be assimilated solely from a theoretical didactic approach where the lecture is the main tool, along with the lack of laboratory practices (which may include the absence of the laboratory itself), as well as the non-inclusion of the rural environment in the topics; these are specific limitations in the case of INEDAF.

Moreover, the theoretical strategies proposed by the responsible teachers do not allow students to relate the content to their life in the rural environment. Therefore, the teaching of natural sciences, in this particular case physics, must transcend the boundaries of describing phenomena, experiments, and forms. It is necessary for the student to seek their own knowledge and relate it to their interests. That should be the most important role of natural sciences: to ensure that the student is competent in terms of knowing, knowing how to do, and knowing how to be, with the support of research and, therefore, using the scientific method. According to Narváez: "Training students for scientific competencies from an early age is a task that every teacher must undertake; since it is the way to bring the child closer to science. This means that teaching-learning strategies must be generated that put students in contact with natural phenomena, so that they develop a desire to inquire about these and manage to construct explanations from those learnings, promoting changes in the way the child conceives science, based on theoretical models" (Narváez Burgos, 2014).

Based on this premise, it is understood that the teacher's exclusively theoretical approach in teaching physics to describe natural phenomena is insufficient. It is necessary for the teacher to reconsider their pedagogical approach and seek new didactic strategies that involve the practical part and, above all, include the student as an active participant in the learning process. In this sense, it is crucial to incorporate research as a strategy for the student to understand, apply, and relate physical phenomena to their environment, thereby awakening a genuine interest in knowledge.

The problem of not including research or experimental practice in the classroom leaves the student without an important tool in acquiring their knowledge, because according to the MEN "replicating directed research processes already carried out by others and addressing problems that arise from their curiosity and their own research will also serve to exemplify the long and rigorous path necessary in the construction of scientific knowledge" (Ministerio de Educación Nacional, 2002). Additionally, they will be able to relate problems and situations from their context. For example, in electromagnetism, it is possible to address topics such as renewable energy, electrical circuits, resource utilization, magnetism, among others. Various problems easily detectable within the rural context and activities can be experimented on, such as measuring temperatures or humidity of crops, automated irrigation systems, solar electric fences, crop germination, lighting or ventilation systems, among others. Functional problems in which physics can be involved to propose a solution.

Therefore, with the research, a guide is designed to allow the teacher and student to implement a project-based teaching strategy, along with didactic activities related to physics, such as "problem situations, micro-projects, and laboratories; which create in the student the capacity to construct new conceptual structures for learning new content and its meaning" (Garzón Florez & Florez, 2006). This can justify the need to generate pertinent educational responses to involve the topics of electricity and magnetism within the rural context and the agricultural focus of the educational institution.

The objective of this work was to design the guide that allows students to formulate small investigations within their environment, which can be approached from various topics related to electricity and magnetism in the physics course. This will allow them to understand the relevance and transversality of this science in the context of the agricultural high school offered by the educational institution.

It is also important to introduce students to the scientific method of research and achieve meaningful learning of knowledge related to electricity and magnetism. This motivates learning, as it "favors the relationship of students with their surrounding environment and fosters competent social participation. Motivation can also lead students to develop social skills" (Hernández Martinez & Villavicencio Torres, 2017). Thus, individual and group learning is benefited.

PROJECT-BASED LEARNING

The approach of PBL as a teaching-learning strategy has its roots in philosophers like Socrates and Aristotle, but this research primarily draws from the ideas of the pedagogue John Dewey. From his experience-based theories, Dewey mentions that learning through action is necessary, as Ruiz highlights: "Dewey maintained a dynamic view of experience, as it constituted an exchange between a living being and their physical and social environment, not just a matter of knowledge" (Ruiz, 2013). For Dewey, experience was of vital importance in the learning process, as a person "learns through experience, through education, through action" (Ruiz, 2013). This is where the idea of the active school emerges, where the student becomes the core of education and the teacher assumes the role of a guide or intermediary between the student and knowledge. Dewey adapted the scientific method to education through five steps or stages described by Ruiz as follows:

1. As in any research, it starts from a problematic situation of uncertainty, which constitutes the first moment of the search and would allow elucidating an idea or solution.

2. A second moment would be given by the development of this conjecture or suggestion through reason (intellectualization of the problem).

3. The third moment would be experimentation, in which different hypotheses are tested to check the adequacy or not of the proposed solution.

4. The fourth moment of the research would be the intellectual reworking of the original hypotheses.

5. The fifth would involve verification, which may lead to various further pathways" (Ruiz, 2013).

However, it is important to note that the PBL approach is not limited solely to Dewey's perspective. There are other theoretical and pedagogical contributions to the development of this strategy, such as Howard Gardner, who proposes the theory of multiple intelligences. This theory emphasizes the diversity of students' abilities and talents and advocates for pedagogical approaches that adjust to their individual strengths. Additionally, PBL has benefited from technological advances and the incorporation of digital resources in the educational process. The use of digital tools and online platforms can enhance students' learning experiences by providing access to updated information, interactive tools, and the possibility of virtual collaboration with other peers.

A key pedagogue related to PBL is Kilpatrick, who is considered a disciple of Dewey and proposed a theory known as the project method. According to Kilpatrick, learning should be child-centered, based on their interests and their physical and social environment. In other words, learning should be connected to the student's real life. Paraphrasing Kilpatrick, education should be considered an integral part of life itself, not just as preparation for the student's future.

In summary, PBL as a teaching-learning strategy is based on the idea of learning by doing and rests on the importance of experience and the dynamic role of the student in their own learning experience. Through the implementation of contextualized projects, students can develop cognitive, social, and emotional skills, achieving meaningful and lasting learning.

These types of teaching-learning methodologies generate academic, social, and personal benefits for the student, given that "students go through a long research process in which they have to answer a complex question. Projects have to go through a careful and rigorous process of planning, management, and evaluation that helps students learn fundamental academic content, skills, and competencies" (Toledo Morales & Sanchez Garcia, 2018). Among the competencies that students manage to develop, those mentioned in figure 1 stand out, encompassing individual and group skills and competencies, such as critical and self-critical capacity, leadership, commitment, creativity, organization, use of ICTs, written and oral communication, among others.

Fig. 1. Competencies Developed by PBL

Taken from: (Toledo y Sánchez, 2018)

- INQUIRY
- PUBLIC AUDIENCE
- NEED TO KNOW

- VOICE AND CHOICE
- REFLECTION AND REVISION
- CHALLENGING PROBLEM OR QUESTION
- CONTENTS, SKILLS, COMPETENCIES

TEACHING PHYSICS IN BASIC AND SECONDARY EDUCATION.

To understand the teaching of physics in Colombia, it is relevant to explore its historical evolution in the country. According to Virgilio Niño, "physics as a science, that is, as a discipline of knowledge, was established in Colombia relatively recently, just in the second half of the 1850s" (Niño, 2012). Before this period, education was predominantly in the hands of religious communities that did not give it much importance. However, there were outstanding figures such as José Celestino Mutis and Francisco José De Caldas, who were involved in physics-related topics through the botanical expedition and the creation of the astronomical observatory. Subsequently, the work of physicists like Julio Garavito became evident.

Furthermore, the establishment of the National University in 1868 and the offering of programs in sciences and engineering provided a significant boost to the development of physics in Colombia. As Niño mentions, "A group of engineers and high school teachers who saw the need to improve the teaching of physics and to develop research created the Colombian Society of Physics in 1955" (Niño, 2012). This society was responsible for establishing the physics department at the National University, and from then on, other universities began to create physics programs and promote research in this area. Locally, the physics program was established at the University of Nariño in 1992, demonstrating the growth and expansion of teaching and research in physics in various academic institutions in the country.

The teaching of physics in Colombia, both in basic and secondary education, falls within the field of natural sciences. According to the basic standards of learning for natural and social sciences, physics is taught to students in tenth and eleventh grades, based on the division of the natural sciences area into biology, physics, and chemistry. Until ninth grade, topics related to physics are integrated into the biology subject, as mentioned by the Ministry of National Education (MEN). "The processes studied by the natural sciences can be divided into three main categories: biological processes, chemical processes, and physical processes. However, these processes do not occur in isolation" (Ministry of National Education, 2002), meaning that they must be worked on jointly and interdisciplinarily.

However, in practice, these subjects are often taught separately and disconnected from the student's environment and the educational institution, creating problems in teaching and learning. To address this issue and meet the objectives set by the standards, new strategies need to be implemented. In addition to the basic learning standards, Colombian official documents also include other guidelines that direct physics education, such as the curriculum guidelines and the Basic Learning Rights (DBA), which outline the competencies students should achieve. For instance, the DBAs for natural sciences include complementary biological, chemical, and physical processes. Therefore, these documents should contribute to the planning of science education within each institution, being addressed collectively.

Moreover, when analyzing perspectives outside of the official ones on science education, we find Chevallard (2015), who criticizes educational stagnation, which he terms "visiting monuments." According to this view, "knowledge is presented as a valuable monument in itself, which students are supposed to admire and enjoy, without having a deep understanding of its current or historical foundations" (Chevallard, 2012).

This description aligns with the traditional teaching method, where the teacher is responsible for conveying content and the student merely admires and applies the knowledge without understanding its contextual relevance. In physics, especially in topics like magnetism and electricity, this situation is evident, as they are often treated as mere add-ons or their importance is overlooked, resulting in students finding no genuine interest in this field of knowledge.

LEARNING ABOUT ELECTROMAGNETIC EVENTS IN SECONDARY EDUCATION

Physics encompasses various branches of study that explain natural phenomena and apply them to technological development worldwide. Among these branches are electromagnetic events, which present certain challenges in teaching and learning due to their complexity. As Hernández and Villavicencio point out, "the teaching of electromagnetism in high school presents some problems, mainly due to the level of abstraction of the concepts involved and the mathematical tools required for formal study. This leads to reluctance and rejection among students towards this area of physics, despite its close connection with the technology they use daily" (Hernández Martinez & Villavicencio Torres, 2017).

Abstraction and use of mathematics are often perceived as challenges when addressing these topics, as the calculations can be complex for students. Although magnetism and electricity are present in the electronic devices they use in daily life, students often lack curiosity to explore and understand how they work, especially those in rural areas. This lack of interest underscores the need for teachers to seek innovative teaching strategies that can reignite interest in this type of learning, starting from lower grades.

Electricity and magnetism should be addressed within natural sciences starting from sixth grade, as outlined by the basic learning standards. For this reason, the physical environment guidelines include standards related to these components. For example, the standards for sixth and seventh grades state that students should be able to "verify the action of electrostatic and magnetic forces and explain their relationship with electric charge," "analyze the potential of natural resources in their environment for energy production and indicate their possible uses," and "identify renewable and non-renewable resources and the dangers they face due to human development" (Ministry of National Education, 2002). There are also standards for eighth and ninth grades. However, the difficulty lies in the effective implementation of these standards by teachers, as natural sciences tend to focus on biology, neglecting some guidelines such as the physical environment.

As a result, students reach tenth and eleventh grades without a solid foundation in electricity and magnetism, which means that most topics related to physics, including electromagnetic events, must be covered from scratch. Consequently, it is impossible to meet the requirements set by official and institutional documents due to the lack of time during the school year, as teachers need to revisit topics from earlier grades.

RESEARCH METHODOLOGY

The research was conducted based on a qualitative paradigm, focusing on analyzing and interpreting the learning of electricity and magnetism in the area of physics. Methods such as direct observation, document analysis, and surveys were administered to students and teachers of tenth and eleventh grades at INEDAF during the year 2022. The choice of a qualitative approach is based on its ability to generate descriptive data and detect observable words and behaviors of individuals. As Taylor and Bogdan state, "it refers in its broadest sense to research that produces descriptive data: people's own spoken or written words and observable behavior" (Taylor & Bogdan, 1987).

Consequently, a methodology based on the qualitative approach was developed for both data collection and analysis. This allowed the researcher to obtain the necessary information through the different instruments applied.

Applying a descriptive method within the qualitative approach enabled the researcher to "detail an educational reality, a specific situation, or the actions, feelings, or perceptions of a group of people in a specific context" (Valle Taiman & Manrique Villavicencio, 2022). It was possible to describe the problem of learning electricity and magnetism from the researcher's perspective and to propose a strategy using PBL (Project-Based Learning). As Tamayo and Tamayo note, descriptive research "involves the description, recording, analysis, and interpretation of the current nature and composition or processes of phenomena" (Tamayo & Tamayo, 2008); this aims to analyze and interpret the learning problem of the mentioned topic in a specific case.

The research was carried out in the tenth and eleventh grades of the Agropecuaria La Floresta Educational Institution, located in the La Floresta hamlet of the Sapuyes municipality. The tenth grade had 10 students aged 15 to 17, of whom 6 were girls and 4 were boys, while the eleventh grade had 9 students aged 16 to 18, of whom 7 were boys and 2 were girls. All students from the two grades mentioned come from the rural area of the La Floresta hamlet or neighboring hamlets from nearby municipalities.

Additionally, the biology teachers from sixth to ninth grade, concerning basic secondary education, were considered. This provided an additional perspective to the research and the work on physics in basic education.

For the application of information collection techniques, qualitative open-ended surveys with structured questions were used to obtain more detailed information, where students articulated their responses to each question.

RESULTS ON LEARNING ELECTROMAGNETIC EVENTS

The research results led to the proposal of a didactic strategy that facilitates the learning of topics related to electromagnetic events and their connection to the students' contextual problems.

Institutional Curriculum

Educational institutions in Colombia have the autonomy to create, formulate, adapt, and organize the mandatory subjects, as well as incorporate optional subjects into their curriculum. This principle is based on Law 115 of 1994, specifically in Article 77, which grants institutions the ability to develop a pedagogical model encompassing methods, teaching strategies, learning, and evaluation. Additionally, "The curriculum includes national, regional, and local human, academic, and physical resources to implement policies and carry out the Institutional Educational Project" (MEN, 1994).

As a result, the natural sciences area is only considered during the quantitative evaluation at the end of each academic period. The institutional evaluation is based on the approval of areas according to the national grading scale and is assessed using traditional strategies, with written exams being the most commonly used, along with group or individual workshops, presentations, and oral lessons. From the researcher's perspective, it can be concluded that the school actors have reduced evaluation to a number at the end of the period, recorded in the report card, without including a qualitative or descriptive explanation of the numerical grade in that area or subject. Consequently, physics becomes just a grade at the end of the period, averaged with other subjects like biology and chemistry, for the approval of the natural sciences area.

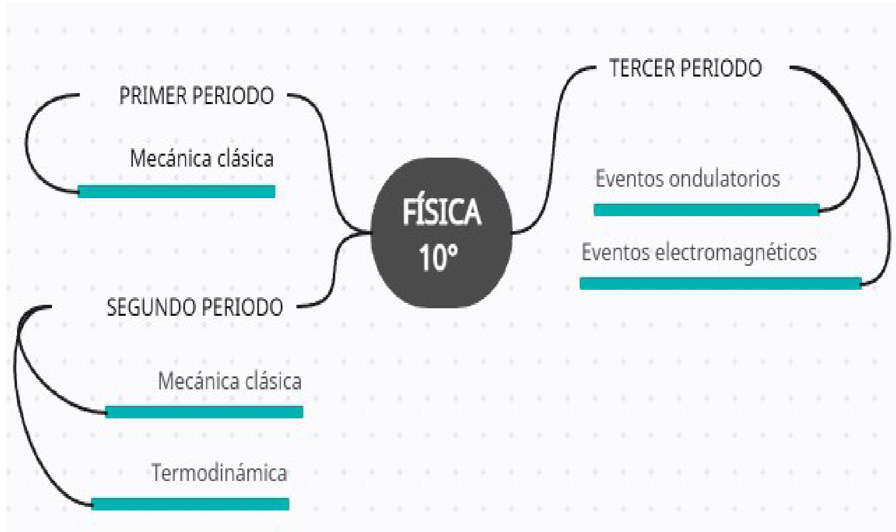
Curricular Planning of Physics

At INEDAF, physics is part of the natural sciences and has been taught since 2023 to ninth grade for 1 hour per week, and to tenth and eleventh grades for 3 hours per week. In practice, it is considered an independent subject both in its planning and in the teaching-learning process. The curriculum was designed based on guiding documents and textbooks from "Los Tres Editores," which include booklets with improvement strategies for the curricular components. These booklets provide guidance to the teacher for planning the curriculum, including learning standards, content, performance, and evaluation strategies, among other aspects. The curricula for ninth, tenth, and eleventh grades for the year 2023 were developed based on the physics booklet and were individually created by the teacher in charge of this subject.

It is important to note that in institutional documents prior to 2021, there was no institutional curriculum for the subject of physics. This means that teachers planned their classes according to their knowledge and personal curricula, which implies a specific problem for the institution, as it lacks a guiding document to work on area projects and fulfill institutional curricular planning.

In the analysis of the physics curricula for INEDAF, five events were identified that comply with the stipulated basic learning standards, distributed with their respective topics over the three academic periods. In 2023, the physics curriculum for ninth grade begins with a leveling of mathematical and theoretical concepts related to physics, such as the history of physics, branches, prominent physicists in each branch, the scientific method, unit conversion, scientific notation, scalar and vector quantities, and vector operations. On the other hand, for tenth and eleventh grades, which have a higher hourly load, content is planned per period related to its corresponding event. For example, in the first period, events related to classical mechanics are covered, which include competency standards and DBA in accordance with the basic content. For more details on the relationship between the academic periods and the events covered in tenth and eleventh grades, see figures 2 and 3 respectively.

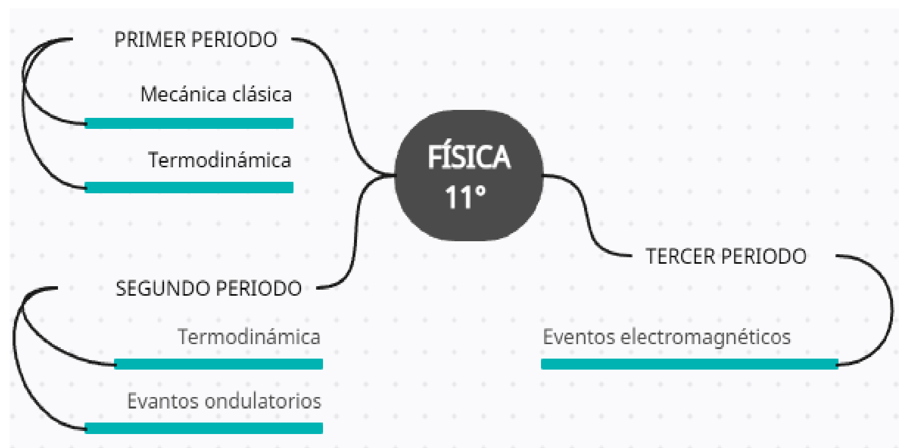
Fig. 2. Distribution of the physics subject for tenth grade.



Source: this research

For tenth grade, the second and third periods cover two events each because the topics are shorter in length.

Fig. 3. Distribution of the physics subject for eleventh grade.



Source: this research

For eleventh grade, the first and second periods cover two events each, leaving the third period for electromagnetic events due to the extensive content

TEACHING AND LEARNING OF ELECTROMAGNETIC EVENTS

As mentioned earlier, the teaching of electromagnetic events is divided into two main components: magnetism, primarily addressed in tenth grade, and electricity, which is complemented in eleventh grade. It is important to analyze the teaching of these topics individually but also consider their constant relationship. Although the topics are presented separately, there is always a bidirectional relationship of concepts.

Magnetism is addressed in tenth grade, along with some concepts related to electricity worked on for most of the third period. However, limited time and lack of previous foundations hinder the achievement of the objectives set in the curriculum. Surveys conducted with eleventh-grade students indicate that they have a basic understanding of magnetism, meaning they lack a complete and detailed knowledge. Therefore, it is necessary to properly address magnetism concepts and provide students with a solid and broad understanding of magnetic phenomena and their applications.

The information provided by surveys conducted with eleventh-grade students about magnetism supports the above. They were asked what they remembered from physics and biology classes related to the topic. 35% of students mentioned the "attraction of one body to another body," while 31% mentioned something related to magnets or magnet attraction; the remaining percentage responded with vague or out-of-context ideas. These responses indicate that many students associate magnetism with the property of attraction, especially towards metals, but they do not obtain a concept in line with the competencies stipulated in the official documents regarding what the student should learn by the end of their high school.

To meet the competencies of knowing, doing, and being, in addition to theoretical concepts, simple practices can be carried out to consolidate learning about magnetism and the magnetic field. These practices include exploring the attraction of magnets to different materials, observing magnetic field lines based on iron filings, experimenting with compasses to understand the Earth's magnetic field, and exploring the interaction between magnets to understand the law of signs. These practices complement and reinforce related concepts, allowing for a more solid understanding.

However, there is a clear lack of practices in all dimensions of this science. When students were asked if they conducted practices or labs related to magnetism and electricity in physics classes, 100% of surveyed students did not remember conducting any type of labs.

On the other hand, the academic program for eleventh grade contemplates the study of electromagnetic events during the third period. However, the allocated time is reduced due to other activities and the end of the school year. It is necessary, then, for students to have a solid foundation in electricity and magnetism, acquired in sixth to ninth grades in the biology subject, to continue the contents and competencies to be developed.

Responses from biology teachers indicate that topics related to electricity and magnetism are not addressed in the subject in basic education. This confirms the lack of teaching in this area. To address the topic, it is important to explore areas such as energy transportation, matter interactions, and their applications in various industries and commercial sectors. This will allow for meeting the standards and providing a broader understanding of electromagnetic events.

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PROPOSAL FOR LEARNING ELECTROMAGNETIC EVENTS WITH PROJECT-BASED LEARNING (PBL)

To promote meaningful learning centered on electromagnetism, it is proposed to use PBL in tenth and eleventh grades. The strategy aims for students to work in teams, actively participate, and apply theoretical concepts through the completion of projects related to electromagnetism.

PBL will allow addressing difficulties in teaching and learning electromagnetic events, linking in turn to the constructivist approach proposed by INEDAF. Students will generate ideas and pose problems related to their environment, providing relevant information obtained from data collection instruments and feedback from teachers. All in accordance with the standards and DBA established in the curriculum.

Thus, through PBL, students will not only acquire theoretical knowledge about electromagnetic events but also develop research skills, problem-solving abilities, and apply physics practically in real situations related to agricultural and livestock topics. The aim is to promote meaningful and relevant learning, where students can perceive the importance of physics in their environment and acquire competencies useful for their future professional performance in the agricultural sector.

For the didactic proposal, the objective is to design practical guides based on PBL, ensuring the learning of electromagnetic events in tenth and eleventh grades, oriented towards solving contextual problems. Therefore, to pose the problems that students will develop in their research, direct observation, teacher responses, and mainly student responses were taken into account. The problem identified for tenth grade is the quality and time in seed germination, specifically in seeds of grasses, vegetables, or vegetables. Therefore, the student will experiment with changes in the variables of time and quality when seeds are exposed to magnetic and electromagnetic fields.

Circuitry is proposed as part of the strategy for electricity in eleventh grade. Students will acquire knowledge about Ohm's law, series and parallel circuits, and Kirchhoff's laws. Additionally, the use of renewable energy sources in electrical circuits can be explored.

To relate the topics to livestock issues in the institutional environment, ideas raised by teachers and students in the collected information will be considered. The issues mentioned by students include the use of solar energy in lighting systems, ventilation of sheds or stables for the production of different animal species. Teachers also emphasize the importance of harnessing natural resources and the advantages of clean and renewable energies, such as solar energy.

In this regard, it is possible to relate electrical circuits to power supply and the configuration of lighting, ventilation, and network systems for the operation of stables or sheds. Students will be able to conduct research and build small-scale models to apply electrical concepts in real situations related to their sector. This will promote meaningful and applied learning, where they can verify and put into practice what they have researched.

PBL is an educational approach that fosters active and meaningful learning through project completion. As Díaz Barriga mentions, "Learning through projects is an eminently experiential learning because one learns by doing and by reflecting on what one does in contexts of situated and authentic practices" (Diaz Barriga, 2006). Therefore, the student with the guidance of the teacher must address some stages to achieve an appropriate final product that generates the necessary knowledge.

As mentioned by the educational organization, course council (2021), PBL is comprised of three necessary stages, "this methodology is organized in a didactic sequence previously planned by the teacher, which involves: i) design and planning of the project, ii) creation and implementation, and iii) public presentation," where both the student and the teacher have specific roles in each of the stages.

For a better organization of the stages and the roles of the teacher and the student, a lesson plan is designed for each grade, which generates a document that describes in an organized and detailed way the activities, objectives, teaching strategies, resources, and evaluation that will be used in a specific teaching session. It is an essential tool for teachers as it provides them with a structured guide to teach a lesson effectively and safely to achieve learning objectives.

For tenth grade, the standard "Establishing a relationship between gravitational and electrostatic fields and between electric and magnetic fields" (Ministry of National Education, 2002) is proposed, which fulfills the specific competence where the knowledge of magnetism and electromagnetism is applied in solving problems in the environment, investigating and experimenting with the effect of magnetic and electromagnetic fields on the germination of locally cultivated grass or vegetable seeds. Additionally, additional competencies such as teamwork, social responsibility, critical and reflective thinking are addressed. The following main contents are involved: Scientific method - Magnetism - Magnetic poles - Magnets - Magnetic field - Electric field - Electromagnets.

While for eleventh grade, the lesson plan describes the standard "Relating voltage and current to the different elements of a complex electrical circuit and to the entire system" (Ministry of National Education, 2002) where the specific competence is proposed: Designing electrical circuit diagrams in series and parallel configurations with the help of Ohm's law and Kirchhoff's laws for lighting and ventilation systems in a barn, in addition to the complementary competencies described earlier and the involved contents include: Electrical energy - Electrical concepts (voltage, current, resistance) - Ohm's law - Series and parallel circuits - Kirchhoff's laws.

Based on this foundation, didactic guides are designed for both the teacher and the student to successfully carry out the learning and research under their responsibility, aiming for a final product that must be presented to the educational community stipulated jointly by the teacher and student, through presentations, articles, reports, models, among other necessary elements.

For the evaluation of the strategy, an evaluation rubric for the teacher is designed, which must be used in each of the established stages and sub-stages, where the different competencies are stipulated, related to the step developed in the research, and the knowledge according to the qualitative national assessment scale.

Conclusion

The difficulties in learning physics in secondary education are diverse, especially in rural contexts. These challenges include the lack of adequate didactics, the lack of contextualization of knowledge, and failures in curriculum planning. To address these issues, it is necessary to incorporate curriculum planning with pedagogical and didactic strategies that involve practical aspects, where research and active participation of students are concrete. This will allow them to build meaningful learning, relate physical concepts to their environment, and foster a genuine interest in science.

Project-Based Learning is based on the idea of learning by doing and is grounded in the importance of experience and active participation of the student, aiming for the student to become the center of the educational process while the teacher assumes the role of a mediator. PBL enables students to develop cognitive, social, and emotional skills, achieving meaningful and lasting learning through contextualized projects. These methodologies generate benefits at the academic, social, and personal levels.

The analysis of the institutional curriculum reveals potentials and difficulties in meeting legal requirements. The main problem identified is the lack of a guideline document for the natural sciences area, which complicates curriculum planning, integration, and cross-curricularization. Also, a quantitative evaluation based on exams and traditional tasks is observed, which does not allow for a qualitative and descriptive evaluation of learning in the physics subject. Despite this, five physics events are identified in the curriculum meshes that comply with the basic learning standards, distributed over the three academic periods. Additionally, concept leveling is included in the ninth grade. This, undoubtedly, can be leveraged.

Teaching electromagnetic events presents challenges in terms of understanding and limited time. Therefore, it is necessary to properly address the concepts of magnetism and electricity, offering students a solid and comprehensive understanding through the development of the three types of knowledge. Furthermore, it is necessary to include practices and experiments to reinforce learning and ensure a meaningful understanding of these contents. The use of Project-Based Learning enables significant learning; applied to electromagnetism, it promotes student participation and the application of theoretical concepts in projects related to the topic. This strategy aims to foster research and problem-solving skills and relate concepts to agricultural and livestock-related issues in the environment. Therefore, PBL offers a dynamic and relevant way of learning, developing useful competencies for the future of students.

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