Bridging the Gap: The Role of Assistive Technologies in Enhancing Translation Accessibility for Visually Impaired Learners in Moroccan Higher Educational Institutions

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ABSTRACT

This study explores the impact of assistive technologies on academic accessibility for visually impaired students in Moroccan higher education, focusing on translation studies. Using a mixed-methods approach, the research finds that technologies like screen readers are crucial, with 85% of participants using them daily. A strong positive correlation (r = 0.78) is observed between technology use, academic satisfaction, improved task efficiency, and mental health. However, issues with Optical Character Recognition (OCR) software and accessibility barriers persist. The study highlights the need for improved assistive technologies and better-designed educational materials, suggesting further research on their long-term academic and professional impacts.

Keywords: Assistive technologies, visually impaired learners, Moroccan higher education, translation accessibility, academic performance, educational inclusion.

INTRODUCTION

The higher education system in Morocco has experienced notable changes recently, with a particular focus on enhancing accessibility and quality (Bounahai, 2014; Ouajdouni et al., 2021). This transformation includes public universities, private institutions, and specialized schools that provide various programs tailored to the socioeconomic demands of the nation (Buckner, 2018; Otmane et al., 2020). However, despite these

improvements, challenges remain, especially in achieving equitable educational access for all societal groups, including students with disabilities (Hayes & Bulat, 2017; Ibourk & Raoui, 2024). Research by Fahim et al. (2021) indicated that the Moroccan government has introduced several reforms, such as the Bachelor-Master-Doctorate (BMD) framework, in order to meet international standards and boost the competitiveness of its graduates. Nevertheless, the support for integrating students with disabilities, particularly those who are visually impaired, is still insufficient, due to a lack of necessary infrastructure and services to ensure their full engagement in higher education (UNESCO, 2021). This situation highlights the urgent need for a more inclusive strategy that caters to the unique requirements of all students, especially those with disabilities.

Moreover, the right to accessibility in education is a fundamental human right and plays a crucial role in fostering inclusive and equitable quality education for everyone (De Beco, 2014; Kearney, 2016; Veriava & Paterson, 2020). For instance, for learners with visual impairments, accessibility encompasses more than just physical entry to educational institutions; it also involves the availability of suitable learning resources, assistive technologies, and nurturing educational settings (Kocyigit & Artar, 2015; Ediyanto, & Kawai, 2019; Kadiri, 2022). Given that approximately 1.3 billion individuals experience some degree of visual impairment, the necessity of making education accessible to this demographic is of global significance (Jones et al., 2019). In particular, in Morocco, the challenge of ensuring accessibility is particularly urgent. Despite ongoing initiatives aimed at enhancing educational access for all, visually impaired students frequently encounter substantial obstacles, such as the scarcity of accessible textbooks, insufficient training for educators on how to assist students with disabilities, and a limited supply of assistive technologies (Aabi & Bracken, 2023; Zohri & Bogotch, 2023). Therefore, facilitating the full participation of these learners in educational activities is not merely an issue of fairness; it is also essential for empowering them to make meaningful contributions to society (Clouder et al., 2019). Indeed, studies indicate that when educational settings are made accessible, visually impaired students are more likely to attain academic success and acquire the skills necessary for independent living and professional endeavors (Tahiri, 2023).

Furthermore, the challenges faced by visually impaired students in accessing translated materials are multifaceted and deeply impact their academic progress (Nugroho et al., 2021; Nugroho & Nababan, 2022; Sunardi et al., 2022; Kimogol, 2023). For example, one significant challenge is the limited availability of materials in accessible formats such as Braille, audio, or large print (Bhardwaj & Kumar, 2017). Even when

translations are available, they often lack the necessary adaptations that consider the unique needs of visually impaired students, such as the inclusion of detailed descriptions for visual content or the proper structuring of information for screen readers (Kumar & Nagar, 2024). Also, the translation process itself may not always account for the cognitive load required to navigate complex academic texts (Arslan, 2015; Pfau & Humblé, 2019; Bielsa et al., 2024), making it difficult for these students to engage with content on an equal footing with their sighted peers.

In addition, in Moroccan higher education, there exists a significant disparity between the resources provided and the requirements of visually impaired students (Tahiri, 2023). Despite initiatives aimed at fostering inclusive education, the funding dedicated to the creation and distribution of accessible learning materials is inadequate (Kroum & Benmassoud, 2017). This issue is particularly noticeable in the limited availability of essential tools and technologies, such as refreshable Braille displays and accessible digital platforms, which are vital for the full academic engagement of visually impaired learners (Mustapha, 2022). Moreover, there is a shortage of qualified personnel capable of developing and modifying educational resources to cater to the unique needs of these students (Abdykaimov, 2021). As a result, this imbalance not only obstructs the academic achievements of visually impaired individuals but also reinforces systemic inequalities within the educational framework (Kapur, 2018; Belay & Yihun, 2020).

In light of these challenges, this study aims to achieve several key objectives in addressing the challenges faced by visually impaired students in Moroccan higher education. First, it seeks to assess the effectiveness of various assistive technologies, such as text-to-speech software, Braille displays, and screen readers, in enhancing the accessibility of translated academic materials. Second, the study will evaluate the current state of accessibility within Moroccan universities by analyzing the availability of assistive tools, the infrastructure supporting these technologies, and the level of staff training. Third, it aims to identify existing gaps and challenges that hinder full academic engagement for visually impaired students. Finally, the study will propose actionable recommendations to improve accessibility, focusing on resources, training, and infrastructure to create a more inclusive learning environment. By addressing these objectives, the study aims to contribute to the development of a higher education system in Morocco that is equitable and accessible for all students, regardless of visual ability.

Besides, it is crucial in this study to propose recommendations for improving accessibility. Based on the findings from the examination and evaluation of assistive technologies, this objective aims to develop a set of

actionable recommendations that can be implemented to enhance accessibility for visually impaired students in Moroccan higher education. These recommendations will address gaps in resources, training, and infrastructure, offering strategies for institutions to better support their visually impaired learners. The ultimate goal is to contribute to the creation of a more inclusive academic environment where all students, regardless of visual ability, have equal access to educational opportunities.

It is also of significant importance in this study to shed light on the key questions related to the accessibility of translated materials for visually impaired learners in Moroccan higher education. Firstly, what are the current challenges in providing translation accessibility to visually impaired learners in Moroccan higher education? This question aims to uncover the specific obstacles that hinder the effective delivery of accessible educational content. Secondly, how effective are the existing assistive technologies in addressing these challenges? This question focuses on evaluating the efficacy of current tools and technologies used to support visually impaired students, examining whether they meet the needs of these learners adequately. Finally, the research will explore what strategies can be implemented to improve accessibility, with the goal of identifying actionable recommendations that can enhance the inclusivity of educational environments in Morocco.

LITERATURE REVIEW

Assistive technology (AT) plays a crucial role in addressing the daily obstacles faced by students with disabilities (Stumbo et al., 2009). Currently, one billion individuals require adaptive products, and projections indicate that over two billion people globally will need at least one such product by 2030 (Kibret et al., 2024). These technologies aim to bridge the gap between an individual's capabilities and the requirements of their environment, particularly in educational settings. For instance, for students with visual impairments, AT is vital for ensuring equitable access to education and enhancing their overall well-being (Smith et al., 2022; Zilz & Pang, 2021). Adaptive products facilitate the educational rights of students across all age groups, promoting their success and inclusion in schools, vocational training, and higher education (Hoogerwerf et al., 2021). When these products are effectively integrated into accessible educational settings and supported by educators and classmates, students with visual impairments are less prone to marginalization, often attain improved academic results, and enjoy enhanced social interaction opportunities (Clouder et al., 2019, Hunt, 2021).

Also, previous studies have consistently highlighted the myriad benefits that assistive technology (AT) offers to students with disabilities, particularly those with visual impairments. For example, in a

comprehensive investigation conducted by Angelo in 2000, the impact of specialized technologies on the skill acquisition of visually impaired students was meticulously analyzed. Specifically, his findings underscored the dual role of these technologies, which not only provide crucial support but also foster cognitive and sensory engagement among learners. By addressing the specific requirements of this group, Angelo's research demonstrated that appropriate assistive tools can markedly improve educational outcomes. For instance, tools such as screen readers, braille displays, and audiobooks can revolutionize the educational experience, enabling students to access information in formats that align with their unique abilities.

In a similar vein, Stodden et al. (2006) conducted an investigation into the uncertainties and lack of guidance regarding the specific assistive technologies necessary for students with disabilities, as well as the effective utilization of available resources. Their findings indicated that such ambiguity arises from multiple sources, including inadequate assessments of individual student requirements, insufficient training for both educators and students on the application of adaptive technologies, and a limited understanding of the variety of tools and resources that could significantly improve learning experiences. They highlighted that without a clear comprehension of the necessary technologies or strategies for their effective integration into the educational framework, students with disabilities may find it challenging to fully leverage the support systems designed to assist them. As a result, the researchers concluded that this disconnect could lead to lost opportunities for these students to realize their full academic capabilities and to engage meaningfully within educational settings.

Similarly, the research conducted by Nelson et al. (2013) underscored the critical impact of assistive technologies on improving academic achievement and language acquisition among students with disabilities, particularly those experiencing visual impairments. Their findings indicated that the incorporation of these technologies within educational frameworks can significantly enhance both the understanding and expressive capabilities of learners. Notably, tools such as screen readers, speech-to-text applications, and Braille displays have proven effective in fostering a more inclusive educational atmosphere, allowing students to better access and interact with their academic materials. In fact, the study revealed that when students were equipped with suitable assistive technologies, they not only exhibited enhanced academic performance but also demonstrated rapid advancements in language skills, which are essential for their comprehensive educational development. This research highlights the necessity of utilizing technology to address disparities in educational achievements for students with disabilities,

ensuring they possess the essential resources to succeed in their academic endeavors.

Seale (2013) highlighted the varied dynamics that students with disabilities experience in relation to assistive technology. This relationship is characterized by its complexity, as students must navigate various challenges that differ in their degree of difficulty. On one side, students frequently encounter relatively straightforward issues, such as learning to set up and use the fundamental features of assistive devices or software. These tasks may involve actions like modifying settings on a screen reader, configuring text-to-speech applications, or ensuring that these tools are compatible with other educational resources. Conversely, Seale (2013) identified that students also confront more sophisticated technological hurdles that necessitate a deeper level of expertise and support, including the customization of adaptive technologies to address specific learning requirements, troubleshooting advanced features, or ensuring the seamless integration of multiple assistive devices. Therefore, Seale (2013) contended that this dual nature of challenges emphasizes the necessity for robust support systems that are adaptable and responsive, providing the guidance and assistance needed to address the wide array of difficulties that students may face.

Murray and Rabiner (2014) demonstrated that assistive technology (AT) possesses a remarkable capacity for real-time adaptation to the individual learning levels of students, delivering tailored experiences that directly address their specific requirements. This capacity for immediate adjustment is essential for fostering an inclusive educational atmosphere, as it guarantees that every student is presented with an appropriate degree of challenge and support, which is vital for their academic development. They highlighted that AT offers prompt feedback, a critical feature that significantly enriches the learning experience by enabling students to identify and rectify errors as they arise, reinforcing their understanding of concepts and enhancing information retention. Also, they emphasized the crucial role of assistive technologies in empowering students with disabilities, as these tools facilitate the completion of tasks or functions that might otherwise be unattainable for them.

Similarly, another recent study by Asongu et al. (2019) found that assistive technology (AT) for students with visual impairments and disabilities can significantly enhance inclusion and reduce stigma in education. In particular, AT addresses challenges faced by these students and positively influences societal attitudes, allowing for greater engagement and autonomy in learning. This engagement normalizes the presence of students with disabilities, fostering a more inclusive environment that values diversity. The authors suggested that broader AT use can shift perceptions of disabilities among peers and educators,

emphasizing strengths over limitations and reducing stigma. They also stressed the importance of effectively integrating AT into educational practices to maximize its benefits, ultimately creating a more equitable learning environment for all students.

Finally, in a recent study conducted by McNicholl et al. (2021), they outlined four significant themes that highlight the multifaceted function of assistive technology (AT) within the academic landscape. Initially, they emphasized that AT is an essential instrument for improving academic engagement, as it facilitates access to course materials, encourages participation in interactive learning environments, and allows students with visual impairments and disabilities to complete assignments in conjunction with their classmates. Also, the research examined the profound psychological advantages associated with AT, highlighting its capacity to enhance students' self-esteem, motivation, and autonomy, which are critical components of their academic achievement. Lastly, the study acknowledged AT's significant contribution to fostering participation not only in academic pursuits but also in social contexts, as it empowers students to engage more actively with their peers and campus activities and to cultivate a more inclusive and supportive educational atmosphere.

METHODOLOGY

Research Design

This research employed a mixed-methods framework that combines quantitative and qualitative data to achieve a thorough and detailed understanding of assistive technology usage among visually impaired students in Moroccan higher education institutions. The choice of a mixed-methods design is intended to identify overarching patterns and trends through quantitative analysis while exploring the individual, subjective experiences of students via qualitative insights. This methodology facilitates a comprehensive perspective on the research issue, addressing not only the "what" and "how much" of assistive technology utilization but also the "why" and "how," which illuminate the profound effects on students' academic and personal experiences.

The quantitative segment of the study concentrated on collecting statistical information via structured surveys administered to a representative group of visually impaired students. These surveys aimed to gather data regarding the types of assistive technologies utilized, their frequency of use, the students' satisfaction levels, and the perceived effects on academic performance. To gather these insights, a questionnaire using a Likert scale was designed and distributed to the participants. The

analysis of this data was intended to reveal overarching trends and correlations that could contribute to a deeper understanding of the effectiveness and accessibility of assistive technologies within higher education environments.

Simultaneously, the qualitative dimension of the study provided an in-depth examination of individual experiences by analyzing tasks completed by participants both prior to and following the implementation or enhancement of assistive technologies. This included pre-tasks that evaluated the students' abilities and strategies without technological support, as well as post-tasks conducted after they gained access to or improved their use of assistive tools. By comparing the results of these tasks, the research aimed to highlight not only the functional advancements enabled by the technology but also the psychological and emotional benefits, such as enhanced confidence and diminished anxiety. Furthermore, qualitative insights were augmented through follow-up interviews and focus group discussions, offering a comprehensive view of how these technologies were assimilated into the students' academic lives and their perceived overall impact.

Participants

The study involved a cohort of seven visually impaired students from the English Department at the Faculty of Letters and Human Sciences in Marrakech and four visually impaired students from the Faculty of the Arabic Language in Marrakech. The group was composed of six female and five male students, providing a balanced gender representation. The selection of participants was intentionally designed to reflect a cross-section of the visually impaired student demographic within these faculties, enhancing the relevance of the results for a wider audience experiencing similar difficulties.

Over ten weeks, these individuals participated in a structured series of activities aimed at evaluating how assistive technologies influenced their academic achievements. During the study, participants were exposed to a range of assistive technologies, with their advancements meticulously tracked to assess variations in task efficiency, completion rates, and overall self-assurance in managing academic responsibilities. This concentrated yet small sample facilitated a thorough investigation into the potential of assistive technologies to effect meaningful change within an educational context.

Data Collection

Quantitative Data Collection

Surveys were carried out among visually impaired students enrolled in the English and Arabic Language Departments at the Faculty of Letters

and Human Sciences in Marrakech. The objective was to collect comprehensive insights regarding their academic experiences, particularly emphasizing the utilization of assistive technologies available in Morocco. These technologies encompass screen readers such as JAWS and NVDA, which facilitate the conversion of on-screen text into speech or Braille, allowing students to engage with digital materials. Furthermore, the study included Braille displays like the Focus 40 Blue to evaluate their effectiveness in translating digital text into Braille, offering a tactile reading option for Braille users. The research also explored text-to-speech software, including applications like Balabolka, and speech recognition tools, such as Dragon NaturallySpeaking, to determine their contributions in converting written content into spoken language and aiding in hands-free tasks.

Furthermore, the survey encompassed inquiries regarding the usage frequency and effectiveness of various assistive technologies, alongside the challenges encountered by students. These challenges included device functionality issues, the accessibility of tools across different academic environments, and the sufficiency of technical support offered by educational institutions. The survey also investigated the application of optical character recognition (OCR) software, such as Kurzweil 1000, which facilitates the scanning of printed materials into digital formats compatible with screen readers. This analysis was crucial for understanding the tangible effects of assistive technology on academic results, yielding essential insights that could inform future improvements in support systems within educational institutions. In addition, the survey assessed students' overall satisfaction with the current support frameworks, including questions about the availability and quality of assistive devices, the responsiveness of faculty and staff to student requirements, and the inclusivity of the learning environment.

Qualitative Data Collection

The qualitative aspect of this research focused on examining the tasks performed by students prior to and following the introduction of assistive technologies. The initial tasks aimed to evaluate students' existing skills and approaches to academic assignments in the absence of, or with restricted access to, assistive tools, creating a baseline that underscores difficulties such as obtaining course materials, effectively managing time, or depending on less effective techniques.

Following the execution of preliminary tasks, students with visual impairments were instructed to utilize assistive technologies, after which a series of post-tasks were conducted to evaluate the influence of these tools on their academic performance, specifically focusing on aspects such as task efficiency, completion rates, and self-confidence. This comparative

analysis provided significant insights into the transformative effects of assistive technologies on the educational experiences of visually impaired students. The qualitative data gathered from these tasks were subsequently examined using NVivo software, which enabled the extraction of essential themes and contributed to a thorough understanding of how assistive technologies enhance academic success.

Data Analysis

Quantitative Data Analysis

The survey data underwent a thorough statistical analysis using SPSS. The analysis commenced with an extensive overview of the sample's demographic attributes, encompassing factors such as age, gender, types and severity of visual impairments, and educational qualifications. Furthermore, the frequency of assistive technology usage among participants was recorded, offering a vital insight into the integration of these tools within their academic activities.

To gain a deeper understanding of the data, inferential statistical techniques were employed. T-tests were conducted to compare mean values across different groups, including male and female students, as well as those with differing degrees of visual impairment, to assess significant differences in their utilization of assistive technologies. In addition, ANOVA (Analysis of Variance) was utilized to investigate the relationships among multiple variables concurrently, such as the effect of assistive technology on academic performance across various demographic categories. These analyses played a pivotal role in revealing trends and patterns that may not have been evident from the descriptive statistics alone.

Correlation analysis was also carried out to evaluate the strength and direction of relationships between various variables. This analysis aimed to determine whether a significant correlation existed between the frequency of assistive technology use and students' reported satisfaction with their academic achievements. By examining these connections, the study sought to identify potential causal relationships or contributing factors that could guide future interventions and support mechanisms.

Qualitative Data Analysis:

A thorough thematic analysis was performed on the qualitative data gathered from both pre-tasks and post-tasks, relying on NVivo and ATLAS.TI software to facilitate and improve the coding process. This structured methodology involved segmenting the data into smaller, manageable parts, which were then systematically coded to reveal recurring themes and patterns indicative of students' varied experiences with assistive technologies. Each data point was scrutinized to identify

significant trends and common issues present in the students' accounts. The analysis aimed to investigate the multifaceted effects of assistive technologies on students' academic experiences, particularly regarding their task completion efficiency, increased independence, and the confidence gained from using these tools.

Besides, the analysis sought to pinpoint specific challenges faced by students, including usability concerns, accessibility barriers within their educational settings, and the sufficiency of the support provided. By exploring these dimensions, the thematic analysis offered a nuanced understanding of how assistive technologies affect not only the academic performance of visually impaired students but also their overall educational journey. These qualitative findings were crucial in enhancing the quantitative results, providing a comprehensive perspective on the effectiveness and limitations of assistive technologies in higher education. The themes identified also illuminated potential areas for improvement in both the design and implementation of assistive technologies, as well as in the broader support systems necessary for the success of visually impaired students. This holistic approach ensured that the study captured the complexities associated with the use of assistive technologies in real-world academic contexts, yielding deeper insights.

FINDINGS

Quantitative Findings

The demographic analysis, as shown in Table 1, reveals a diverse participant group characterized by a fairly even gender ratio, with 54.5% female and 45.5% male participants. The majority of participants are aged between 20 and 25 years (63.6%), while a smaller segment falls within the 26 to 30 years range (36.4%), indicating a predominantly youthful demographic typical of university students. In terms of visual impairment, most participants experience moderate (45.5%) or mild (36.4%) impairments, with a lesser number facing severe impairment (18.2%).

Participants' educational backgrounds are fairly balanced across Introduction to Translation and Translation courses (both at 36.4%), with a slightly lower representation in Advanced Translation Studies (27.2%). This distribution indicates that participants are at various stages of their translation education. Furthermore, a significant majority are enrolled in the English Language Department (63.6%), compared to a smaller group in the Arabic Language Department (36.4%). This distribution sheds light on the linguistic and academic environments these students are navigating, highlighting a strong emphasis on English language studies. Overall, the table presents a varied group of visually impaired students, differing in gender, age, visual impairment levels, and academic focus, which offers a

valuable context for examining the influence of assistive technologies on their educational experiences.

Table 1: Demographic Overview

Demographic Characteristics	Frequency (N)	Percentage (%)
Gender		
Female	6	54.5%
Male	5	45.5%
Age Range		
20-25 years	7	63.6%
26-30 years	4	36.4%
Visual Impairment		
Mild	4	36.4%
Moderate	5	45.5%
Severe	2	18.2%
Educational Qualifications		
Introduction to Translation	4	36.4%
Translation	4	36.4%
Advanced Translation Studies	3	27.2%
Faculty		
English Language Department	7	63.6%
Arabic Language Department	4	36.4%

Moreover, the information illustrated in Figure 1 offers a comprehensive insight into the frequency of use and adoption levels of various assistive technologies among students with visual impairments. Specifically, it is evident from the data that screen readers, including JAWS and NVDA, are the predominant tools, with an impressive 85% of students employing them on a daily basis. This substantial daily engagement emphasizes the essential function these technologies serve in facilitating students' access to digital academic resources effectively. In contrast, Braille displays, such as the Focus 40 Blue, are utilized by 55% of students on a weekly basis, indicating a notable, though less frequent, dependence on tactile reading approaches. Besides, text-to-speech software like Balabolka and speech recognition applications such as Dragon NaturallySpeaking are used moderately on a weekly basis by 65% of students. This level of usage implies that while these technologies are valuable for activities such as composing assignments and taking notes, they do not hold the same level of importance in daily tasks as screen readers do.

Lastly, optical character recognition (OCR) software, represented by Kurzweil 1000, shows the lowest adoption rate, with merely 40% of students utilizing it on a monthly basis. The infrequent use of this technology likely stems from the technical difficulties and limited accessibility associated with such software, which may impede its incorporation into the students' routine academic practices. In summary, the table underscores the diverse levels of dependence on various assistive technologies, with screen readers standing out as essential instruments, while other technologies cater to more specialized or infrequent requirements.

Figure 1: Usage Frequency and Types of Assistive Technologies.
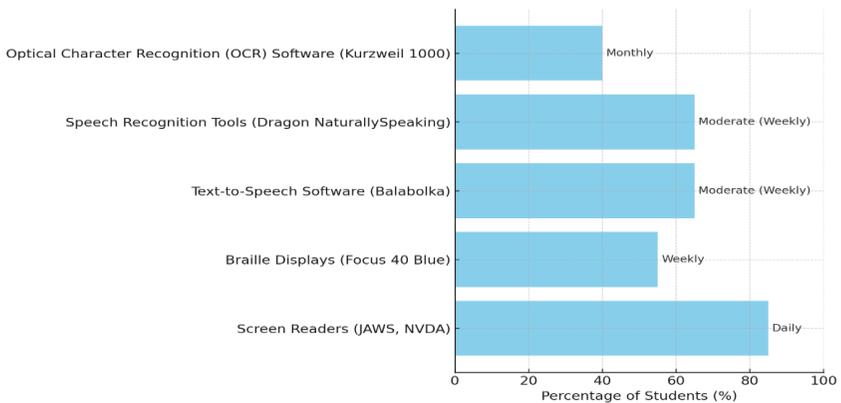
Moving on, the examination of Table 2, which centers on student satisfaction and the perceived impact on academic performance, uncovers several significant findings regarding the elements that contribute to student contentment, particularly about the utilization of assistive technologies. Firstly, the data indicates a high level of overall satisfaction, with an average rating of 4.2 out of 5, suggesting that students generally feel positive about the assistive technologies at their disposal. An impressive 90% of respondents acknowledged that these technologies have had a beneficial effect on their academic achievements, highlighting their essential role in facilitating the completion of academic tasks with greater efficiency. Moreover, the analysis reveals a strong positive relationship ($r = 0.78$) between the regularity of technology usage and academic satisfaction, implying that increased engagement with assistive technologies correlates with enhanced satisfaction regarding academic results. In contrast, a significant negative correlation ($r = -0.65$) was identified between the duration spent on non-academic activities and academic satisfaction, suggesting that devoting more time to non-academic interests, such as social media, adversely affects students' satisfaction with their academic experiences. This finding highlights the

importance of managing time effectively to maintain a balance between academic responsibilities and leisure activities.

Notably, the research indicates a negligible correlation ($r = 0.05$) between the time allocated for physical exercise and academic satisfaction, implying that physical activity does not play a significant role in influencing students' satisfaction levels in an academic context. In addition, a strong positive correlation ($r = 0.72$) was observed between the availability of technical support and overall satisfaction, reinforcing the necessity of providing dependable technical assistance to maximize the benefits of assistive technologies. Lastly, the data illustrates a negative correlation ($r = -0.58$) between the accessibility of assistive technologies and levels of frustration, indicating that enhanced accessibility can lead to reduced frustration, emphasizing the critical need for the widespread availability and accessibility of assistive tools within educational environments.

On the other hand, the survey revealed a number of significant challenges faced by students, including issues related to device malfunctions, software compatibility, and a lack of adequate technical support from educational institutions. A striking 58% of students expressed feelings of frustration stemming from the limited availability of assistive technologies, which was quantitatively supported by a negative correlation ($r = -0.58$) between accessibility and frustration levels. These difficulties were especially evident in the use of Optical Character Recognition (OCR) software and Braille displays, as students found it challenging to incorporate these essential tools into their everyday academic activities. The insufficient technical support, despite a strong positive correlation ($r = 0.72$) between access to such support and overall satisfaction, intensified these challenges, leaving numerous students feeling neglected by their educational institutions. This deficiency in both support and accessibility not only obstructed the effective application of these technologies but also led to a decline in overall academic satisfaction, as indicated by the significant negative correlation ($r = -0.65$) between increased time spent on non-academic pursuits and the challenges faced, which students often resorted to when confronted with these obstacles.

In addition, Table 3 presents a comprehensive analysis of the relationship between gender, severity of visual impairment, satisfaction levels, and the utilization of assistive technologies, particularly focusing on screen readers. The findings indicate that there are no notable differences between genders, as both male and female students report similar satisfaction scores (4.2 for males and 4.1 for females) and exhibit comparable levels of access to and effectiveness of assistive technologies, evidenced by a p-value exceeding 0.05.

Table 2: Satisfaction Levels and Perceived Academic Impact.

Factor Analyzed	(r)	Impact on Satisfaction	Interpretation
Overall Satisfaction Rating	-	Satisfaction Rating: 4.2 out of 5	High satisfaction with assistive technologies
Impact of Assistive Technologies on Academic Performance	-	90% reported a positive impact	Assistive technologies significantly improve academic task completion
Frequency of Technology Use vs. Academic Satisfaction	r = 0.78	Strong Positive Correlation	Increased use of technology correlates with higher satisfaction in academic outcomes
Time Spent on Non-Academic Activities vs. Academic Satisfaction	r = -0.65	Negative Correlation	More time on non-academic activities leads to lower academic satisfaction
Time Spent on Physical Exercise vs. Academic Satisfaction	r = 0.05	Near-Zero Correlation	Physical exercise does not significantly impact academic satisfaction
Access to Technical Support vs. Overall Satisfaction	r = 0.72	Positive Correlation	Better access to technical support enhances overall satisfaction
Accessibility of Assistive Technologies vs. Frustration Levels	r = -0.58	Negative Correlation	Improved accessibility reduces frustration, highlighting the need for widespread availability of assistive technologies

This outcome implies that gender does not significantly influence the usage or satisfaction associated with assistive technologies among the surveyed student population. In examining the severity of visual impairment, a distinct trend is observed: students experiencing more severe impairments demonstrate a greater reliance on assistive technologies, particularly screen readers. Those classified with severe impairments report the highest frequency of screen reader usage, at 85%, alongside the highest satisfaction rating of 4.5. This indicates a strong positive relationship between the severity of impairment and the perceived advantages of assistive technologies. Conversely, students with moderate

impairments exhibit a moderate usage rate of 60% and a slightly lower satisfaction score of 4.0, while those with mild impairments show the least reliance, with only 30% daily usage and a satisfaction rating of 3.8. This pattern suggests that as the severity of visual impairment diminishes, so does dependence on and satisfaction with assistive technologies. The results underscore the vital need for effective support and accessible technological solutions for students with severe impairments to improve their educational experiences.

Table 3: Gender and Severity of Visual Impairment

Category	Group	Average Satisfaction Rating	Daily Usage of Screen Readers (%)	Key Findings
Gender	Male	4.2	-	No significant gender differences in usage or satisfaction levels (p > 0.05)
Gender	Female	4.1	-	Assistive technologies are equally accessible and effective for both genders
Severity of Visual Impairment	Severe Impairment	4.5	85%	Higher dependency on assistive technologies; strong positive correlation with academic satisfaction
Severity of Visual Impairment	Moderate Impairment	4.0	60%	Moderate usage and satisfaction; lower dependency compared to those with severe impairments
Severity of Visual Impairment	Mild Impairment	3.8	30%	Least dependency on assistive technologies; lower satisfaction compared to more severely impaired peers

Qualitative Findings

The examination of the data illustrated in Table 4 reveals considerable obstacles encountered by students with visual impairments in their educational endeavors. To begin with, a notable 75% of these students expressed challenges in obtaining course materials, frequently depending on their classmates for support. This reliance not only hindered their academic advancement but also cultivated feelings of inadequacy and dependence on others. 60% of the students reported that they devoted an inordinate amount of time to completing assignments due to ineffective strategies, which resulted in heightened frustration. Consequently, this lack of efficiency in managing their coursework exacerbated a larger issue of academic stress, with 68% of the respondents experiencing increased anxiety concerning their academic performance.

Table 4: Nvivo Analysis of Preliminary Investigations

Analysis Aspect	Statistic/Percentage	Key Findings
Challenges in Accessing Course Materials	75%	The majority of students experienced difficulties accessing course materials, often relying on peers for assistance. This reliance contributed to feelings of inadequacy and dependence.
Excessive Time Spent on Assignments	60%	Students reported spending excessive time on assignments due to ineffective methods, leading to frustration.
Heightened Anxiety Regarding Academic Performance	68%	A significant portion of students experienced heightened anxiety related to their academic performance.
Negative Emotions (Sentiment Analysis)	72%	NVivo sentiment analysis revealed that 72% of responses reflected negative emotions, such as frustration, anxiety, and diminished self-confidence.

Also, sentiment analysis conducted using NVivo revealed that 72% of the coded feedback reflected negative emotions, including frustration, anxiety,

and a decline in self-esteem. Together, these results emphasize the significant repercussions of accessibility issues on both the academic success and emotional health of visually impaired students, indicating an urgent necessity for effective solutions.

In contrast, the information illustrated in Table 5 highlights the significant influence of assistive technologies on the productivity and autonomy of students. An impressive 82% of the students reported a considerable decrease in the time needed to complete their tasks while utilizing these technologies, which emphasizes their role in improving efficiency. Specifically, the screen reader software JAWS was instrumental for one participant, leading to a 50% reduction in the time allocated for reading assignments, demonstrating the concrete advantages of such specialized tools.

Table 5: ATLAS.TI Analysis of the Efficiency and Independence of Post-Assistive Technologies

Code Group	Code	Frequency/Percentage	Description/Quotation
Increased Efficiency	Time Reduction with Assistive Technologies	82%	82% of students reported a significant decrease in the time spent on tasks with assistive technologies.
Increased Efficiency	Time Reduction with JAWS	50%	One participant reported a 50% reduction in time spent on reading assignments after using JAWS software.
Enhanced Independence	Reduced Need for Assistance	78%	78% of participants indicated a reduced need for peer or faculty assistance due to assistive technologies.
Enhanced Independence	Increased Self-Efficacy	64%	64% increase in perceived self-efficacy among students due to increased independence.

Furthermore, the data reveals a significant shift towards increased independence among participants, with an impressive 78% reporting a notable reduction in their reliance on peers or faculty for academic support. This positive change is directly attributed to the integration of assistive technologies, which have played a crucial role in this transformation. The use of these technologies appears to have empowered students to manage their academic responsibilities more autonomously. This trend towards greater self-sufficiency is further supported by a substantial 64% increase in students' perceived self-efficacy. This rise in self-efficacy reflects a deeper sense of confidence and self-reliance, indicating that the assistive technologies have not only facilitated academic success but have also contributed to the students' overall confidence in their abilities. The combination of these factors underscores the essential role that assistive technologies play in enhancing students' academic performance and personal growth. By enabling students to navigate their academic tasks with increased effectiveness and independence, these technologies prove to be indispensable tools in fostering a more empowered and self-assured student body.

Also, Table 6 provides a compelling analysis of the positive effects that assistive technologies have on both academic performance and psychological well-being among students. The data indicates that 70% of students reported improved grades and better comprehension of course materials following the introduction of these technologies, highlighting their effectiveness in enhancing academic outcomes. In addition, the ability to access digital content in real-time led to a 20% improvement in class participation for some students, suggesting that assistive technologies not only support academic success but also encourage more active engagement in learning activities.

On the psychological front, the benefits are equally significant. A substantial 75% of students reported enhanced psychological well-being, underscoring the broader impact of these technologies beyond mere academic performance. This improvement in well-being is further reflected in a 68% reduction in anxiety levels and a 72% increase in confidence, particularly in managing academic workloads. These figures demonstrate that assistive technologies help alleviate the emotional and psychological pressures associated with academic challenges. Moreover, 80% of students felt more empowered and less marginalized, indicating that these tools contribute to a more inclusive and supportive educational environment. Overall, the findings suggest that the integration of assistive technologies is instrumental not only in improving academic outcomes but also in fostering a positive and empowering experience for students.

Table 6: ATLAS.TI Analysis of Academic Performance and Psychological Benefits of Post-Assistive Technologies

Code Group	Code	Frequency/Percentage	Description/Quotation
Improved Academic Performance	Higher Grades and Comprehension	70%	70% of students reported higher grades and better comprehension of course materials post-intervention.
Improved Academic Performance	Improved Class Participation	20%	One participant noted a 20% improvement in class participation due to real-time access to digital content.
Psychological and Emotional Benefits	Enhanced Psychological Well-Being	75%	75% of students experienced enhanced psychological well-being.
Psychological and Emotional Benefits	Reduced Anxiety	68%	68% reduction in anxiety levels reported by students after using assistive technologies.
Psychological and Emotional Benefits	Increased Confidence	72%	72% increase in confidence among students, particularly in managing academic workloads.
Psychological and Emotional Benefits	Empowerment and Reduced Marginalization	80%	80% of students felt more empowered and less marginalized within the academic environment.

However, although the outcomes were generally favorable, the qualitative analysis highlighted persistent challenges that students encountered while using assistive technologies. Usability issues were notably significant with specific technologies; for instance, 45% of students experienced difficulties with Optical Character Recognition (OCR) software, reporting inaccuracies in scanning and reading printed materials. Such usability problems often resulted in frustration, impeding students' capacity to complete their academic tasks effectively.

Accessibility obstacles within educational environments also surfaced as a major issue. Around 52% of students faced challenges with inadequately designed digital platforms that lacked full compatibility with their assistive technologies. Furthermore, 40% of students indicated that inconsistent technical support intensified their struggles in effectively utilizing these tools. These barriers not only diminished the functionality of assistive technologies but also adversely affected students' overall academic experiences.

Besides, the limited availability of certain assistive technologies presented another significant hurdle. While 85% of students had consistent access to screen readers, only 30% reported easy access to advanced Braille displays, and merely 40% could reliably use OCR software. This disparity in access restricted students' ability to fully incorporate these tools into their academic routines, limiting their overall effectiveness and diminishing the potential advantages these technologies could provide.

DISCUSSION

The results of this research offer a comprehensive perspective on the experiences of visually impaired students within higher education, particularly focusing on their engagement with assistive technologies. The demographic analysis presented in Table 1 highlights a varied participant group, characterized by a nearly balanced gender ratio and a significant representation of younger individuals aged 20 to 30 years. This demographic profile aligns with the typical composition of university students, indicating that the challenges and achievements identified in this study may resonate widely across similar educational environments.

The quantitative results underscore the vital importance of assistive technologies in improving the academic experiences of visually impaired students. As illustrated in Figure 1, screen readers, including JAWS and NVDA, are crucial resources for these individuals, with 85% of respondents reporting daily usage. This substantial frequency of use highlights the essential role that screen readers play in enabling access to digital academic materials. Conversely, the data reveals a comparatively lower dependence on other assistive technologies, such as Braille displays and OCR software, with only 55% and 40% of students utilizing these tools on a weekly and monthly basis, respectively. These statistics imply that, while these alternative technologies hold value, they may not be as central to the daily academic routines of visually impaired students as screen readers.

The examination of student satisfaction and the academic impact, as presented in Table 2, underscores the significant role that assistive technologies play in enhancing educational outcomes. An impressive 90% of students indicated that these technological tools positively influenced

their academic achievements, while a robust positive correlation ($r = 0.78$) was identified between the frequency of technology utilization and overall academic satisfaction. This evidence strongly suggests that consistent interaction with assistive technologies is vital for fostering academic success. In addition, the analysis indicates a noteworthy negative correlation ($r = -0.65$) between the duration spent on non-academic pursuits and levels of academic satisfaction, emphasizing the importance of effective time management in sustaining high academic satisfaction.

Despite the generally favorable effects of assistive technologies, the study reveals ongoing challenges that students face. As illustrated in Table 4, 75% of students reported experiencing difficulties in accessing course materials, often depending on their peers for support, which led to feelings of inadequacy and reliance. Moreover, 45% of students encountered usability problems with Optical Character Recognition (OCR) software, indicating a pressing need for more intuitive and dependable tools. The issue of accessibility within educational environments is further exacerbated by the fact that 52% of students reported encountering poorly designed digital platforms. This situation highlights a significant deficiency in the availability of accessible educational resources, which must be addressed to adequately support visually impaired students.

The qualitative results presented in Tables 5 and 6 offer valuable insights into how assistive technologies influence students' efficiency, autonomy, and psychological health. A notable 82% of students indicated a marked decrease in the time required to complete academic assignments, especially with screen readers such as JAWS, which one participant claimed reduced their reading time by 50%. In addition, 78% of students reported enhanced independence, underscoring the empowering nature of these technologies. This is further supported by a 64% increase in perceived self-efficacy, indicating that these tools not only enhance academic outcomes but also strengthen students' confidence and independence.

On the psychological side, 75% of students noted improvements in their well-being, with significant declines in anxiety (68%) and increases in confidence (72%). These results illustrate that assistive technologies are vital not only for academic achievement but also for fostering emotional and psychological wellness among students. Nonetheless, the study identifies areas needing enhancement, particularly regarding the accessibility and usability of specific technologies, as only 30% of students reported easy access to advanced Braille displays, and 40% consistently utilized OCR software.

CONCLUSION AND RECOMMENDATIONS

This research sought to explore the effects of assistive technologies on the academic success and mental health of visually impaired students enrolled in higher education. Specifically, the investigation focused on how these technologies impacted students' academic performance, autonomy, and overall satisfaction, while simultaneously examining the obstacles and difficulties encountered by these individuals in utilizing assistive devices. The results of the study revealed several significant quantitative findings. For instance, a substantial 85% of the participants reported daily use of screen readers, which were found to be essential for completing academic assignments. A strong positive correlation ($r = 0.78$) was identified between the regular use of assistive technologies and the level of academic satisfaction experienced by the students. In addition, 82% of the respondents indicated that they experienced notable improvements in efficiency, suggesting that these technologies significantly lessened the time needed to accomplish academic tasks.

Qualitative data indicated that assistive technologies not only fostered greater independence and self-efficacy among students but also contributed positively to their psychological state, with 68% reporting decreased anxiety levels and 75% experiencing enhanced overall well-being. Nevertheless, ongoing challenges persisted, particularly concerning usability problems with optical character recognition (OCR) software and accessibility issues within educational environments, which continued to impede the academic experiences of some students.

Given these findings, the results of this research carry significant implications for the development of educational practices and policies. The investigation emphasized the necessity for universities to allocate resources toward ensuring consistent access to a diverse array of assistive technologies. Furthermore, it brought to light the critical need for enhancing the design and accessibility of digital platforms utilized within academic environments. The study demonstrated that assistive technologies are vital not only for improving academic outcomes but also for bolstering the psychological well-being of students with visual impairments, empowering them, and promoting greater independence and self-assurance.

In terms of future research directions, the study recommended examining the long-term impacts of assistive technologies on both the academic achievements and career trajectories of visually impaired students, as well as assessing the unique requirements of individuals with varying degrees of visual impairment. Practical suggestions for educational institutions included the enhancement of technical support services, the expansion of access to underutilized technologies such as

advanced Braille displays and optical character recognition (OCR) software, and the provision of continuous training to ensure that both students and faculty can effectively utilize these essential tools.

However, this research encountered specific limitations in its design and data collection processes that could potentially affect how the results are interpreted. One of the most significant constraints was the relatively small sample size, which, when coupled with the lack of demographic diversity, poses challenges to the generalizability of the findings. Specifically, the study included all visually impaired students at both institutions within Cadi Ayyad University, primarily because of their limited number. While this approach ensured that every possible participant within the target population was included, it also meant that the sample was inherently narrow, both in size and scope.

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Conflict of Interest Statement

The author declares no conflicts of interest related to the content of this article.

Ethics Statement

This study was conducted by the ethical principles outlined in the World Medical Association's Declaration of Helsinki for research involving human participants. The research adhered to the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals, focusing on including a representative sample of the population in terms of sex, age, and ethnicity. The terms "sex" and "gender" were used accurately throughout the manuscript. Informed consent was obtained from all participants before their involvement in the study, and their privacy rights were strictly observed, ensuring confidentiality and anonymity of all personal data.

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