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Physics teaching II: electricity and magnetism from experimental practice with concrete material and virtual applications

María Andrea Botero Grisale[1], Diego Fernando Galviz Cataño[2], Juan Carlos Cardona Acosta[3], Oswaldo Alonso Álvarez Galvis[4], Juan Fernando Correa Wachter[5], Yamil Alberto Mosquera Córdoba[6]
[1]*Engineering Faculty, CorporaciónUniversitaria Americana, Colombia*
[2,3,4,5,6]*Economic Faculty, CorporaciónUniversitaria Americana, Colombia*
Corresponding Author; María Andrea Botero Grisale

Abstract : *The university student of CorporaciónUniversitaria Americana university institution. Manifests, through written tests and the heuristic method used in class, the flaws for the understanding of the concept of distance force and its effects. They are faced with the old Aristotelian problem: How is it possible for two objects to exert forces, with no contact between them? What can be the mechanism for this to happen? What interaction are you talking about? This has caused a setback in learning or a forced and empty advance, evidenced in low grades, demotivation, apathy, poor inclusion in their learning, personal frustration, very low participation and dropout.*
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I. INTRODUCTION

Teaching physics brings with it the anchor of conducting experimental practice. Experimentation brings the student closer to understanding the phenomenon. Regardless of the debate about whether it is first experienced and then conceptualized or the opposite way, experimentation cannot be exempt from teaching any physics course. Teaching physics without experimentation is an empty practice, since it is not presented coherently integrated with scientific procedures

In the case of the Physics II course of the CorporaciónUniversitaria Americana, whose contents deal with electrostatics, electric and magnetic field, it was evident after several semesters, the difficulty faced by students for the apprehension of the concepts. Especially, because the physics course is presented through complex and abstract models[1]. How to show an electron to explain electric charge?, How to show the electric field that explains the remote interaction of charges ?. Theoretical models are not enough and to achieve this it is necessary to use digital applications and manipulable concrete material for students that lead them to connect theory with reality.

The work presents the implementation of the proposal for the teaching of Physics II through virtual applications and use of concrete material which is intended for the easy acquisition of the student and low cost. The proposal is based on the pedagogical model of the university of meaningful learning, collaborative learning and self-regulated processes.

II. RESEARCH PROBLEM

The teaching of the Physics II course in any institution of higher education implies that much of its content is taught from its effects, that is, what we see: a lit lamp, the electrical circuit of a house, the attraction and repulsion of objects, magnetic interactions (magnets). The issue is not simple, because understanding the effects of charge interactions requires that we also understand, where it comes from and how these particles behave at the microscopic level.

It is precisely this abstract naturality of the electricity and magnetismphenomena, compared to those of mechanics, which translates into difficulties of understanding and frustration in many students[2]. Additionally, the almost absence of laboratory experiences and the general extension of the syllabus, makes it one of the subjects with the highest degree of academic failure[3]. Many times the teacher is more interested in teaching the mathematical nature of the course than in offering strategies for students to elaborate scientific explanations[4], situation that is achieved leveraged in experimentation.

The reflection focuses on the search for experimentation activities of an attractive and manipulable character by the students, in such a way that the gap between the abstract and the experiential for the course is achieved and learning results are obtained in the students.

III. METHODOLOGY

The proposed methodology for the intervention was carried out based on three phases that seek to improve the teaching of the physics course II and, consequently, the results in student learning. Potentially meaningful material is used for students including the virtual resource.

Phase 1: Know the previous structure of the student on the concept of strength. Use of the heuristic method to identify your previous ideas, arguments, successes and conceptual errors. A test is applied where everyday situations are investigated and the application and argumentation of the electrostatic force and electric field concept is necessary, as a fundamental structure for the course of electricity and magnetism. The test is applied after class discussions and explanation of some electrostatic concepts.

Phase 2: Application of laboratory practices with concrete material and digital applications, in the development of activities such as: Electrostatic field and electrical potential, magnetic field and magnetic materials, electrical current and circuits. Students answer questions in the context of the practices where they explain the observed phenomena. Weeks after practice the test is repeated.

Phase 3: Evaluation and reflection of effectiveness indicators.

Information collection instruments.

•Test of 18 multiple-choice questions that involve conceptual, argumentative and procedural questions. Peer validated from the department of basic sciences of the American University Corporation.

• Experimental activity guides with concrete material, developed collaboratively by the students of the course.

• Experimental activity guide with virtual applications, developed individually (self-regulated) and in study teams.

IV. RESULTS ANALYSIS

From the non-dropout of the students or the non-repetition of the course, the impact of the proposal is analyzed. This allows to determine the influence of experimentation with virtual applications and concrete material in student learning.

Analysis of test results after theoretical explanation and without experimentation

The test consists of an 18-question questionnaire designed to assess the argumentative, procedural and conceptual capacity acquired by the student after explanations from the theoretical and mathematical. The test begins with questions in the context of electrostatic force and behavior of the charges, then inquires about the concept of electric field and electric potential. It is chosen not to include magnetic field questions due to the progress of the course.

Analysis of practical laboratory results with concrete and virtual material

Three experimental practices were designed (see Annex 1): Electrostatic field practice and electrical potential: The purpose is for students to take measurements of current and potential difference. For this they must have a voltage source (12 or 9 V battery), resistors, protoboard, multimeter, connection cables, wave generator. This practice is first developed in the free virtual Proteus or Multisim simulator. Previously the students were explained the handling of both platforms in terms of their generalities. After simulating the assembly virtually, they take it to reality with the materials and check the virtual results and those given by the reading of the multimeter in physics. Each experimental practice has procedural and argumentative questions, where they must validate the concepts of the topics worked. The virtual experimental practice and with concrete material is developed in groups.

Magnetic field practice and magnetic materials: With this practice students will demonstrate and recognize the influence of a magnetic field in the flow of electric current by induction and can also manipulate magnetic materials and create electromagnets. For this, they must have elements that are easily accessible such as: iron filing, boxed wire, voltage source (battery), copper wire, power resistance, compass, galvanized screw. In this practice the students make descriptions from the observed according to the variations proposed in the experimental guides and others that they themselves propose. This time there are no simulated experiences, everything is manipulated. They contrast the information obtained in the experimental results with the theoretical information of the course contents.

Electrical current and circuit practice: Access to physical resources to perform electrostatic and magnetism practices is sometimes not easy due to the cost of equipment. There are even behaviors from the physical phenomenon itself, which are not easy to observe. However, virtual practice with simulators, favors in the treatment of basic concepts, observing, investigating, carrying out activities, as well as supporting the student in the elaboration and exchange (exchange of knowledge) of results[5] and It contributes to guide the student in the construction of his knowledge through observation […]. This seeks to keep the student in a learning cycle[2]. Thus, a practice of electrical current and circuits was designed from the virtual Multisim simulator. Students must justify the procedures of each situation manually. The simulator favors a contrast of its manual results with the simulated in the application.

In the evaluation of experimental practices, the procedural part and the argumentative part have equal evaluative weight. In both, the concepts that students should handle about the course are evidenced.One week after concluding the experimental activities raised, the 18-question test is applied again. Without variation in it, the results were more encouraging. On this occasion 22 students pass the test, this means 88% of the course. This shows that the experimental activity privileged student learning and not only that. Until the second test application, no student had dropped out. A reading is made here of the importance of including the student in real situations that help to diminish the level of abstraction of the Physical course II that makes it tedious for the majority.

Both in the test and in the experimental practices, the students show argumentative, procedural and conceptual mastery in the electric field, electric potential, electric current and circuits. This strategy highlights the importance of contextualizing experimental situations, which are presented to the student as a way to motivate the study and, in addition, enables training in terms of skills or competencies to solve problems specific to the context[4].They must be based on the proposed methodology. In addition, they must be clear and articulated so that they show the evolution of the subject. It is advisable to reflect aspects such as: authors in the field, journals, growth of the field of knowledge, major research centers in the world, countries where research on the subject has more boom, knowledge networks around the subject, dissemination mechanisms knowledge of the subject, among other aspects that they consider relevant.

Additionally, it is suggested that from the revision of the trends the subtropics, applications and methodologies that are being investigated or applied in the specific subject of study are shown. Which, in turn, will allow us to establish foundations so that research projects, monographs, integrating projects, seedbeds, among others, can be properly supported and have a place in the Faculty.

V. CONCLUSION

Although the material of the university laboratory is limited, in the experimental guides it is proposed to practice with easily acquired material for the students. This allows to resort to resources that are not sophisticated and that show the effects of the phenomenon. A second objective is achieved here, because it is shown that an experimental practice emerges from the shirt of rigor shown in the books and allows physics to be experienced with common and close matters.

The efficiency of the results of the experimental practice is not only a matter of the physical course II. In other research studies in the context of the teaching of science, it is shown that the difficulties in a student's learning are markedly reduced as there is experimentation in the classroom. Therefore, experimental activity requires not only the provision of elements that lead to its execution, but also the preparation of the teacher in both theoretical and experimental concepts.

Virtual practices were presented to students as the opportunity to check the theoretical basis of electrical circuits. The willingness to freely manipulate the variables involved in the physical phenomenon, helped students explain the behavior of a flow of charges that, from the theoretical point of view, is absolutely abstract that is not visible to the human eye.

The evaluation of the intervention results was an ongoing process. The response of the students was evaluated from the attitudinal, procedural, argumentative, responsible part in the development of virtual practices and with concrete material.

Experimental practices favor the student's autonomous and self-regulated learning process, the development of scientific attitudes and higher thinking processes, which remain in evidence at the time of proceeding in the experimentation and argumentation of the results.

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