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Abstract-- The learning gap in secondary school chemistry in the State of Mexico constitutes a significant educational problem that impacts academic performance and motivation toward the sciences; the complexity of the content has exacerbated deficiencies in prior knowledge, such as reading comprehension and mathematics, creating difficulties in understanding problems that may arise when calculating the mass of a substance and in properly applying the basic operations required for accurate calculations in this subject.

The State of Mexico has one of the highest rates of educational lag nationwide, with a large portion of its population having not completed secondary school. This phenomenon is associated with multiple factors, including socioeconomic conditions, family environment, student demotivation, traditional teaching practices, and a lack of technological resources in schools.

The research adopts a qualitative approach to analyze the causes of academic underachievement in Chemistry among students under 15 years of age. It is found that the disconnect between the student and the school, as well as a negative perception of the subject, contribute to low performance and dropout rates, especially in exact sciences such as Chemistry and Mathematics.

Likewise, the limited use of teaching strategies and activities, along with the scant integration of technology as pedagogical tools, contribute to students' lack of interest. Although there are proposals highlighting the educational potential of social media and digital resources, their implementation faces obstacles such as a lack of teacher training and institutional support.

The achievement gap in Chemistry does not depend solely on students' individual abilities, but on a combination of pedagogical, emotional, contextual, and motivational factors that can improve both learning and students' attitudes toward the sciences.

Keywords-- State of Mexico, chemistry, learning gap.

Abstract-- The learning gap in Chemistry at the secondary school level in the State of Mexico represents a significant educational problem that affects academic performance and students' motivation toward science. The complexity of the subject content, combined with deficiencies in prior knowledge such as reading comprehension and basic mathematics, hinders the learning process in this discipline.

The State of Mexico has one of the highest rates of educational lag at the national level, with a large proportion of the population that has not completed secondary education. This phenomenon is associated with multiple factors, including socioeconomic conditions, family environment, student demotivation, traditional teaching practices, and the lack of technological resources in schools.

This research adopts a qualitative approach to analyze the causes of academic lag in Chemistry among students under 15 years of age. It is found that the disconnect between students and the school, as well as a negative perception of the subject, contributes to low academic performance and school dropout, particularly in exact sciences such as Chemistry and Mathematics.

Additionally, the limited use of dynamic teaching strategies and the scarce integration of technology as a pedagogical tool contribute to students' lack of interest. Although there are proposals that highlight the educational potential of social networks and digital resources, their implementation faces obstacles such as insufficient teacher training and limited institutional support.

Keywords-- State of Mexico, chemistry, lag.

INTRODUCTION

The teaching of chemistry at the secondary level represents a challenge for many students due to the complexity of its concepts and the way the subject is taught. In the Mexican educational context, academic lag in this science has become a problem because it affects school performance and discourages scientific learning.

Specifically regarding educational lag as a percentage of the total population aged 15 and older in conditions of educational lag, the State of Mexico reports the highest figure nationwide, as 3,263,532 people did not complete primary and secondary school or are illiterate—that is, 24.7 percent of the 13,199,000 people in this population group. Specifically, at the secondary education level, 2,038,292 residents of the State of Mexico did not complete this grade level.

This contributes to many factors hindering progress in science and education in Mexico, which could lead to economic decline in the coming decades and stall efforts to boost education.

This gap makes it difficult to maintain student attention in the classroom, especially when competing with social media platforms that capture curiosity for learning in mere minutes. If this is extrapolated to a 50-minute class where a certain percentage of the teaching population consists of older educators with outdated ideas that perpetuate subpar teaching conditions, the situation is compounded by the fact that many elementary-level educational institutions lack the technology required by today’s standards.

Currently, we have little support for teaching in the educational sphere because regulations are somewhat flexible in certain areas, such as accommodations; however, a large portion of the population in Mexico does not prioritize completing a full course of study from preschool through higher education. There are various factors affecting education in Mexico, including the economic situation, the family, the student as an individual, and the school. Analyzing each factor that contributes to educational backwardness, with a focus on chemistry, it is clear that certain foundational skills—such as reading comprehension and basic mathematics—are necessary to achieve better performance in the classroom (Arango, 2006).

Based on the opinion of Barrios (2017), the foundation of current education lies in redefining teaching methods and reconstructing educational spaces, adapting them to a society subject to continuous change. Hence, social media constitutes one of the most representative tools of Web 2.0, and should therefore be considered a pedagogical alternative within school settings, given its deep-rooted presence and appeal among students (Barrios, 2017).

However, if we hope to compete with major powers that adopt Barrios's perspective, the idea of relying on technology to gain deeper knowledge and serve as a working tool for teachers by 2026 is nothing short of a utopian fantasy.

In addition to training, significant government support is needed to compete with major powers that already use these resources as a foundation for developing various educational software. Even without stepping into a laboratory, such software could help teenagers visualize the types of reactions that can occur, giving them a clearer understanding of what happens in a chemical reaction or in a state of matter, or apply this knowledge to emerging issues such as water pollution or various types of energy.

Based on the foregoing, the aim is to adopt a qualitative approach and analyze some factors influencing academic lag to understand the scientific gap in chemistry. This science has the potential to generate great curiosity and significant achievements; it is no coincidence that we have a Nobel laureate in the field. (Bobadilla, 2022).

Currently, this science encompasses many approaches, both practical and theoretical, that could lead to a revolution that ultimately impacts the universe, life, or the planet itself.

However, to make such a breakthrough, we need a solid foundation. Currently, in Mexico—and specifically in the State of Mexico—we are facing a significant gap compared to other states in the country. This is without mentioning the vast knowledge and technology gap compared to first-world countries, which possess the technology, mindset, and drive to compete with future generations to leave a lasting legacy for humanity. (Bolivar, 2005).

General Objective

To examine the factors contributing to the lag in secondary-level chemistry in the State of Mexico.

Specific Objectives

In the study of chemistry among secondary school students in the State of Mexico, the lag will be analyzed from a qualitative perspective, along with the causes affecting this population under the age of 15. The ability of this population to learn or establish that educational connection is far from that of an average student in a first-world country, which is why questions arise regarding this decline in student performance—despite being so close to Mexico City—and what factors might be driving them to drop out of school. (Olvera, 2022).

More specifically, the aim is to examine the chemical sciences, which lag further behind than other fields such as the humanities, which offer a degree of openness or a different educational approach. (Castillo, 2013)

DEVELOPMENT

There are various terms to define educational lag; currently, it can be understood as the difference between a student's age and the educational level they should have to follow an educational path that allows them to reach their goal. The purpose is for them to acquire solid tools, thereby increasing their chances of aspiring to a better standard of living. (Espinoza-Islas, 2022)

On the other hand, this delay that students experience indicates a predisposition to complete their studies on time and in the proper manner. This lag results in reduced employment opportunities or an economy that relies more on temporary projects or manual labor to make ends meet. (Mateus, 2022).

There are various types of school disengagement, and not all forms of dropout should be considered educational lag (Torres & Tenti, 2000); however, in the State of Mexico, one might question how it can have one of the highest rates of student dropout when compared to other states in the country, and the most alarming one given its proximity to one of the largest cities, Mexico City. This allows for certain perspectives on the fact that dropping out of school may be a personal decision, premature due to a lack of motivation, or, as mentioned by Rumberger (2001), caused by a disconnect between the student and the school. (Kauzar, 2024). Specifically in the scientific field, science has been falling behind among this population due to teaching methods and the environment surrounding the student; they do not feel connected to the subject, leading to dropout or declining performance in the exact sciences, such as Mathematics and Science.

Focusing specifically on the subject of Chemistry, there are two exact sciences that must be mastered beforehand to reach this subject for the first time; however, in both, various difficulties may arise in understanding how life emerged or how the subject is presented. (Ponce, 2021)

Society today has a very fast-paced lifestyle based on technology, but it focuses more on social media than on learning things that previously sparked curiosity and the effort to analyze how they could be done or imagined to conduct a range of experiments.

There are many websites available today that could help us overcome our ignorance; science itself is wonderful—every particle that makes up matter can be analyzed both microscopically and macroscopically.

The perception of learning chemistry is very complex because some students view the concepts as fleeting ideas rather than truly learning them; others face circumstances that prevent them from participating fully. Interest in and disengagement from the subject lead to various behavioral changes that hinder learning improvement. The difficulties students face in the chemistry classroom include a lack of prior knowledge, factors that prevent them from being present during class, and a lack of understanding of new topics (Mendoza, 2019).

The strategies currently recommended for teachers do not involve daily preparation, as that only leads to demotivation; rather, the teacher must ask themselves: “How can we increase interest in someone who has problems at home or establish a connection in the classroom?” This question generates different approaches in the discussion.

However, there are ways to motivate some adolescents, such as various group activities, or, as Skinner mentioned, using incentives like a piece of candy or a comic book, which help the adolescent or student realize that the task they are performing is the right one to improve their performance. (Osorio, 2010).

In the early stages of chemistry, one begins to question its history: how the chemical elements were discovered, how they were organized, and how they were linked. In today’s world, the best approach for any teacher of this wonderful science is to create analogies that provide clear points of reference, so that students do not view science as something catastrophic, but rather as something glorious—and this, in turn, increases the likelihood that some students will feel motivated to continue learning.

Educational lag is a complex problem that manifests itself both in students’ academic trajectories and in their actual acquisition of knowledge. Traditionally, this phenomenon has been defined as the gap between a student’s age and the educational level they are expected to have reached, with the implication that such a discrepancy hinders access to solid academic tools and opportunities that could improve the individual’s quality of life. This conception, while useful for describing an observable aspect of the gap, is reductionist if limited to a chronological issue, since the gap refers not only to how many years a student is behind a standard but also to how they acquire knowledge and develop the competencies necessary to integrate into their social and productive environment. (Oviedo, 2005).

The relationship between educational lag and social development has been widely discussed: it is argued that a deficient or incomplete education limits opportunities for decent employment, pushes young people toward informal occupations or manual labor, and ultimately perpetuates cycles of precariousness. This socioeconomic perspective demands attention because it situates the educational problem within a that transcends the classroom and involves public policies, resource distribution, and comprehensive social support. In states such as the State of Mexico, for example, where significant rates of student dropout are reported, this structural dimension of educational lag takes on greater relevance: it is not merely that students do not complete their education within the expected timeframe, but that the educational system itself does not adequately respond to the needs of those facing conditions of inequality, reduced motivation, or a lack of family and institutional support.

One of the factors that largely explains the persistence of educational lag is the disengagement between students and school. Authors such as Rumberger have emphasized that not all school dropout is due to a lack of cognitive ability or discipline, but rather to an emotional and social disconnect from the educational institution. When students do not perceive school as a meaningful space where their voice, interests, and achievements are recognized, dropout rates and

academic decline intensify. This is particularly evident in exact sciences such as Mathematics and Chemistry, where the level of abstraction is high and where traditional, memory-centered teaching can be demotivating for those who do not find meaning in the content presented to them.

Learning chemistry represents a paradigmatic case within the discussion of academic lag. Chemistry, by its very nature, requires a progressive construction of concepts that build upon prior learning, such as knowledge from other natural sciences and logical-mathematical skills. Often, students arrive at this subject with conceptual gaps that hinder their understanding of abstract phenomena such as chemical reactions, molecular structures, or chemical equilibrium. This situation is linked not only to prior deficiencies but also to negative perceptions of the subject: many students view it as difficult, lacking practical meaning, or disconnected from their daily reality. This perception is a key factor in academic underachievement in chemistry, as a lack of motivation and a superficial understanding of concepts act as barriers to deep learning. (Flores, 2022).

This problem can be addressed through creative pedagogical approaches that transform the way chemistry is taught and learned. Recent research on creative pedagogy in chemistry education underscores the importance of integrating strategies that foster imagination, active participation, and connections to real-world experiences. For example, the use of pedagogical models—which emphasize connecting, restructuring, elaborating, applying, performing tasks, and evaluating—has shown that pre-service teachers who incorporate these practices into microteaching are able to design activities that strengthen

both students' conceptual understanding and creativity. This approach not only increase motivation but also fosters a form of learning based on exploration, innovation, and active reflection. (Hernandez, 2021)

Authors in the field of chemistry education also highlight the role of interactive methods in developing students' creative thinking. Strategies such as problem-based learning, inquiry-based learning (POGIL), case-based discussions, and simulation-based labs allow students to alternate between divergent thinking—which generates novel ideas—and convergent thinking—which evaluates the validity of those ideas within a scientific framework. This constructivist approach, which promotes reflective and collaborative activity, helps students view chemistry not merely as a collection of formulas and isolated facts, but as a dynamic discipline where creative and critical thinking are essential skills. (Farinango, 2024)

The framing of chemistry as a creative discipline is not merely rhetorical: recent research suggests that when students are aware of the creative possibilities within chemistry, their perception of the subject changes radically. Marion E. van Brederode, for example, argues that creativity should be conceptualized as an explicit learning objective within chemistry classes, integrating activities designed to stimulate both innovative and analytical thinking. This approach helps students recognize chemistry as a discipline where original solutions to real-world problems can be proposed, which in turn increases their motivation and commitment to learning. (Salazar-Hernandez, 2021).

The implementation of creative strategies can take various forms, ranging from activities that integrate art and science to experimental design exercises where students explore their own research questions. For example, courses that blend artistic observation with chemical concepts have shown that students can internalize complex content more deeply when a variety of sensory and cognitive stimuli are integrated and meaning is linked to experience. These types of approaches are grounded in constructivist theories that emphasize that knowledge is actively constructed rather than passively transmitted.

In addition to creative methodologies, it is essential to consider the importance of technological and pedagogical content knowledge, a concept developed from the work of Lee Shulman, who proposes that teachers must not only master chemistry content but also know how to teach it effectively, integrating technological tools, teaching strategies, and a deep understanding of their students' context. This approach allows for adapting instruction to the specific needs of each group and addressing factors that contribute to academic underachievement, such as the lack of connection between theory and practice or insufficient contextualization of the content.

In summary, addressing academic underachievement in chemistry requires a pedagogical transformation that reconfigures not only what is taught, but also how it is taught and how students are engaged in the learning process. It is not merely about conveying content, but about creating meaningful learning experiences that spark curiosity, foster creativity, and allow students to build connections between scientific concepts and their own reality. Through the integration of creative strategies, interactive approaches, and a deep understanding of educational needs, it is possible to reduce the barriers that perpetuate the gap and create opportunities for more students to gain a solid and motivating understanding of chemistry.

Educational lag is a complex phenomenon that has been defined in various ways; broadly speaking, it can be considered the gap between a student's age and the educational level they should have attained, which shapes their academic trajectory and opportunities for personal and professional development. This lag not only limits access to fundamental knowledge but also impacts the student's ability to acquire solid tools that enable them to aspire to a better quality of life and more competitive performance in the workplace. From this perspective, educational lag becomes a structural obstacle that goes beyond mere lack of school attendance, as it affects both the student's cognitive abilities and practical skills, thereby limiting their effective integration into society and the workforce. Various studies have noted that educational lag is not manifested solely in delayed completion of studies but is also closely linked to demotivation and school dropout. Torres and Tenti (2000) emphasize that not all patterns of school withdrawal should be considered educational lag; rather, some reflect students' personal decisions. However, in specific contexts, such as the State of Mexico, particularly high rates of student dropout are observed, suggesting the existence of both social and institutional factors that hinder retention in the education system. Proximity to major urban centers, such as Mexico City, does not necessarily guarantee better academic outcomes, indicating that educational lag is a multidimensional phenomenon shaped by socioeconomic, family, and cultural factors.

In this regard, Rumberger (2001) emphasizes the importance of the bond between the student and the school as a determining factor in educational dropout. When students do not feel integrated into the school environment, they are more likely to drop out, which exacerbates academic lag. This phenomenon is particularly evident in exact sciences such as Mathematics, Physics, and Chemistry, where learning processes require a continuity of prior knowledge and a high level of motivation to understand complex concepts and establish logical relationships between them. Chemistry, by its nature, depends on an understanding of the fundamentals of other exact sciences, meaning that any difficulty in prior learning can generate a cumulative effect that deepens the student's academic lag and demotivation.

Learning chemistry faces additional challenges in the current context due to the fast pace of society, the influence of technology, and the prevalence of social media in students' daily lives. These tools, while potentially useful for learning, often become distractions that divert attention away from scientific content. This situation contributes to many students perceiving chemistry as an abstract, complicated, or even irrelevant subject, rather than recognizing its application in everyday phenomena and its importance for the development of analytical and scientific skills. The negative perception of chemistry not only affects student motivation but also influences their behavior and the way they approach academic challenges, creating a vicious cycle in which disinterest fuels academic lag and vice versa.

Among the main difficulties students face in learning chemistry are a lack of prior knowledge, inattention during class due to external factors, and difficulty understanding new and complex concepts. These limitations highlight the need for educational strategies that focus not only on the teacher's academic preparation but also on creating an effective connection with students, fostering their curiosity and analytical skills. Creating a motivating learning environment that takes into account each student's personal and social circumstances is essential for mitigating academic underachievement and improving outcomes in this discipline. (Delgado, 2016).

Various strategies can be used to motivate students, ranging from the implementation of interactive classroom activities to incentives based on positive reinforcement, such as those suggested by Skinner, which may include simple rewards that recognize effort and academic achievement. However, motivation should not be viewed solely as an external mechanism; it is also important to foster intrinsic motivation by creating meaningful learning experiences, such as conducting experiments, solving problems, and relating content to students' daily lives. In this regard, teachers play a crucial role, not only as transmitters of knowledge but as facilitators of curiosity and critical thinking.

A historical approach to chemistry can be an effective pedagogical resource for connecting students with the discipline. Understanding how chemical elements were discovered, how they were organized, and how they are interconnected allows for contextualizing the content and giving it meaning, transforming chemistry from an abstract subject into a fascinating and accessible field. Likewise, the use of analogies, everyday examples, and visual resources helps students internalize complex concepts and apply them effectively in different contexts. This teaching approach not only improves learning but also has a positive impact on student motivation and perception of science. (Lamus, 2020)

DISCUSSION AND ANALYSIS OF RESULTS

The qualitative analysis shows that academic underachievement in chemistry is not solely due to students' individual abilities, but rather to a combination of pedagogical, emotional, and contextual factors.

The lack of dynamic teaching strategies, low interest in the subject, and the absence of academic support contribute significantly to this lag. Furthermore, the negative perception of chemistry as a difficult subject reinforces demotivation and poor performance.

The issue of educational lag is examined from multiple perspectives, aiming to provide a comprehensive view of this phenomenon and its implications for students' lives. The gap between a student's age and the educational level they should have attained is linked to the possibility of achieving better living conditions.

This definition serves as a useful starting point, but it can be considered limited, as it oversimplifies a phenomenon that depends not only on individual factors but also on social, economic, and cultural conditions that affect students' retention and academic performance. From this perspective, education adopts a primarily individualistic and linear approach, focused on the student's educational trajectory rather than on the systems that produce or perpetuate educational lag.

Furthermore, the socioeconomic approach must be considered, which points out that educational lag reduces employment opportunities, leading students to informal or manual labor jobs. This view allows us to understand the impact of educational lag on working and economic life, linking education and social development. The structural dimension of educational lag recognizes that education not only has individual consequences but is also closely linked to the social and economic context.

Another study addresses educational lag from the perspective of school dropout, distinguishing between types of disengagement from school and citing Rumberger (2001) to highlight the disconnection between the student and the institution as one of the causes of early dropout. This approach introduces the psychosocial dimension of educational lag, highlighting the importance of the relationship between students and the school. However, this author does not delve into how this disengagement is measured or into effective strategies to counteract it, which limits the applicability of this approach. Even so, it represents a valuable approach because it emphasizes institutional and emotional responsibility in school retention, complementing the individualistic and socioeconomic perspectives.

With regard to science education, and particularly chemistry, academic underachievement also manifests itself as difficulties in science and math subjects, linked to gaps in prior knowledge, a lack of motivation, and social environmental factors. This pedagogical perspective allows us to understand academic underachievement from a micro-educational approach, centered on the classroom and on teaching-learning processes.

However, the causes and effects are intertwined: demotivation leads to a learning gap, and at the same time, the learning gap produces demotivation. Despite this, the pedagogical approach allows for the proposal of concrete strategies for teachers and highlights the importance of motivation, individualized support, and understanding of prior content as key factors for effective learning.

The topic of motivation is addressed from a behaviorist perspective, referencing Skinner and proposing incentives such as rewards to improve student performance. While these strategies may be effective in the short term, they have limitations because they do not consider the deeper structural and emotional factors that contribute to educational lag.

Likewise, the importance of teacher creativity, classroom dynamics, and the use of analogies to facilitate the understanding of complex concepts is emphasized, which can foster students' intrinsic motivation and interest in science.

It is important to include a cultural and technological perspective, noting that today's society—characterized by heavy use of social media and a fast-paced lifestyle—has displaced curiosity and interest in scientific learning. This contextual view allows for situating the student within their social and cultural environment, but it runs the risk of blaming individuals or technology without analyzing how educational methodologies could integrate these elements in a positive and enriching way. Therefore, although it is a relevant approach to the debate on educational lag and learning, it is presented in a one-sided manner and lacks evidence to support its claims.

The multidimensional view of educational lag considers individual, socioeconomic, institutional, pedagogical, motivational, and cultural factors. Among its strengths is the ability to recognize that educational lag is not merely an academic problem but has diverse causes and consequences, requiring the attention of multiple stakeholders, including teachers, institutions, and educational policies. Furthermore, the inclusion of theoretical references and specific examples helps lend some validity to the arguments. However, the analysis has significant limitations: it confusingly mixes causes and effects, fails to integrate the different approaches in a coherent manner, and in some cases relies on assumptions rather than empirical evidence, which weakens the strength of the arguments.

Table 1.

Multidimensional Model of Educational Disadvantage in Chemistry

DIMENSION	KEY FACTORS	RELATIONSHIP TO THE GAP	TYPE OF IMPACT
Pedagogical	Limited teaching strategies, lack of teacher creativity, absence of analogies.	Hinders understanding of content.	Academic.
Individual	Low interest, prior perception that the material is difficult, lack of motivation.	Reduces performance and participation.	Academic / Personal.
Socioeconomic	Social inequality, lack of resources.	Limits educational and employment opportunities.	Social / Economic.
Psychosocial	Disengagement between school and student disengagement, lack of support.	Contributes to school dropout.	Institutional / Emotional.
Motivational	Use of external incentives (behaviorism), lack of intrinsic motivation.	Temporary improvement or leads to disinterest.	Behavioral.
Cultural and technological	Intensive use of social networks , changes in lifestyles.	Declining interest in science.	Contextual.
Structural	Interaction of all the above factors.	Explains the lag as a complex phenomenon.	Multidimensional.

CONCLUSIONS

In conclusion, this study represents an effort to understand educational lag from different perspectives, addressing individual, social, cultural, and pedagogical factors. Its value lies in offering a broad and multifaceted view of the phenomenon, although it would be necessary to delve deeper into the relationship between causes and consequences, strengthen the empirical basis, and articulate the different approaches more clearly. Only then could a more robust and comprehensive analysis be generated, capable of effectively guiding intervention and improvement strategies in the educational sphere, particularly in science education.

From a qualitative perspective, it is concluded that academic lag in chemistry learning at the secondary level in Mexico is strongly related to how students experience and perceive the subject.

It is essential to promote more active teaching strategies, such as learning based on experiments and everyday situations, that foster students' understanding and interest.

Addressing academic lag through a comprehensive approach will improve not only academic performance but also students' attitudes toward science.

FUTURE WORK

Based on this research, the aim is to strengthen this area in the near future through the design and implementation of strategies that promote the optimal development of skills, enabling students to acquire solid knowledge and characteristics that will help them better understand science and foster a more engaging connection with the subject.

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