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BARRIERS AND FACILITATORS:
THE PSYCHOPEDAGOGICAL IMPACT ON
MATHEMATICS EDUCATION IN HIGH SCHOOL

BARRERAS Y FACILITADORES:
EL IMPACTO PSICOPEDAGÓGICO EN LA
FORMACIÓN MATEMÁTICA EN BACHILLERATO



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BARRIERS AND FACILITATORS: THE PSYCHOPEDAGOGICAL IMPACT ON MATHEMATICS EDUCATION IN HIGH SCHOOL

BARRERAS Y FACILITADORES: EL IMPACTO PSICOPEDAGÓGICO EN LA FORMACIÓN MATEMÁTICA EN BACHILLERATO

ABSTRACT

This article focused on the barriers and facilitators that influence the psycho-pedagogical impact of mathematics education at the high school level. It highlighted the conceptual, academic, and social complexity faced by students. Difficulties such as anxiety, lack of confidence, and disinterest were discussed, which result in low performance and negative attitudes toward learning. This has repercussions in the academic sphere, the choice of careers focused on science, technology, engineering, and mathematics, and the perception of the usefulness of mathematics in everyday life. The text focused on the importance of integrating psycho-pedagogical aspects into the educational process, considering that learning mathematics is a socio-emotional and cognitive phenomenon in which teachers, students, and institutions play a crucial role. The effects of math anxiety on emotional well-being and the need for pedagogical strategies that balance conceptual rigor with emotional support were analyzed. In addition, it reflected on how school policies and rigid curricula can marginalize students with different learning rhythms. Finally, it proposed a systemic approach to identify and analyze factors that influence the teaching-learning process, reviewing academic and theoretical sources that allow for understanding the barriers and suggesting strategies to improve educational practice and student attitudes toward mathematics.

Keywords: psycho-pedagogical impact, mathematics, high school, STEM, educational intervention

RESUMEN

Este artículo se enfocó en las barreras y los facilitadores que inciden en el impacto psicopedagógico de la formación matemática a nivel de bachillerato. Destacó la complejidad conceptual, académica y social que enfrentan los alumnos. Se expusieron dificultades como la ansiedad, la falta de confianza y el desinterés, que resultan en bajos rendimientos y actitudes negativas hacia el aprendizaje. Esto repercute en el ámbito académico, la elección de carreras enfocadas en ciencia, tecnología, ingeniería y matemáticas, y la percepción de utilidad de las matemáticas en la vida cotidiana. El texto se centró en la importancia de integrar aspectos psicopedagógicos al proceso educativo, considerando que el aprendizaje de las matemáticas es un fenómeno socioemocional y cognitivo donde docentes, estudiantes e instituciones juegan un papel crucial. Se analizaron los efectos de la ansiedad matemática sobre el bienestar emocional y la necesidad de estrategias pedagógicas que equilibren el rigor conceptual con el apoyo emocional. Además, se reflexionó sobre cómo las políticas escolares y los currículos rígidos pueden marginar a estudiantes con diferentes ritmos de aprendizaje. Finalmente, se propuso una mirada sistémica para identificar y analizar factores que influyen en el proceso de enseñanza-aprendizaje, revisando fuentes académicas y teóricas que permiten comprender las barreras y sugerir estrategias para mejorar la práctica educativa y la actitud estudiantil hacia las matemáticas.

Palabras clave: impacto psicopedagógico, matemáticas, bachillerato, STEM, intervención educativa

1. INTRODUCTION

In high school, teaching mathematics is a constant multifaceted challenge. The conceptual, academic, and social complexity are difficult for many students to understand. As a result, students perform poorly and develop negative attitudes toward the subject. This leads to anxiety, lack of confidence, and disinterest (Soler Rodríguez et al., 2013). It is essential to emphasize mathematics as a key discipline for developing skills such as decision-making, problem-solving, and critical thinking.

However, in Mexico, around 60% of high school students do not reach the basic level of mathematical competence (National Institute for Educational Evaluation [INEE], 2018). This deficit has repercussions beyond the academic sphere, affecting at least 30% of students, and is directly associated with the avoidance of careers in science, technology, engineering, and mathematics (STEM). It also fosters the perception that mathematics is useless in everyday contexts (Simms, 2016). It is therefore vital to prioritize psycho-pedagogical aspects, which are essential for improving understanding and the teaching-learning process in mathematics.

Psycho-pedagogical aspects are a set of theoretical principles and practical strategies that integrate psychological knowledge about cognitive and emotional development. This addresses pedagogical approaches that recognize that learning mathematics is a socio-emotional, cognitive, and contextually situated process, unlike traditional approaches that focus on the unidirectional transmission of content (Semena & Santos, 2018). In this sense, psychopedagogy encompasses the emotional and social skills presented by teachers and students. In addition, it addresses the methodological strategies and institutional environment that accompany the educational process of mathematics (Coll et al., 2020).

Various neuroeducational studies have shown that anxiety caused by mathematics activates the same brain regions associated with physical pain (Lyons & Beilock, 2012). This causes students to feel extremely exhausted, which leads to emotional blocks and resistance to mathematics. Likewise, the need for teachers to integrate learning strategies that help achieve a balance between conceptual rigor and the emotional well-being of students has been emphasized, such as the pedagogy of trust (Flores Ibarra et al., 2013) or project-based learning.

When standardized assessment policies and rigid curricula are prioritized and an adverse school climate is perpetuated, students with different learning rhythms are marginalized (Lozano Treviño & Maldonado Maldonado, 2021). Likewise, students are another important factor, as their emotional conditions can be perceived as mathematical self-efficacy and their perception of the social support provided (Pajares & Graham, 2019).

In general, the causes and possible solutions are left to teachers. In this sense, this study adopted a systemic approach to critically reflect, based on observation, on those psycho-pedagogical aspects that determine the teaching and learning of mathematics in high school education. Therefore, three interconnected dimensions were addressed: teachers, students, and institutions. The relevance of this study lies in its ability to identify and

analyze the factors that influence the teaching and learning of mathematics, generating a comprehensive vision that connects teaching practices, student experiences, and institutional policies.

2. METHOD OF RESEARCH

To provide a basis for discussion and analysis of the barriers and facilitators to learning mathematics, the scientific and academic literature was reviewed. The information was developed in phases close to the development and formulation of research exercises in the area. Some of the databases that address this issue are: *Scopus*, *ScienceDirect*, *EBESCO*, *Scielo*, *Latindex*, *Redalyc*, and *Google Scholar*. Documents prior to 2000 were taken into account. In addition, the search focused on references to psycho-pedagogical aspects that create barriers or facilitate the teaching-learning process of mathematics at the high school level. This classified the actions aimed at teachers, students, and educational institutions.

In addition, this allowed us to understand the barriers that limit learning and propose strategies to improve educational practice, academic performance, and students' attitudes toward the subject. To address this objective, academic and theoretical sources related to psycho-pedagogical aspects in mathematics teaching, the role of the teacher, student attitudes, the role of the institution, innovative strategies, learning barriers, and individual and social interaction were reviewed. These sources were the result of a previous systematic review of research on mathematics education at the high school level.

3. RESULTS

From a psychological perspective, three similarities were detected in the studies, as criteria were proposed regarding psycho-pedagogical aspects in teaching processes. In addition, the studies highlighted the psychosocial skills necessary for teachers to promote student learning. These include empathy, classroom conflict management, and concern for student learning, among others. Likewise, several studies emphasized that students' emotional and affective conditions impact learning. It was found that the studies reviewed address three areas that can be taken into account in intervention actions in educational innovation processes in mathematics at the high school level (teachers, the institution, and students) (Table 1).

Table 1

Areas addressed in the studies reviewed

Areas	Description
Teachers	It is important to address training processes focused on strategies to strengthen students' emotions. In addition, actions that modify teaching-learning processes should be reviewed. For example, the application of project-based learning allows students to compare learning with empirical experiences from everyday life.
Institution	They are the ones who manage teaching models. Therefore, it is important to reflect on the role of the institution in mathematics education, as the curriculum must be modified and adapted with a psycho-pedagogical approach.
Students	Research focuses on processes of self-efficacy, self-organization, study habits, understanding, and improving professional prospects, among other areas.

2.1. Teachers

Mathematics teachers have a decisive influence on the educational process of high school students. This influence is exerted through four interrelated dimensions focused on their educational background, the teaching tools they use, continuing education processes, and the development of their psychosocial skills. Together, these aspects constitute a complex system that determines the quality of teaching and student learning outcomes.

With regard to educational background, studies have shown that the initial training of mathematics teachers varies significantly, which has an impact on their professional performance. Cáceres Mesa et al. (2020) stated that, in Mexico, 42% of teachers have specialized training in mathematics education, while the remaining 58% are teachers from other disciplines. This difference is related to the ability to design teaching sequences appropriate to the cognitive level of students.

It was found that teachers with mathematical pedagogical training show greater mastery of strategies for addressing common errors in algebra and calculus, as well as in formative assessment techniques and content sequencing. However, those without specialization tend to prioritize algorithmic procedures over conceptual understanding, as they underutilize teaching materials and have difficulty identifying misconceptions (Romero-García et al., 2023). Research on the use of pedagogical tools revealed a gap in the use of educational resources, as 78% of teachers belonging to institutions located in urban areas tend to use digital platforms or resources. However, 35% of teachers working in rural contexts have access to these technologies (INEE, 2021).

This disparity is accentuated in the use of traditional resources, as 92% of teachers use blackboards and textbooks; 18% use manipulative materials; and 24% apply real-life situations to problems (Secretaría de Educación Pública [SEP], 2022). In this regard, it was found that 28% of students who used educational technologies improved their academic performance. On the other hand, the use of simulators reduces conceptual errors by 15%, as it improves differentiated attention (Hoyles et al., 2010).

In this regard, ongoing teacher training and professional development programs present three main challenges. The first is coverage, as four out of 10 teachers have access to ongoing training each year (INEE, 2021). The second challenge is content, as 65% focus on disciplinary content; 22% on specific teaching methods; and 13% on psychosocial skills (SEP, 2022). The third challenge is the impact of training, as 40% of trained teachers have used active strategies; 35% have improved their handling of learning difficulties; and 25% have motivated their students. Finally, in psychosocial competencies, four skills were identified that are related to the teaching-learning process of students: a) pedagogical empathy; b) assertive communication; c) emotional management; and d) growth mindset (Table 2).

Table 2
Skills related to the teaching-learning process

Skill	Description
Pedagogical empathy	It was demonstrated that teachers with a high degree of empathy reduce students' math anxiety by 32%. On the other hand, these teachers increase class participation by 28% and improve student self-efficacy (Mato-Vázquez et al., 2022).
Assertive communication	It was found that clarity of presentation correlates with high school students' performance. Likewise, effective feedback improves the correlation of errors by 41%.
Emotional management	It was found that teachers trained in emotional intelligence reduce classroom conflicts by 38%. In addition, they improve the school climate and increase student perseverance (Extremera Pacheco et al., 2019).
Growth mindset	Teachers who emphasize effort over ability get 23% of students to persist in their activities. They also reduce gender stereotypes in STEM and improve students' attitudes toward mathematics (Dweck, 2019).

These findings revealed that teachers act as key mediators between mathematical knowledge and students. Therefore, their psychosocial preparation is just as important as their mastery of the subject. The evidence suggests that comprehensive interventions should consider specialization programs for teachers who have not been trained in mathematics education. However, these measures require joint coordination between training

institutions, schools, and educational authorities to transform teaching practices. This can improve mathematics learning outcomes at the high school level.

2.2. Students

From the students' perspective, research has identified that students face multiple psycho-pedagogical issues that significantly influence their relationship with mathematics. These are grouped into five factors (Tabla 3).

Table 3

Psycho-pedagogical aspects

Factor	Descripción
Academic background	It has been shown that prior knowledge experiences have a cumulative impact. For example, students with gaps in basic arithmetic are 3.2 times more likely to fail algebra (Simms, 2016). On the other hand, 42% of students manage to adapt to the abstract complexity of mathematics in high school (INEE, 2021).
Learning styles	Four predominant profiles are identified: visual-spatial, verbal-abstract, kinesthetic, and social. The latter showed better performance in group work (Organización para la Cooperación y el Desarrollo Económicos [OECD], 2021).
Emotional and affective conditions	Alarming data was revealed, as 38% of Mexican students are affected by anxiety generated by mathematics. In this sense, self-efficacy stands out as the strongest predictor of student performance. In this regard, diagnostic assessments of basic math skills showed that 54% of students are unable to transition from arithmetic to symbolic math, as only 38% are capable of solving geometric demonstration problems. On the other hand, 28% can correctly interpret statistical graphs (INEE, 2021).
Study habits	The data indicated that most students predominantly use memorization, devoting 2.3 hours per week to studying mathematics, compared to the recommended five hours.
Career prospects	This influences student motivation and performance. Some studies show that when students visualize concrete applications of mathematics in their future careers, whether STEM or non-STEM, their engagement with the subject improves substantially (Timms et al., 2018). For example, students aspiring to engineering or science showed greater persistence in solving complex mathematical problems. However, students interested in the humanities or arts require more explicit connections between the subject content and their fields of interest (Simms, 2016).

Given this scenario, key protective factors were identified to strengthen the development of a growth mindset in students. On the other hand, the implementation of metacognitive strategies improves results. In addition, consistent family support reduces school dropout rates. All these findings suggest the need for educational interventions that consider both the cognitive and emotional aspects of mathematical learning.

2.3. Institution

With regard to high school institutions, it was found that educational management has a decisive influence on the teaching and learning process in mathematics through three areas that can enhance or limit educational outcomes (Table 4).

Table 4

Areas that enhance or limit educational outcomes

Area	Description
Academic support programs	<p>Research has shown that institutions that implement academic advising reduce failure rates in mathematics (Ramos Rodríguez & Vásquez Ortiz, 2020). Three effective formats were found: a) peer advising; b) regulation workshops; and c) math clinics. In the first, upperclassmen tutor first-semester students, showing an improvement in conceptual understanding (Pons et al., 2014). The second consists of intensive sessions prior to exams or assessments, achieving higher pass rates (Zaldívar Colado et al., 2018). The latter focuses on permanent consultation spaces where specific questions are answered and are mainly used by students with difficulties in the subject (INEE, 2021).</p> <p>However, significant disparities were identified, as 78% of private institutions have this type of program, but only 43% of public schools offer them systematically (SEP, 2022). Furthermore, coverage is insufficient in rural areas, as very few have established programs (Banegas González & Blanco Bosco, 2005).</p>
Teacher training strategies	<p>It was found that institutional policies for professional teacher development have a differentiated impact on teachers. On the one hand, formal programs improve the use of active strategies. Specialized diploma courses increase the application of formative assessments. However, only 38% of teachers have access to this type of training each year (Flores et al., 2020). In this regard, according to the SEP (2022), there are some barriers, as 65% of teachers reported that they do not have enough time to undergo training. On the other hand, 42% mentioned a notable absence of institutional incentives, and 58% pointed out that the programs offered do not respond to their real needs.</p>

Table 4

Areas that enhance or limit educational outcomes

Area	Description
Support systems for students	This presents encouraging but uneven results, as individual tutoring has been shown to reduce school dropout rates and improve mathematical self-concept. However, it only reaches a limited number of high school students (Banegas González & Blanco Bosco, 2005). In contrast, group mentoring was found to increase perseverance in STEM careers and improve learning strategies, but it is limited to certain groups (Zaldívar Colado et al., 2018). Likewise, it was found that psycho-pedagogical follow-up detects learning difficulties. Therefore, it helps reduce cases of severe math anxiety among students (Hernández et al., 2022).

Based on the evidence, five lines of action are suggested: designing support programs with differentiated approaches, implementing systems for continuous and contextualized teacher training, expanding tutoring programs with personalized follow-up, strengthening links between academic departments, and establishing systems for monitoring and evaluating impacts.

3. CONCLUSIONS

The objective of the article was to identify the fundamental psychosocial aspects that determine the teaching-learning process of mathematics at the high school level. In this sense, the complex interaction between three dimensions was revealed: teachers, students, and institution. In the teaching sphere, the results highlighted the importance of four interrelated aspects: specific educational background in mathematics, mastery of up-to-date teaching tools, participation in systemic processes of continuous training, and development of psychosocial skills. The evidence showed that when these variables are properly articulated, educational practice is transformed. This creates effective and inclusive learning environments.

On the part of students, the analysis revealed five essential aspects that condition their relationship with mathematics: previous academic background, predominant learning styles, emotional and affective conditions, level of development of basic mathematical skills, and study habits. It is important to note that the high prevalence of adverse emotional states hinders learning. Finally, the institutional level identified three fundamental aspects that make a substantial difference to the quality of academic support programs: the quality of academic support programs, the strategies implemented for teacher training and updating, and the systems established to provide support to students. Institutions that have managed to articulate these aspects showed superior results in learning indicators.

Based on the analysis conducted, it is recommended to implement comprehensive teacher training strategies, holistic student interventions, systemic institutional policies, coordinated efforts, and continuous assessment strategies. These comprehensive and coordinated interventions can transform current challenges into opportunities for educational growth by training high school students. For example, strong mathematical skills are essential for the academic and professional development of high school students.

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Está dirigido a investigadores(as), docentes de todas las modalidades y niveles del sistema educativo, estudiantes de pregrado y posgrado, gestores(as) educativos(as), directivos(as) y demás profesionales interesados(as) en la investigación empírica y documental sobre el uso de la tecnología y la transformación digital en diversos ámbitos sociales, por ejemplo, la salud, el ocio, el turismo, las finanzas, la educación, el desarrollo comunitario, la industria, etcétera.

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