Using virtual assistant for learning selected topics of Physics

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Abstract - **With the increase in the use of mobile applications and advances in artificial intelligence, the use of emerging technologies such as chatbots has increased. Given its characteristics, this type of applications is beginning to be used in the educational area, so there is a need to measure its impact and ensure its effectiveness in the learning process. This study implements the use of a chatbot to increase the conceptual understanding of Newton's laws, integrating it into a didactic sequence in conjunction with active learning activities. For the analysis of the data, an exploratory study with a pre-experimental design was carried out on several university physics groups, with a total of 122 participants. Hake's g was calculated to know the gain in the students' conceptual understanding. The results of this study demonstrate that although there is an increase in students' conceptual understanding, the design of the didactic sequence needs to be improved to increase the percentages obtained. Likewise, it is necessary to develop instruments that allow direct measurement of the impact of the use of chatbot on student learning and the selection of a control group to compare the results of students who completed the didactic sequence, with those that take a traditional physics class.**

Index Terms – Chatbot, Educational Innovation, Higher Education, STEM.

INTRODUCTION

I. Physics Education

Due to the development of technology, physics has changed both substantially and in its methodologies for learning [1]. The use of emerging technologies in education has been based on theories where the student is placed at the center of his knowledge, which causes him to take a fully active role. In the teaching of physics, many of the courses continue to make traditional methodologies, where the teacher occupies the central part, causing the full potential that technology can offer [2]. For this reason, it is crucial to design didactic strategies that integrate the use of emerging technologies with student-centered activities.

II. Chatbots and professor Atom

The ubiquity of mobile devices has modified how people interact with their peers, content, and their surroundings [3]. Most students use mobile technologies to study in spaces other than common areas [4]. Thanks to the development of artificial intelligence, the use of applications such as virtual assistants and chatbots is increasing [5] - [7]. These are computer programs that use artificial intelligence to hold a conversation [8] through natural language [9], focusing on solving specific tasks.

Within education, these technologies have been used in various contexts. There are examples of research where conversational agents with different uses are implemented [10] - [17], ranging from support to the teacher in the evaluation, to as a tool to develop various skills in the student.

Within the Tecnologico de Monterrey, a chatbot called Professor Atom was designed, which uses artificial intelligence to communicate through Google Assistant. In it, you can consult more than 140 concepts of physics, where the user can request the definition, a video explanation, an example, and its formula. It is an open environment and can be accessed by mentioning "Talk to Professor Atom" within the Google Assistant application.

METHODOLOGY

The research objective is to know the change in the level of conceptual understanding of Newton's laws that students of university physics developed by having carried out a didactic sequence where the use of a chatbot with active learning activities is integrated. For the latter, the Tutorial in Introductory Physics (TIP) of Newton's forces and laws were used and used as a reference [18]. By integrating both, the instructional design of the tutorial and the ubiquity of emerging technology are used, putting the student at the center of their learning.

With these premises in mind, an exploratory study was carried out with a pre-experimental design due to the degree of control of the external variables [19]. There were a total of 122 participants from different engineering careers, where 31% were in a traditional model and 69% in a competency-based and student-centered model. It started with an activity with the chatbot and in person with the objective of:

- Publicize the characteristics of the chatbot and the resources necessary for its use. This action avoids false expectations regarding its use.
- Give instructions on how to use it to improve the experience and thus be support for student learning.

The steps of the didactic sequence designed are shown in Figure 1.

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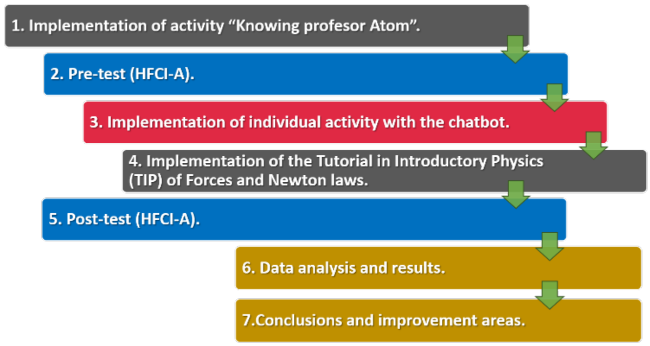

FIGURE I
STAGES OF THE DIDACTIC SEQUENCE

Subsequently, a pre-test was applied to know the level of conceptual understanding that students have before the application of the didactic sequence. As a third step, the individual activity based on the TIPs was implemented so that the students had the first approach with the concepts of Newton's laws. After the tutorials were applied, where these concepts are analyzed in greater depth. Then the HFCI post-test is applied to compare it with the pre-test and observe the change in the level of conceptual understanding of the students. Once this was done, the data was analyzed in order to observe the results and establish the conclusions finally.

ANALYSIS AND RESULTS

For the analysis of the data, statistical descriptive and dispersion parameters were obtained for the pre-test and post-test. These values are observed in Table I.

TABLE I
POINT SIZES AND TYPE STYLES

Indicator	Pre-test	Post-test	Change
Mean	33.7%	38.2%	+
Median	35.7%	35.7%	=
Mode	35.7%	28.6%	-
Stand. Dev.	15.1%	18.4%	+
Min Score	0%	0%	=
Max Score	78.6%	92.9%	+

The Half Force Concept Inventory (HFCI) version A [20], [21] was used as a pre-test and a post-test to understand the difference in conceptual understanding due to Newton's didactic sequence of laws. With the results in each of the tests, the Hake’s gain was calculated [22]. The results are seen in Figure II.

The graph shows those issues where there was an increase in the level of conceptual understanding by having positive Hake’s gain values. The themes where this result is available are those of free fall, Newton's third law, force motion, kinematics and force motion cluster. Within the results, it is observed that all the subjects related to Newton's laws obtained positive values of Hake's gain, being the force motion cluster the one that gained a higher percentage with 9.94%.

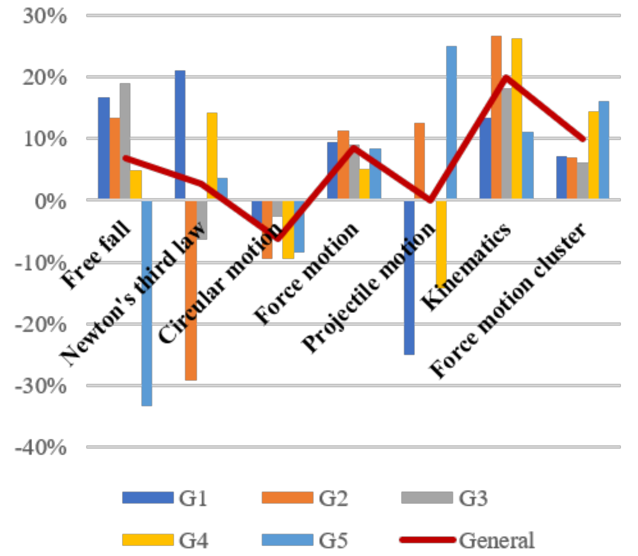

FIGURE II
RESULTS OF THE HAKE’S GAIN BY GROUP AND SUBJECT COMPARED TO THE GENERAL RESULT.

For a detailed analysis of the impact of the didactic sequence on issues directly related to the understanding of Newton's laws, Hake's gain was calculated considering only these themes and was compared with Hake's gain calculated based on considering all the issues. The behavior of the groups is visualized in Figure III. It shows that three of five groups have a greater gain with respect to Hake's gain of all subjects.

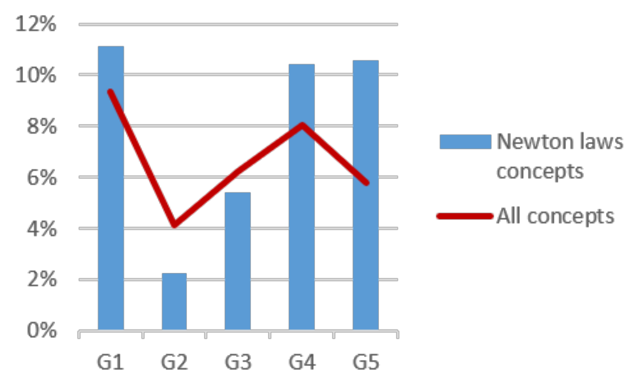

FIGURE III
HAKE’S GAIN BY GROUP CONSIDERING ONLY THE NEWTON LAW ISSUES COMPARED TO THE HAKE’S GAIN OF ALL THEMES.

Both the groups of a traditional model and those belonging to a competency-based model had positive learning, so there were groups of both curricula, which showed a Hake's gain of the subjects of Newton's Laws less than that obtained by the total. With these results, it is observed how the change in the level of conceptual understanding of Newton's laws was once the didactic sequence was carried out.

DISCUSSION

The implementation of the didactic sequence opens the possibility of continuing to investigate in greater depth how to improve students' understanding of using technologies such as chatbots in conjunction with active learning activities such as tutorials.

Although there was an increase in students' conceptual understanding, the design of the didactic sequence needs to be improved to increase these percentages. In further research, we will experiment with a control group to compare whether there is a significant difference in the understanding of the students who finish the didactic sequence, with those who have a traditional physics class.

Finally, further investigation is needed to know how chatbot impacts student learning, so it is proposed for future work to establish instruments that allow this parameter to be measured.

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APPENDIX 1

Some screenshots of the application are shown in Figures IV-VII.

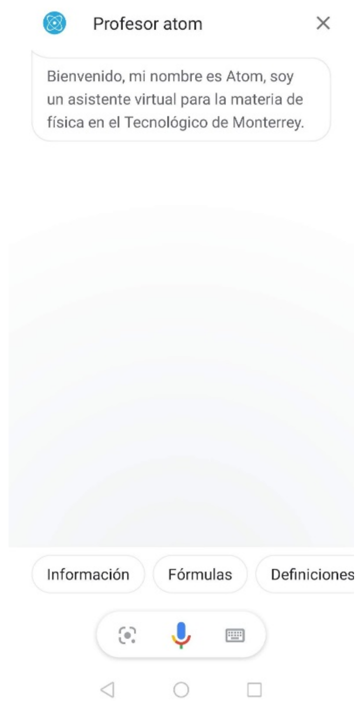

FIGURE IV

FIGURE V

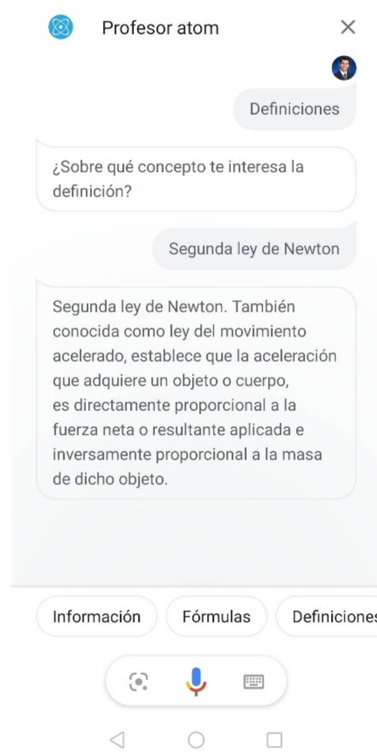

FIGURE VI

FIGURE VII