

Use and effectiveness of inclusive technologies in decentralized technological institutes in the state of Veracruz, México

Uso y efectividad de tecnologías inclusivas en institutos tecnológicos descentralizados del estado de Veracruz, México

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Summary. The purpose of this article is to analyze the use and effectiveness of inclusive technologies in decentralized technological institutes in the state of Veracruz, Mexico. A quantitative descriptive study was conducted. A survey was administered to the 21 technological institutes to identify the disabilities served, the technological tools available, training on inclusive technology, and perceptions of its effectiveness. The results showed that 95% of the institutes (20/21) serve 117 students with motor disabilities (32%), sensory disabilities (21%), language/communication disabilities (18%), psychosocial disabilities (16%), intellectual disabilities (12%), and multiple disabilities (1%). Only 4 institutes (19%) have inclusive technologies and 3 (14%) use them; there is 1 adapted classroom (5%), 5 have teacher training (24%), and only 1 has protocols (5%), despite the fact that 81% claim to promote inclusion. Those who do use technology rate it as effective (levels 4–5) for performance, retention, and participation. It is concluded that, although Veracruz Technological Institutes have made progress in adopting new technological tools to promote inclusion, it is necessary to optimize their use through greater training, investment, and comprehensive strategies that guarantee their effectiveness and sustainability.

Keywords: inclusive education; technologies; disability; higher education; Veracruz.

Resumen. El propósito de este artículo es analizar el uso y la efectividad de las tecnologías inclusivas en institutos tecnológicos descentralizados del estado de Veracruz, México. Se realizó un estudio descriptivo cuantitativo. Se aplicó una encuesta a los 21 institutos tecnológicos para identificar las discapacidades atendidas, las herramientas tecnológicas disponibles, la capacitación en tecnología inclusiva y las percepciones sobre su efectividad. Los resultados mostraron que el 95% de los institutos (20/21) atiende a 117 estudiantes con discapacidades motoras (32%), discapacidades sensoriales (21%), discapacidades del lenguaje/comunicación (18%), discapacidades psicosociales (16%), discapacidades intelectuales (12%) y discapacidades múltiples (1%). Solo 4 institutos (19%) cuentan con tecnologías inclusivas y 3 (14%) las utilizan; hay 1 aula adaptada (5%), 5 tienen capacitación docente (24%) y solo 1 cuenta con protocolos (5%), a pesar de que el 81% afirma promover la inclusión. Quienes sí utilizan la tecnología la califican como efectiva (niveles 4-5) para el desempeño, la retención y la participación. Se concluye que, si bien los Institutos Tecnológicos de Veracruz han avanzado en la adopción de nuevas herramientas tecnológicas para promover la inclusión, es necesario optimizar su uso mediante mayor capacitación, inversión y estrategias integrales que garanticen su efectividad y sostenibilidad.

Palabras Clave: educación inclusiva; tecnologías; discapacidad; educación superior; Veracruz.

1 Introduction

Inclusive education is a global education policy issue. It can be defined as a positive response to diversity that is identified with the participation, achievements, and removal of barriers for all groups involved, such as students, teachers, families, and communities, becoming a fundamental pillar of international education policies [1]. This approach promotes the full participation of students with disabilities in regular school settings, removing barriers and providing the necessary support for their learning. In Mexico, this commitment is reflected in a robust regulatory framework: the General Law for the Inclusion of Persons with Disabilities [2], the Federal Law to Prevent and Eliminate Discrimination [3], and the General Education Law [4] establish the obligation to ensure equitable access to education for this population. Although inclusive education policy has advanced in formal terms, multiple studies warn that there are still substantial differences between what is established in regulations and the actual practices experienced in higher education institutions [5, 6]. In Mexico, only a small percentage, between 4% and 5%, of people with disabilities manage to access higher education, which shows a significant lag in attention to this sector [6, 7]. In this context, inclusive or assistive technologies are seen as strategic tools for promoting the academic participation of students with disabilities. These tools range from devices such as screen

readers, hearing aids, and adapted keyboards to applications and platforms that facilitate interaction and access to content. According to Puyalto [8], when used appropriately, these technologies can eliminate pedagogical communication barriers, allowing for teaching that is more tailored to the individual needs of students. Similarly, international organizations point out that technology, accompanied by effective pedagogical methodologies, can strengthen inclusive educational processes by offering accessibility and personalization in teaching processes [9]. However, several studies warn that the availability of technology alone does not guarantee inclusion; its effectiveness depends largely on contextual factors, such as teacher training, universal design of educational resources, and institutional support [8, 10].

In Veracruz, decentralized technological institutes (belonging to the National Technological Institute of Mexico but administered at the state level) face the challenge of offering higher technological education to a broad and diverse student body. There are currently 21 such institutes spread across different regions of the state, serving thousands of students in engineering fields. Given the diversity of their student body, it is pertinent to examine the extent to which these centers are equipped and prepared to incorporate technological tools designed for people with disabilities. To date, there has been little specific research on the use of inclusive technologies in these institutions and the perceptions of teachers and administrators in this regard. Analyzing this situation is important for identifying best practices, outstanding needs, and areas of opportunity in the implementation of inclusive education at the higher education level. In this context, the overall objective of this research is to evaluate the use and perceived effectiveness of inclusive technologies in decentralized technological institutes in the state of Veracruz. Specific objectives include: (a) describing the main disabilities of students attending these institutes; (b) identifying whether the institutions have adapted technologies and inclusive software; (c) identify training in the use of inclusive technologies; and (d) analyze how teachers and administrators perceive the contribution of these technologies to improving the learning and integration of students with disabilities. Based on this analysis, the aim is to offer a critical view of the achievements made and the barriers that still exist, in order to propose recommendations that contribute to strengthening inclusive education in the field of technology education. The methodology used is detailed below, the results obtained are presented, and finally, the conclusions and suggestions derived from the study are discussed.

2 Methodology

This study adopts a descriptive quantitative approach, focusing on the application of a survey specifically designed to collect data on the use of inclusive technologies in technological institutes in Veracruz, Mexico. The population covered included the 21 decentralized technological institutes in the state, as they constitute the entire set of state-administered higher education technology centers. The instrument was administered to management personnel and academic coordinators with experience in activities aimed at students with disabilities. Data collection was carried out during June-July 2025 using an electronic form sent by institutional email, thus ensuring broad geographical coverage and ease of participation by the institutions.

The questionnaire consisted of open-ended and closed-ended questions divided into four main sections, in line with the objectives of the research. The first section collected general data on the institution, requesting information on the institution of origin, the respondent's position, the type and number of students with disabilities (motor, sensory, intellectual, psychosocial or mental, language and communication, and multiple), as well as whether the institution has inclusive technologies (such as screen readers, specialized software, and adapted devices). The second section focused on collecting information on the existence or absence of adapted technologies, inclusive software, the use of such technology by teachers, and technologically adapted classrooms for students with disabilities. The third section included questions on teacher training in the use of these technologies, institutional protocols to ensure equitable access to inclusive technologies, and the promotion of a culture of inclusion and respect for diversity. The fourth section of the survey addressed perceptions of effectiveness: using 5-point Likert scales, respondents evaluated how effective they considered the inclusive technologies implemented to improve the academic performance and integration of students with disabilities. Cronbach's alpha was applied to validate the internal consistency of the questionnaire, with an overall value of 0.894.

Once the responses from the schools had been collected (with 100% participation from all 21 schools, equivalent to 100% of the target population), the data was analyzed. For closed-ended multiple-choice questions and Likert scales, descriptive statistics were calculated: absolute frequencies and arithmetic means. Given the relatively small size of the population (21 surveys), the analysis focused on general trends rather than statistically significant inferences. The results are organized below in the order of the specific objectives, complementing the quantitative statistics with qualitative findings to provide a more complete perspective.

It is important to note that ethical considerations were respected throughout the process: participation was voluntary, the confidentiality and anonymity of the institutions and participants was maintained (presenting the data in aggregate form without identifying individual names), and the results focused exclusively on educational improvement. Under this methodological approach, the study aimed to provide an accurate picture of the current situation in Veracruz's technological institutes regarding the use and effectiveness of inclusive technologies for students with disabilities.

3 Results

Desde sus inicios, la acreditación ha aportado enormes beneficios al Sistema Educativo Mexicano; en buena medida, porque siempre ha sido impulsado por personal académico de instituciones preocupadas por la calidad; sin embargo, como todos los procesos, debe ser actualizado de manera regular para seguir gozando de sus beneficios. Algunos de sus aspectos positivos incluyen la mejora de la calidad educativa; su impacto en el posicionamiento y prestigio de los programas educativos e instituciones; también ha generado cambios institucionales en la comunicación, el flujo de información y la integración de los actores académicos [9–11], adicionalmente fomenta la formación continua y mejora en el proceso pedagógico de los profesores; así como una mejor planeación de las tutorías[12]. Otro aspecto muy benéfico de la acreditación en las instituciones de educación superior, ha sido el fortalecimiento de los programas de investigación y su articulación con los posgrados; así como el fomento a la vinculación con los sectores productivo y social [13]. Finalmente, la acreditación también ha sido utilizada como una estrategia de rendición de cuentas [9].

3.1 Profile of students with disabilities served

The data collected reveals that the vast majority of decentralized technological institutes in Veracruz currently serve students with some type of disability. Specifically, 20 of the 21 campuses (95%) reported having at least one student with a disability enrolled in their academic programs. Only one institute reported not having any students with disabilities during the study period. The most common disabilities among the institutions are motor and sensory disabilities (hearing and visual). Motor disabilities (people with reduced mobility or wheelchair users) are present in 16 of 21 technological institutes, or 76%. Sensory disabilities are reported in 11 institutes (52%). On the other hand, 7 out of 21 (33%) report intellectual or developmental disabilities (e.g., Down syndrome, autism, or others that affect cognitive functions). Psychosocial or mental disabilities are present in 8 schools (38%), while language and communication disabilities are identified in 7 (33%). Finally, only one institute (5%) reported having a student with multiple disabilities. These figures reflect that there is significant diversity in special educational needs in the Veracruz technological subsystem, implying varied challenges for institutions in terms of accessibility and adaptations.

Fig. 1 shows the distribution of the 117 students with some type of disability reported by all decentralized technological institutes in the state of Veracruz, Mexico. It can be seen that the largest category corresponds to motor disabilities (37 students; 32%). This is followed by sensory disabilities (visual and hearing impairments) with 25 students (21%); language and communication disabilities with 21 (18%); psychosocial or mental disabilities with 19 (16%); and intellectual or developmental disabilities with 14 (12%). Only one case of multiple disabilities (1%) was reported, i.e., a student with more than one condition.

It should be noted that most decentralized technological institutes in Veracruz report serving at least one student with a disability. On average, each institute serves between five and six students with disabilities, ranging from a single student to a maximum of 23 in one institute. There is a gap in technological coverage, as 20 out of 21 institutes, approximately 95.2%, serve students with disabilities. In addition, 80% of the institutes that have students with disabilities (16 out of 20 institutes) lack inclusive technology. This creates inequality, as the absence of inclusive technologies in most institutes means that students with similar needs receive different support depending on the institution. This result indicates that institutional accessibility policies have not been channeled into infrastructure and technological resources in most schools, and that their adoption does not seem to have been managed or is not part of a budgetary priority in most technological schools. The lack of inclusive technology can create barriers in: access to digital materials, communication, design and implementation of assessments, as well as learning speed, which can negatively impact the performance and retention of students with disabilities.

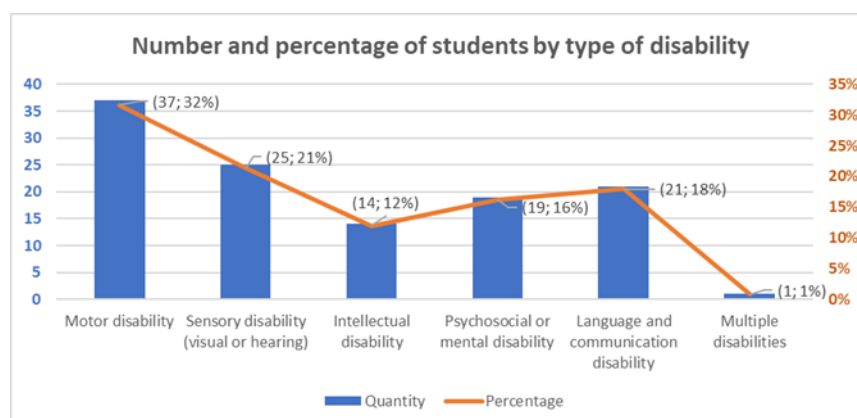


Figure 1. Number and percentage of students by type of disability. Source: Own elaboration

3.2 Infrastructure and technological access

With regard to the technological support tools available in the institutions, the results show a mixed picture. Of the 21 campuses that serve students with disabilities, 4 indicated that they had adapted technologies (screen readers, special keyboards, etc.), equivalent to 19%. The same 4 technological institutes reported having inclusive software (e.g., NVDA, JAWS, accessible Moodle, or other), re-presenting 19%. Of the 21 technological institutes, 4 (19%) reported having inclusive technologies; however, only 3 (14%) use them in their educational activities, which means that 1 technological institute does not use them despite having them. This may be due to problems of insufficient training, lack of curriculum planning, resistance to change, maintenance, or lack of adaptation of materials. Finally, only one institute (5%) reported having technologically adapted classrooms for students with disabilities, which shows a lag in the implementation of technological infrastructure. Fig. 2 presents the data described above.

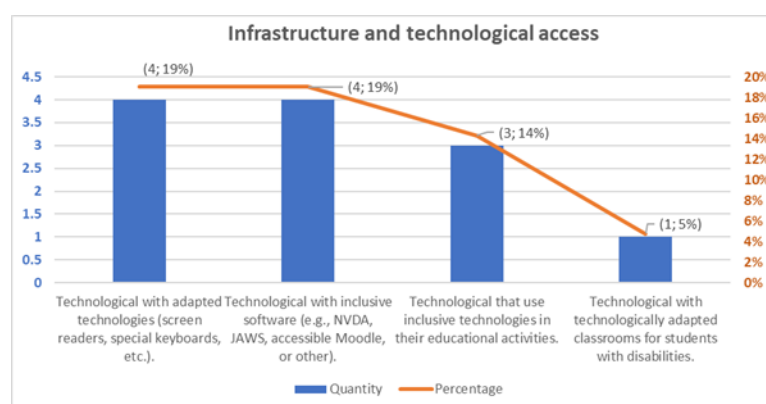


Figure 2. Infrastructure and technological access. Source: Own elaboration

3.3 Teacher training and institutional policies

Another relevant aspect is teacher training and the existence of institutional policies for inclusive technology. Only 24% of the institutes (5/21) stated that their teachers have received specific training in the use of assistive technologies and ICT-supported inclusive education strategies. In most cases, this training has consisted of short workshops or introductory courses organized by the institutions themselves or by organizations such as TecNM. Interestingly, four of the five technical colleges that have received training reported having inclusive technology, but only one of these technical colleges has been trained and does not yet have the technological tools. In terms of institutional policy, only one institute (1/21; 5%), belonging to the four technological institutes that have inclusive technology, reported having institutional protocols in place to ensure equitable access to inclusive technologies. Although 81% of the institutes (17/21) claim to promote a culture of inclusion and respect for diversity, only 19% (4/21) have specific inclusive technologies. This gap of 61 percentage points highlights a discrepancy between institutional discourse and the material resources that enable accessibility, suggesting the

need to transform declarative inclusion into practices supported by infrastructure and technology. Figure 3 presents the resulting data on teacher training and institutional policies.

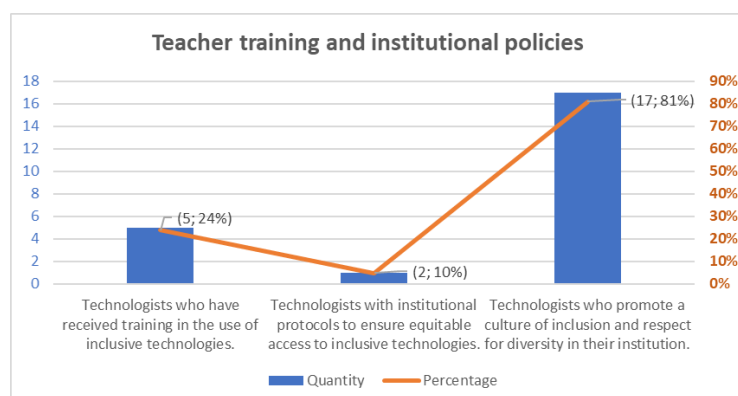


Figure 3. Teacher training and institutional policies. Source: Own elaboration.

3.4 Perception of the effectiveness of inclusive technologies

One of the main focuses of the study was to find out how institutional actors assess the real impact of inclusive technologies on the learning and integration of students with disabilities. In general terms, the perception is favorable, although with some reservations. When evaluating the effectiveness of these tools on a scale of 1 to 5, the four institutes that reported using inclusive technologies selected the highest levels (4 and 5), classifying them as “effective” or “very effective.” These institutes consider that inclusive technologies have been effective in improving the academic performance of students with disabilities, that they have contributed to reducing dropout rates among students with disabilities, inclusive technologies facilitate the social and academic inclusion of students with disabilities within the school, and that significant improvements have been observed in the participation and integration of students with disabilities thanks to the use of inclusive technologies. These participants believe that, thanks to the use of technology, students with disabilities are able to access course content more independently and participate more confidently in academic activities.

4 Discussion

The Veracruz State Expenditure Budget for fiscal year 2025 and its annexes do not include a specific allocation for inclusive technologies for higher education [11]. The document is divided into chapters and administrative units, but “inclusive technologies” or any related term are not found in a specific allocation. If resources are needed for this purpose, they must come from current expenditure or own revenue, which could also cause problems in financial audits. The Ministry of Finance and Planning reiterates that the budget is created under standardized classifications and that there are no specific codes for “assistive technology” in education [12].

The Veracruz Ministry of Education [13] has a Program for Inclusion and Educational Equity (PIEE), but public information does not allocate funds for assistive technology in upper secondary and higher education. Similarly, the National Technological Institute of Mexico reports allocating resources to Decentralized Technological Institutes (ITD), such as the one in Veracruz, in generic budget items, without a specific line item for inclusive technologies. As of September 2025, there is no budget allocation in Veracruz for assistive technologies in higher education. This shows that inclusion is usually financed indirectly, through broader programs (scholarships, academic support, or teacher training) rather than specific budget lines.

Master plans, such as the Veracruz Development Plan [14] and the Veracruz Comprehensive Education Program [15], consider inclusive education a right, in line with the National Development Plan [16] and the United Nations (UN) [17]. However, they are largely declarative in nature, in the sense that they do not establish specific financing mechanisms. Although the SEV reports providing inclusion support to more than 24,000 students, this support is limited to basic education. In higher education, on the other hand, technological investment remains a black box. The National Association of Universities and Institutions of Higher Education (ANUIES) [18, 19] and the Ministry of Public Education (SEP) [20] promote inclusion in higher education and the incorporation of technologies in this context. The University of Veracruz (UV) is a state example of educational accessibility, but

it also lacks transparency in its spending on accessible technology. In general, Veracruz has an inclusive discourse, but no budget.

The results of this research illustrate this disparity: although 95% of ITDs serve students with disabilities, only 19% have adapted technologies, 24% offer teacher training in inclusion, and only 14% use assistive technology in the classroom. This difference between what is said and what is done coincides with previous studies that have already pointed out the gap between regulations and reality in Mexican higher education [5, 6].

Even so, decentralized technologies that have inclusive technologies implemented report positive results: improvement in retention, performance, and participation of students with disabilities, with high ratings on the Likert scale (4-5). This result is consistent with the international literature [8, 21-23], which highlights the potential of digital technologies not only as pedagogical support tools, but also as agents of innovation in teaching, assessment, and collaboration. In this sense, their implementation also responds to international commitments such as the Salamanca Statement [24] and the General Law for the Inclusion of Persons with Disabilities [3].

However, the success of these actions depends on cultural and educational factors. There is still resistance to change, a lack of knowledge about technology, and a lack of specific teacher training. As indicated in [10], professional training in inclusive education is a cornerstone for developing accessible environments. In Veracruz, these restrictions are exacerbated by the unequal distribution of resources among schools, reproducing educational inequalities.

In Mexico, Mexico City has broad social programs (such as best school or transportation scholarships) that, without being called “assistive technology,” have an impact on reducing access barriers. In Jalisco, the State Program for Inclusion and Disability normalizes an inclusive approach (without disaggregation by university), a programmatic advantage compared to Veracruz. At the Latin American level, countries such as Chile have calls for funding for technical aids through [25], Colombia has generated national guidelines for inclusive education with technological components, and in Ecuador, the distribution of ICT has favored student participation [23]. This difference means that Veracruz lags behind other states and countries in the region where technological inclusion has been institutionalized and even explicitly funded.

Evidence also shows the impact of cultural barriers on technology adoption. [26] has warned that inclusion requires not only resources but also a cultural shift that eradicates stigma and promotes reasonable accommodations. These attitudinal barriers, coupled with a lack of institutional awareness and specialized support, have an impact similar to physical barriers [27-29]. In intercultural contexts, linguistic and ethnic barriers still exist that widen inequality. If these aspects are not taken into account, inclusive technology may be underutilized, failing to improve retention and learning.

In this context, the case of Veracruz is justified by three gaps: 1) budgetary, as there are no earmarked funds for the purchase and maintenance of inclusive technologies; 2) programmatic, as strategic plans (PVD, PVEI) do not include financing schemes for higher education; and 3) cultural/educational, due to resistance to change and a lack of teacher training. Comprehensive measures are needed to close these gaps: creating a cross-cutting budget annex for accessibility, a state catalog of consolidated purchases, micro-credential programs in digital accessibility, Regional Accessibility Centers, and a public monitoring system with impact indicators.

In sum, despite Veracruz's recognition of inclusion in its programmatic discourse, it lags behind entities such as Mexico City and Jalisco, and even further behind countries such as Chile and Colombia, which have explicit policies and funding. To advance toward educational equity, it is necessary to align budgets, programs, and institutional culture, ensuring not only the availability of inclusive technologies but also their pedagogical and cultural integration into higher education.

5 Conclusions

In summary, the use and effectiveness of inclusive technologies in Veracruz decentralized technological institutes have made significant but insufficient progress. Although virtually all institutes serve students with disabilities and express a favorable stance toward inclusion, only a minority have assistive technologies and trained personnel to use them. Those campuses that have adequately implemented these tools confirm their beneficial potential, reporting improvements in academic performance and participation among students with special needs. However, most institutions have not yet fully integrated inclusive technology into their educational processes, revealing a gap between inclusive rhetoric and operational reality. Based on the findings, the following practical recommendations are proposed to strengthen technological inclusion in these institutions: ongoing teacher training, investment in accessible resources, institutional policies and protocols, and collaborative networks on inclusive technologies.

In conclusion, Veracruz's decentralized technological institutes have taken initial steps toward technology-supported inclusion, but they still face considerable challenges in consolidating truly inclusive higher education.

Closing the identified gap will require sustained institutional commitment, comprehensive strategic planning, and the allocation of adequate resources. Only through a combination of political will, human capital development, and equitable provision of supportive technology can the promises of inclusive education become tangible realities in Veracruz classrooms and throughout the country. The experience documented in this paper can serve as a reference and starting point for promoting concrete improvements; the path to full inclusion is an evolving process, but the results obtained provide guidance on where to focus efforts and reinforce the conviction that, with the right support, no student should be left behind in their right to a quality education.

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