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Original article

Student perception of the use of mobile devices in learning Mathematics in the second year of high school

Percepción estudiantil sobre el uso de dispositivos móviles en el aprendizaje de matemáticas en segundo de bachillerato

Percepção dos alunos sobre o uso de dispositivos móveis na aprendizagem da matemática no segundo ano do ensino médio

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ABSTRACT

The use of mobile devices in education has sparked debate regarding their impact on mathematics learning, particularly at the General Unified Sixth Form level. The aim of this study was to analyze the perceptions of second-year General Unified Sixth Form students at the 'Olmedo' Educational Center regarding the use of mobile phones in mathematics learning. A quantitative study was conducted, employing a non-experimental design with a descriptive scope. The sample consisted of 40 students. An adapted and validated questionnaire was administered, comprising nine items distributed across three dimensions: attitudes towards mobile learning, interest in its use, and technological availability. The data were analyzed using descriptive statistics and graphical representations. The main findings revealed a moderately positive perception of mobile phone use in mathematics learning. The students recognized its educational potential and its accessibility as a

teaching resource. However, reservations were identified regarding academic participation in digital environments and technical limitations, mainly associated with connectivity issues. It is concluded that, although there is openness towards mobile learning, its effective integration into the classroom requires structured pedagogical strategies, intentional teacher mediation and institutional support aimed at ensuring adequate technological conditions.

Keywords: mobile learning; mobile devices; education in Ecuador; mathematics; student perception.

RESUMEN

El uso de dispositivos móviles en el ámbito educativo ha generado debates respecto a su influencia en el aprendizaje de las matemáticas, especialmente en el nivel de Bachillerato General Unificado. El objetivo del estudio estuvo dirigido a analizar la percepción de los estudiantes de segundo de Bachillerato General Unificado de la Unidad Educativa Olmedo sobre el uso del teléfono móvil en el aprendizaje de las matemáticas. Se realizó un estudio con enfoque cuantitativo, diseño no experimental y alcance descriptivo. La muestra estuvo conformada por 40 estudiantes. Se aplicó un cuestionario adaptado y validado, integrado por nueve ítems distribuidos en tres dimensiones: actitudes hacia el aprendizaje móvil, interés por su uso y disponibilidad tecnológica. Los datos fueron procesados mediante estadística descriptiva y representaciones gráficas**.** Los principales hallazgos evidenciaron una percepción moderadamente positiva sobre el uso del teléfono móvil en el aprendizaje de las matemáticas. Los estudiantes reconocieron su potencial educativo y su accesibilidad como recurso didáctico. No obstante, se identificaron reservas relacionadas con la participación académica en entornos digitales y limitaciones técnicas, principalmente asociadas a problemas de conectividad. Se concluye que, aunque existe apertura hacia el aprendizaje móvil, su integración efectiva en el aula requiere estrategias pedagógicas estructuradas, mediación docente intencionada y apoyo institucional orientado a garantizar condiciones tecnológicas adecuadas.

Palabras clave: aprendizaje móvil; dispositivos móviles; educación en Ecuador; matemáticas; percepción estudiantil.

RESUMO

O uso de dispositivos móveis na educação tem gerado debates sobre sua influência na aprendizagem da matemática, especialmente no nível do Ensino Médio. Este estudo teve como objetivo analisar as percepções de alunos do segundo ano do Ensino Médio da Unidade Educacional de Olmedo sobre o uso de celulares na aprendizagem da matemática. Foi realizado um estudo quantitativo, não experimental e descritivo. A amostra foi composta por 40 alunos. Foi aplicado um questionário adaptado e validado, composto por nove itens distribuídos em três dimensões: atitudes em relação à aprendizagem móvel, interesse em seu uso e disponibilidade tecnológica. Os dados foram processados utilizando estatística descritiva e representações gráficas. Os principais resultados revelaram uma percepção moderadamente positiva do uso de celulares na aprendizagem da matemática. Os alunos reconheceram seu potencial educacional e acessibilidade como recurso didático. No entanto, foram identificadas reservas relacionadas à participação acadêmica em ambientes digitais e limitações técnicas, principalmente associadas a problemas de conectividade. Conclui-se que, embora haja abertura em relação à aprendizagem móvel, sua integração efetiva na sala de aula requer estratégias pedagógicas estruturadas, mediação intencional do professor e apoio institucional voltado para a garantia de condições tecnológicas adequadas.

Palavras-chave: aprendizagem móvel; dispositivos móveis; educação no Equador; matemática; percepção estudantil.

INTRODUCTION

In the context of the digital age, smartphones, tablets, and other technological resources have become ubiquitous tools in students' daily lives. Their use is no longer restricted to entertainment and interpersonal communication, but now plays a strategic role in educational environments (Haleem *et al.*, 2022); this technological integration not only accompanies the learning process but also has the potential to transform teaching and learning practices by promoting personalization, interactivity, and ubiquitous access to knowledge (Hernández Argueta *et al.*, 2017).

Despite these advantages, concerns persist regarding their influence on mathematics learning (Vásconez Villavicencio & Pardo Paredes, 2020). On the one hand, mobile devices facilitate access to educational applications and interactive resources that can contribute to the understanding of

complex mathematical concepts. On the other hand, their inappropriate or excessive use can generate distractions, reduce effective study time, and foster technological dependence, affecting academic performance.

Several studies indicate that the use of cell phones in mathematics education is valuable when it is pedagogically guided and limited to complementary functions (Vera Macay, 2021). Along these lines, it is proposed that the device be understood as a supporting teaching resource and not as a substitute for the traditional teaching process. Strategies such as reserving its use for reinforcement activities or consultation outside of school hours allow its potential to be harnessed without interfering with classroom dynamics (Avendaño Porras & Hernández Hernández, 2022).

The debate surrounding cell phone use in academia generates both enthusiasm and concern. Proponents highlight immediate access to digital educational resources, the possibility of personalized learning, and the development of essential 21st-century technological skills (Major *et al.*, 2021; Hernández Martín, 2023). Furthermore, tools such as apps with gamification elements can increase student motivation and participation (Smirani & Yamani, 2024). However, adverse effects are also documented when use lacks clear pedagogical guidance. Constant notifications and digital multitasking can decrease concentration and negatively impact academic performance. Additionally, technological dependence can limit students' cognitive autonomy (Zhang & Xu, 2025). In the Ecuadorian context, the intensive use of cell phones during periods of virtual education reinforced their presence in the school environment. In contrast, other countries have adopted restrictive regulations to mitigate potential negative effects.

This problem is evident at the Olmedo Educational Unit, where a sustained increase in the use of mobile devices among second-year students of the Unified General Baccalaureate has been observed. Given that the subject of Mathematics demands high levels of concentration and systematic practice, it is pertinent to analyze how this technological trend affects the learning process.

Therefore, the general objective of this study is to describe the perception of the use of mobile devices within the mathematics learning process in second-year students of the Unified General Baccalaureate of the Olmedo Educational Unit.

Impact of cell phone use on mathematics learning

Mobile learning, or *mobile Mobile learning* (m-learning) is configured as an educational modality that relies on the use of portable technological devices, such as smartphones, tablets, laptops, personal digital assistants, and devices with augmented reality applications, facilitating ubiquitous, flexible, and personalized learning processes (Hasanah *et al.*, 2020). This form of learning allows students to access educational content in real time, without depending on a fixed physical space, favoring the contextualization and authenticity of knowledge (Traxler, 2007). From this perspective, m-learning is positioned as a dynamic extension of e-learning, with the added value of mobility and immediacy. Its integration into educational environments enables not only the efficient distribution of multimedia materials but also the implementation of strategies such as: task reminders via messaging, viewing of recorded classes, and participation in interactive assessments (Moura & Carvalho, 2008).

According to Rosman (2008), m-learning describes various ways in which people learn or stay connected to educational environments while on the go, interacting with peers, teachers, and instructional resources. The devices used are typically mobile phones or personal digital assistants, as well as the convergence of both in today's *smartphones.*

The ability to use mobile devices anytime, anywhere promotes personalized learning and its adaptation to individual needs. In this sense, m-learning constitutes an innovative tool within Information and Communication Technologies (ICTs), which enhances knowledge construction (Haleem *et al.*, 2022). Likewise, Krouska *et al.* (2021) argue that this modality not only provides mobility, but also promotes autonomy and self-efficacy through continuous access to educational resources.

From a constructivist perspective, m-learning is conceived as an opportunity for students to assume an active role in their learning process, establishing dynamic interactions with information, teachers, and peers (Zhang & Xu, 2025). Complementarily, connectivism emphasizes that learning in mobile environments arises from the creation of networks and connections between diverse sources of information, reinforcing the need to develop digital skills for their proper management (Martínez Hurtado *et al.*, 2025).

Consequently, mobile learning, when implemented with pedagogical intent, can increase motivation, foster active participation, and strengthen critical thinking—essential skills in contemporary

education. Furthermore, it represents an effective alternative within distance education modalities, expanding opportunities for access to knowledge.

The impact of m-learning on mathematics teaching has been extensively analyzed. Looi *et al.* (2021) point out that the use of specific mobile applications improves skills such as visualizing abstract concepts, problem-solving, and independent practice of mathematical procedures. Tools such as graphing calculators, algebra applications, and platforms with gamification elements constitute relevant support resources for this discipline.

In the school setting, the inclusion of mobile devices can foster greater participation and collaboration among students, facilitating real-time problem-solving and immediate feedback. However, the authors caution that their effectiveness depends on clear teaching strategies that define their pedagogical use.

Similarly, Vera Macay (2021) argues that the appropriate use of cell phones can help reduce math anxiety by offering more flexible and accessible practice environments. However, she emphasizes that their positive impact is contingent upon lesson planning and coherent methodological integration within the teaching and learning process.

Pedagogical approaches, perceptions and advantages of mobile learning

The adoption of mobile technologies in education is based on various contemporary pedagogical approaches. From a constructivist perspective, mobile devices function as mediating tools that enable the active construction of knowledge through contextualized, collaborative, and meaningful experiences (Siemens, 2019).

In line with this, connectivism, proposed by Downes (2020), argues that learning in digital environments occurs through the connection between multiple sources of information and knowledge nodes. The constant accessibility offered by mobile devices facilitates this process by enabling continuous interaction with content, platforms, and learning networks. This approach highlights the importance of developing students' skills in critical analysis, selection, and information management.

Likewise, active methodologies such as project-based learning (PBL) and the flipped *classroom Learning* methodologies find in mobile technologies a strategic support for the promotion of

meaningful learning. Smirani and Yamani (2024) argue that these methodologies, supported by mobile devices, strengthen creativity, autonomy, research capacity and collaborative work.

However, the effective integration of mobile technologies requires that the teacher assume a mediating and guiding role, designing activities with pedagogical intent and selecting relevant and high-quality digital resources.

From a teaching perspective, the use of mobile devices offers advantages such as the diversification of teaching strategies, access to updated resources, and the possibility of implementing immediate formative assessments. Furthermore, it facilitates addressing the diversity of learning styles and paces present in the classroom. However, challenges have also been identified, such as the risk of distractions, technological dependence, and the persistence of the digital divide between students with varying access to technological resources (Hernández Argueta *et al.*, 2017). Added to this is the need for ongoing training for effective pedagogical integration.

From a student's perspective, the main perceived advantages include flexibility in accessing content, autonomous and personalized learning, and dynamic interaction with educational materials (Mendoza *et al.,* 2022). Furthermore, mobile learning can strengthen a sense of responsibility and self-management.

However, among the disadvantages noted are the difficulty in maintaining concentration due to the multiple distractions present in mobile devices, information overload, and the need to develop self-regulation skills for their proper use.

In summary, m-learning and the pedagogical use of mobile devices represent a significant opportunity for educational innovation; however, their effectiveness depends on rigorous didactic planning and continuous training for both teachers and students.

MATERIALS AND METHODS

Research approach, type and design

The study was developed under a quantitative approach, with a non-experimental cross-sectional design, because the variables were not deliberately manipulated, and the data collection was carried out at a single point in time.

Furthermore, the research was designed with a descriptive scope, aimed at characterizing students' perceptions of mobile device use in mathematics learning. Therefore, it did not seek to establish causal relationships or measure direct effects on academic performance, but rather to identify perceptual trends associated with the use of mobile technologies in the educational context. This methodological choice is consistent with the study's purpose, which is to explore how students value the incorporation of mobile devices into the learning process, especially in school settings where their pedagogical integration is still developing.

Participants

The population consisted of 120 second-year students of Unified General Baccalaureate (BGU) from the Olmedo Educational Unit.

The sample was selected using non-probability convenience sampling, considering those students who voluntarily agreed to participate in the study and who met the criterion of frequent use of mobile devices in their academic life. This criterion ensured that the participants had direct experience with the phenomenon under investigation.

The final sample consisted of 40 students, aged between 15 and 16 years. In addition, sociodemographic data such as gender, age, and academic year were collected to characterize the sample and contextualize the results obtained.

Sociodemographic characterization of the sample

Table 1 shows the main demographic characteristics of the participants. Regarding gender, 62.5% were female and 37.5% were male. As for age, 70% were 16 years old, while 30% were 15 years old.

In relation to the academic parallel, the distribution was as follows: Second BGU C (43.6%), Second BGU B (35.9%) and Second BGU D (20.5%).

Table 1. Demographic characteristics of the participants

Variable	Category	%
Gender	Male	37.5
	Female	62.5
Age	15 years	30.0
	16 years old	70.0
Academic parallel	Second BGU B	35.9
	Second BGU C	43.6
	Second BGU D	20.5

Data collection instrument

For data collection, a structured questionnaire entitled *Mobile Learning and Its Effectiveness in Mathematics* was used, adapted from previous studies with empirical validation (Yosiana et al., 2021). The instrument was applied in digital format using the Google Forms platform.

The questionnaire consisted of nine items distributed across three analytical dimensions related to student perception of mobile learning in the area of mathematics:

a) Attitudes towards mobile learning: included three items (1, 2 and 3), aimed at exploring the general perception of the flexibility and potential of mobile devices to facilitate learning in different contexts.
b) Interest in learning with mobile technologies: comprised of two items (4 and 5), intended to investigate the level of motivation, involvement and evaluation of academic content mediated by mobile devices.
c) Technological availability and technical conditions made up of four items (6, 7, 8 and 9), which evaluate access to technological resources and possible logistical or technical barriers that may limit active participation in mobile learning environments.

Responses were recorded using a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). Two negatively worded items were included to control for acquiescence or automatic responses.

Prior to its application, the instrument was subjected to a process of translation and cultural adaptation, following the methodological guidelines proposed by Hambleton *et al.* (2004) and Muñiz *et al.* (2013), in order to guarantee its semantic, idiomatic and contextual equivalence in the Ecuadorian educational field.

Subsequently, content validation was performed through expert judgment in mathematics education and educational technologies, who evaluated the relevance, clarity, and coherence of the items. In a subsequent phase, a pilot test was conducted with students of similar characteristics to the study sample, which allowed verification of clarity, comprehension, and response time, resulting in minor adjustments to the wording of some items.

The internal consistency of the instrument was calculated using Cronbach's alpha coefficient, obtaining a value of $\alpha=0.82$ for the total scale, which indicates an adequate level of reliability for descriptive studies.

Finally, the questionnaire was administered to the selected sample through an online form, guaranteeing the ethical principles of research, such as informed consent, confidentiality of information and anonymity of responses.

Data analysis

Data processing and analysis were performed using SPSS statistical software version 27. Prior to analysis, items formulated in a negative sense were recoded in order to maintain consistency in the interpretation of the scale.

Due to the descriptive nature of the study, descriptive statistics were used for data analysis. Relative frequencies were calculated to characterize the sociodemographic variables (gender, age, and academic section), as well as the means for each of the questionnaire items. The results were organized into descriptive tables and presented graphically.

RESULTS

Analysis of the general perception of mobile phone use in mathematics learning

To gain an overview of the trends observed in student perception, average values were calculated for each of the dimensions assessed in the questionnaire. Table 2 presents the results for the three dimensions analyzed: attitudes toward mobile learning, interest in learning with mobile technologies, and technological availability.

Table 2. Average student perception by dimension

Dimension	Items	Average
Attitudes towards mobile learning	1, 2, 3	3.50
Interest in learning with mobile technologies	4, 5	3.34
Technological availability and technical conditions	6, 7, 8, 9	2.82

The results show that the dimension with the highest rating corresponds to attitudes towards mobile learning (M=3.50), which demonstrates a relatively favorable perception regarding the educational potential of mobile devices.

The dimension of interest in learning with mobile technologies (M=3.34) presented a moderate rating, suggesting that, although students recognize the value of these tools, their motivation to use them in learning mathematics is not completely high.

Finally, the technological availability and technical conditions dimension (M=2.82) registered the lowest average value, which shows the presence of limitations mainly associated with technical factors, such as internet connectivity or stable access to digital resources.

Analysis of student perception by item

To examine the observed trends in greater detail, table 3 presents the means and standard deviations for each of the questionnaire items. The values ranged from 2.23 to 3.95 on a five-point Likert scale.

Table 3. Average and standard deviation per item of the questionnaire

Item	Summary statement	Average
1	Study mathematics anywhere, anytime	3.50
2	I learned new things with my mobile phone that went beyond the book.	3.95
3	I enjoy participating in online discussions	3.05
4	I'm interested in learning math using my mobile phone.	3.55
5	Online materials help to understand better	3.13
6	Working online is a waste of time	2.53
7	I have a mobile device available.	3.80
8	I experienced network issues during mobile learning.	2.70
9	Learning with a mobile phone is a waste of learning space	2.23

In this analysis, it is noted that the item with the highest score was Item 2 (M=3.95), related to the discovery of new knowledge through the use of the mobile phone, beyond the use of the textbook; this suggests that students perceive the device as a useful tool to expand access to academic information.

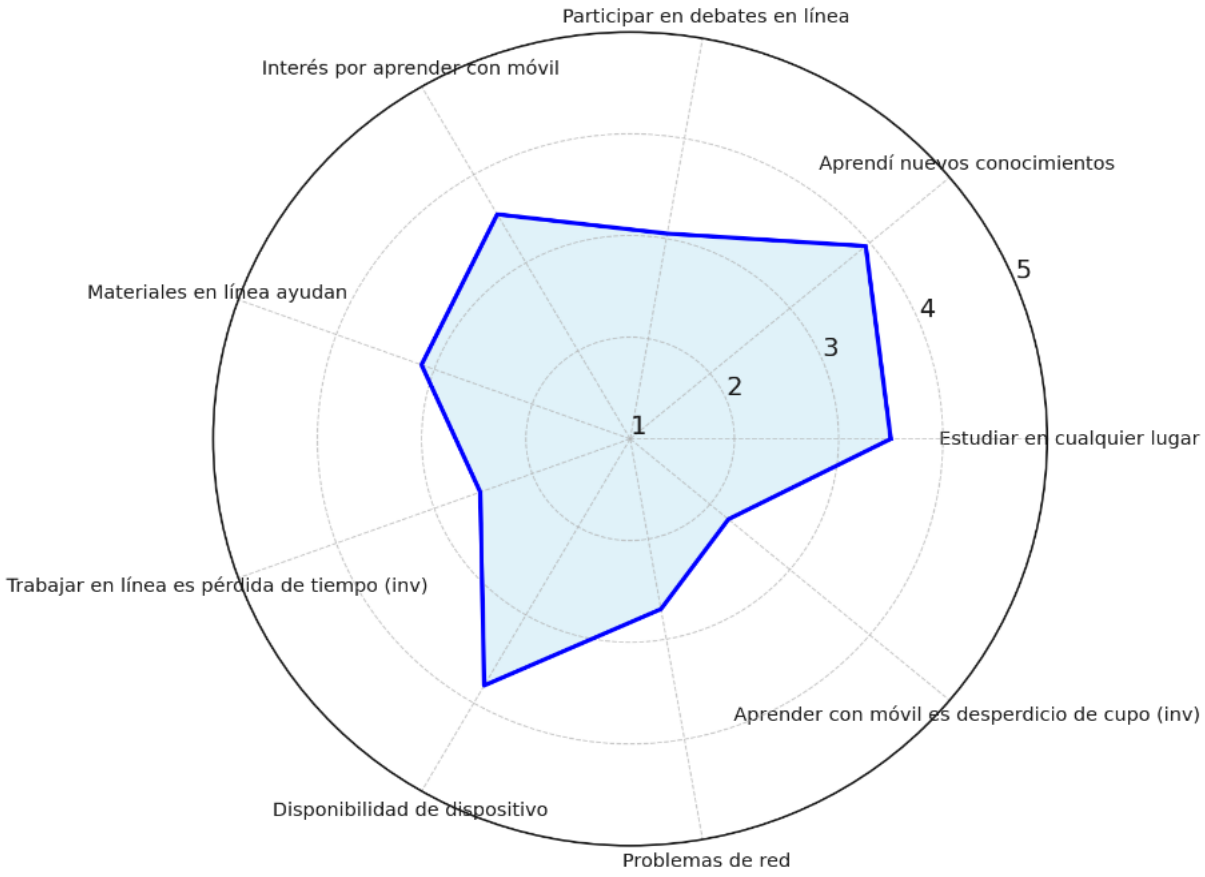
Similarly, Item 7 (M=3.80) revealed a high availability of mobile devices among participants, confirming the widespread presence of these technologies in the student environment. Regarding interest in learning mathematics using mobile phones, Item 4 (M=3.55) reflected a moderately favorable assessment. However, items associated with participation in digital environments, such as Item 3 (M=3.05) and Item 5 (M=3.13), showed intermediate values, suggesting that academic interaction mediated by mobile devices is still at moderate levels.

On the other hand, items phrased negatively received the lowest scores, particularly items 9 (M=2.23) and 6 (M=2.53). These results indicate a low level of agreement with statements questioning the educational value of mobile learning, suggesting that students do not express a clearly negative perception of device use in academic contexts.

Regarding technological conditions, Item 8 (M=2.70) showed the presence of connectivity difficulties in part of the sample, which could influence the continuity of the use of digital resources in educational activities.

Integrated visualization of student perception

To provide an integrated representation of students' perceptions of mobile phone use in mathematics learning, a radar chart was created using the average values obtained for each of the nine questionnaire items (Graph 1). This graphical representation allows for a comparative visualization of the trends observed in students' perceptions of mobile phone use in mathematics learning.



Graph 1. Average perception of mobile phone use in learning mathematics

The graph shows that the highest values are concentrated in items related to access to mobile devices and the discovery of new knowledge, while intermediate values are associated with participation in digital environments and the use of online educational materials. Likewise, the lowest values correspond to items phrased negatively, confirming a low acceptance of unfavorable perceptions toward mobile learning.

Taken together, these results suggest that students recognize the educational potential of mobile phones as a support resource in learning mathematics, although their integration into more interactive and collaborative academic activities still shows moderate levels of participation.

DISCUSSION

The study results show a moderately positive perception among second-year high school students regarding the use of mobile phones in learning mathematics. While participants acknowledge the device's educational potential and report high technological availability, their levels of participation in digitally mediated academic activities remain moderate. This apparent contradiction suggests that the presence of mobile devices in the educational environment does not automatically translate into effective learning processes, confirming that access to technology is a necessary, but not sufficient, condition for promoting significant pedagogical transformations.

The results align with those reported by Qiang *et al.* (2025), who, in an analysis of research trends on mobile learning in mathematics education, identified a sustained increase in studies since 2020; however, they also emphasized that the positive effects on learning depend primarily on the pedagogical design that guides the technological integration. Similarly, Güler *et al.* (2022) demonstrate that mobile learning can generate significant improvements in mathematical performance when technological applications are incorporated within structured teaching strategies aimed at developing problem-solving skills.

For their part, Jara Ulloa & Casillas Alcalá (2025) suggest that, although the use of mobile devices can improve autonomy and access to educational resources, their impact on academic performance in mathematics is not always significant. Similarly, the systematic review by Pedraja Rejas *et al.* (2024) concludes that the integration of mobile tools has the potential to improve both learning outcomes and critical thinking in university students, although it emphasizes that these effects are maximized when teaching strategies are accompanied by appropriate instructional design and effective teacher mediation.

However, the results of this study suggest that, in the analyzed context, the educational use of mobile devices is still in its early stages. Although students acknowledge that mobile phones facilitate access to additional information and educational resources beyond traditional materials, their participation in digitally mediated collaborative or interactive activities remains limited. This finding aligns with that reported by Macías Giler *et al.* (2025), who document that the daily use of mobile phones among adolescents does not always translate into productive learning practices, as it is frequently characterized by digital multitasking and fragmented information consumption.

From a pedagogical perspective, this situation can be interpreted as a manifestation of the existing gap between technological availability and meaningful educational use. Several studies have indicated that the presence of digital devices in the classroom does not, in itself, guarantee an improvement in learning processes, especially when their incorporation is not accompanied by clear instructional planning (Major *et al.*, 2021). In the specific case of mathematics education, Looi *et al.* (2021) highlight that mobile technologies can facilitate the visualization of abstract concepts and promote independent practice, but their effectiveness depends on how these tools are integrated with the learning objectives and the pedagogical strategies implemented by the teacher.

Furthermore, the results highlight the influence of contextual factors that condition the implementation of mobile learning. The scores associated with connectivity problems demonstrate that limitations in technological infrastructure continue to represent an obstacle to the full integration of digital resources in the classroom. This situation has been widely documented in studies on digital education in developing countries, where inequalities in access to connectivity networks can restrict the use of educational technologies (Haleem *et al.*, 2022).

From a theoretical perspective, the study's findings can be interpreted in light of approaches such as constructivism and connectivism. Mobile learning, when implemented appropriately, can foster active knowledge construction processes by allowing students to interact with multiple sources of information and establish connections between different educational resources. However, as Zhang and Xu (2025) point out, the intensive use of digital technologies can also generate dynamics of technological dependence when self-regulation and critical thinking skills are not developed simultaneously. In this sense, the moderate perception of academic engagement in digital environments observed in the study could reflect an initial stage of technological appropriation in which students are still developing competencies to use mobile devices for educational purposes.

Furthermore, the study provides relevant evidence for the contemporary debate on regulating the use of mobile devices in educational institutions. Restrictive policies have been implemented in various school systems to limit their presence in the classroom due to concerns related to distraction and loss of attention (Muñoz Sancho *et al.*, 2025). However, the results obtained suggest that the discussion should not focus exclusively on prohibiting or permitting the use of these devices, but rather on developing pedagogical strategies that guide their use toward meaningful academic activities.

The study's findings support the idea that mobile learning represents a significant opportunity for educational innovation in mathematics, but its transformative potential depends largely on pedagogical mediation and institutional conditions. In this regard, recent research has demonstrated its potential to improve student engagement, the visualization of abstract concepts, and academic performance (Güler *et al.*, 2022; Martínez Gómez & Nicolalde, 2025). Therefore, teacher training in the pedagogical use of digital technologies and the strengthening of school technology infrastructure emerge as key factors for advancing toward teaching models that effectively integrate mobile devices into mathematics learning. (Meylani, 2025).

Regarding the study's objective, the results indicate that students' perception of mobile device use in mathematics learning is moderately positive, although influenced by pedagogical and technological factors. These findings are related to the current regulatory framework of the Ecuadorian education system, particularly Ministerial Agreement No. MINEDUC 2025-00015-A issued by the Ecuadorian Ministry of Education, which states that mobile devices are not mandatory school supplies in educational institutions. This provision reinforces the need to develop institutional policies and pedagogical guidelines that allow for the responsible and coherent integration of these technologies with educational objectives.

The results indicate that high school students have a moderately positive view of mobile phone use in learning mathematics; however, both favorable perceptions and reservations about its pedagogical usefulness coexist. While its widespread availability and potential to facilitate access to educational content are acknowledged, participation in digitally mediated academic activities remains at intermediate levels, reflecting a gap between access to technology and its effective integration into teaching practices.

The educational use of mobile devices is considered to depend not only on their availability, but also on teacher guidance, the design of teaching strategies that direct their use for academic purposes, and institutional conditions that favor their integration into the classroom. Furthermore, limitations related to technological connectivity continue to be a factor that hinders the effective use of mobile learning in school settings.

Overall, the study indicates that mobile devices can be a valuable supplementary resource for mathematics learning when integrated into structured pedagogical approaches. Consequently, teacher training in the pedagogical use of digital technologies and the strengthening of school

technology infrastructure emerge as key elements for promoting a more effective integration of mobile learning in education.

Limitations of the study

The study has some limitations that should be considered when interpreting the results. First, the sample size was relatively small (n=40) and was selected using non-probability convenience sampling, which limits the generalizability of the results to other educational contexts or student populations. While the sample provided an initial approximation of the phenomenon analyzed, future studies could increase the number of participants and incorporate probabilistic sampling procedures to strengthen the representativeness of the data.

Secondly, the research was conducted at a single educational institution, meaning that the results reflect the specific conditions of the institutional context studied, particularly regarding pedagogical practices and technological connectivity. Therefore, future comparative studies could analyze different educational institutions to provide a broader understanding of the impact of mobile learning on mathematics education.

The data obtained are based on students' perceptions of mobile device use in mathematics learning, which means the results reflect subjective assessments and not necessarily direct effects on academic performance. Future studies could complement this type of perceptual analysis with objective indicators of academic performance or experimental designs that evaluate the impact of mobile learning on learning outcomes.

Finally, the research focused on a descriptive analysis of the data, so it was not possible to explore more complex statistical relationships between variables or potential differences based on students' sociodemographic characteristics. Future research could incorporate inferential analyses or statistical models to deepen our understanding of the factors that influence the effective integration of mobile devices in mathematics learning.

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Conflict of interest

Authors declare no conflict of interests.

Authors' contribution

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.

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