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Teaching Strategies for Teaching and Learning Rectilinear Motion Uniformly Accelerated in Unified General Baccalaureate Students

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Abstract---*The purpose of this research was to analyze the teaching strategies used in the teaching and learning of uniformly accelerated rectilinear motion among first-year students of the Unified General Baccalaureate at the "Cinco de Mayo" Fiscomisional Educational Unit, located in the Chone canton, during the 2025-2026 period. To this end, a student survey and observation sheet were administered to evaluate the effectiveness of these strategies. The main problem identified was students' difficulty understanding abstract concepts such as acceleration and the relationship between velocity, time, and distance, which negatively impacts their ability to solve physical problems. The theoretical framework addressed various teaching strategies aimed at improving the teaching and learning process in this context. The objective was to diagnose, through a questionnaire, the level of understanding of concepts related to uniformly accelerated rectilinear motion and analyze the causes of the difficulties observed. The research adopted a qualitative, quantitative, and documentary approach, utilizing inductive and deductive methods, and employed questionnaires as the primary technique to interpret the results. The findings show that many students experience conceptual confusion, which significantly affects their academic performance.*
Keywords---*conceptual understanding, strategies, teaching-learning, uniformly accelerated rectilinear motion.*

Introduction

Teaching Uniformly Accelerated Rectilinear Motion (UARM) represents a significant challenge in education, particularly at the Unified General Baccalaureate level, due to its conceptual complexity. This research is based on the analysis of how didactic strategies, supported by the use of Information and Communication Technologies (ICT), can significantly transform the teaching-learning process. Understanding concepts such as acceleration, velocity, time, and distance depends not only on the transmission of theoretical information but also on the methodologies used in the classroom. Evidence in the educational field has shown that the implementation of active methodologies, complemented by technological resources, not only facilitates the assimilation of content but also transforms the learning environment into a dynamic, motivating, and student-centered space.

The central problem of this research lies in students' recurring difficulty understanding abstract concepts related to MRUA, which affects their ability to solve physics problems, diminishes their academic performance, and weakens their motivation toward science. This situation calls for the search for innovative teaching strategies that respond to the characteristics of today's students and contribute to more meaningful learning (Chávez-Rosado et al., 2024).

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A notable characteristic of the study group is the diversity of learning styles, which poses an additional challenge for teachers: the need to adapt their teaching strategies to address different ways of assimilating information. In this context, the integration of active, participatory methodologies and the use of technological resources is proposed as a way to personalize teaching, foster inclusion, and promote the active participation of all students. These strategies create an environment where learning is more effective, favoring the development of scientific skills and critical thinking.

The theoretical approach of this research is based on various pedagogical currents. Constructivism, represented by Jean Piaget (2000), emphasizes that learning is an active process where students construct their knowledge from their previous experiences. Vygotsky's (2001), sociocultural theory highlights the role of the social and cultural context, as well as interaction with others, as essential elements for cognitive development. Meanwhile, Kolb's (2014), experiential learning theory emphasizes the importance of transforming experience into knowledge, which in the field of physics teaching implies conducting experiments, simulations, and practical activities that allow the theory to be applied to real-life situations.

The main objective of this research was to assess, using a questionnaire, the level of understanding of concepts related to the MRUA and analyze the causes of the difficulties encountered. The effectiveness of various methodological strategies on students' academic performance and motivation was also evaluated.

As Maldonado & Mena (2020) argue, "teaching strategies must be adapted to students' needs, promoting active and meaningful learning." Along the same lines, González & Ruiz (2019) assert that "the integration of educational technologies into physics teaching can significantly improve motivation and academic performance." These statements support the need to rethink traditional pedagogical practices and move toward more inclusive, participatory, and technologically integrated approaches.

In short, this research seeks to contribute to the improvement of physics teaching at the secondary level through the identification and application of relevant teaching strategies based on sound educational theories. The goal is to ensure that students not only understand fundamental physics concepts but also develop skills that allow them to address academic and everyday challenges critically and reflectively (Indolia et al., 2018).

Materials and Methods

This research adopted a quantitative approach to analyze the effectiveness of various teaching strategies in teaching Rectilinear Uniformly Accelerated Motion (RUAM). To this end, inductive and deductive methods were used as the foundation of the research process.

The inductive method allowed for the observation of specific classroom phenomena and the collection of data based on the concrete experiences of students and teachers. Through this approach, patterns and trends in the application of teaching strategies were identified, facilitating a contextualized analysis of the results. This method is essential in educational settings because it is based on everyday classroom practice, enabling the collection of direct information through observations, semi-structured interviews, and surveys, providing a realistic view of the influence of teaching strategies on the learning process.

The deductive method, for its part, complemented the analysis by applying general theories about physics teaching to specific situations observed in the classroom. This approach allowed for the validation or refutation of hypotheses derived from previous observations, establishing connections between the use of specific teaching strategies and students' academic performance, based on well-established theoretical principles in the field of science learning and teaching.

Structured questionnaires were administered to students, designed to evaluate the effectiveness of the teaching strategies implemented. The data obtained were processed using descriptive statistical techniques, such as calculating percentages and averages, which allowed for the identification of behavioral patterns, interest levels, and recurring difficulties in understanding the MRUA. The relationship between the methodologies used by teachers and students' academic performance was also evaluated.

It is worth noting that this research also considered the impact of educational technologies and active methodologies, recognizing their potential to make classes more interactive, visual, and motivating. However, current limitations were also analyzed, such as the digital divide and the need for ongoing teacher training for the effective implementation of these resources.

A bibliographic review was conducted of scientific articles, specialized books, and previous studies related to teaching strategies in physics, specifically those related to uniformly accelerated rectilinear motion. This documentary analysis provided theoretical support for the research, identified relevant pedagogical approaches, and provided empirical support for the methodological proposals developed.

The study population consisted of 272 Unified General High School students from the "Cinco de Mayo" Fiscomisional Educational Unit, located in the Chone canton. From this population, a representative sample of 70 first-year high school students was selected, which facilitated systematic data collection and quantitative analysis of the results.

Analysis and Discussion of the Results

The results presented correspond to data obtained through a questionnaire administered to identify the prior knowledge of students entering their first year of high school at the "Cinco de Mayo" Fiscomisional Educational Unit. The questionnaire was designed to determine how the implemented teaching strategies impact the teaching and understanding of Uniformly Accelerated Rectilinear Motion (UARM).

The analysis focused on evaluating the effectiveness of the methodologies used by teachers and their impact on students' understanding of key concepts. In this regard, Sánchez Hurtado & Valencia Núñez (2021) highlight the importance of applying methodological strategies that strengthen problem-solving skills, which is directly related to the findings of this research.

Difficulties in the implementation of teaching strategies

Teaching strategies are defined as a systematic set of actions and methods that teachers employ to facilitate student learning. These strategies seek not only to transmit knowledge but also to promote critical thinking, analytical thinking, and problem-solving skills.

- The variability in students' learning styles makes it difficult for a single strategy to be effective for everyone.
- The lack of adequate materials and tools limits teachers' ability to implement innovative strategies.
- Lack of adequate training in modern teaching strategies can lead teachers to use outdated methods.
- Many educators may be resistant to adopting new strategies due to their comfort with traditional methods.

The implementation of strategies such as multisensory learning and differentiated instruction faces limitations due to a lack of specialized training and adequate resources (Vera & Saltos, 2025). It is noteworthy that, although teachers are motivated to incorporate innovative strategies into their teaching, the conditions in which they operate often limit their effectiveness. The lack of specialized training means that many educators do not feel confident implementing these strategies.

Strategic leadership is essential for guiding the implementation of innovative teaching, promoting a shared vision and a culture of learning (Hernández et al., 2023). It emphasizes that education leadership cannot be underestimated, given that effective leadership not only provides clear direction but also fosters a collaborative environment where all school stakeholders, including teachers, students, and parents, feel engaged.

The factors that limit educational innovation include time, budget and emotional exhaustion of teachers (Badilla Alvarado & Baltodano Zúñiga, 2003), which show that educational innovation does not depend solely on the will of teachers, but is deeply influenced by external factors, the lack of time to plan and execute new strategies, combined with reduced budgets that limit access to resources and training, creates an environment not conducive to innovation.

Innovative pedagogical strategies face significant challenges in teacher training (Lagla et al., 2024), especially in preparing to meet the demands of digital natives. This is a contemporary challenge in education: the need for teachers to adapt to the characteristics and expectations of students in the digital age, since rapid technological evolution not only changes the way students access information but also transforms the nature of learning.

Effect of Teaching Strategies on Learning Uniformly Accelerated Rectilinear Motion

By using interactive simulation resources and hands-on experiments, a deeper understanding of concepts is promoted. This not only facilitates the assimilation of complex theories but also stimulates critical thinking and problem-solving. Furthermore, by increasing student engagement and interest, this translates into improved academic performance and the ability to apply this knowledge in real-life contexts, strengthening their overall science education (Bezanilla et al., 2019).

The use of interactive simulations in teaching physical concepts allows students to visualize and experience phenomena that would otherwise be abstract (Brusilovsky & Millán, 2007), Interactive simulations serve as a powerful tool because they allow students to manipulate variables and observe results in real time.

Teaching strategies that actively engage students not only enhance understanding but also foster critical skills such as analysis and problem-solving (Hattie, 2009). These types of strategies promote deeper learning as students not only receive information but also process, discuss, and apply it.

Active learning, which includes hands-on experiments, provides students with opportunities to explore and apply concepts, resulting in greater knowledge retention (Chi, 2009). Through this learning, not only facilitates the exploration of concepts, but also helps students relate theory to practice.

Student engagement in interactive activities not only increases their interest but also translates into higher academic performance by applying knowledge in real-life situations (Baker, 2016). When students participate in interactive activities, their interest and motivation increase, leading them to devote more time and effort to their learning.

In this research, which aimed to analyze the relationship between teaching strategies and the teaching-learning process of Rectilinear Uniformly Accelerated Motion (RUAM) in first-year high school students, the initial approach was to question how these strategies were being incorporated into students' educational practices. Throughout the study, various key concepts related to physics teaching were applied and analyzed, focusing on understanding how these methodologies influence knowledge acquisition and the development of problem-solving skills associated with RUM.

a) Final speed calculation
b) Free fall calculation
c) Acceleration calculation

A study was conducted using structured questions addressed to first-year high school students at the Cinco de Mayo Fiscomisional Educational Unit. The first question focused on calculating final velocity, the results of which are presented in Table 1.

Table 1
Calculation of final speed

Alternatives	Frequency	Percentage (%)
A→ The final speed increases if force is applied	4	5.7
B→ The final speed is always constant	0	0
C→ Speed depends on time	2	2.9
D→ The final speed is calculated with the distance	36	51.4
E→ The force applied when traveling the distance	28	40.0

It was observed that only 5.7% of students correctly understood that the final velocity of an object increases as a function of the applied force. It is noteworthy that no student (0%) considered that velocity can remain constant while a force is applied, indicating that the majority recognize that force causes changes in motion. However, significant conceptual confusion is evident: 51.4% of students confuse final velocity with calculating the distance traveled, revealing a poor understanding of the relationship between these fundamental concepts of Uniformly Accelerated Rectilinear Motion. Furthermore, 40% of respondents identified that force is related to displacement, although not necessarily to final velocity, suggesting a partial understanding that requires reinforcement through more effective teaching strategies. Regarding the question that addresses how the speed of an object changes in free fall, physics students must understand this concept; the different proposed answers to this question are detailed in Table 2.

Table 2
How the speed of an object changes in free fall

Alternatives	Frequency	Percentage (%)
A→ The speed of the object is constantly increasing	4	5.7
B→ Height affects fall time	21	30.0
C→ It can fall faster if force is applied to it	10	14.3
D→ It has constant acceleration	35	50.0
E→ None of the above answers	0	0

According to the survey, the majority of respondents 50% correctly identified that constant acceleration is what occurs during free fall, which demonstrates a good level of understanding of the physical concept, however, the remaining 50% chose incorrect or incomplete answers, which shows that common confusions still exist, 5.7% confused acceleration with speed, 14.3% interpreted that applying force alters free fall, while 30% said that it is better to focus on external factors such as height without attending to the main physical cause of the movement. The relationship between net force and acceleration, a fundamental aspect of Newton's second law, was investigated. The answers provided by students on this topic are presented below, which can be seen in Table 3.

Table 3
Relationship between net force and acceleration

Alternatives	Frequency	Percentage (%)
A→ The greater the force, the greater the acceleration	27	38.6
B→ Acceleration is always positive	15	21.4
C→ The mass of the object does not affect the acceleration	14	20.0
D→ Acceleration can be zero	14	20.0
E→ None of the above	0	0

Within the survey carried out it was shown that 38.6% chose the correct option since, the greater the force, the greater the acceleration, which there is a significant dispersion among the other alternatives, including some conceptually incorrect, this suggests that there is confusion about the principles of dynamics, especially regarding the role of mass and the direction of acceleration. However, 21.4% erroneously maintain that acceleration is always positive, this statement is incorrect, since acceleration can be negative, depending on the direction of the force, 20% expressed that the mass of the object does not affect the acceleration, this reveals that part of the group does not recognize the role of mass in this physical relationship, while the other 20% expressed that acceleration can be zero, which is a correct statement in certain contexts, such as when the net force is zero. However, being at the same response level as incorrect options, this may reflect confusion or a lack of clarity in the formulation of the concept.

Analysis

The findings obtained from the questionnaire administered to first-year high school students at the "Cinco de Mayo" Fiscomisional Educational Unit reveal significant challenges in teaching Uniformly Accelerated Rectilinear Motion (UARM), as well as the need to rethink the teaching strategies used in the classroom.

One of the most relevant aspects relates to the understanding of final velocity as a function of the applied force. Only 5.7% of students answered correctly, while 51.4% confused about velocity with calculating distance, suggesting a superficial understanding of the relationship between the physical variables involved. This result coincides with that proposed by Chi (2009), who states that active learning—which includes practical experiences—is more effective for internalizing abstract concepts such as MRUA. Although no student considered that velocity remains constant when a force is applied (0%), which could be interpreted as an intuitive notion of change in movement, the high proportion of errors highlights the need for more effective and contextualized teaching strategies.

Regarding the phenomenon of free fall, it was identified that only 5.7% of students understand that the speed of an object in free fall increases constantly. Although 50% recognize that acceleration is constant, conceptual errors persist: 30% incorrectly associate height with fall time, and 14.3% believe that the object can fall faster if force is applied to it. These misperceptions can be attributed to teaching based exclusively on theory, without the support of interactive simulations or practical experiences, as suggested by Brusilovsky & Millán (2007) and Hattie (2009), who highlight the importance of visual and active environments for understanding physical phenomena.

Regarding Newton's second law, the results show that 38.6% of students correctly identified that greater force equals greater acceleration, reflecting an acceptable level of understanding of the principle. However, 21.4% incorrectly stated that acceleration is always positive, while 20% are unaware of the influence of mass on acceleration. These misconceptions should be addressed with methodologies that include real-world problem-solving and physical manipulatives, as proposed by Kolb (2014) and Baker (2016), who argue that experience-based learning and interaction with the environment foster a more solid and lasting understanding.

While the results reflect a favorable predisposition toward the use of teaching strategies, they also reveal significant barriers to their implementation. Among the factors that limit the effective use of innovative methodologies are:

- The diversity of learning styles makes it difficult to apply a single strategy uniformly.
- The scarcity of technological and material resources restricts the possibility of carrying out practical or interactive activities.
- The lack of teacher training in active methodologies forces many educators to resort to traditional methods, which are less effective in teaching abstract content.

As Vera & Saltos (2025) point out, there is a significant gap between teachers' pedagogical intentions and their actual capacity to implement innovative strategies. This situation is also supported by Badilla Alvarado & Baltodano Zúñiga (2003), who warn that workload, lack of funding, and emotional exhaustion directly affect educational innovation.

On the other hand, Hernández et al. (2023), underline the fundamental role of pedagogical leadership in creating an institutional culture that favors methodological change, an aspect that in many contexts is still absent or poorly consolidated.

Despite the challenges, the results support the effectiveness of methodologies based on participation, experiential learning, and the use of ICTs. The analysis shows that when students interact with simulations, conduct experiments, or solve contextualized problems, they not only better understand concepts but also increase their motivation and academic performance.

This is consistent with what was stated by González & Ruiz (2019) and Maldonado & Mena (2020), who recognize the value of ICT and differentiated strategies to meet the needs of students, especially in subjects with a high abstract load, such as physics.

The results show that a significant proportion of students experience conceptual confusion that affects their academic performance. These difficulties are exacerbated by factors such as a lack of specialized training in active methodologies, a shortage of appropriate teaching resources, and the limited integration of technological tools into teaching practices. Furthermore, the diversity of learning styles among students demands a more flexible and differentiated pedagogical approach focused on their specific needs (Huang et al., 2015).

However, it was also proven that the use of innovative strategies such as interactive simulations, experimental activities, experiential learning, and collaborative participation significantly contributes to the development of higher cognitive skills, strengthens the understanding of physical phenomena, and fosters a more positive attitude toward science. These methodologies transform the classroom into a dynamic, inclusive, and motivating environment in which students become active participants in their learning.

Conclusions

The research demonstrated that active teaching strategies, complemented by the use of ICTs, are effective tools for improving the teaching-learning process of the MRUA (Mechanical Instructional Materials) among first-year students of the Unified General Baccalaureate. The diagnosis, based on the administration of questionnaires, revealed significant deficiencies in the understanding of fundamental concepts such as final velocity, acceleration, and free fall, highlighting the persistent limitations of traditional methodologies used in the classroom.

Therefore, it is concluded that improving the teaching of MRUA and, in general, physics content in secondary education requires a sustained institutional commitment. It is essential to promote ongoing teacher training in contemporary teaching strategies, guarantee access to technological resources, and foster a school culture oriented toward pedagogical innovation. Only in this way will it be possible to achieve a more meaningful, equitable education adapted to the challenges of the 21st century.

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