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Impact of Active Strategies on the Teaching-Learning Process: Case Study

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Abstract--- *The implementation of an active learning strategy supported by simulation for learning is considered a fundamental task within the educational task. In this sense, this research has the purpose of determining the impact of virtual simulators on the teaching-learning process. For this purpose, a quantitative approach was given, using a quasi-experimental methodological design, where with a first group (Control), a demonstration class was carried out without the help of virtual simulators. With a second group (Experimental), a demonstration class was held using these types of tools. The results showed that, at the level of the participating high school students, the use of virtual simulators motivates them and facilitates learning. On the contrary, the development of the traditional class demotivated and did not generate interest in the participating students. At the level of conclusions, the use of virtual simulators has a positive impact on learning; it is proven that virtual simulators provide practically useful content in the educational field.*

Keywords--- *active strategies, impact, teaching-learning process.*

Introduction

Active strategies in the teaching-learning process are the part of education that is responsible for the construction of knowledge based on the rigor of the methodology used, at the same time that it also occurs in the area of people's daily life where there are various ways of observing the world, understanding and assimilating knowledge, where each of them requires active participation.

The importance of epistemology in education lies in the fact that it seeks to observe scientific knowledge from the point of view of the daily life of human beings and their own perspective. Based on the above, this exercise aims to relate epistemology to the way the teacher teaches and lays the foundations to achieve meaningful learning in the different fields of knowledge.

By way of illustration, it is indicated that it is important to promote training and teacher support spaces for the training and development of skills in teachers, not only in methodologies, but in active teaching techniques that enable the integration of training processes, where the integration of technology into the educational process continues to be a challenge. Consequently, teachers must facilitate learning by incorporating dynamics where the student interacts and experiments (Pereira-Santos et al., 2019).

In this sense, the importance of active techniques in the teaching-learning process is evident. In this regard, Imbert (2022) points out that the student acquires his knowledge from his daily praxis in an operational manner but has weaknesses in the visualization and formulation of the problem and, therefore, in problem solving (p. 1312). In this regard, Cristancho & Suarez (2021) identify that active strategies are part of the methodological changes required by new educational systems, through which the transfer of knowledge is carried out in a dynamic way. In a study carried out by Najib et al. (2022), it is indicated that through virtual simulation, students are helped to learn physics through simulated learning. It is determined that students can improve the level of learning of physics, compared to students who study the same subject conventionally. (p. 73).

On the other hand, to understand the dynamics of active techniques in the teaching-learning process, it is essential to identify the different learning styles of each student to determine their potential and individualities. From a more general perspective, there are as many ways to learn as there are students in the classroom. This is meant to mean that contrary to the obsolescence of traditional methodologies, active strategies in the teaching-learning process motivate the student to develop meaningful learning.

It should be considered, on the other hand, that it is essential to build spaces where the use of active strategies in the teaching-learning process is motivated, not only at the level of methodologies, but through access and use of simulation environments through which meaningful learning is enabled, where the integration of this type of environments based on active teaching has a significant impact. Therefore, teachers must develop pedagogical updating processes aimed at facilitating learning by incorporating methodologies where the student interacts with simulation applications (Nithyanandam, 2020).

In this context, the research problem is formulated: How do active strategies impact the teaching-learning process? At the same time, the objective of the research was to determine the impact that active strategies have on the teaching-learning process in third-year BGU students at the Raymundo Aveiga Educational Unit in the city of Chone. On the other hand, the hypotheses to be tested in the research were: H_a = There are significant differences between the control and experimental groups regarding the impact that the PhET simulator has on teaching the electric field and T_o = There are no significant differences between the control and experimental groups regarding the impact that the PhET simulator has on teaching the electric field.

The research adopted a quantitative and qualitative approach. On the other hand, the methodologies used were related to the bibliographic, inductive, deductive, and descriptive methods. The types of research used during the investigation were correlational and experimental. The collection of information was carried out through pre- and post-knowledge tests on the students (control and experimental group).

Materials and Methods

The research adopted a quantitative and qualitative approach. On the other hand, the methodologies used were related to the bibliographic, inductive, deductive, and descriptive methods. The types of research used during the investigation were correlational and experimental. The collection of information was carried out through pre- and post-knowledge tests on the students (control and experimental group).

For this purpose, initially, at the "Raymundo Aveiga" Educational Unit in the city of Chone, province of Manabí, a demonstration class was held for the control group, using only theoretical information, and where the teaching material was graphics. In a second moment, a demonstration class was held for the experimental group, using the PhET virtual simulator.

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Analysis and Discussion of the Results

Active strategies in the teaching-learning process

During this process, a process of practice and experimentation of Physics is proposed with the help of innovative resources, supported by virtual simulators given the importance of these laboratory practices which provide students with the possibility of learning from their own experiences; This can and should be used to stimulate curiosity, the pleasure of investigation and discovery, as well as the possibility of exploring, manipulating, making mistakes and recognizing them.

The key to success in teaching does not lie merely in the development of resources, materials, or didactic prototypes, but also influences the active teaching strategy used for the pedagogical intervention. In this sense, before going to the classroom, it is necessary to reflect on the way the content is oriented based on the needs, difficulties, knowledge, abilities, and skills of the students (Duarte et al., 2022).

It is essential to reorient educational praxis, to adjust it to the premise that currently one of the most appropriate ways of teaching is based on the use of simulation programs that contribute to simulating and graphing the different theories, statements, and contents proposed in the curricular framework. At the same time, the teacher must try to determine what the students' prior knowledge is and, based on this information, plan the activities and exercises specific to a subject or area of knowledge (López-Torres et al., 2020).

The integrative teaching task can be used, if we talk about basic education, in conferences as a source of motivation, scientific culture and dissemination of science, in practical classes and laboratories as the development of intellectual and experimental skills, and seminars as the development of investigative skills (Estévez et al., 2020). The epistemological requirements of education in the current region call for teachers to develop research processes based on interdisciplinary aspects, but they also propose the exercise of active techniques based on specialized teacher training in any area of knowledge.

Compared to a traditional class, the proposed approach presents a clear advantage by using technological resources as laboratory tools, which allows experimentation with various studied phenomena. It is essential, therefore, to redesign the lesson plan to incorporate these technological tools, which will facilitate the transmission and acquisition of knowledge. In this way, it will be possible to take advantage of students' interest in technology and the virtual environments in which they operate (Lino et al., 2023).

Learning science involves a qualitatively different way from the everyday way of learning as it requires explicit learning, closer to a perspectivist conception of knowledge, and an interpretation of the world guided by system ontological principles, epistemological principles closer to constructivism and conceptual principles that attend to the complexity of interactions and overcome the data-centered attachment, typical of naive realism (Bravo et al., 2022).

The teaching-learning process inherent to science in all its aspects presents insufficiencies related to the learning of the contents and their application in solving their own problems, as well as at the level of technology and the student environment in general. This causes a contradiction with the current demands that society demands of education in general in the context of improvement (García et al., 2024).

Technology and disruptive innovation are based on the growing popularity of collaborative tools, in which there are preparations that lead to innovation, deploying new learning strategies to stimulate the capacity of students, allowing them to improve their academic training. Therefore, inserting technology as a strategic means allows improving interaction with the student in synchronous classes, generating debates and participating critically in solving problems, awakening their motivation to investigate, and read (Zambrano & Meza, 2022).

Active strategies in the teaching-learning process

In recent decades, active teaching techniques have provided new opportunities to improve the educational process through simulation strategies. Online simulators have emerged as an effective educational tool that allows students to explore and understand abstract physics concepts more dynamically and interactively. Through interaction, the student better visualizes knowledge and, therefore, understands it (Guamán et al., 2023).

Active teaching techniques such as simulation promote the development of scientific competencies, skills for the design and construction of educational models that assertively influence the teaching and learning process of science, promoting the creativity and motivation of students; Likewise, it is a didactic space for the development of innovative strategies that encourage the discovery and use of accessible resources for this purpose of scientific knowledge (Farfán et al., 2023).

The benefits attributed to active techniques in teaching different fields of knowledge have led to the intersection of teaching-learning modalities and methods that seek to enhance the strengths of said technology applied in education. One of these approaches interweaves augmented reality with mobile learning and simulation-based learning activities (Acedo et al., 2022).

The problem of student learning arises when there is a difficulty for the teacher in how to transmit their knowledge; Being a factual science, it is not alien to the problem described in this research work, where experimental demonstrations are fundamental in the teaching-learning process (Nogales et al., 2020).

Laboratory practices are commonly carried out in person, however, this idea has been changing with the emergence of ICT, allowing us to overcome the limitation of physical space, in addition to helping to make up for the lack of laboratory instruments that some institutions have. The virtual laboratory is a technological tool that allows the simulation of laboratory experiments. to do so, it uses programmed algorithms that allow the replication of laws or principles present in real life (Lucero et al., 2020).

The difficulty in learning science is attributed to factors such as the lack of specialized laboratories and experts in these subjects in educational institutions. Although some centers have high-quality laboratories, there are essential experiments that cannot be carried out due to the lack of tools and equipment necessary to address topics such as two-dimensional and three-dimensional vectors, displacement of objects, and charge radiation, among others (Yaipen, 2023).

According to Yunzal & Casinillo (2020), the result of the research shows that the use of the PhET simulator has revealed a slight improvement in the students' learning of Physics. In other words, conducting this research revealed that PhET simulation can slightly improve students' academic performance in Physics (p. 224). On the other hand, Vergara-Bravo et al. (2024) maintains that active teaching techniques maintain a balance in the educational process because they improve the concretion of knowledge; on the other hand, communicative skills are fundamental for the development of the human being in all its contexts, managing verbal and non-verbal aspects in specific situations (p. 139).

Simulators are a tool used as an active teaching method in various areas; However, in education, it is not really known how much these processes optimize and impact the learning of educational content. The above leads to the question: to what extent do simulators allow theoretical knowledge to be put into practice in the teaching-learning process? More specifically, what level of practice of theoretical knowledge do simulators promote? And which simulators contribute to meaningful learning in students? (Garizurieta, 2018).

The relationship between epistemology and teacher training requires the incorporation of new methodologies and the updating of didactic tools in order to optimize the processes of knowledge generation in the teaching activity. At the same time, propose processes of continuous improvement of teacher training to help their development as individuals and as professionals. Historically, teacher training has been characterized by being traditional and theoretical. From our reality, teaching practice should be considered as an active and participatory activity where the incorporation of technological aspects is combined (Haenen, 2001).

Population and sample


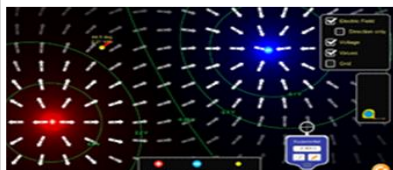
The population was made up of teachers and students from the “Raymundo Aveiga” Educational Unit. On the other hand, the sample was made up of two groups of 20 third-year BGU students, each (control and experimental groups).

Characterization

The purpose of this exercise (Table 1) was to determine the impact of active strategies on the teaching-learning process. Verify that virtual simulators motivate the active participation of students in the classroom. For this, an exercise was planned through which the PhET simulator was used to explain the fundamentals of the electric field. The purpose of the exercise was to generate information that made it possible to demonstrate the impact that the use of virtual environments for learning about the electric field had on the students (Cedeño-Rivadeneira & Mendoza-Loor, 2024).


The incorporation of active strategies based on the use of virtual environments in the field of the teaching-learning process represents a qualitative leap since it introduces new didactic elements as tools for a better understanding of the different statements that are part of the different subjects. However, the implementation of these environments reveals various problems of all kinds. Firstly, there is the logistical part, since not all educational institutions have the possibility and resources to install computing centers; Secondly, there is the training of teachers in aspects related to the use of computer applications, and finally, not all students have a computer with Internet at home. Table 1 shows the characterization of exercise 1, and Table 2 shows the characterization of exercise 2.

Table 1
Characterization of exercise no. 1

 	<p><i>Relationship between electric field and distance</i></p> <p>This was the simulation topic presented to high school students. The foundations of the relationship that exists between the electric field and distance are theoretically explained.</p> <p>Through the PhET simulation, the student was able to demonstrate what happened when the measuring instrument was placed in different positions of the electric field, showing different readings depending on the distance from the point charge.</p> <p>Learning objectives</p> <p>Identify the elements that make up an electric field.</p> <p>Measure the voltage of the electric field as a function of the distance from the point charge.</p>
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Source: Exercises for control and experimental groups

Table 2
Characterization of exercise no. 2

	<p><i>Physics class description in the classroom</i></p> <p>Explain that the presence of an electric field around a point charge allows us to understand the action of force at a distance, the action at a distance between charges through the conceptualization of the electric field and the visualization of the effects of field lines, and determine the force experienced by a charge within an electric field, by solving exercises and application problems.</p> <p>Goals</p> <p>Develop active learning strategies that develop the ability to interpret the study of the electric field, for the solution of proposed activities.</p>
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Source: Exercises for control and experimental groups

The purpose of this exercise (Table 2) was to theoretically explain the fundamentals of the electric field, using as teaching material the illustrations from the 2nd year of Baccalaureate text delivered by the Ministry of Education, where the student can only demonstrate the different elements with which an electric field can be generated through illustrations. That is, they only limited themselves to observing them and listening to the teacher's explanation. At the same time, the resolution of an exercise on the calculation of the electric field intensity was proposed.

Analysis of differences (Control vs. experimental)

During the teaching-learning process of Physics, difficulties arise such as: rote learning of formulas and a lack of graphic visualization of the statement, and student demotivation. By way of explanation, Physics is one of the subjects that students have the greatest problem with when learning. In this context, it is considered that it is difficult to teach about a topic in which the student does not have a graphic context, or at least an experimental one, where the dynamics of the physical phenomena studied are evident. According to [Laffita & Rodríguez \(2017\)](#), during the teaching-learning process of Physics, a student is observed who tends to learn in a reproductive way, limiting

their possibilities for critical and self-critical reflection of the contents they learn (p. 250). Figure 1 shows the results obtained from the experimental group, and in 2 shows those obtained from the control group.

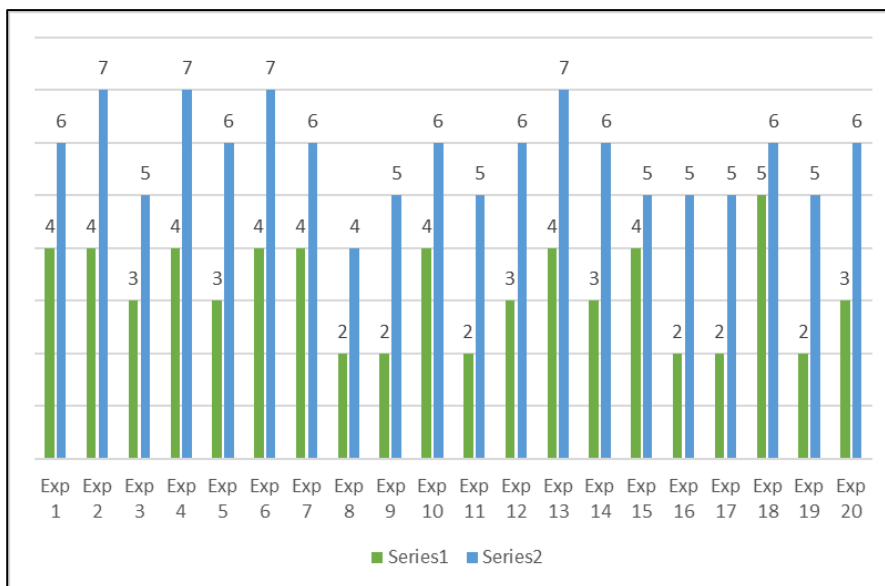


Figure 1. Results obtained from the experimental group
Source: Information obtained from students BGU third year

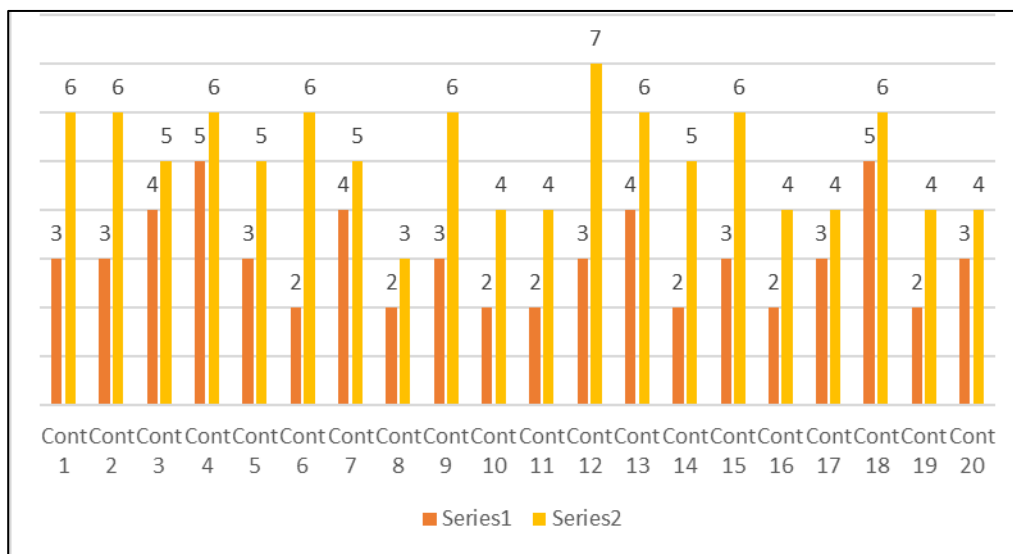


Figure 2. Results obtained from the control group
Source: Information obtained from students BGU third year

When analyzing the results obtained with the implementation of a pre and post-test regarding the impact of active strategies in the teaching-learning process of Physics, and more specifically in the calculation of the electric field through the use of the PhET simulator in third-year high school students of the Raymundo Aveiga Educational Unit (control and experimental groups). The data obtained show that at the level of the pre-test implemented, the mean of the control group obtained a value of 3.00, while the mean of the experimental group obtained a value of 2.95. On the other hand, the data obtained show that, at the level of the post-test implemented, the mean of the control group obtained a value of 4.75, while the mean of the experimental group obtained a value of 5.75, meaning that there is a significant difference. Table 3 shows the analysis of post-test evaluations

Table 3
Analysis of Post-Test Evaluations

		Group statistics			
	Groups	N	Media	Standard deviation	Media del error standard
Post-test evaluations	Control	20	4.75	1.0440	0.233
	Experimental	20	5.75	0.8291	0.186

Source: Knowledge test, control, and experimental groups

When analyzing the differences obtained with the implementation of a post-test regarding the impact of active strategies in the teaching-learning process of Physics in third-year high school students. The control group obtained a mean of 4.75, showing a standard deviation of 1.0440 and a mean standard error of 0.233. While the experimental group obtained a mean of 5.75, it yielded a standard deviation of 0.8291 and a mean standard error of 0.186.

The most palpable difficulties that the Ecuadorian educational model presents is the low level of meaningful learning obtained by a significant segment of students. Unfortunately, some students were not able to consolidate their basic knowledge of Physics due to the lack of implementation of dynamic and motivating methodologies. In this sense, the research focused on investigating the impact of the PhET simulator on the teaching and learning of the electric field. For this purpose, two moments were proposed. The first corresponded to the development of an educational activity using the school text for teaching the electric field. The second moment corresponded to demonstrating the impact that the implementation of the PhET simulator had on the teaching and learning of the electric field.

In this context, a fundamental contradiction is determined in the sense that at the level of the educational institution where the research was carried out, there are two computer laboratories, however, the authorities do not allow their use. At the level of government provisions, the regulations determine that teaching tools must be used to improve the teaching-learning process in all areas of knowledge. Where the Organic Law of Intercultural Education, [LOEI \(2023\)](#) clearly states, in its Art. 10.- Curricular flexibility. A. Curricular adaptations: When the national curriculum is complemented or adapted to the educational needs of the student body. It involves designing, applying, and evaluating tools that allow individuality to be assumed in the teaching-learning process, in order to guarantee inclusion, permanence, learning, promotion, and completion within the educational system.

It is clear that, when identifying the impact of active strategies in the teaching-learning process, it is necessary to refer to terms such as the systematic planning of all the components that make up an educational proposal, which constitutes a tool through which the assessment of the proposed educational objectives is possible. Consequently, said planning must become an articulating element between the different elements that make it up, in the same way the training scope is delimited, which will allow the student to deploy their skills and competencies based on the requirements and demands that society imposes on them.

The opposite would mean that the methodological strategies adopted in the educational proposal fall into obsolescence and hinder the transfer of information to students, much more so when it comes to information that requires active didactic elements to ensure that students achieve meaningful learning. In this regard, [Noro \(2019\)](#), indicates that obsolescence is wear and tear, the loss of effectiveness, where the passage of time and the lack of implementation cause a progressive deterioration of educational methodologies (p. 3).

The role of the governing body of education in guiding school activities is related to the interest in acting in terms of configuring the educational praxis linked to the proposal of each of the educational institutions. Therefore, the question arises as to what and how to organize various processes and resources inherent to the educational proposal, in such a way that it produces expected results. In this sense, active teaching strategies have a fundamental role which is to articulate and optimize the training process in any area of knowledge.

Based on what was stated, in the first scenario it was evident that a majority segment of the participating students did not manage to pass the knowledge test (Control group). At the same time, it was demonstrated that traditional methodological strategies generate a negative impact on the teaching and learning of the electric field. The reasons are several, firstly, it is an eminently technical topic, therefore, the student has no possibility of recording readings on the electric field, nor can he visualize the behavior of the other components in real time, since the theoretical approach is based on carrying out exercises from the school text and the explanation on the blackboard.

The results obtained in the second scenario corresponded to the impact of the PhET simulator on the teaching and learning of the electric field (Experimental group). It should be noted that the topic of study constitutes one of the fundamental aspects of learning Physics, therefore, its complete understanding is of great help for most students. By

way of illustration, an activity was designed through which active techniques were introduced; for the present case, the PhET simulator in order to explain the fundamentals of the electric field.

The results obtained showed that, indeed, a total change was observed in the attitude of the students, where this type of simulator facilitated the learning of the electric field and its principles, and theoretical/practical foundations were clearly understood. In a similar study, Ben Ouahi et al. (2021) concluded that the simulation exercises positively impacted the performance of the students in the experimental group and improved their understanding and skills, allowing them to overcome certain difficulties in learning Physics (p. 9).

On the other hand, the hypothesis to be tested in the research was: H_a = There are significant differences between the control and experimental groups regarding the impact that the PhET simulator has on the teaching of the electric field, for which the results obtained made it possible to show that, through the implementation of the PhET simulator, the third-year high school students of the Raymundo Aveiga Educational Unit were able to actively participate and measure in real time the different magnitudes that make up an electric field, fulfilling the statement of the proposed hypothesis.

Conclusions

The impact of active strategies on the teaching-learning process was theoretically based; mention was made of the research variables, which were addressed and developed bibliographically in a systematic way. Based on the above, information related to theories, concepts, conclusions, and points of view that were part of other investigations was obtained. It should be noted that the study of active strategies in the teaching-learning process at the level of the local educational system has a transcendental contribution through which the student must develop an adequate level of their competencies, and where the contribution of active techniques is fundamental for learning.

The use of active techniques such as virtual simulators has a positive impact on the learning of the electric field; it is proven that virtual simulators provide practically useful content in the educational field. At the same time, virtual learning simulators constitute a motivating aspect for students in the teaching-learning process of the electric field. However, the factors that hinder the development of meaningful learning about the electric field are diverse, among which it is evident that the teaching materials used by teachers are obsolete, which means that students do not understand the explanations, but they also become demotivated.

A fundamental contradiction is evident between the need that both teachers and third-year high school students of the Raymundo Aveiga Educational Unit have regarding the use of computer laboratories and the refusal of the authorities to authorize their use, which is contrary to current educational regulations.

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