



Impact of digital technologies on the educational inclusion of students with disabilities

Impacto de las tecnologías digitales en la inclusión educativa de estudiantes con discapacidad

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ABSTRACT

This research analyzed the impact of inclusive digital technologies on the educational inclusion of university students belonging to different careers of a Bolivian university. The study was developed under a quantitative approach, with a pre-test and post-test pre-experimental design applied to a sample of 180 university students. The purpose of the research was to evaluate the variations produced in digital accessibility, academic participation, teacher-student interaction, autonomy in learning and technological satisfaction after an intervention based on inclusive digital tools. A structured questionnaire with a Likert-type scale validated by expert judgment and with a high reliability determined by Cronbach's Alpha ($\alpha = 0.91$) was used for data collection. The technological intervention included accessible virtual platforms, adapted digital materials, collaborative tools and technological resources aimed at strengthening educational inclusion processes. The results showed significant increases in all the dimensions evaluated during the post-test, highlighting improvements in digital accessibility and technological satisfaction. Statistical analyses using Student's t-test for related samples confirmed statistically significant differences between the pretest and the posttest ($p < 0.05$). It is concluded that inclusive digital technologies contribute positively to the strengthening of more accessible, participatory, and equitable university environments for students with disabilities within the Bolivian higher education context.

Keywords: inclusive education, digital technologies, educational accessibility, university students, disability.

RESUMEN

La presente investigación analizó el impacto de las tecnologías digitales inclusivas en la inclusión educativa de estudiantes universitarios pertenecientes a diferentes carreras de una universidad boliviana. El estudio se desarrolló bajo un enfoque cuantitativo, con diseño preexperimental de tipo pretest y postest aplicado a una muestra de 180 estudiantes universitarios. La investigación tuvo como propósito evaluar las variaciones producidas en accesibilidad digital, participación académica, interacción docente-estudiante, autonomía en el aprendizaje y satisfacción tecnológica después de una intervención basada en herramientas digitales inclusivas. Para la recolección de datos se utilizó un cuestionario estructurado con escala tipo Likert validado mediante juicio de expertos y con una confiabilidad alta determinada mediante Alfa de Cronbach ($\alpha = 0,91$). La intervención tecnológica incluyó plataformas virtuales accesibles, materiales digitales adaptados, herramientas colaborativas y recursos tecnológicos orientados a fortalecer procesos de inclusión educativa. Los resultados evidenciaron incrementos significativos en todas las dimensiones evaluadas durante el postest, destacándose mejoras en accesibilidad digital y satisfacción tecnológica. Los análisis estadísticos mediante la prueba t de Student para muestras relacionadas confirmaron diferencias estadísticamente significativas entre el pretest y el postest ($p < 0,05$). Se concluye que las tecnologías digitales inclusivas contribuyen positivamente al fortalecimiento de entornos universitarios más accesibles, participativos y equitativos para estudiantes con discapacidad dentro del contexto de educación superior boliviano.

Palabras clave: educación inclusiva, tecnologías digitales, accesibilidad educativa, estudiantes universitarios, discapacidad.

INTRODUCTION

Educational inclusion constitutes a primary challenge for higher education institutions due to the need to guarantee equal opportunities, accessibility, and academic participation for students with disabilities. Padilla-Muñoz (2011) argues that educational inclusion involves eliminating pedagogical, social, and structural barriers that limit the effective participation of students within learning environments. From this perspective, universities have begun to incorporate digital technologies aimed at strengthening accessibility and academic retention processes.

Advancements in information and communication technologies have transformed traditional teaching models through virtual platforms, multimedia resources, and digital tools adapted to diverse educational needs. Various studies show that ICTs facilitate more participatory and accessible educational experiences in inclusive contexts (Reyes Chávez & Prado Rodríguez, 2020). In this regard, Romero Martínez et al. (2018) argue that inclusive technological tools allow instructional content and methodologies to be adapted to the characteristics of students with disabilities.

In the university context, digital technologies have gained relevance due to their capacity to enhance academic autonomy, communication, and access to educational resources. Cabezas Cerna et al. (2025) point out that accessible technological tools promote the active participation of university students with functional diversity through adaptive platforms and inclusive digital resources. These strategies contribute to reducing barriers related to information access and academic interaction processes (Cepeda Navarrete et al., 2023).

Inclusive digital technologies have also fostered the development of cognitive and communicative skills in students with intellectual disabilities. Laabidi et al. (2014) highlight that learning technologies for individuals with disabilities represent a fundamental element for expanding educational opportunities and strengthening academic inclusion. These tools facilitate more adaptive and accessible teaching processes within university environments (Cubillos-Bravo & Avello-Sáez, 2022).

The development of assistive technologies has generated new possibilities for strengthening educational inclusion within universities. López and Valenzuela (2015) argue that special educational needs require adaptive strategies designed to guarantee participation and equitable access within educational processes. In recent years, the growth of emerging technologies and systems based on artificial intelligence has expanded educational accessibility alternatives (Kooli & Chakraoui, 2025).

From another perspective, Pérez Saavedra and Tornero Roballo (2025) consider that emerging technologies represent an innovative alternative for strengthening inclusive educational processes through adaptive digital tools. These technological innovations allow for a more efficient response to the diverse educational needs present within the university context (Rajapakshe et al., 2026).

Digital accessibility currently constitutes a critical component of inclusive university education. Zúñiga Bolívar and Hincapié Gallón (2021) showed that physical and structural barriers still exist that limit the effective inclusion of students with disabilities within university institutions. These limitations affect access to virtual platforms, educational materials, and academic interaction processes (Montiel Arreaga & Falquez Torres, 2024).

Various studies have shown that the integration of digital technologies promotes participation and academic inclusion. Valenzuela et al. (2020) highlight that digital technologies strengthen educational integration and the participation of students belonging to vulnerable groups within university contexts. The use of accessible platforms and inclusive digital tools enables the creation of more participatory and equitable educational environments (Laitón Zárate et al., 2017).

Enhancing teachers' digital competencies represents another critical factor for the development of inclusive practices mediated by digital technologies. López Cabrera et al. (2019) consider that the adoption of educational technologies depends significantly on teacher training processes, pedagogical innovation, and institutional support. From a social and educational perspective, inclusion requires understanding dimensions related to participation, equity, and the recognition of diversity within university spaces (Iarskaia-Smirnova et al., 2024).

In Bolivia, universities face challenges related to technological accessibility, curricular adaptation, and support for students with disabilities within increasingly digitalized educational contexts. The need to strengthen inclusion processes through accessible technological tools has generated interest in conducting research to measure the impact of digital technologies on university students across different majors. In this context, the present study aimed to analyze the impact of an intervention based on inclusive digital technologies using a pretest-posttest design applied to 180 university students from a Bolivian university.

METHODS

The present research was developed under a quantitative approach because it allowed measuring and comparing the impact of inclusive digital technologies on the educational inclusion of university students with disabilities through the statistical analysis of the data obtained during the research process. The study was oriented toward the collection of objective information related to accessibility, academic participation, educational interaction, and perception of inclusion before and after the application of a technological intervention.

The type of research was applied, as it sought to generate knowledge oriented toward solving problems related to educational inclusion within the university context through the use of inclusive technological tools. Likewise, a descriptive and comparative scope was developed because the characteristics of the studied phenomenon were analyzed and subsequently the results obtained between the pretest and posttest applied to the participants were compared.

The research design corresponded to a pre-experimental study with pretest and posttest measurement in a single group. This design allowed evaluating the changes produced after the technological intervention applied to university students belonging to different majors at a university in Bolivia. Initially, a pretest was applied to diagnose the level of educational inclusion perceived by the students before the intervention. Subsequently, a process of implementing inclusive digital technologies was developed, and finally, a posttest was applied with the purpose of identifying variations in the analyzed dimensions.

The population consisted of university students belonging to different academic majors at a Bolivian university. The sample was composed of 180 students selected through non-probability convenience sampling, considering criteria related to availability, voluntary participation, and access to technological tools used during the research. The participants presented different academic characteristics and conditions related to educational accessibility and the use of digital resources within the university environment.

As inclusion criteria, students officially enrolled in the university during the corresponding academic period, students who agreed to voluntarily participate in the research, and students with regular access to institutional digital platforms and resources were considered. Participants who did not complete the technological intervention activities or who presented incomplete questionnaires during any of the phases of the study were excluded.

The technique used for data collection was the survey. As an instrument, a structured questionnaire with a Likert-type scale of five response options was used: never, almost never, sometimes, almost always, and always. The instrument consisted of 25 items distributed across five dimensions: digital accessibility, academic participation, teacher-student interaction, autonomy in learning, and satisfaction with the use of inclusive digital technologies.

The digital accessibility dimension evaluated aspects related to ease of access to virtual platforms, adapted materials, and accessible technological resources. The academic participation dimension analyzed the level of student involvement in educational activities mediated by digital technologies. The teacher-student interaction allowed assessing communication and academic guidance during the educational process. Autonomy in learning evaluated the students' capacity to develop academic activities through digital tools. Finally, the technological satisfaction dimension examined the perception of usefulness and effectiveness of the implemented inclusive technologies.

The instrument was subjected to a validation process through expert judgment consisting of specialists in inclusive education, educational technology, and research methodology. The observations made allowed improving the clarity, relevance, and coherence of the items established within the questionnaire. Subsequently, a pilot test was developed with university students who were not part of the final sample, with the purpose of verifying comprehension, application time, and internal consistency of the instrument.

The reliability of the questionnaire was determined using Cronbach's alpha coefficient, obtaining a value considered adequate to guarantee stability and internal consistency in the responses obtained. This procedure ensured the statistical reliability of the instrument applied during the pretest and posttest phases.

The technological intervention lasted eight weeks and consisted of the implementation of inclusive digital tools aimed at strengthening the accessibility and academic participation processes of the students. During this period, accessible virtual platforms, adapted multimedia materials, digital readers, automatic subtitles, collaborative tools, and technological resources designed to promote interaction and inclusive learning within the university environment were used.

Data collection was carried out in two moments. In the first phase, the pretest was applied before starting the technological intervention to identify the initial level of educational inclusion perceived by the participants. In the second phase, the posttest was applied at the end of the intervention with the purpose of comparing the results and determining the variations produced after the implementation of the inclusive digital tools. For data processing, the Statistical Package for the Social Sciences (SPSS) version 26 software was used. Descriptive statistics procedures were applied using frequencies, percentages, means, and standard deviations to analyze the behavior of the studied variables.

This study adhered to ethical principles regarding confidentiality, anonymity, and the voluntary participation of students. All participants were informed of the study objectives and provided informed consent. The collected data were used solely for academic and scientific purposes, ensuring the protection of participants' personal information throughout the research process.

Results

The results revealed significant differences in the dimensions of educational inclusion following the implementation of inclusive digital technologies among university students from various majors. Pretest and posttest comparisons showed improvements in digital accessibility, academic participation, teacher-student interaction, learning autonomy, and technological satisfaction.

Prior to the final administration of the instrument, a reliability analysis was performed using Cronbach's alpha coefficient to verify the internal consistency of the questionnaire. The statistical analysis yielded the following result:

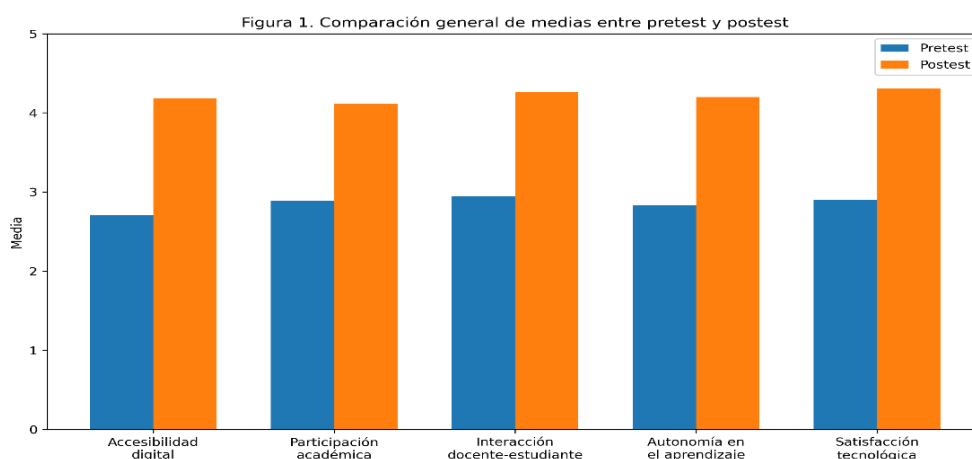
The obtained value demonstrated high reliability for the instrument, indicating adequate internal consistency among the items comprising the evaluated dimensions. This result ensured stability and precision in measuring the variables related to educational inclusion and inclusive digital technologies among the participating university students.

General comparison between pretest and posttest

Descriptive analyses showed increases in all evaluated dimensions following the technological intervention. Digital accessibility had a mean of 2.71 in the pretest and 4.18 in the posttest. Academic participation increased from 2.89 to 4.11, while teacher-student interaction increased from 2.95 to 4.26. Similarly, learning autonomy increased from 2.83 to 4.20, and technological satisfaction reached a final mean of 4.31, compared to the initial mean of 2.90.

Figure 1 presents the general comparison of means obtained before and after the intervention using inclusive digital technologies.

Figure 1. General comparison of means between pretest and posttest



Note. The figure represents the differences obtained in the evaluated dimensions. Source: Own elaboration.

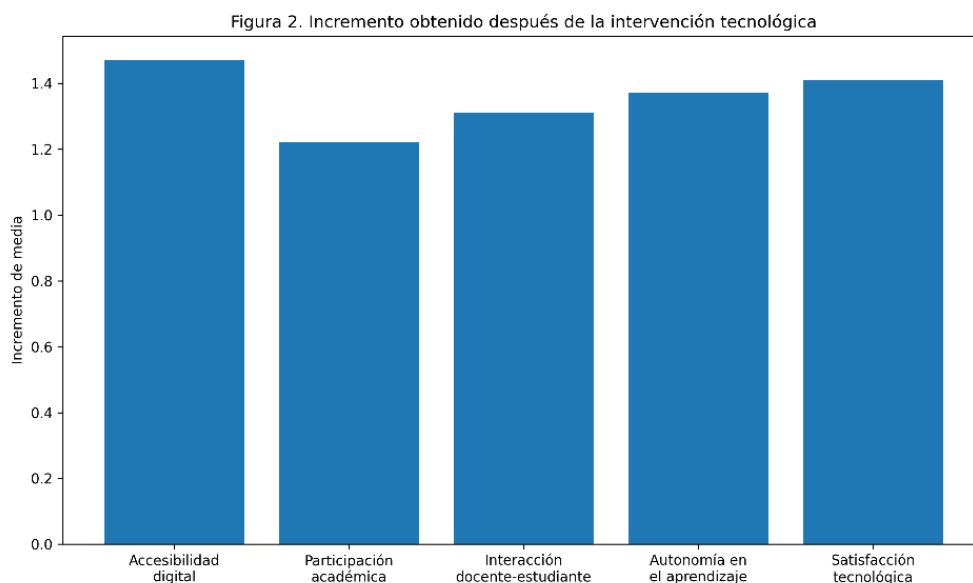
The results showed a significant increase in all analyzed dimensions. The greatest changes were recorded in technological satisfaction and digital accessibility, demonstrating that the implementation of inclusive digital tools enhanced access to educational resources, virtual platforms, and academic activities adapted to the needs of the participating students.

Increase in results after the technological intervention

Comparative analysis revealed that all dimensions increased after the implementation of inclusive digital technologies. Digital accessibility increased by 1.47 points, while technological satisfaction increased by 1.41 points. Learning autonomy increased by 1.37 points, and teacher-student interaction grew by 1.31 points. Finally, academic participation showed a positive difference of 1.22 points between the pretest and posttest.

Figure 2 shows the increase obtained in each evaluated dimension after the technological intervention.

Figure 2. Increase obtained after the technological intervention



Note. Pretest and posttest results for the dimensions of educational inclusion and inclusive digital technologies. Source: Own elaboration.

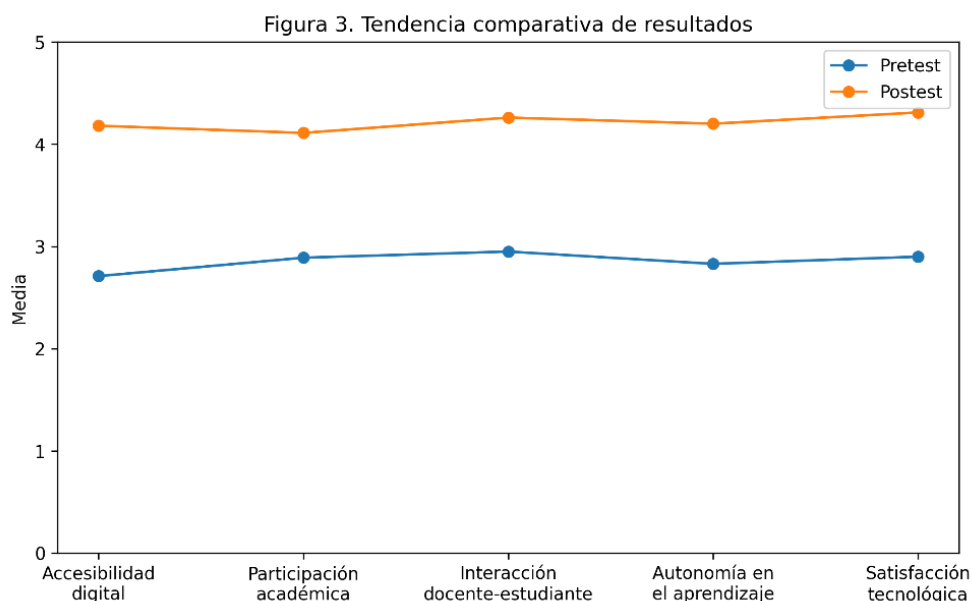
The figure indicates that inclusive digital technologies generated substantial improvements in accessibility and student satisfaction, showing that the implemented tools enhanced the conditions for learning and academic participation within the university environment. Similarly, the improvements observed in teacher-student interaction and academic autonomy reflect greater student integration during educational activities mediated by digital technologies.

Comparative trend of results

The overall results showed an upward trend in all evaluated dimensions following the technological intervention. Students reported higher levels of academic participation, educational interaction, and learning autonomy through the use of the accessible platforms, adapted materials, and inclusive digital tools implemented during the study.

Figure 3 presents the comparative trend of the results obtained in the pretest and posttest.

The overall results showed that all dimensions evolved positively after the technological intervention. The upward trend in the means demonstrates that inclusive digital tools contributed significantly to strengthening accessibility, academic communication, student participation, and technological satisfaction within the evaluated university context.

Figure 3. Comparative trend of results between pretest and posttest.

Note. Behavior of the evaluated dimensions before and after the implementation of inclusive digital technologies in university students. Source: Own elaboration.

Finally, statistical analyses using Student's t-test for paired samples revealed statistically significant differences between pretest and posttest scores across all analyzed dimensions ($p < 0.05$). These results indicate that the intervention based on inclusive digital technologies had a positive effect on the educational inclusion of the participating university students.

DISCUSSION

The results of this study demonstrate that the implementation of inclusive digital technologies led to significant improvements in digital accessibility, academic participation, teacher-student interaction, learning autonomy, and technological satisfaction among university students from various majors. The differences observed between the pretest and posttest scores reflect the positive impact of the digital tools implemented during the intervention.

The findings regarding digital accessibility align with those of Tecnología educativa Puentes Orozco et al. (2026), who argue that technological accessibility is an essential component for ensuring equal educational opportunities. The results of this study demonstrate that accessible platforms and adapted materials fostered more inclusive educational conditions for the participating students (Rizk & Hillier, 2022).

The positive perception of technological satisfaction aligns with the findings of Romero Figuera (2024), who argues that ICT and inclusive communication are fundamental elements for strengthening more accessible and participatory higher education models. The satisfaction reported by students post-intervention reflects a favorable acceptance of the digital resources implemented during the study (Reeves-Huapaya et al., 2025).

The results regarding academic autonomy indicate that inclusive digital technologies enhanced independent learning capacities among university students. Zambrano Sánchez et al. (2026) assert that digital technologies are valuable tools for improving accessibility and inclusive learning processes. These improvements also align with research analyzing inclusive educational technologies across various educational levels (Ranzato et al., 2025).

The results also highlighted challenges related to technological implementation and institutional sustainability. Murillo-Jiménez et al. (2025) identified barriers linked to insufficient infrastructure, institutional limitations, and limited technological integration in inclusive education. Throughout the study, the need to further strengthen technological resources and teacher training to consolidate permanent inclusive processes within the university context was evident (Maia Ferreira et al., 2015).

The improvements observed in academic participation and educational interaction relate to the findings of Tiwari et al. (2015), who state that teacher perceptions and beliefs directly influence the implementation of inclusive practices within educational institutions. Our results demonstrate that academic support and the use of accessible digital platforms facilitated more effective educational communication processes among university students with disabilities.

The findings of this study demonstrate that inclusive digital technologies represent an effective means to strengthen educational inclusion, academic accessibility, and student participation within the Bolivian university context. The improvements recorded post-intervention show that implementing adapted technological tools can significantly contribute to developing more accessible, participatory, and equitable educational environments for students with disabilities.

CONCLUSIONS

This study demonstrates that the implementation of inclusive digital technologies had positive effects on the educational inclusion of university students from various majors at a Bolivian university. Comparing pretest and posttest scores revealed significant improvements in digital accessibility, academic participation, teacher-student interaction, learning autonomy, and technological satisfaction following the intervention.

The findings indicate that inclusive digital tools facilitated access to virtual platforms, adapted educational materials, and accessible technological resources, thereby fostering more equitable academic conditions for the participating students. The increase observed in the digital accessibility dimension demonstrates that incorporating adapted technologies reduced difficulties related to virtual navigation, content access, and participation within the university environment.

The study also demonstrates that inclusive digital technologies enhanced academic participation and educational interaction between students and teachers. The improvements in communication, collaboration, and academic support show that the implemented accessible virtual platforms and technological tools strengthened student integration during the intervention activities.

Another key finding was the enhancement of the participants' learning autonomy and technological satisfaction. Students reported greater independence in completing academic activities using inclusive digital resources, reflecting a positive perception of the utility and functionality of the technologies applied within the university context.

The results obtained indicate that inclusive digital technologies represent an effective strategy for promoting educational inclusion among university students with disabilities. However, the research also highlights the need to continue strengthening processes related to teacher training, institutional accessibility, and technological infrastructure to guarantee the sustainability of inclusive practices within higher education.

The application of inclusive digital tools contributed to the development of more participatory, accessible, and equitable educational environments, demonstrating that the integration of adapted technologies can significantly enhance teaching and learning processes in university contexts. These findings provide relevant evidence of the potential of digital technologies to strengthen educational inclusion within the Bolivian and Latin American contexts.

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CONFLICT OF INTEREST

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