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ASSESSMENT OF ASSISTIVE TECHNOLOGY GAPS IN ENGINEERING PROGRAMS BASED ON UN SDGS 4, 8 AND 16

ANÁLISE DAS LACUNAS DE TECNOLOGIA ASSISTIVA EM CURSOS DE ENGENHARIA COM BASE NOS ODS 4, 8 E 16 DA ONU

ANÁLISIS DE LAS BRECHAS DE TECNOLOGÍA ASISTIVA EN PROGRAMAS DE INGENIERÍA CON BASE EN LOS ODS 4, 8 Y 16 DE LA ONU

Camila Dias Juscelino Alce[1], Josivaldo Godoy da Silva[2]

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ABSTRACT

This study assessed accessibility and Assistive Technology (AT) gaps in Civil and Electrical Engineering programs at a university in Mato Grosso do Sul, Brazil, focusing on students with physical disabilities and considering Sustainable Development Goals (SDGs) 4, 8, and 16. A descriptive case study with technical-dimensional assessment was conducted through on-site observations, dimensional measurements, photographic records, and comparisons with ABNT NBR 9050:2020. The findings revealed heterogeneous levels of accessibility compliance, including limitations in accessible routes, academic furniture, laboratory workstations, restrooms, drinking fountains, and common-area seating. Although some architectural elements met the assessed accessibility criteria, the provision and integration of AT and accessible resources were insufficient to fully support autonomy and participation. Based on the literature, these barriers may also have implications for collective health and institutional resource planning; however, health and economic outcomes were not directly measured. SDG 4 showed the most direct relationship with the findings, while SDGs 8 and 16 were associated with professional training and institutional inclusion, respectively. The study reinforces the importance of integrating accessibility and AT into furniture, equipment, and institutional planning to promote autonomy, equity, and inclusion in higher education.

KEYWORDS: *Accessibility. Assistive Technology. Physical Disability. Collective Health. Higher Education. Sustainable Development Goals 4, 8 and 16.*

RESUMO

A pesquisa avaliou as condições de acessibilidade e as lacunas de Tecnologia Assistiva (TA) nos cursos de Engenharia Civil e Engenharia Elétrica de uma universidade no estado de Mato Grosso do Sul, Brasil, com foco em estudantes com deficiência física e considerando os Objetivos de Desenvolvimento Sustentável (ODS) 4, 8 e 16. Foi realizado um estudo de caso descritivo com avaliação técnico-dimensional, por meio de observações in loco, medições dimensionais, registros fotográficos e comparações com a ABNT NBR 9050:2020. Os resultados revelaram níveis heterogêneos de conformidade em acessibilidade, incluindo limitações nas rotas acessíveis, mobiliário acadêmico, bancadas de laboratório, sanitários, bebedouros e assentos em áreas comuns. Embora alguns elementos arquitetônicos atendessem aos critérios de acessibilidade avaliados, a oferta e a integração de TA e recursos acessíveis foram insuficientes para apoiar plenamente a autonomia e a participação.

[1] UFMS, undergraduate student.
[2] UNESP, Master's and PhD in Automation.

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Com base na literatura, essas barreiras também podem apresentar implicações para a saúde coletiva e para o planejamento de recursos institucionais; contudo, desfechos de saúde e econômicos não foram diretamente mensurados. O ODS 4 apresentou relação mais direta com os achados, enquanto os ODS 8 e 16 foram associados, respectivamente, à formação profissional e à inclusão institucional. O estudo reforça a importância de integrar acessibilidade e TA ao mobiliário, aos equipamentos e ao planejamento institucional para promover autonomia, equidade e inclusão no ensino superior.

PALAVRAS-CHAVE: Acessibilidade. Tecnologia Assistiva. Deficiência Física. Saúde Coletiva. Ensino Superior. Objetivos de Desenvolvimento Sustentável 4, 8 e 16.

RESUMEN

La investigación evaluó las condiciones de accesibilidad y las brechas de Tecnología Asistiva (TA) en los programas de Ingeniería Civil e Ingeniería Eléctrica de una universidad del estado de Mato Grosso do Sul, Brasil, con énfasis en estudiantes con discapacidad física y considerando los Objetivos de Desarrollo Sostenible (ODS) 4, 8 y 16. Se realizó un estudio de caso descriptivo con evaluación técnico-dimensional mediante observaciones in situ, mediciones, registros fotográficos y comparaciones con la norma ABNT NBR 9050:2020. Los resultados revelaron niveles heterogéneos de cumplimiento de los criterios de accesibilidad, con limitaciones en las rutas accesibles, el mobiliario académico, los puestos de trabajo de laboratorio, los sanitarios, los bebederos y los asientos de las áreas comunes. Aunque algunos elementos arquitectónicos cumplieron con los criterios evaluados, la provisión e integración de TA y recursos accesibles fueron insuficientes para favorecer plenamente la autonomía y la participación. Según la literatura, estas barreras también pueden tener implicaciones para la salud colectiva y la planificación institucional; sin embargo, los resultados de salud y económicos no se evaluaron directamente. El ODS 4 presentó la relación más directa con los hallazgos, mientras que los ODS 8 y 16 se asociaron con la formación profesional y la inclusión institucional, respectivamente. El estudio refuerza la importancia de integrar la accesibilidad y la TA en la planificación institucional para promover la autonomía, la equidad y la inclusión en la educación superior.

***PALABRAS CLAVE**: Accesibilidad. Tecnología Asistiva. Discapacidad Física. Salud Colectiva. Educación Superior. Objetivos de Desarrollo Sostenible 4, 8 y 16.*

INTRODUCTION

Promoting accessibility in the university environment is essential to ensuring the right to education, work, and full participation of people with physical disabilities (PD) in institutional life. Thus, assistive technologies (AT) play a fundamental role by promoting greater autonomy, safety, and, consequently, inclusion in the physical and functional spaces of higher education. However, the mere existence of AT does not ensure effective inclusion, as appropriate adaptations for people with physical disabilities are also required (Mantoan; Prieto, 2023).

Assistive technologies comprise products, services, and strategies aimed at promoting the autonomy and social participation of people with disabilities (Almalky; Qaysi, 2025). According to the World Health Organization (WHO) and the United Nations Children's Fund (2022), these

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resources include physical devices and digital solutions that are essential in educational and social contexts. Educational inclusion is directly linked to architectural and technological accessibility, an indispensable condition for guaranteeing the right to education. In Brazil, where a significant portion of the population has some type of disability (Instituto Brasileiro de Geografia e Estatística [IBGE], 2023), expanding access to these resources is fundamental. However, despite the high demand, AT provision remains uneven and limited, with gaps in the implementation of normative guidelines (Brasil, 2023; Domingues; Laplane, 2024).

Physical disability is characterized by complete or partial alterations in motor functions that may compromise mobility, coordination, balance, and the performance of daily activities and may be congenital or acquired. In the Brazilian context, official data indicate that 3.4% of the population has difficulty walking or climbing stairs, an indicator related to physical disability, reinforcing the need for accessible and inclusive environments and resources, especially in public institutions. Thus, despite normative advances, people with disabilities still have lower levels of educational attainment and labor market participation, highlighting challenges in effectively implementing accessibility and ensuring autonomy and social participation for people with PD (IBGE, 2023).

The barriers faced by students and professionals with PD in higher education are mainly related to architectural accessibility and circulation. Non-standard ramps, non-operational elevators, narrow doors, inadequate furniture, and non-adapted restrooms hinder autonomous movement and access to classrooms, laboratories, and libraries. These obstacles directly affect academic retention and participation, creating inequalities in educational pathways and increasing the risk of dropout (Mantoan; Prieto, 2023; Martins; Pieczkowski, 2024; Sassaki, 2010).

From a collective health perspective, these barriers may also affect the psychosocial well-being of students with disabilities. Adequate access to AT has been associated with higher levels of well-being and academic self-efficacy, as well as positive effects on competence, adaptability, and self-esteem (McNicholl; Desmond; Gallagher, 2023). Therefore, insufficient accessibility may extend beyond physical limitations, restricting participation and increasing the need for institutional support and subsequent adaptations.

Difficulties related to the use of internal spaces are also frequent, including non-adapted desks, fixed tables, and insufficient turning space for wheelchairs. The absence of universal planning and consistent institutional policies reinforces these barriers, contradicting legal and normative guidelines such as ABNT NBR 9050:2020 and the Brazilian Law for the Inclusion of Persons with Disabilities. Studies indicate that accessible university environments favor not only the right to education but also the academic performance and autonomy of students

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with physical disabilities (Bastos et al., 2023; Bersch, 2017).

The United Nations (UN) 2030 Agenda also addresses accessibility from a cross-cutting perspective through the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), which promotes inclusive educational conditions; SDG 8 (Decent Work and Economic Growth), which promotes equitable and safe working conditions; and SDG 16 (Peace, Justice and Strong Institutions), which focuses on accessible, accountable, and inclusive institutions.

The integration of physical accessibility, AT, and institutional sustainability therefore represents a strategic challenge for public universities (United Nations General Assembly, 2015; World Health Organization; United Nations Children's Fund, 2022). In the Brazilian context, ABNT NBR 9050 defines technical parameters for accessibility in buildings, furniture, and urban spaces and represents an essential normative reference for evaluating academic environments (ABNT, 2020).

This gap highlights the need for a systematic analysis relating normative compliance to the functional and institutional conditions of educational spaces (Brasil, 2015; World Health Organization; United Nations Children's Fund, 2022). From an institutional perspective, inadequate AT provision may also increase demands for individualized support and subsequent adaptations, highlighting the importance of incorporating accessibility into institutional planning and resource allocation.

In this sense, this study aimed to assess AT and accessibility conditions in the materials and environments of the Civil Engineering and Electrical Engineering courses at a partner university of the Federal University of Mato Grosso do Sul, Brazil, identifying gaps, inconsistencies, and insufficiencies in relation to UN SDGs 4, 8, and 16. The study sought to relate these findings to the current state of accessibility and inclusion in the university environment by recording compliance and non-compliance with applicable standards, thereby supporting the planning, management, and continuous improvement of institutional inclusion policies. The results may inform university initiatives aimed at fostering equitable and inclusive education.

1. THEORETICAL REFERENCE

The initial literature review revealed a gap in studies connecting AT in higher education with SDGs 4, 8, and 16, particularly regarding students with physical disabilities. No publications with an approach similar to that proposed in this research were identified in the databases consulted during the literature search. Therefore, the search was broadened to include related scientific and technical literature on accessibility, educational inclusion, physical disability,

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sustainability, and institutional practices. This broader framework provided the theoretical foundation for examining the conditions identified in the investigated academic environments.

Accessibility in higher education involves conditions that enable the autonomy, functionality, and participation of people with disabilities in academic activities. In this context, AT comprises products, equipment, devices, resources, strategies, practices, and services intended to improve functionality, autonomy, independence, and participation (Brasil, 2015; World Health Organization; United Nations Children's Fund, 2022). Functionality is therefore central to AT, as its classification depends on whether a resource is intended to support an individual's functional needs and participation.

AT must, however, be distinguished from physical accessibility, universal design, and architectural adaptations. Universal design refers to the conception of products, environments, programs, and services that can be used by all people, as far as possible, without the need for adaptation or specialized design (Brasil, 2015). Physical accessibility, in turn, concerns the conditions that allow spaces, buildings, furniture, and equipment to be reached and used safely and autonomously (ABNT, 2020). Therefore, an accessible architectural element does not automatically constitute AT.

In this study, an element was classified as AT only when its primary function was to directly support or improve the functioning, autonomy, or participation of a person with a disability or reduced mobility. Architectural elements and general accessibility conditions, such as access ramps, non-slip floors, approach areas, accessible circulation spaces, and elevators, were classified as physical accessibility features rather than AT when they constituted part of the built environment. Accessible or adjustable furniture, such as tables, workbenches, service counters, seats, and chairs, was classified according to its function: as accessible furniture when designed to provide inclusive use of the environment, and as AT only when specifically intended or adapted to meet an individual's functional needs. This criterion prevents architectural accessibility and accessible furniture from being automatically classified as assistive technology.

Educational inclusion therefore depends on the combined availability of appropriate AT, accessible environments, and institutional policies that support students' full participation (Bastos et al., 2023). These dimensions are complementary but conceptually distinct. Together, they contribute to autonomy, academic participation, and equity in higher education (Papadopoulos et al., 2024). AT may also contribute to educational, psychological, and social outcomes, including academic engagement and participation among students with disabilities (McNicholl et al., 2021).

From a technical perspective, ABNT NBR 9050:2020 (ABNT, 2020) provides dimensional and functional parameters for assessing physical accessibility in buildings, spaces, and furniture.

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In this study, these parameters were used to assess the accessibility conditions of the investigated environments, while the classification of AT was based on its specific relationship with individual functioning, autonomy, and participation.

2. METHODOLOGY

This research is characterized as a descriptive case study with a technical-dimensional, exploratory, and field-based approach, conducted at the campus of a partner university of the Federal University of Mato Grosso do Sul, Brazil.

The study investigated the existence, adequacy, and limitations of AT and accessibility conditions in the academic environment, relating them to SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 16 (Peace, Justice and Strong Institutions). The analysis focused on identifying gaps and inadequacies in the Civil Engineering and Electrical Engineering courses and relating the findings to the current state of accessibility and inclusion in the university environment to support continuous institutional improvement.

Initially, a literature search was conducted on the UN SDGs, Brazilian technical standards, particularly ABNT NBR 9050:2020, scientific articles, technical reports, and institutional publications related to accessibility, AT, sustainability, and inclusion in educational environments. The databases consulted included Scientific Electronic Library Online (SciELO), the Coordination for the Improvement of Higher Education Personnel (CAPES) Journal Portal, Web of Science (WoS), and PubMed, in addition to reports from the Brazilian Institute of Geography and Statistics (IBGE). The literature search was conducted from September to October 2025 and resulted in 25 scientific articles, in addition to normative documents and institutional reports. Among the scientific articles, five were considered particularly relevant to the research topic, three of which were international.

Subsequently, field research was conducted through on-site observations in the classrooms of the Civil Engineering block; the laboratories of the Electrical Engineering block, including the Electrical Machines Laboratory (LABMAC), Electronics and Electrical Circuits Laboratory (LABLEC), Materials and Electrical Controls Laboratory (LABMEC), and Energy Efficiency in Motor Systems Laboratory (LAMOTRIZ); the multipurpose building; and common areas between the blocks, such as restrooms, ramps, administrative service areas, and corridors. Dimensional measurements were performed on furniture, sanitary facilities, drinking fountains, workbenches, circulation spaces, and accessibility-related architectural elements and equipment.

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These facilities were selected to identify similarities, differences, and accessibility limitations across different academic environments, allowing a broader assessment of physical accessibility and conditions affecting autonomy and participation.

Data collection and documentation were performed using a 5 m measuring tape, a 1 m measuring tape, a measuring ruler with a level, and a Samsung S23 smartphone for photographic records. Each dimensional item was measured twice to confirm the recorded value and reduce measurement errors. The measurements and observations were subsequently recorded and organized in an Excel spreadsheet.

The assessment checklists were developed specifically for this study based on the accessibility requirements and dimensional parameters established by ABNT NBR 9050:2020 and on the theoretical framework concerning AT, physical accessibility, functionality, autonomy, and inclusion. The assessed items were selected according to their relevance to the use of academic environments by people with physical disabilities and included architectural accessibility conditions, accessible furniture and equipment, and AT when applicable. Each checklist contained the assessed component, the applicable normative criterion, the measured or observed condition, the compliance classification, and field observations.

Compliance was classified as YES when the observed or measured condition met the applicable normative criteria; NO when the condition did not meet the applicable criteria or when a required accessibility feature was absent; and PARTIAL when only part of the applicable requirements was met or when accessibility was provided under restricted conditions. Items that were not applicable to a specific environment were not classified as compliant or non-compliant.

After the technical assessment, the evaluated items were related to SDGs 4, 8, and 16 according to their function and their relationship with the scope of the study. This association was analytical and was not based on a previously validated SDG assessment instrument. Conditions related to access, circulation, learning spaces, and participation in academic activities were associated with SDG 4 because of their relationship with inclusive and equitable access to education. Conditions related to accessible workstations, laboratories, safety, autonomy, and professional training were associated with SDG 8 because of their relationship with preparation for participation in inclusive and accessible working environments. Conditions related to physical access to the institution, administrative services, accessible information, and institutional participation were associated with SDG 16 because of their relationship with accessible and inclusive institutions. These associations were interpreted in relation to Targets 4.a, 8.5, 16.6, and 16.7 and their corresponding indicators; however, the official SDG indicators themselves were not directly measured in this study.

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The assessment was based on systematic observation, direct dimensional measurements, photographic records, and comparison between the observed conditions and the applicable normative parameters. The analysis considered: (i) compliance with applicable technical standards; (ii) functional suitability for use by people with physical disabilities; and (iii) consistency with principles of accessibility, autonomy, safety, inclusion, and equity. The potential implications of the identified barriers for collective health, social participation, and institutional resource planning were discussed based on scientific literature rather than directly measured as health or economic outcomes.

The results were interpreted comparatively across the investigated environments to identify recurring patterns, limitations, differences, and opportunities for improvement.

3. RESULTS AND DISCUSSION

In this section, the results obtained from the collected data are presented and organized into tables according to the accessibility and AT aspects evaluated. Each item was assessed for compliance with ABNT NBR 9050 and associated with the SDGs according to its functional contribution: SDG 4 to inclusive education, SDG 8 to safe and inclusive participation in academic and work-related activities, and SDG 16 to equitable access to institutional spaces and services. The results support the identification and discussion of accessibility gaps in the environments analyzed. All figures presented below were prepared by the authors.

Table 1. Location analyzed: Multipurpose Space

SDG		ANALYSIS			
Relevant	**Linkage criterion**	**Category**	**Item analyzed**	**Normative criterion**	**Compliance**
SDG 4	Ensures physical access to educational spaces and supports inclusive education	Vertical accessibility	Elevators / platforms	Cabin ≥ 1.10 × 1.40 m; door ≥ 0.80 m	YES
SDG 8	Supports accessible and autonomous participation in study and work activities	Accessible workstation	Adjustable table	Height 0.75–0.85 m; maneuvering area Ø ≥ 1.50 m	NO

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SDG 16	Supports safe and equitable access to institutional spaces and services	Institutional accessibility	Non-slip floor	Regular, firm, and non-slip floor; no protrusions > 5 mm	PARTIAL

Source: Authors (2026).

Table 2. Location analyzed: Civil Engineering Block, classrooms and public environments

SDG		ANALYSIS			
Relevant	**Linkage criterion**	**Category**	**Item analyzed**	**Normative criterion**	**Compliance**
SDG 8	Supports safe and inclusive participation in academic and work-related activities	Ergonomic accessibility	Adapted seats	Stable; with support; safe transfer	NO
SDG 16	Enables equitable and autonomous access to institutional services	Access to institutional services	Accessible service counter	Height between 0.75 and 0.85 m	NO
SDG 16	Enables equitable physical access to institutional spaces and services	Institutional accessibility	Access ramps	Maximum slope: 8.33% (1:12); width ≥ 1.20 m; landings ≥ 1.20 m	YES

Source: Authors (2026).

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Table 3. Location analyzed: Electrical Engineering Block, Electrical Machines Laboratory (LABMAC)

SDG		ANALYSIS			
Relevant	**Linkage criterion**	**Category**	**Item analyzed**	**Normative criterion**	**Compliance**
SDG 4	Enables wheelchair users to access furniture and participate in educational activities	Furniture	Approach area	Frontal or lateral wheelchair approach; minimum clear area of 0.80 × 1.20 m; maneuvering space with a diameter of 1.50 m when a full turn is required.	PARTIAL

Source: Authors (2026).

Table 4. Location analyzed: Electronics and Electrical Circuits Laboratory (LABLEC)

SDG		ANALYSIS			
Relevant	**Linkage criterion**	**Category**	**Item analyzed**	**Normative criterion**	**Compliance**
SDG 4	Ensures accessible laboratory workstations and supports the autonomous participation of students with physical disabilities in practical educational activities	Furniture	Accessible workbenches	Workbench height: Maximum tabletop height ≤ 0.85 m. Faucets and controls: Operation by lever, sensor, or light pressure; no wrist twisting or excessive force required. Reach height: Between 0.40 and 1.20 m from the floor.	NO

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Source: Authors (2026).

Table 5. Location analyzed: Materials and Electrical Controls Laboratory (LABMEC)

SDG		ANALYSIS			
Relevant	**Linkage criterion**	**Category**	**Item analyzed**	**Normative criterion**	**Compliance**
SDG 4	Supports accessible and safe seating, enabling students with physical disabilities to participate in educational activities	Furniture	Seats and chairs	Seat height between 0.46 m and 0.48 m; armrests to facilitate transfer.	NO

Source: Authors (2026).

Regarding access and horizontal circulation, the corridors of all five buildings analyzed had widths equal to or greater than 1.20 m, meeting the minimum width adopted in this study based on ABNT NBR 9050 for accessible circulation. However, in three of the five buildings, the continuity of the accessible route was compromised by untreated level differences greater than 5 mm or by conditions that restricted continuous access to different levels.

Regarding vertical accessibility, elevators and ramps were not simultaneously available as alternative means of vertical circulation in the buildings analyzed. In the Multipurpose Space, access to the upper floor depended on the elevator shown in Figure 1. This condition indicates dependence on a single accessible means of vertical circulation; however, it was not classified as normative non-compliance solely because of the absence of a redundant ramp. Figure 2 shows the access ramp to the Electrical Engineering block, a single-story building with level differences at its entrance.

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Figure 1. Multipurpose Space equipped with an elevator intended for serving people with reduced mobility



Source: Authors (2026).

Figure 2. Access ramp to the Electrical Engineering laboratories



Source: Authors (2026).

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Regarding floor conditions, visual inspection identified apparent surface wear in high-traffic areas, particularly in the external area of the Multipurpose Space, as shown in Figure 3. These conditions were recorded as potential accessibility and safety concerns. However, because no specific slip-resistance or friction test was performed, the functional non-slip performance of the floors could not be confirmed based solely on visual inspection.

Figure 3. Apparent wear on the floor of the Multipurpose Space



Source: Authors (2026).

With respect to academic furniture, standard desks were identified in all 15 classrooms examined (100%; n = 15), as shown in Figure 4. ABNT NBR 9050 establishes accessibility parameters for tables, including dimensions that allow frontal wheelchair approach. The measurements indicated that the existing desks did not meet the accessibility parameters adopted in this study, despite the availability of physical space for wheelchair approach.

Teacher desks, in some cases, had heights within the dimensional range considered in the assessment (0.75–0.85 m). However, the desks examined did not provide adequate clear space underneath for wheelchair approach and were intended primarily for conventional use. Therefore, dimensional compatibility in height alone did not ensure functional accessibility.

Furthermore, in the laboratory workstations assessed, particularly in the Electrical Engineering block, accessibility was limited by furniture and equipment that did not fully support autonomous use by people with physical disabilities. No adjustable workbenches or comparable assistive solutions were identified in the laboratory environments examined. Figure 5 illustrates workbenches whose dimensions did not meet the accessibility criteria adopted in this study.

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These findings demonstrate that compliance with isolated physical dimensions does not necessarily ensure functional accessibility or autonomous participation.

From a collective health perspective, the identified barriers may have broader implications for autonomy, participation, and psychosocial well-being. Previous research has associated adequate AT provision with greater well-being, academic self-efficacy, competence, adaptability, and self-esteem among university students with disabilities (McNicholl; Desmond; Gallagher, 2023). These outcomes were not directly measured in the present study; therefore, their potential relationship with the identified barriers is discussed based on the literature rather than interpreted as an observed effect.

If these barriers persist, they may continue to restrict academic participation and increase demands for subsequent adaptations and institutional support, with potential implications for resource planning and the institution's capacity to promote equitable access.

These findings are consistent with previous studies showing that barriers related to accessibility and inadequate assistive resources can restrict the participation and autonomy of students with disabilities in higher education (Bastos et al., 2023; Papadopoulos et al., 2024). The coexistence of compliant architectural elements with inadequate furniture and equipment suggests that accessibility has been incorporated unevenly across the analyzed environments, with greater attention to basic physical access than to conditions for autonomous use and participation.

Figure 4. Standard desks in the Civil Engineering block, designed for the general public (measurements in cm)

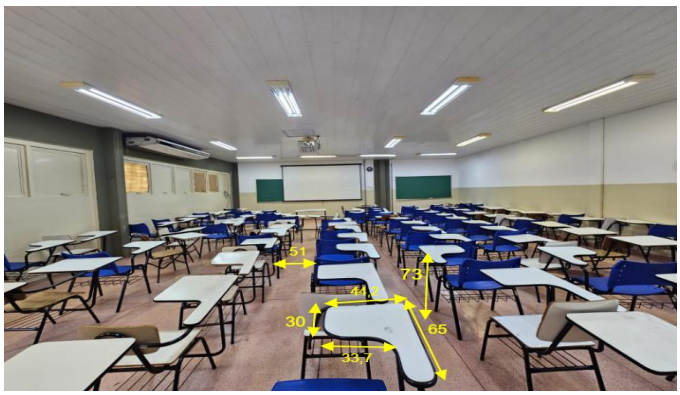

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Figure 5. Electrical building furniture designed for the general public (measurements in cm)



Source: Authors (2026).

Regarding the restrooms, the assessment identified inadequacies in the arrangement of grab bars, incomplete maneuvering areas, and limitations affecting effective use by people with physical disabilities. Consequently, the accessible restrooms were classified as partially compliant with the criteria adopted in this study. Figure 6 shows the women's restroom in the Electrical Engineering block, where, despite compliance with some dimensional requirements, the sink and mirror did not meet the accessibility parameters assessed.

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Figure 6. Absence of accessible sink and mirror in the women's restrooms of the Electrical Engineering block (measurements in cm)



Source: Authors (2026).

Finally, in the Electrical Engineering block, the existing drinking fountain presented inadequacies regarding the accessibility criteria assessed, particularly its height and conditions for autonomous use by people with physical disabilities (Figure 7). In addition, no accessible seats were identified in the common areas of the five buildings assessed. Figure 8 shows an example of seating in the common area of the Electrical Engineering block designed for general use without accessibility adaptations.

Overall, a noteworthy finding was that compliance with isolated dimensional requirements did not necessarily ensure functional accessibility. Although all corridors analyzed met the minimum width requirement, accessible route continuity was compromised in three of the five buildings.

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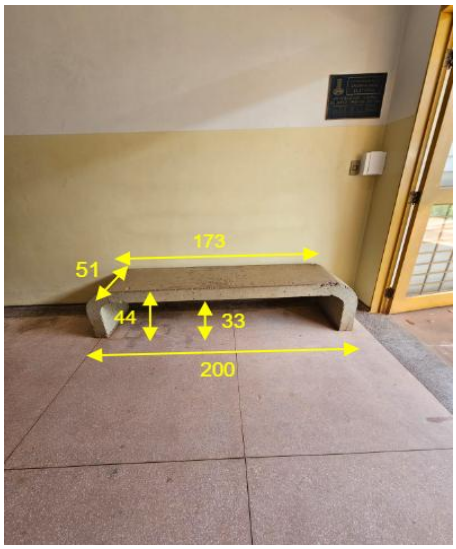
Figure 7. Only water fountain in the Electrical Engineering block, designed for the general public (measurements in cm)



Source: Authors (2026).

Figure 8. Seating in the common area of the Electrical Engineering block without accessibility adaptations (measurements in cm)



Source: Authors (2026).

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The findings were related to specific SDG targets and indicators. SDG 4 showed the most direct relationship through Target 4.a and Indicator 4.a.1, which address inclusive and disability-sensitive educational facilities. SDG 8 was indirectly related to Target 8.5 and Indicators 8.5.1 and 8.5.2, as the study assessed conditions for professional training but did not measure employment outcomes. SDG 16 was associated with Targets 16.6 and 16.7 and their indicators from an institutional inclusion perspective; however, these indicators do not directly measure physical accessibility. Therefore, the official SDG indicators were used as a reference and were not directly measured in this study.

4. CONCLUSION

Given the results obtained, the insufficient provision and inadequate integration of AT and accessible resources in the analyzed environments limited their alignment with the principles of SDGs 4, 8, and 16. The objective of the study was achieved by identifying and characterizing the main accessibility and AT gaps in the analyzed environments and relating these conditions to the selected SDGs. The findings indicate that accessibility was predominantly addressed through isolated physical adaptations, with heterogeneous levels of compliance, without fully integrating assistive solutions that support autonomy, equity, and participation in the academic environment.

Regarding SDG 4, the identified barriers may limit equitable access to educational environments and full academic participation. In relation to SDG 8, inadequate furniture, equipment, and assistive resources may restrict conditions for professional training and skill development. For SDG 16, the findings highlight the importance of strengthening institutional accessibility practices to promote more inclusive and equitable university environments.

From a collective health perspective, the findings reinforce the broader relevance of AT in promoting healthier and more inclusive academic environments (McNicholl et al., 2021; McNicholl; Desmond; Gallagher, 2023).

The findings demonstrate that compliance with isolated physical accessibility requirements is insufficient to ensure effective inclusion, reinforcing the need to integrate AT and accessible resources into furniture, equipment, and institutional planning to promote accessibility, collective health, and equitable participation.

The study is limited by the number of courses and environments analyzed and by its single-institution design. Health and economic outcomes were not directly measured and were discussed based on the literature. Future studies should include other institutions, students with disabilities, and direct assessments of health and institutional costs. The study contributes by

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integrating technical accessibility assessment with AT and SDGs 4, 8, and 16 in the analysis of engineering educational environments. These findings may support institutional planning aimed at improving accessible furniture, equipment, and academic environments.

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