EVALUATION OF INTERNET ACCESS BY STUDENTS AT A FEDERAL EDUCATIONAL INSTITUTION IN NORTHERN BRAZIL

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ARSTRACT

Goal: This study presents the results of assessing Internet access by students at a federal educational institution in northern Brazil.

Theoretical Framework: The study's theoretical framework relates information technologies through Internet access to learning. It shows that the more adequate Internet access is in educational institutions' daily routines, the better the students' performance in learning and its developments in technical, scientific, and technological production.

Method: The method used was a survey, the population of which consisted of students who attended classes during the three shifts during which the institution operated. The students were consulted through a questionnaire with multiple-choice questions, the results of which were generated using descriptive statistics and presented in frequency tables.

Results and Discussion: The findings showed deficiencies in a) the connection attributes, b) insufficient connection about the types of use by students, c) the connection provided is of low quality, and d) there is excess demand in relation to the low institutional supply, especially in the evening shift.

Research Implications: This study shows that internet services must be the object of multidisciplinary treatment and cannot represent the exclusive view of ICT professionals or education specialists. Unidisciplinary views prevent several fundamental nuances of institutional core activities from being overlooked.

Originality/Value: The research's originality lies in the empirical observation that it is essential that educational institutions plan long-term internet provision strategically, jointly by ICT professionals, education specialists, teachers, and students.

Keywords: Internet access, ICT, Learning, Internet quality, Assessment of internet access.

AVALIAÇÃO DO ACESSO À INTERNET POR PARTE DO CORPO DISCENTE DE UMA INSTITUIÇÃO FEDERAL DE ENSINO DO NORTE DO BRASIL

RESUMO

Objetivo: Este estudo apresenta os resultados da avaliação do acesso à internet por parte do corpo discente de uma instituição federal de ensino que atua no Norte do Brasil.

Referencial Teórico: A estrutura teórica do estudo relaciona as tecnologias da informação, através do acesso à internet, com a aprendizagem. Mostra que quanto mais adequado for o acesso à internet no cotidiano das instituições de ensino, maior e melhor tende a ser o desempenho dos alunos em relação ao aprendizado e seus desdobramentos, em forma de produção técnica, científica e tecnológica.

Método: O método utilizado foi o de levantamento, cuja população foi constituída pelos alunos que frequentam as aulas nos três turnos de funcionamento da instituição, consultados através de um questionário com questões de múltipla escolha, cujos resultados foram gerados com o auxílio de estatísticas descritivas e expostos em tabelas de frequências. Resultados e Discussão: As descobertas mostraram deficiências a) nos atributos da conexão, b) insuficiência da conexão em relação aos tipos de usos pelos alunos, c) a conexão disponibilizada é de baixa qualidade e d) há excesso de demanda em relação à baixa oferta institucional, especialmente no turno noturno.

Implicações da Pesquisa: Este estudo mostra que os serviços de internet precisam ser objeto de tratamento multidisciplinar, não podendo representar a visão exclusiva de profissionais de TIC ou de especialistas em educação. As visões unidisciplinares impedem que diversas nuances fundamentais às atividades-fim institucionais não sejam percebidas.

Originalidade/Valor: A originalidade da pesquisa consiste na constatação empírica de que é fundamental que o planejamento da oferta de internet por parte de instituições educacionais seja feito de forma estratégica, de longo prazo, conjuntamente pelos profissionais de TIC, especialistas em educação, professores e alunos.

Palavras-chave: Acesso à internet, TIC, Aprendizagem, Qualidade da internet, Avaliação do acesso à internet.

EVALUACIÓN DEL ACCESO A INTERNET POR PARTE DEL CUERPO ESTUDIANTIL DE UNA INSTITUCIÓN EDUCATIVA FEDERAL DEL NORTE DE BRASIL

RESUMEN

Objetivo: Este estudio presenta los resultados de la evaluación del acceso a Internet por parte del estudiantado de una institución educativa federal que opera en el Norte de Brasil.

Marco Teórico: La estructura teórica del estudio relaciona las tecnologías de la información, a través del acceso a internet, con el aprendizaje. Se muestra que cuanto más adecuado es el acceso a Internet en el cotidiano de las instituciones educativas, mayor y mejor tiende a ser el desempeño de los estudiantes en relación con el aprendizaje y sus consecuencias, en la forma de producción técnica, científica y tecnológica.

Método: El método utilizado fue una encuesta, cuya población estuvo conformada por estudiantes que asisten a clases en los tres turnos operativos de la institución, consultados a través de un cuestionario con preguntas de opción múltiple, cuyos resultados se generaron con ayuda de estadística descriptiva y se expusieron en frecuencia. mesas.

Resultados y Discusión: Los hallazgos mostraron deficiencias en a) atributos de conexión, b) conexión insuficiente en relación con los tipos de uso por parte de los estudiantes, c) la conexión brindada es de baja calidad y d) existe exceso de demanda en relación a la baja institucional suministro, especialmente en el turno de noche.

Implicaciones de la investigación: Este estudio muestra que los servicios de Internet deben ser objeto de un tratamiento multidisciplinario y no pueden representar la visión exclusiva de los profesionales de las TIC o los especialistas en educación. Las opiniones unidisciplinarias evitan que se pasen por alto varios matices fundamentales de las actividades institucionales centrales.

Originalidad/Valor: La originalidad de la investigación consiste en el hallazgo empírico de que es fundamental que la planificación de la provisión de Internet por parte de las instituciones educativas se realice de manera estratégica y a largo plazo, de manera conjunta por profesionales TIC, especialistas en educación, docentes y estudiantes.

Palabras clave: Acceso a Internet, TIC, Aprendizaje, Calidad de Internet, Evaluación del acceso a Internet.

1. INTRODUCTION

Information and communication technologies (ICT) are in every corner of human life (Machado & Giacomazzo, 2021; Smutny & Vehovar, 2020) and have completely transformed reality. They dominate production systems (Margherita & Braccini, 2024; Wani & Mishra, 2024) and operations (Khalis et al., 2024; Lind et al., 2024), often in a revolutionary way. The presence and massive use of digital technologies are likely the singular characteristics of contemporary reality, differentiating our historical moment. As the natural results of technologies are

multiplication and diversification due to increasing technological innovation (Alkaabi et al., 2024; Sun et al., 2024), every day, we are inundated with countless solutions to existing problems and even to those we do not yet have. ICT has also substantially impacted educational environments (Fandir, 2024; Tomczyk et al., 2020; Zafar et al., 2022). They have allowed new pedagogical models and teaching procedures to be introduced in classrooms and laboratories, substantially increasing scientific, artistic, and cultural production at all stages of educational cycles and increasing the number of academic technologies for solving problems and meeting the needs of communities, organizations and institutions in their operating environments. These positive impacts, however, result from joint strategic management between ICT professionals and education specialists, in addition to users, students, and teachers.

In this sense, this study aimed to evaluate internet access by the student body of a public institution operating in the North region of Brazil. To this end, it formulated four guiding questions focused on evaluating the attributes of the connection, sufficiency of the connection about the types of uses by students, quality of the connection, and demand about the institutional supply. The survey method was used, and the population consisted of all students from the three shifts of the institution, who were consulted through a questionnaire with multiple choice questions, the results of which were generated with descriptive statistics displayed in frequency tables. The conclusion shows the insufficiency and inadequacy of institutional internet access.

2. ICT, INTERNET ACCESS AND LEARNING

To understand and evaluate the use of the Internet in the learning process, it is necessary to understand the conceptual and operational scope of information and communication technologies, Internet access, and learning. This is because science explains the relationships between these three phenomena differently than most people who do not have in-depth knowledge of their limitations and explanatory depths from science think. In this sense, this section aims to show the state of the art on these three phenomena so that the theoretical-empirical architecture of this study can be understood.

2.1 Information and Communication Technologies

Based on scientific literature, the conceptual understanding of information and communication technologies (ICT) can be divided into three major categories. The first considers it a diverse set of tools and resources (Al-Sabawi, 2023; Amie-Ogan & Nwosu, 2023; Ibenwa et al., 2024). The idea of a set is related to the aggregate of things and subsets that have something in common. ICTs have in common the handling of information from two subsets: informational and communicational tools and resources. Tools are the means through which resources are obtained, processed, and made available in the form of information to their recipients; resources, on the other hand, are all the inputs that enter the system, are processed, and their products are distributed to their users, clients, and consumers. The inputs of the subsets, also called subsystems, are data considered as each response generated for a specific question or record of a specific occurrence. A person's age is data, as is the answer to a question, regardless of its length or the number of words it contains. Computers, software, the internet, and electrical, electronic, and computational networks are included in this set, which includes the services provided by professionals who operate them. The second category sees ICT as a technology (Khasawneh, 2024; Nwadike & Effanga, 2024) or tool (Chowdhury & Haque, 2023; Batrakova et al., 2024), both with the same conceptual and operational meaning. Technology (as well as any tool) encapsulates knowledge to solve a given problem or meet a given need (Nascimento-e-Silva, 2020; Nascimento-e-Silva, 2021a). In this conception, ICT is computing systems, connectivity, communications, means of transfer, and information, such as texts, articles, tables, images, audio, and countless others. Also included are knowledge, experiences, accumulated information, physical, organizational, and administrative means, and several

others, mainly the services provided to users, customers, and consumers, such as internet services and support. The third major category can be called infrastructure (Iluno et al., 2024) to designate all efforts to develop any element of the set of technologies (Wahyuni et al., 2024), as well as the application of knowledge and skills (Mahmud et al., 2024). This third category underpins the need for information and communication technologies to fulfill their mission of communicating, whether between an individual and another individual or between an individual and the group to which they belong, regardless of the group size. If the necessary technology does not exist, ICT managers and professionals need to develop and apply it, but always focus on the results intended by the intended objectives, both ICT subsystem and system, and of the individual, group, or organization. This study focuses on this third category, ICT infrastructure. If ICT is a set of tools and resources, infrastructure is one of its most essential subsets, as can be seen from the studies by Oikonomou et al. (2022), Hashem (2020), and Cassia et al. (2024), among others. In logical-operational terms, infrastructure is the bottom part of a scheme on which the structure and superstructure are based. As an extension to the ICT area, the infrastructure makes its structures and superstructures work. Infrastructure is also composed of resources, organizational capabilities, artifacts, tools, facilities, and other specific components responsible for the acquisition, processing, storage, dissemination, and use of information, which are component elements of the ICT structure.

The studies by Benmoussa et al. (2024) consider infrastructure to be any aspect of ICT, such as hardware, software, networks, applications, and systems necessary to support the IT structure of an organization. This means that the infrastructure must allow the functioning of the structural elements, which, in turn, must be directed towards achieving the superstructural objectives. The superstructural objectives are, for example, those intended by the production systems of factories, the marketing of retail organizations, and learning, as in the case of educational institutions. In operational terms, the superstructure combines hardware, software, technologies, and human capabilities (Ile & Ejekwu, 2024) so that the organizational systems function correctly and achieve their objectives. In educational organizations, the infrastructure is taken from a technical point of view (Çaldağ & Gökalp, 2023), with the mission of supporting data and information handling practices, mainly through the Internet. Thus, the more significant, stable, and faster the access and connection, the greater the institutional robustness tends to be, as inferred from Fan and Pan's study (2023).

2.2 The Internet as an infrastructural element

The Internet is predominantly seen in the literature as a global digital network (Hamdan et al., 2023; Horvath & Vojtechovsky, 2023; Salar et al., 2023; Riswandi et al., 2023). What is understood as a network is the connection of a device (notebook, cell phone, camera, desktop, etc.) with at least one other; as the number of devices is colossal, the number of links (connections) is correspondingly colossal. The diagrammatic representation of a part of this set of links has the appearance of a network in which each link or set takes the form of a node. This network or web is used to transmit data and information from one device to another in the world and store an unthinkable quantity of this data and information through telephone lines and satellites, with varied rules and protocols. Another way of viewing the Internet is as a global network system (Tugarev, 2023). The system's connection unit is computers, which currently take on different forms and varieties when taken from the point of view of receiving data and information, which are processed and transformed into new data and information, which is the predominant system age in science. This means the Internet is a system for receiving, transforming, and disseminating data and information, mainly about all spheres of human life. Often, however, users cannot control the information they receive, which is when the Internet behaves as a low-choice media environment, as shown in the study by Audemard (2023), as opposed to the conception of a mass communication tool par excellence, when available

information can be easily stored, shared and accessed (Kutuk, 2023). The Internet as an infrastructural tool of ICT depends on what science calls Internet access.

To fulfill its role as an ICT infrastructure, internet access needs to consider some essential aspects, depending on its mission. One of them is the access condition (Sumaedi, 2020). If the condition is manageable, the greater its infrastructural potential will tend to be; the more inhibiting the condition, the less impact it will have on the functioning of the structure. The second is the possession of the absolute minimum provisions (Dimov, 2022) so that management can handle it with a view to the functioning of the superstructure, so that the greater the provision, the more robust the access tends to be. The third is the fixed connection speed, generally above 200 Kbps in at least one direction (Larsen et al., 2023), in a stable manner. The fourth is connecting individual or organizational users through the most varied types of devices (Synowiec, 2021), each with different connection speed characteristics. The fourth is the ability of people and organizations to effectively connect to the network with their devices (DuBose-Morris et al., 2021) to access any site at a stable and satisfactory speed. Access, therefore, is a fundamental condition for the internet to function and, in this way, to make the structure of an organization work so that its superstructural elements fulfill their missions and achieve their sectoral objectives. Access is made from a specific location or mobile, depending on telephone signals or satellites (Greiman et al., 2023). By combining the achievements of sectoral objectives, organizations, and institutions fulfill their missions and achieve their strategic objectives. In the case of educational institutions, one of their strategic objectives is the learning of their student body.

2.3 Access to the internet and learning

Lumbantobing et al. (2023) showed that access to ICT infrastructure, especially the Internet, is essential for learning. It is through the internet that learning strategies and methods are designed and implemented, and their effects are evaluated according to contemporary reality. As the quality of the internet is questionable, the interaction between students and teachers is also compromised, which results in low-quality learning. The study by Maulidyawati et al. (2021) reaffirms the essentiality of the Internet in student learning when access is facilitated anywhere and at any time. The essentiality becomes fundamental when teaching is online, via videoconferencing, or other resources and learning environments. When a management system is created as a prerequisite for using the Internet, the probability of success increases significantly, as shown in the study by Penedaa et al. (2023). Another result of this study was the frustration of students who cannot access learning materials due to unstable and low-quality internet. The study by Rochbani (2024) shows that traditional media generates much lower learning than those obtained with the help of the Internet if access is of satisfactory quality. As today's society is digital, even when the subjects are traditional, students always turn to the internet to consolidate their learning, especially when the learning is urgent, as was the case with the COVID-19 pandemic (Zou & Zou, 2024).

Internet quality has a direct and significant impact on students' academic performance. A slow or unstable connection can lead to frequent interruptions during essential activities, such as accessing online libraries, learning platforms, and collaboration tools. Silva (2015) highlights that these technical problems not only affect the performance of daily academic tasks but also contribute to increased stress and frustration among students, reducing the effectiveness of learning and the motivation to participate in extracurricular activities. One of the main benefits of high-quality internet is easy access to educational resources, including scientific articles, e-books, educational videos, and online courses. Almeida (2016) emphasizes that the lack of quick and reliable access to these resources significantly limits students' ability to conduct indepth research and stay current with the latest trends and discoveries in their fields of study. In

institutions where the internet is deficient, students often face difficulties meeting deadlines for assignments and projects, compromising the quality of their academic output.

Scientific initiation is a vital component in the education of higher education students, promoting the development of research and critical thinking skills. Polloni (2013) points out poor internet quality can inhibit student participation in scientific initiation programs. Many activities depend on robust internet access for literature review, data collection, and communication with advisors. Rodrigues (2009) adds that high latency and frequent connection drops make it difficult to conduct online experiments and use specific software for data analysis, compromising the quality and continuity of research.

Poor internet quality also compromises students' preparation for the job market. In a study conducted by Nunes (2008), it was observed that the lack of a stable and fast connection prevents students from developing essential technological skills, such as online communication tools, project management platforms, and specialized software. Gonçalves (2017) argues that this skills gap can result in less prepared and competitive professionals, negatively affecting their employment opportunities and career advancement. The reputation and credibility of an educational institution are closely linked to the quality of its services, including its internet infrastructure. Souza (2012) notes that institutions that fail to provide a reliable internet connection may experience a decrease in the trust of students, parents, and industry partners. This can lead to a drop in new student enrollment, the formation of strategic partnerships, and compromised participation in scientific collaborations and events. Damasceno (2014) suggests that adopting measures to improve internet quality can improve the student experience and strengthen the institution's position in the national and international educational scenario. Several measures can be adopted to mitigate the negative impacts of poor internet quality. Almeida (2016) recommends regular network audits to identify and resolve connectivity issues. Polloni (2013) suggests implementing fair Internet usage policies, ensuring all users have adequate access during peak hours. In addition, Rodrigues (2009) proposes the creation of a technical support center dedicated to resolving connection issues quickly and efficiently, minimizing downtime and user frustration. Internet quality is a crucial factor that influences several aspects of students' academic performance and educational experience. The studies reviewed show that improving internet infrastructure can bring significant benefits, including improved academic performance, increased participation in scientific initiation activities, better preparation for the job market, and strengthening institutional credibility. Therefore, investing

3. RESEARCH METHODOLOGY

students' academic and professional success.

This study used the survey method to generate answers to research questions based on nominal data. It is a qualitative study aiming to generate in-depth explanations of the phenomenon under study. The study applied a synchronous perspective, having the institution's students at all levels of professional training as the unit of analysis. The procedures used are described below.

in technological and administrative solutions to ensure high-quality internet is essential for

3.1 Study design and procedures

The research was conducted over five weeks, with 13 steps to ensure the desired results were achieved within the expected timeframe. In the first week, a literature review was conducted on methodologies for assessing internet quality and the state of the art on ICT, ICT infrastructure, and internet access. At the same time, meetings were held with the information technology (IT) team of the institution under study to understand the network infrastructure, providers, and current configurations. In the second week, speed, latency, and ping tests began; they were carried out from the 7th to the 17th in the institute's classrooms, library, and programming laboratory, with a total of nine samples: three tests in the morning shift, three in the afternoon

shift and three in the evening; the data collected and the observations of the students were documented. The data collection was completed on the 16th and 17th of the third week. The documented variables were analyzed, and we outlined the pattern for the three shifts. In the morning, the connection is unstable but tolerable; in the afternoon, the connection is suitable for use; in the evening, it is most often unavailable for heavy processing, and large documents cannot be downloaded; for teachers, HD videos or even taking attendance in class are almost impossible tasks to perform. Another task performed on these days was filling out the questionnaires. Table 1 summarizes these procedures.

Table 1. Procedures performed in the study design.

Stages	Dates	Weeks	Procedure descriptions
01	01		Literature review: Internet quality assessment methodologies.
02	02 – 03	1	Meetings with the IT team to understand the network infrastructure, providers, and current configurations.
03	04 e 07		Data collection on Internet plans, contracted speeds, and connection types.
04	08 - 17		Speed and latency tests.
05	08 - 17	2	Ping tests to assess connection latency.
06	16 – 17		Analysis of the results of speed and latency measurements.
07	16 - 17	3	Application of questionnaires to students
08	18 e 21		Preliminary analysis of empirical results
09	22		Meeting with the Statistics advisor.
10	23	4	Meeting with the IT team
11	24		Meeting with the IT advisor, discussing the final report
12	25, 28-29		Preparation of the final report, together with advisors and IT professionals
13	31	5	Presentation of the final report, results obtained, and possible solutions.

Source: Prepared by the authors.

In the fourth week, a resulting question was given after plotting the answers given by students from the three shifts regarding the results of the internet speed measures collected, obtaining the shift most affected by the internet connection and the variables that may be causing this problem. After the end, a meeting was held with the statistics advisor to determine if the calculated variables were correct. The week ended on the 25th, after a presentation of results with the IT team, with the guidance of the computer science teacher, who helped in the preparation of the final report, addressing the rules of the text, tables, and figures, among others, within the previously established standards. In the last week, the final report was prepared, containing all the information related to the research, such as the contracted plan, methods used for analysis, results of the data collected from the forms, and the representative variables of the most affected shift.

3.2 Population and sample

Table 2 presents the quantitative population of this study. The sample size for analyzing the results was calculated from 195 questionnaires completed by students: 40 from secondary school, 80 from the integrated category, and 75 from higher education. This sample size corresponds to half of the students enrolled in the institution. To avoid compromising the sample size, students who were absent on the day of data collection, those who withdrew their enrollment, those who changed institutions, and those who were expelled, among others, were removed from the calculation. Despite all the efforts of researchers, coordinators, and teachers, the sample size was only 23 students, representing a low participation rate in completing the questionnaires.

Table 2. Representation of the number of students in 2023

Entry Modalities	Courses	Places	Total	50% per shift	50% of students
Subsequent	Electronics	40	80	135	20
	Industrial Automation	40	1		20
Integrated	Electronics	80	160	1	40
	Mechatronics	80			40
Higher	Control and Automation Engineering	30	150		15
Education	Electronics	30]	60	15
	Mechatronics	30			15
	Telecommunications Systems	30			15
	Logistics	30			15
Total		390	390	-	195

Fonte: dados coletados pelos autores.

The questionnaires covered 195 students, 135 of whom attended full-time and 60 attended night classes. Data collection for the research was carried out by applying questionnaires to students enrolled at the institution. However, the number of people who responded to the survey did not reach the expected level, with only 23 questionnaires duly completed and returned. The questionnaires were presented as an opportunity for students to express their opinions and contribute to improving the institutional environment. In addition, the benefits of the research for the school community were emphasized.

However, some factors may have influenced the low level of participation in the research. The students' lack of time, the large number of curricular activities, and the lack of motivation to answer questionnaires may have been some obstacles. Additionally, the questionnaires may not have been administered at an opportune time or in a format that would attract the students' attention. Considering the particularities of the Amazon context, with connectivity challenges in several regions, the research highlights the need for more in-depth investigations into the issue of internet access in higher education institutions in the region. For future research, it is suggested that mixed methodologies, combining questionnaires with interviews, be used to obtain more detailed information about students' experience with the internet and the challenges faced.

3.3 Materials used

The Campus provided the materials for conducting this research. Three computers from the programming lab were used, the only ones with the Office package available; a smartphone for collecting connection tests and form responses; and two headsets used in video conferences with the IT team and advisors. The computers were used to prepare forms, spreadsheets (one for each shift and one for general), and reports to inform advisors and coordinators. They were also used to measure the results, containing information collected in the field and the final diagnosis of the problem.

The smartphone was essential for measuring information traffic, conducting ping tests, monitoring the continuous speed variation of the network, and determining download and upload speed. The tests provided by Google and the "Speed Test" website were used in real-time. The smartphone was also made available to students who did not have a network or who did not have a means to respond to the forms.

The headsets were used in conferences held with the IT teams and advisors. Videoconferences were used to avoid unnecessary travel by the team responsible for presenting the plan contracted by the institution, determining how many students they covered, determining how many Mbps were contracted, and comparing results, among others. Videoconferences with advisors were held after the pre-established goal of the questionnaires was met, presenting the initial report with information about the contracted package, field data, and observations by IT professionals about discrepancies and problems that were highlighted. Headsets were used to optimize the

time of the team responsible (due to the one-month deadline to complete the study), advisors, and IT professionals since they had much demand and little time available to provide services.

3.4 Data: Instrument, collection and analysis

The data collected by the questionnaires were nominal. Nominal data are characterized by their format of words, phrases, sentences, and even paragraphs. They are composed of names (Turkson et al., 2021; Nascimento-e-Silva, 2023). This data type is organized to generate results in simple frequency, percentage frequency, cumulative frequency, and mode (Florian et al., 2022; Nascimento-e-Silva, 2023). The results of nominal data are usually presented in table form, in which one of the columns shows the categories. In the others, at least the simple and percentage frequency is obtained, a procedure that was used for this investigation. Table 3 summarizes the structure of the data collection strategies.

Table 3. Structure of data collection instruments

Analytical dimension	Analytical category	Instrument	Data type
Access infrastructure	Number of students	Interview	Rational
	Available connection	Interview	Rational
	Students using the network	Interview	Rational
Evaluation of connection attributes	Mbps available	Questionnaire	Nominal
	Speed variation	Questionnaire	Nominal
Assessment of types of connection uses	Content accessed	Questionnaire	Nominal
	Internet quality	Questionnaire	Nominal
Connection quality assessment	Internet connection	Questionnaire	Nominal
	Negatively affected students	Questionnaire	Nominal
	Complaining students	Questionnaire	Nominal
Demand assessment	Students using the network	Questionnaire	Nominal

Source: Prepared by the authors.

The data related to the number of students at the institution and the specificity of the internet connection were of the rational type. Rational data are characterized by presenting an absolute zero, as is the case with a student's daily downloads and the internet speed, measured in bps. The results of the rational data were also presented in table form. The data were collected in interviews with IT personnel.

4. RESULTS AND DISCUSSION

The assessment of the quality of internet access at the institution under study is contained in this section. First, the results related to each guiding question are presented: 1) what attributes of the connection are provided? 2) What are the types of connections used by the students? 3) how do the students evaluate the quality of the connection provided, and 4) what is the relationship between the demand for connection and the connection provided?

4.1 Attributes of the connection provided

The research on the current network situation and on which methodologies could be used to test the quality of the network is aimed at understanding the infrastructure, contracted plan, and capacity to support connected students. This initial survey of data provided by the team on internet plans, contracted speeds, and connection types generated the results in Table 4. Basic activities are performed by most students, with a quantity of 2.0 Mbps, generating 570 Mbps of internet use. The other categories are very little used.

Table 4. Number of connections available, according to the provider

Categories	Students by	Total	Total internet spent
	category	Mbps	(Mbps)
Basic activities	285	2,0	570

Heavy downloads	4	5,0	20
Videoconferences	10	1,5	15
Total	299		605

Source: Data collected by the authors.

Table 5 shows the variation in internet speed during the three shifts: morning, afternoon, and night. There is a significant fluctuation in speed, with the night shift presenting the most significant instability and lowest average speed. This variation corroborates the information presented in the article, which identified that the night shift is the most affected due to the presence of full-time students after regular hours, increasing demand, and overloading the network.

Table 5. Variation in connection speed during the shifts

Shifts	Frequencies	Frequencies %
Night	17	74
Afternoon	3	13
Morning	2	9
Full-time	1	4
Total	23	100

Source: Data collected by the authors.

Rodrigues (2009) highlights that high latency and network instability during peak hours can be attributed to congestion caused by many users' simultaneous use. In this case, the proposed solution includes implementing network management technologies to balance the load and constantly improve connection quality.

4.2 Assessment of Connection Usage Types

Table 6 presents the multiple-choice responses to the question that sought to find out when students can access the internet at the institution and what types of content they view. The results indicated that 87% use the Internet for quick research, 78.3% for academic work, 69.6% for transportation applications, 52.2% for social networks, and 21.7% for videos on digital platforms. The data reveals that most students use the campus internet primarily for academic activities. This result reinforces the importance of a stable, high-quality internet connection to support students' academic needs. Almeida (2016) and Silva (2015) emphasize that fast, reliable internet is essential for efficiently completing academic tasks, allowing students to access information and resources for their studies quickly.

Table 6. Types of content viewed by students at the institution.

Types of content viewed	Frequencies	Frequencies %
Quick internet searches	20	40
Academic papers	18	35
Transport applications	16	31
Social networks	12	24
Videos on digital platforms	5	10
Total	51	100

Source: Data collected by the authors.

The significant use of the Internet for transportation applications (69.6%) and social networks (52.2%) indicates that students also depend on the connection for their daily activities and communication, reflecting the need for a robust network that supports multiple functions simultaneously. Rodrigues (2009) suggests that implementing network management technologies can help prioritize academic traffic, ensuring critical activities have the necessary bandwidth even during peak hours.

The lower use of the Internet for videos on digital platforms (21.7%) can be attributed to the instability and low connection quality, as identified in other results. Gonçalves (2017) points out that a high-quality network must support video transmission, which is increasingly essential for digital learning and online classes. Investments in network infrastructure improvements, such as upgrading to fiber optic networks and implementing mesh networks, can help meet student demand and improve connection quality (Souza, 2012). Furthermore, fair use policies and educating students on efficient Internet usage practices can optimize network performance for all users.

Table 7 illustrates the assessment of Internet quality. Most students, especially during the evening shift, rate the connection below expectations. This negative perception can be associated with the difficulties faced during academic activities and research, as discussed in the article.

Table 7. Assessment of Internet quality.

Answers	Frequencies	Frequencies %
Yes	16	69,6
Not	7	30,4
Total	23	100,0

Source: Data collected by the authors.

Table 8 presents the results of the question that sought to know whether students conduct research and assignments or consume media on campus. Most respondents (69.6%) indicated that they carry out these activities on campus, while 30.4% responded that they do not. This information is crucial to understanding students' Internet use in the academic environment. Conducting research and academic assignments, as well as consuming media, require a stable and high-speed Internet connection. Almeida (2016) emphasizes that adequate Internet access is essential for academic productivity, allowing students to conduct efficient research, collaborate on projects, and access study materials effectively.

Table 8. Where students carry out their activities.

Answers	Frequencies	Frequencies %
Carries out activities on campus	16	69,6
Does not carry out activities on campus	7	30,4
Total	23	100,0

Source: Data collected by the authors.

Silva (2015) highlights that the lack of a quality connection can lead to frustration and demotivation, negatively impacting academic performance. The high percentage of students who use the Internet for academic activities on campus (69.6%) highlights the urgent need for improvements in network infrastructure. This demand is even more critical considering the data discussed in the literature review, where it was observed that connectivity problems, especially during the night shift, significantly affect the quality of teaching and research (Rodrigues, 2009; Souza, 2012). Investments in network infrastructure, including expanding bandwidth and implementing advanced technologies, are essential to meet student needs and improve the academic experience on campus. Furthermore, Gonçalves (2017) suggests that fair use policies and user education on efficient Internet use practices can help optimize connection availability and quality, ensuring that all students benefit equally from online resources.

4.3 Connection quality assessment

Table 9 shows the results of the questions on how students describe the internet networks they use. It was found that 47.8% of students consider the connection unstable, and another 47.8% consider it very poor. Only a tiny portion of students (4.3%) describe the connection positively.

No responses indicate that students do not have access to the internet on campus. These results reveal a primarily negative perception of the quality of the internet on campus, with 95.6% of students classifying the connection as unstable or inferior. This negative perception aligns with the challenges described in the literature, where internet connection quality is a critical factor for the efficiency of academic activities.

Table 9. How is the internet connection on campus described?

Categories	Frequencies	Frequencies %
The connection is unstable	11	48
The connection is terrible	11	48
The connection is good	1	4
Total	23	100,0

Source: Data collected by the authors.

Almeida (2016) and Silva (2015) highlight that internet instability can cause frequent interruptions in academic activities, hindering the completion of research, assignments, and even participation in online classes. High latency and frequent connection drops can demotivate students and negatively affect their academic performance. Rodrigues (2009) suggests that implementing advanced technologies, such as fiber optic networks and network management systems, can help improve connection stability and speed. Gonçalves (2017) adds that fair use policies and user education on efficient internet usage practices are essential to optimize connection quality and ensure all students can access resources appropriately. Students' negative perception reinforces the need for urgent investments in improvements to campus network infrastructure. Improving internet quality will increase student satisfaction and contribute to a more productive and efficient academic environment, as Souza (2012) suggested. Table 10 shows the findings for the question that sought to know if students have ever been negatively affected by Wi-Fi network accessibility. Most students (91.3%) indicated they were negatively affected, while 8.7% responded that they were not. The data indicate that Wi-Fi network accessibility is a significant problem for most students. The high percentage of those negatively affected reinforces the urgent need for improvements in campus network infrastructure. Almeida (2016) and Silva (2015) highlight that accessibility problems can cause frequent interruptions in academic activities, resulting in loss of productivity and increased stress among students. Rodrigues (2009) suggests that implementing advanced technologies, such as mesh networks and upgrading to fiber optics, can significantly improve Wi-Fi connection coverage and stability. Additionally, setting up additional access points in highdemand areas can help better distribute network traffic and ensure that all students have efficient access to the Internet.

Table 10. Students negatively affected by campus network

Answers	Frequencies	Frequencies %
Yes	21	91
Not	2	9
Total	23	100,0

Source: Data collected by the authors.

Gonçalves (2017) emphasizes the importance of network management policies prioritizing academic activities and ensuring all users can access the Internet without interruptions. Educating users on efficient Internet usage practices can also help reduce network load and improve accessibility. The high rate of students negatively affected by Wi-Fi network accessibility underscores the need for a robust action plan to address these issues. Investments in network infrastructure and technologies are essential to creating an academic environment that effectively supports students' needs and promotes a positive learning experience. Table 11

shows the responses to the question that sought to know whether students had ever witnessed any reports of colleagues or acquaintances who had negative experiences with network access. Most respondents (91.3%) indicated that they had witnessed reports of negative experiences, while 8.7% had not witnessed such reports. The data reveal that most students are aware of negative experiences related to accessing the Wi-Fi network, which indicates that connectivity problems are widespread and affect the collective perception of the quality of the internet on campus.

Table 11. Students who witnessed complaints about access to the network

Answers	Frequencies	Frequencies %
Yes	21	91
Not	2	9
Total	23	100

Source: Data collected by the authors.

Almeida (2016) and Silva (2015) emphasize that widespread negative perceptions can decrease student motivation and confidence in the institution's technological infrastructure. The recurrence of adverse reports underscores the importance of a robust institutional response to address these issues. Rodrigues (2009) suggests that implementing advanced technologies, such as upgrading fiber optic networks and configuring mesh networks, can significantly improve connection quality. In addition, installing additional access points in high-demand areas can help better distribute network traffic, ensuring more efficient coverage. Gonçalves (2017) points out that network management policies and educating users on efficient Internet usage practices are essential to optimizing connection quality. This includes prioritizing academic activities over recreational Internet use during peak hours. The high rate of students who reported negative experiences reinforces the need for an action plan that addresses technical issues and user concerns. Investments in network infrastructure and the implementation of advanced technological solutions are crucial to improving students' connectivity experience and restoring confidence in the quality of campus internet.

4.4 Assessing the demand for connection

Table 12 shows the responses to the question that sought to assess the use of the Wi-Fi network provided by the institution. Most respondents (95.7%) use the institution's network, while 4.3% do not. This result highlights the importance of the campus Wi-Fi network for students, with 95.7% of students using it, underscoring the critical need for a high-quality and reliable internet connection. As Almeida (2016) discussed, fast and stable internet availability is essential for carrying out academic activities, such as research, participation in online classes, and collaboration on projects. Rodrigues (2009) emphasizes that a well-managed and high-capacity Wi-Fi network can support the increasing demands of students, especially in higher education environments where research and innovation are central.

Table 12. Students using the institution's Wi-Fi network.

Answers	Frequencies	Frequencies %
Yes	22	95,7
Not	1	4,3
Total	23	100,0

Source: Data collected by the authors.

The lack of quality internet can lead to frequent interruptions and frustration among students, negatively impacting their academic performance and motivation. Silva (2015) suggests that, given the high use of institutional Wi-Fi networks, implementing advanced technologies, such as mesh networks and fiber optics, can significantly improve coverage and connection stability.

These improvements are essential to support the volume of users and the diversity of activities that depend on the Internet. The importance of a good internet connection is also corroborated by Gonçalves (2017), who highlights that a robust internet infrastructure is essential to maintain the competitiveness of higher education institutions and to ensure that students can access educational resources efficiently.

The question asked whether students would research there if the institution offered a superiorquality Wi-Fi network. All respondents indicated that they would. The unanimous response from students highlights the critical importance of a high-quality internet connection for academic activities. This unanimity reinforces the urgent need for investments in campus network infrastructure to ensure an efficient and reliable connectivity experience. Studies by Almeida (2016) and Silva (2015) show that internet quality determines academic productivity and student motivation. A high-quality Wi-Fi network would allow students to conduct research, participate in online classes, collaborate on projects, and access educational resources efficiently. Adequate connection can lead to frustration, demotivation, and compromised academic performance.

The study by Rodrigues (2009) suggests that implementing advanced technologies, such as fiber optic networks and network management systems, can provide the stability and speed needed to meet student demand. The configuration of mesh networks and the installation of additional access points are also recommended to improve coverage and avoid congestion. The study by Gonçalves (2017) highlights that fair use policies and user education on efficient internet use practices are essential to maintaining connection quality. The combination of infrastructure investments and the implementation of management policies can ensure that all students have equitable and efficient access to the network. The unanimous willingness of students to use a higher-quality Wi-Fi network highlights the importance of immediate action to improve the campus's Internet infrastructure. These improvements would increase student satisfaction and promote a more productive and innovative academic environment.

4.5 Discussion of results

The evaluation of the connection attributes can be considered unsatisfactory because, in the context analyzed, the internet connection instability during the night shift is caused by the excess of integrated shift students who remain on campus after regular hours. This stay overloads the network because the institution did not schedule a specific time for students to conduct research and schoolwork. This finding highlights the need for the institution to develop specific interventions to limit student access, which is not a recommended attitude, or to improve the network infrastructure so that it can meet the demands of students who use the internet for academic activities. In both situations, there is a need to develop an operations plan for these services jointly between ICT professionals, pedagogues, teachers, and students so that the solution found is in harmony with the needs and possibilities of these actors, as recommended by studies such as those by Gxhaweni, T., & Plaatjies (2023) and Pradana et al. (2023).

An assessment of the types of connection use indicated that poor connection quality significantly impacts students' academic productivity, especially those developing PIBIC projects and students in night-shift courses. A comparison with the literature indicates that this instability results in student demotivation, as discussed in the studies by Silva (2015), Suci et al. (2021), and Nazir and Khan (2021), and compromises academic performance, as pointed out in the studies by Rodrigues (2009), Adhikari et al. (2024), Nazir and Khan (2021), and Aladsani et al. (2022).

The assessment of connection quality showed that most students depend critically on the Wi-Fi network to conduct research and other academic activities. This dependence reinforces the need for a more robust and reliable network, which is quite different from what is currently offered and has been for some years. The institution must develop and implement a strategic ICT plan by professionals in line with the new skills and knowledge executives in this area must have today. Since the institution has barely improved the quality of its connection for many years, it is likely that it does not have an operational, strategic plan in which the professionals themselves can obtain the financial resources necessary to improve quality and not be dependent on other institutional actors and external organizations, even if they are from the government itself. The literature corroborates this necessary attitude by highlighting the importance of an internet infrastructure of at least reasonable quality for academic and scientific success (Gonçalves, 2017; Moraes, 2020).

An assessment of the demand for connection shows that the institution has failed to balance the demand and supply. This makes students critically dependent on the insufficient supply offered for several years. The imbalance worsens yearly with the increasing number of students without the supply and quality of the internet connection keeping up with the growth. Several studies have shown that the imbalance between demand and supply generates a series of undesirable consequences for organizations and institutions (Aziz et al., 2021; Biagi et al., 2020; Nugraha et al., 2024). In the case of technical and technological education institutions, the harmful consequences are no less damaging.

In summary, the assessment of these aspects indicates that network overload during the night shift, student dissatisfaction with the quality of the internet, and critical dependence on online resources significantly limit academic performance. This suggests that improving the network infrastructure on campus is crucial to ensuring a productive and efficient educational environment. The implications of these findings include the urgent need for investments in network technology, such as the implementation of fiber optic networks and the adoption of fair internet use management policies so that all students can appropriately access the necessary resources.

5. CONCLUSION

This study unsatisfactorily assessed the Internet access provided by a federal technological education institution operating in the North of Brazil to its students. The findings showed deficiencies in a) the connection attributes, b) the insufficiency of the connection regarding the types of use by students, c) the low quality of the connection, and d) excess demand about the low institutional supply. The leading cause of the low quality of the Internet in the evening shift is the excess of simultaneous users, mainly due to the stay of full-time students after regular hours. This means that, without specific interventions, the network will continue to be unable to support the demand, impairing students' academic activities. This finding has direct implications for campus management, suggesting that limiting Internet access after regular hours or expanding network capacity are necessary measures to improve the quality of the connection. Practical examples include implementing fair use policies for the Internet and investment in network infrastructure, as the literature suggests.

Comparing the findings with the theoretical-empirical framework, it is observed that institutions that have implemented significant network improvements obtain similar positive results, increasing student satisfaction and academic productivity. These examples reinforce the need to adapt these practices to the context of the institution analyzed. The main discovery was that students were being affected by the excess of students in the hallways, which broadened the management's vision so that situations like this, which affect the smooth functioning of the institute, would no longer occur.

It is suggested that the institution make a joint decision between the teaching staff, ICT professionals, students, and professors, either by limiting access so that the connection flow remains stable or by contracting an internet package with higher quality than the current one. This measure will probably maintain quality and encourage students to participate more in

research, science fairs, or conferences. It is recommended that the campus management invest in expanding the network infrastructure, such as installing fiber optic networks and creating fair use management policies for the internet. Furthermore, it is suggested that future research be conducted to assess the impact of these improvements on the quality of education, student satisfaction, and the exploration of new technologies that can support an increasing number of users.

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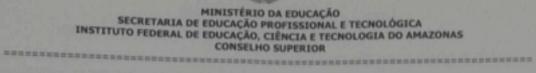
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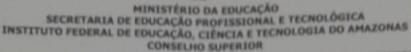
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