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The use of Modellus as a Didactic Strategy for Teaching-Learning Kinematics in Students of the Fiscomisional Educational Unit "Cinco de Mayo"

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Abstract---*The research focused on the use of Modellus as a didactic strategy for the teaching-learning of kinematics in second-year high school students at the Cinco de Mayo Fiscomisional Educational Unit. The results obtained from surveys are presented, which demonstrate the benefits of this tool in the educational process. The main problem was how to facilitate the understanding of kinematics concepts in the teaching-learning context. A classification of the themes of uniformly accelerated and varied rectilinear motion was made. The objective was to propose a teaching strategy based on the Modellus simulation program to facilitate the understanding of these topics. The technique applied was a questionnaire that allowed analyzing and interpreting the use of Modellus in the classroom. The results of this study conclude that Modellus is an effective tool that optimizes the teaching of kinematics and promotes more dynamic and effective learning.*
Keywords---*kinematics, methodology, Modellus, teaching strategy, teaching-learning.*

Introduction

The methodology is the set of strategies, techniques and procedures that guide the research process, from formulating questions to obtaining results, guaranteeing the validity and reliability of the findings. It is a structured and systematic path that ensures the rigor and quality of the research. The methodology is fundamental in the investigative process, since it provides a framework that guides and organizes the actions to follow to achieve the proposed objectives in an effective and efficient manner. Its correct application guarantees the credibility and relevance of the results obtained, being an essential tool for any study or investigation.

Research methodology is a fundamental aspect of any research process, as it provides the structure and steps necessary to carry out a study in a rigorous and systematic manner. According to Tamayo & Tamayo (2004), research methodology is a set of methods and techniques that guide the researcher in carrying out their study, allowing them to obtain valid and reliable results. The teaching of kinematics, and in particular rectilinear movement, is essential in the understanding of basic physical concepts. However, it has traditionally faced challenges in terms of conceptual understanding, student motivation, and the ability to relate theory to practical applications. In this context, the use of Modellus as a teaching tool offers various advantages and opportunities that justify its application in the educational field.

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Modellus enables a visual and interactive representation of rectilinear motion, facilitating the understanding of abstract concepts such as position, velocity and acceleration by providing a more tangible and dynamic experience for students. Modellus' ability to create and manipulate rectilinear motion models allows students to experiment with different scenarios, adjust parameters, and see how they affect motion. This encourages active learning and exploration of concepts through hands-on experimentation (Burbano-Pantoja et al., 2015; Contreras & Hernández, 2023; Montes, 2000).

The interactive and experiential nature of Modellus can increase student motivation by engaging them in hands-on, challenging activities. This can lead to greater participation in the learning process and better use of lessons. Modellus allows the creation of personalized models and the adaptation of activities according to the needs and levels of the students. This facilitates instructional differentiation and attention to students' different ways of learning. By working with Modellus, students develop skills in using simulation and modeling tools, preparing them to address real-world problems that require understanding and application of kinematic concepts (Morris et al., 1999; Ten Dam & Volman, 2004; Jang, 2008; Chen et al., 2011).

Using Modellus as a teaching strategy in teaching kinematics lies in its ability to improve conceptual understanding, increase student motivation and engagement, and prepare students to apply their knowledge in practical, real-world situations. These benefits make Modellus a valuable tool to enrich the learning experience in the field of kinematics. Do not use numbers or alphabets in headings and sub-headings (*Example A. Introduction 1. Body)*. Use the following style for headings and sub-headings-

Methodologies

The research was developed in the Fiscomisional Educational Unit "Cinco de Mayo", with second-year high school students divided into two parallels: A and B. In parallel A, the Modellus software was used as a didactic strategy for teaching uniformly accelerated rectilinear movement. or varied (MRUA and MRUV), while in parallel B the traditional teaching method was applied. The type of research was based on a quantitative approach and used a quasi-experimental design with control and experimental groups to evaluate the impact of Modellus on the understanding of uniformly accelerated rectilinear motion.

The materials used were, Modellus Software: Used to simulate and visualize kinematics concepts.Structured questionnaire: Designed to collect data on students' perceptions of the teaching strategies used and their impact on the understanding of the topics.Traditional resources: They include exercise guides, theoretical presentations and problems to solve analytically. Computers and projector: Necessary to run and display Modellus simulations in the classroom.In parallel A, classes were developed using Modellus, where students interacted with simulations that allowed them to explore and visualize key kinematics concepts, such as position, velocity and acceleration.In parallel B, a traditional methodology was used based on theoretical explanations and exercises carried out on the blackboard. Both groups worked with the same content, adjusted to the themes of uniformly accelerated or varied rectilinear movement.A survey was applied using a questionnaire with closed questions to evaluate the students' perception of the understanding of the topics and the effectiveness of the methodology used. Additionally, class interactions and participation dynamics in both groups were observed (Morales Chinchay, 2020; Hernández-Sampieri & Mendoza, 2020; Rodríguez Jiménez & Pérez Jacinto, 2017).

Analysis and Discussion of the Results

Modellus is an educational computer modeling program that allows the creation and simulation of physical and mathematical phenomena, which are used in the teaching of exact sciences, it allows you to create, prepare and solve a problem using the mathematical representation of the system to simulate it, manipulating thus the variables (time, distance, etc.) and observing how the physical phenomenon occurs. The idea is to use it as a way of interpreting problems, observing what greatness exerts of influence, regardless of the calculations. The Modellus program allows you to simulate physical phenomena and allows you to analyze examples by modifying the variables associated with each simulation. They can be used in various physical situations. They are shown in figure 1.

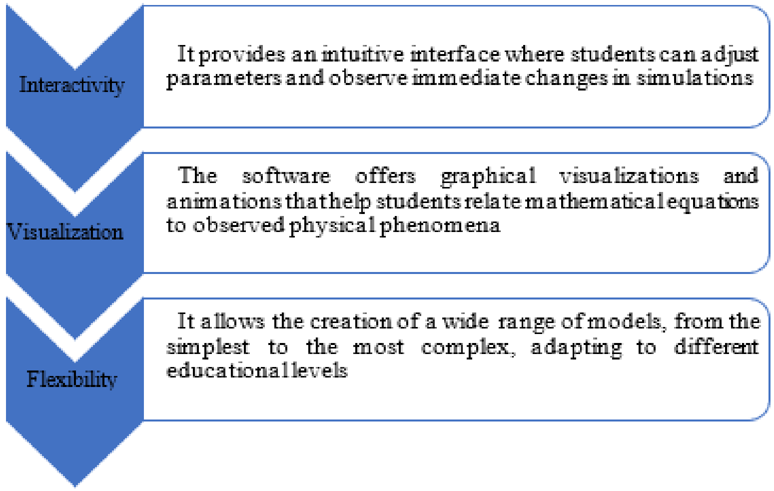

Figure 1. Main features of Modellus program

Educational Benefits

For Veit & Teodoro (2002), Modellus allows for "constructivist learning", which begins with the definition of ideas and has cognitive benefits. This process is because the use of the software is not trivial; It is a slow learning process that requires architectural thinking to build the simulations and has a personal and cognitive construction. The objective of this process was to develop the students' worldview based on the scientific knowledge acquired.

Uniformly Accelerated Rectilinear Motion

Rectilinear Movement refers to movement in a straight line and accelerated indicates that the acceleration is constant throughout the movement. In this type of motion, the speed of the object changes uniformly with time. Understanding this type of movement is essential for the study of other more complex movements and for the application of general physical laws. The integration of Modellus in the teaching of uniformly accelerated rectilinear movement has a constructivist approach. Studies in all these fields agree that knowledge is not simply a copy of previous reality, but is a dynamic and interactive process through which the mind interprets external information and creates increasingly complex models according to Coll's approaches.

Constructivist learning theory maintains that students can learn most effectively when they actively construct their knowledge through interaction and exploration as expressed (Piaget, 1970; Vygotsky, 2011). By using Modellus in teaching uniformly accelerated rectilinear motion, it allows students to experiment with variables such as acceleration and initial velocity, observing the results directly and visually. A survey was conducted for students related to Modellus, this is shown in Table 1.

Table 1
Survey applied to students

Questions asked	SI (%)	NO (%)	HALF (%)
Do you now have a clear idea of what the movement of a body is?	88	3	9
Did you know of any educational software in which the movements of a body can be simulated?	2	63	35
Do you think that this type of simulation provided you with a better understanding to study the movement of bodies?	97	0	3
Do you think it was easier for you to solve physics exercises in the modellus simulation program?	98	1	2
You would like your teacher to implement this modellus simulator in their physics classes.	100	0	0

For most students, it was very clear what movement of a body is, since 88% responded yes, 9% said they half understood and finally 3% said they did not understand at all. On the other hand, the students stated that they did not know of any educational software in which the movements of a body can be simulated, since 63% answered no, and 35% answered halfway and 2% yes. The students believe that this type of simulation does provide them with a better understanding to study the movement of bodies, since 97% answered yes, and 3% answered no, they also confirmed that it was easier to solve physics exercises, in the simulation program Modellus, which in a traditional way since 98% responded yes, 2% responded halfway and 1% responded no. And finally, the students were asked a question if they would like to implement this Modellus simulator in their physics classes and they all answered yes since it was easier for them to solve the exercises through the simulations provided by the Modellus program (Sánchez & Selva, 2011; Azuero Simon, 2015; Yautibug Sagñay, 2015).

The results obtained show that the use of Modellus software as a teaching strategy has a positive impact on the teaching-learning of kinematics. The students in parallel A, who used Modellus, showed a deeper and more dynamic understanding of concepts such as position, velocity and acceleration, compared to those in parallel B, who worked under a traditional approach. This finding coincides with previous studies that highlight the value of technological tools to make abstract concepts in physics more accessible.

The initial survey made it possible to identify the level of prior knowledge of the students, which was essential to design appropriate teaching strategies. In both groups, limited understanding of basic concepts was observed at baseline. However, at the end, the students who worked with Modellus stood out not only for their better performance in problem solving, but also for their ability to interpret graphs and relate movement variables, skills that are essential in learning kinematics (Neves et al., 2013; Araujo et al., 2008; Zhou et al., 2023; Xhelaj & Burlando, 2022).

On the other hand, parallel B showed more fragmented learning, with greater dependence on memorization of formulas and procedures. Although they managed to solve basic problems, they presented difficulties when facing situations that required conceptual analysis or the application of multiple variables. This contrast highlights the limitations of traditional methods when it comes to fostering meaningful, long-term learning. Despite the observed benefits, the use of Modellus also posed certain challenges, such as the need for additional time to familiarize students with the software and the dependence on technological resources, which may not be available in all educational contexts. However, these challenges can be overcome with adequate planning and teacher training, which reinforces the viability of incorporating technological tools in the classroom as a complement to traditional methodologies (Higgins & Nicholl, 2003; Davies et al., 2000; Aryani et al., 2016; Karma et al., 2019).

Despite the challenges associated with the use of Modellus, such as teacher training and technological availability, the observed benefits justify its integration into teaching. This study reinforces the importance of incorporating technological tools to make learning more dynamic, meaningful and aligned with the educational demands of the 21st century.

Conclusions

The use of Modellus as a teaching strategy proved to be effective in improving the understanding of fundamental kinematics concepts, such as position, velocity and acceleration. Parallel A students, who interacted with simulations, developed stronger analytical skills, especially in the interpretation of graphs and the relationship between variables of uniformly accelerated or varied rectilinear motion. In comparison, the traditional methodology applied in parallel B showed limitations, evidencing more superficial learning and dependent on memorization. Although useful for basic exercises, this strategy did not favor the development of analytical skills or deep conceptual understanding, underlining the need to update pedagogical approaches in physics.

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