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Students' Perceptions on AI-Supported Learning for Universal Design and Accessibility Compliance in the Built Environment

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Abstract: *Accessibility in the built environment is essential for inclusivity, yet the technical complexity of the Malaysian Standard MS 1184:2014 Universal Design and Accessibility in the Built Environment - Code of Practice (Second Revision) often creates challenges for students in applying universal design principles effectively. To address this, the Universal Design Assistant (UD-AI) was developed as an AI-supported learning tool that provides immediate and standard-compliant guidance. This study evaluated students' perceptions of UD-AI in terms of usefulness, usability, reliability, and satisfaction. Data were collected through a questionnaire comprising 15 Likert-scale items and three open-ended questions, enabling the examination of both numerical trends and participants' elaborated perspectives. A total of 77 undergraduate students enrolled in BST506 Building Control and Safety course participated in the study. Quantitative data were analyzed to calculate mean scores, while qualitative responses were thematically reviewed to capture user experiences. The findings revealed overwhelmingly positive perceptions of UD-AI, with an overall high mean score (M = 4.30). Usefulness (M = 4.38) and satisfaction (M = 4.35) emerged as the strongest predictors of acceptance, demonstrating that students valued UD-AI for simplifying complex standards, supporting assignments, and building confidence in applying universal design principles. Ease of use (M = 4.22) and reliability (M = 4.16) were also rated positively. Qualitative feedback highlighted enhanced understanding of the MS 1184:2014, ease of navigation, practical application support, and increased confidence, alongside suggestions for greater visual references and interactive features. Overall, UD-AI shows significant potential as an innovative pedagogical tool that bridges the gap between theory and practice in accessibility education, while also serving as a professional reference for consistent application of universal design standards in the built environment.*

Keywords: accessibility compliance, AI-supported learning, students' perceptions, universal design

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1. Introduction

The concept of Universal Design (UD), articulated by Ronald L. Mace in 1985, emphasizes the creation of products and environments that are usable by all individuals, irrespective of age, ability, or social status (Mace, 1985). UD minimizes the need for later modifications, a principle that the Center for Universal Design (1997) reinforces through the *Principles of Universal Design*. Global agendas, exemplified by the United Nations Sustainable Development Goals (SDG), particularly on *Sustainable Cities and Communities* (SDG 11), emphasize the importance of inclusivity, accessibility, and equity in urban environments, aligning closely with UD principles.

Accessibility is recognized as fundamental to social inclusion, with frameworks such as the United Nations Convention on the Rights of Persons with Disabilities (CRPD) affirming the right to access environments on an equal basis (UN, 2006). Yet, barriers persist due to inadequate design practices and limited integration of UD principles (Zahari et al., 2023; Kamarudin, 2023). In Malaysia, the Malaysian Standard *MS 1184:2014 Universal Design and Accessibility in the Built Environment - Code of Practice (Second Revision)* serves as the primary reference for achieving inclusivity, providing detailed specifications for ramps, circulation spaces, signage, and facilities for all. However, its technical complexity poses challenges for both students and practitioners, while limited exposure in education contributes to competency gaps. In addition, the price of MS 1184:2014, which exceeds RM300, is considered costly for students (Kamarudin et al., 2025).

Traditional teaching approaches often fall short in equipping students to integrate accessibility into design decision-making. This situation underscores the need for innovative pedagogical tools that make technical standards like MS 1184:2014 more engaging and applicable. Artificial Intelligence (AI) offers a promising pathway, as it enhances learning efficiency, provides personalized support, and simplifies complex content (Kamarudin et al., 2025). In higher education, AI increasingly applies to personalize learning, automate assessments, and deliver adaptive feedback (Holmes et al., 2019; Chen et al., 2020). In built environment education, AI tools hold potential as virtual assistants, providing real-time, context-specific guidance that complements traditional methods and bridges the gap between theoretical understanding and practical application.

Universal Design Assistant (UD-AI) was developed by Kamarudin (2024) in response to teaching and learning challenges related to UD and accessibility in the built environment. This tool designed to provide immediate, standard-compliant answers derived solely from the local accessibility standard, MS 1184:2014. UD-AI functions as a learning aid that reduces reliance on manual referencing and enhances understanding of accessibility requirements. Beyond enhancing comprehension, it encourages students to integrate accessibility considerations more consistently in accessibility compliance-related courses and design projects. However, the success of such an AI-supported tool depends largely on its acceptance by students. Accordingly, the objective of this study is to investigate students' perceptions of UD-AI regarding its usefulness, usability, reliability, and overall satisfaction as a learning tool for UD and accessibility compliance.

2. Literature Review

The literature review positions this study across several key areas: the conceptual foundations of accessibility and UD; the persistence of physical barriers within the built environment; the role of access audits and the application of MS 1184:2014; and educational integration through the development of UD-AI as a learning tool.

2.1 Accessibility and Universal Design

Accessibility in the built environment represents a fundamental aspect of UD, ensuring equitable use by individuals of all abilities. UD extends beyond meeting minimum accessibility standards to creating environments that are inherently usable by all without the need for adaptation (Mace, 1985). The seven principles of UD, as presented in Table 1, provide a comprehensive framework for UD practice (North Carolina States University, 1997). These principles emphasize inclusivity by addressing factors such as equitable use, perceptible information, and low physical effort, ensuring that environments cater to a wide spectrum of users. Collectively, they serve as a practical guide for translating the philosophy of UD into measurable design strategies applicable across diverse contexts.

Table 1: The Principles of Universal Design (UD)

UD Principles	Description
Equitable Use	The design is useful and marketable to people with diverse abilities
Flexibility in Use	The design accommodates a wide range of individual preferences and abilities
Simple and Intuitive Use	Use of the product is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
Perceptible Information	The design can communicate its necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities
Tolerance for Error	The design minimizes hazards and the adverse consequences or accident or unintended actions
Low Physical Effort	The design can be used efficiently and comfortably and with a minimum fatigue
Size and Space for Approach and Use	Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture or mobility

Source: Ahmad Zawawi et al. (2024b); adapted from The Center of Universal Design (1997)

Accessibility extends beyond technical compliance and connects fundamentally to broader concerns of social justice, equity, and sustainability (Dempsey et al., 2011; Frías-López & Queipo-de-Llano, 2020). When accessibility is treated solely as an afterthought or retrofit, opportunities for inclusivity are diminished, and the transformative potential of UD reduces. Frías-López & Queipo-de-Llano (2020) suggest that reasonable adjustment is understood not merely as adherence to technical standards, but also in relation to contextual factors such as feasibility and equity.

Embedding UD principles from the beginning of the design process ensures that environments transcend mere compliance and become genuinely equitable, sustainable, and socially responsive. A bibliometric analysis conducted by Ahmad Zawawi et al. (2024) further indicates growing global and Malaysian interest in accessibility and UD research, reflecting increasing recognition of the need to align compliance with broader UD principles. Nevertheless, despite these advances, persistent physical barriers in the built environment continue to limit inclusivity, underscoring the gap between policy, design intentions, and real-world practice.

2.2 Physical Barriers in the Built Environment

Physical barriers remain a persistent challenge despite the presence of clear standards. Field studies have reported obstacles such as narrow doorways, steep ramps, and poorly designed toilets across various building types, including healthcare, education, commercial, and heritage facilities (e.g., Bashiti et al., 2016; Zahari et al., 2023). Barriers exists in the street-level environment, where pedestrian walkways often lack adequate width, curb cuts, or continuous tactile paths, thereby restricting safe and independent mobility for persons with disabilities (Kamarudin et al., 2022). Transportation-related barriers are equally pressing, as mobility-challenged individuals in the Klang Valley continue to encounter inconsistent public transport accessibility, poorly maintained infrastructure, and negative attitudes from service personnel, all of which restrict independent mobility (Mothiravally et al., 2014; Kamarudin et al., 2023).

Meanwhile, heritage buildings present an additional layer of complexity due to conservation requirements. Research in Malaysia indicates the ongoing tension between preserving historical authenticity and fulfilling modern accessibility expectations (Zahari et al., 2023). More recently, Zahari et al. (2024) emphasize that facilities management in heritage buildings requires balancing compliance with sensitive adaptation, often demanding innovative solutions such as integrating ramps, lifts, and tactile paths without compromising cultural value.

Across these contexts, whether in general buildings, street-level environments, transportation systems, or heritage sites, valuable case studies emerge that assist students in appreciating the importance of adaptable design strategies and a nuanced understanding of accessibility requirements. At the same time, these persistent challenges highlight the critical role of systematic access audits as a practical tool for evaluating compliance with MS 1184:2014 and guiding improvements in the built environment.

2.3 Access Audits and Compliance with MS 1184:2014

An access audit serves as one of the most effective methods for identifying physical barriers in the built environment. Holmes-Siedle (1996) highlights access audits as systematic evaluations that aim to identify and rectify accessibility issues within buildings. More recent studies, such as Ramli et al. (2022), underscores the continued importance of access audits, building upon the foundational contributions of Holmes-Siedle. In the Malaysian context, access audits are carried out with reference to MS 1184:2014, which specifies the requirements for UD and accessibility in the built environment. These audits typically examine external access features such as ramps and parking, internal circulation including corridors, doors, and lifts, as well as information provision such as signage and tactile indicators (Ahmad Zawawi et al., 2024b).

Although UD ideally embeds at the design stage, many existing buildings and facilities lack such considerations during their construction. Hence, access audits are necessary to identify barriers and propose improvements. The legal mandate for access audits in Malaysia is supported by the Persons with Disabilities Act 2008 (Act 685), the Uniform Building By-Laws 1984 (Amendment of By-law 34A), and the Malaysian Standard MS 1184:2014. The latest version of MS 1184:2014 supersedes MS 1184:2002 (Code of Practice on Access for Disabled Persons to Public Buildings) and MS 1331:2003 (Code of Practice for Access of Disabled Persons Outside Buildings). Beyond legal compliance, past research demonstrates that access audits contribute to inclusivity, enhance safety and risk management, and promote cost and operational efficiency (Ahmad Zawawi et al., 2024b).

Deriving access audits from the 232-page MS 1184:2014 constitutes a time-consuming task, as the relevant requirements for different spaces and facilities must be first identified and extracted. To address this challenge, the development of AI-based tools becomes imperative for streamlining checklist creation, supporting systematic evaluations, simplifying compliance with accessibility standards, and offering users real-time responses to related queries.

2.4 AI Integration in Higher Education

Research demonstrates that the integration of AI-assisted teaching methodologies enhances both cognitive outcomes and student satisfaction. Zhou et al. (2024) demonstrate that problem-based learning augmented by AI significantly improves students' knowledge retention and competence in comparison to conventional methodologies. In a related study, Li et al. (2025) reported that domain-specific AI applications supported higher-order reasoning in complex subject areas. Beyond knowledge acquisition, AI contributes to socio-emotional engagement; Wang et al. (2025) find that embodied AI agents in mixed reality environments foster inquiry and encourage active collaboration. Collectively, these studies illustrate the potential of AI to enrich educational experiences by reinforcing knowledge, enhancing applied competence, and deepening learner engagement.

Although these benefits appear promising, the literature indicates several persistent challenges. Chen (2025) identifies barriers such as insufficient digital literacy and resistance among faculty, while Rahman (2025) emphasizes concerns related to privacy, academic integrity, and ethical standards within educational contexts. These issues align with insights from the *Technology Acceptance Model* (TAM) (Davis et al., 1989), which posits that users' adoption of technology largely depends on their perceptions of its usefulness and ease of use. Therefore, even when AI demonstrates strong pedagogical benefits, its effective integration requires deliberate strategies that address user acceptance, ensure reliability, and balance the development of critical thinking and professional competencies against the risk of over-reliance or superficial engagement.

2.5 Universal Design Assistant (UD-AI) as an Educational Innovation

In the realm of built environment education, accessibility frequently serves as a final compliance obligation rather than an integral design philosophy that is embraced from the outset. This approach constrains the opportunities available to students for cultivating both technical proficiency and empathy in responding to the varied needs of users. Integrating accessibility education from the outset of the curriculum is important, yet students commonly encounter difficulties in comprehending and applying the technical requirements of standards such as MS 1184:2014 (Kamarudin et al., 2025).

The *Universal Design Assistant* (UD-AI) represents a specialized adaptation of Generative Pre-trained Transformer (GPT), distinguishing itself from general-purpose AI tools through its dedicated focus on accessibility education. It was developed to address the difficulty of interpreting technical standards by providing an AI-enhanced, context-specific learning platform. UD-AI delivers prompt, standards-compliant feedback, conducts real-time compliance checks, offers contextual explanations, and responds to design-related queries. Reducing reliance on manual referencing enhances understanding and retention of UD principles. Through scenario-based learning across diverse building contexts, UD-AI ensures consistent and adaptable application of standards, functioning simultaneously as a practical reference and a pedagogical tool that systematically embeds accessibility into design curricula.

Situated within the broader context of AI in education, UD-AI is expected to translate the recognized benefits of AI, such as knowledge reinforcement, applied competence, and student engagement into the specialized domain of UD. This study represents the first attempt to gather students' perceptions of UD-AI, with the aim of evaluating its potential effectiveness as an educational innovation. UD-AI is expected to continue evolving as both a teaching aid and a catalyst for embedding accessibility more proactively as a fundamental design philosophy rather than a compliance-oriented requirement.

3. Methodology

The study employed a quantitative survey design that was complemented by qualitative input derived from open-ended responses. The approach was selected to capture both measurable perceptions of students regarding the UD-AI and their subjective experiences while utilizing the tool.

Population and Sampling

The target population of this study consisted of 78 second-year undergraduate students enrolled in the course *BST506 Building Control and Safety* at Universiti Teknologi MARA, Shah Alam. They represented the first cohort of the course, undertaken between October 2024 and February 2025. The topic of accessibility forms part of the syllabus, making the students familiar with the context of UD and accessibility compliance. Eligibility to participate required that students had used UD-AI in their learning activities, ensuring that all responses were based on actual user experiences.

The Raosoft sample size calculator indicated that, with a 95% confidence level, a 5% margin of error, and a 50% response distribution, the recommended minimum sample size was 65 (Raosoft, Inc., 2004). A total of 77 valid responses were obtained in this study, which represented a response rate of 98.7%. The sample size exceeded the recommended threshold, which ensured that the data collected were adequate, reliable, and representative of the population.

Research Instrument

Data were collected using a structured questionnaire that was disseminated digitally through the students' class communication group. The instrument consisted of two main sections. Section A contained fifteen (15) items that were measured on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). These items were designed to assess students' perceptions of UD-AI concerning usefulness, usability, reliability, and overall satisfaction. Section B comprised three (3) open-ended questions that enabled students to offer qualitative input by elaborating on the most helpful features of UD-AI, suggesting areas for improvement, and describing any challenges they encountered while utilizing the tool. The questionnaire was developed in close alignment with the study objectives and contextualized to reflect the specific functions of UD-AI as an AI-supported learning tool.

4. Data Analysis and Discussion

The data from the Likert-scale items were analyzed using IBM SPSS Statistics 29.0, where mean scores were calculated to summarize students' perceptions of UD-AI. The interpretation of these mean scores adhered to conventional categorization outlined by Davis et al. (1989) and more recently applied in perception studies such as Salmee and Abd Majid (2022), as shown in Table 3. This approach facilitated the identification of overall trends in students' evaluations of UD-AI across dimensions such as usability and reliability.

Table 3: Mean Score Ranges for Students' Perception of UD-AI

Level	Average mean score (range)
Low	1.00 – 2.33
Moderate	2.34 – 3.66
High	3.67 – 5.00

Source: Adapted from Davis et al. (1989) and Salmee & Abdul Majid (2022)

The qualitative responses obtained from the open-ended questions underwent thematic analysis, which facilitated the identification of recurring themes associated with the strengths, areas for improvement, and challenges encountered in the use of UD-AI within the learning process.

4.1 Quantitative Findings

The findings of this study align closely with the *Technology Acceptance Model* (TAM) (Davis et al., 1989) and provide empirical evidence for the role of UD-AI in enhancing accessibility education. The overall high mean score (M = 4.30) reflects strong student acceptance of UD-AI, indicating that it effectively addresses many of the challenges noted in the literature regarding the complexity the application of MS 1184:2014.

Table 3: Mean Scores of Students' Perceptions of UD-AI

Category	Questionnaire Item	Mean score
Perceived Usefulness & Learning Impact *(Mean Score: 4.38)*	UD-AI helps me understand the principles of Universal Design.	4.36
	I find UD-AI a useful tool for learning about MS 1184:2014.	4.44
	UD-AI supports my assignments or design projects related to accessibility.	4.38
	Using UD-AI has improved my awareness of inclusive design practices.	4.39
	UD-AI encourages me to consider accessibility more thoroughly in my designs.	4.40
	UD-AI has increased my confidence in applying Universal Design principles.	4.30
Usability & Ease of Use *(Mean Score: 4.22)*	The interface of UD-AI is student-friendly and intuitive.	4.40
	I can easily navigate and understand the responses provided by UD-AI.	4.35
	I did not need prior experience to use UD-AI effectively.	3.92
Reliability & Trust *(Mean Score: 4.16)*	I believe the information provided by UD-AI is accurate and based on the MS 1184:2014.	4.05
	UD-AI consistently provides reliable answers to my questions.	4.23
	I trust UD-AI as a supplementary tool in my Universal Design learning.	4.19
Satisfaction & Advocacy *(Mean Score: 4.35)*	I use UD-AI as a reference for design studio work or coursework.	4.19
	I am satisfied with UD-AI as a learning aid.	4.40
	I would recommend UD-AI to my classmates or other students.	4.45
Overall Mean Score		**4.30**

Perceived Usefulness

The highest-rated dimension, *Perceived Usefulness & Learning Impact* (M = 4.38), reflects TAM's construct of usefulness. Students reported that UD-AI helped them in understanding UD principles, applying MS 1184:2014 in coursework, and improving their design confidence. This finding is significant given that MS 1184:2014 is widely acknowledged as technically complex and challenging for students to apply without support (Kamarudin et al., 2025). Previous studies highlighted that physical and systemic barriers persist in practice despite the existence of accessibility standards (Zahari et al., 2023; Ahmad Zawawi et al., 2024b). These persistent gaps underscore the need for pedagogical innovations. UD-AI addresses this gap by simplifying regulatory language into practical knowledge, complementing earlier findings that accessibility is often treated as compliance rather than a design philosophy (Zahari et al., 2023).

Perceived Ease of Use

Usability & Ease of Use (M = 4.22) also scores highly, showing that students found UD-AI intuitive and accessible. High ratings for ease of navigation (M = 4.35) and interface friendliness (M = 4.40) indicate that students could engage with complex standards with minimal cognitive load. This aligns with literature noting that traditional teaching approaches often fall short in making MS 1184:2014 engaging for students (Kamarudin, 2025). The findings also resonate with broader educational studies that demonstrate AI's capacity to simplify complex knowledge and enhance engagement (Holmes et al., 2019; Chen et al., 2020). Although the score for prior experience was slightly lower (M = 3.92), it still supports the principle of *simple and intuitive use* as outlined by the Center for Universal Design (North Carolina State University, 1997).

Reliability and Trust

The category *Reliability & Trust* (M = 4.16) scored slightly lower than usefulness and ease of use, though still within the high range. Students generally trusted UD-AI's accuracy and reliability, reflecting confidence in its standard-compliant responses. This is critical, as accessibility education requires precise interpretation of regulatory clauses. The slightly lower score parallels wider debates about the trustworthiness and consistency of AI in education (Chen, 2025; Rahman, 2025). In particular, Rahman (2025) cautioned that ethical and credibility issues can limit long-term acceptance of AI tools. In this context, ensuring UD-AI's continuous alignment with MS 1184:2014 is essential to sustain reliability and credibility.

Satisfaction and Behavioral Intention

Satisfaction & Advocacy (M = 4.35) reflects TAM's behavioral intention construct, capturing students' willingness to continue using UD-AI and recommend it to peers. High ratings for satisfaction (M = 4.40) and recommendation (M = 4.45) indicate strong advocacy potential. This is consistent with literature showing that AI-supported learning can foster engagement, knowledge reinforcement, and collaboration (Zhou et al., 2024; Wang et al., 2025; Li et al., 2025). Importantly, the willingness of students to recommend UD-AI suggests sustainability of adoption beyond the classroom, reinforcing its potential as both a pedagogical and professional tool.

4.2 Qualitative Findings

The analysis of open-ended survey responses revealed five prominent themes regarding students' experiences with UD-AI as a learning tool for MS 1184:2014 accessibility compliance.

Enhanced Understanding of Standards

Students highlighted that UD-AI simplified the complexity of MS 1184:2014, transforming technical clauses into clear, practical explanations. For example, one respondent noted, *"The most helpful feature of UD-AI is its ability to provide precise, standard-based guidance strictly according to MS 1184:2014,"* while another explained, *"It helps me identify accessibility requirements without opening the hardcopy of the Malaysian Standard."* This outcome resonates with the literature that identifies the technical difficulty of MS 1184:2014 as a barrier to effective teaching and learning (Kamarudin et al., 2025). Similarly, accessibility research highlights that despite established standards, persistent barriers remain in practice (Zahari et al., 2023; Ahmad Zawawi et al., 2024b), which underscores the need for tools that facilitate more consistent application of requirements. UD-AI responds to these gaps by making standards more usable and comprehensible for students.

User-Friendly Interface

Ease of use was a recurring theme, with students describing UD-AI as *"Easy to use and easy to gain knowledge about universal design"* and *"Fast response and easy to understand."* Such perceptions demonstrate how the tool reduced cognitive load and encouraged engagement. This aligns with the UD principle of simple and intuitive use (North Carolina State University, 1997), which stresses minimizing user effort. It also supports findings that conventional teaching approaches often fail to make accessibility standards engaging, and that AI-supported learning can simplify complex material and increase motivation (Holmes et al., 2019; Chen et al., 2020).

Practical Application Support

Students consistently valued UD-AI's ability to bridge theory and practice. One participant stated, *"Helps me design disabled-friendly buildings,"* while another affirmed, *"Provides practical examples of universal design principles that I can apply in assignments."* These findings echo the literature that emphasizes the importance of access audits and compliance checks for translating regulatory requirements into practice (Holmes-Siedle, 1996; Ramli et al., 2022). By demonstrating how standards apply in real-world contexts, UD-AI reinforces experiential learning and reflects calls to embed accessibility considerations into early design processes rather than treating them as afterthoughts (Frías-López & Queipo-de-Llano, 2020).

Increased Confidence

Students reported greater self-efficacy in applying UD principles after using UD-AI. As one explained, *"Now I can check for compliance without always asking my lecturer,"* while another remarked, *"Improved my confidence in applying universal design principles."* This theme reflects the role of AI tools in fostering student independence and higher-order reasoning (Li et al., 2025), as well as their potential to reduce reliance on traditional authority figures by offering instant, accurate feedback. It also supports Kamarudin (2024), who positioned UD-AI as a tool designed to reduce dependence on manual referencing and enhance confidence in accessibility compliance.

Suggestion from Respondents

While overall perceptions were positive, students suggested enhancements such as *"more diagrams, photographs, and visual references for compliant and non-compliant features."* Another respondent requested *"references to the specific page or clause in MS 1184:2014."* Although UD-AI already provides such references if requested, this feedback highlights the importance of user guidance and interface clarity. These improvement requests parallel the ongoing challenges in AI integration noted by Chen (2025) and Rahman (2025), including the need to refine usability and ensure transparency to strengthen user trust. Importantly, the emphasis on visuals reflects the UD principle of perceptible information, ensuring that critical knowledge is effectively communicated to diverse learners (North Carolina State University, 1997).

5. Conclusion and Future Direction

UD-AI demonstrates strong potential as an innovative pedagogical tool that bridges the gap between theory and practice in UD education. It empowers students to integrate accessibility more effectively into their assignments and design work and, beyond academia, can serve as a professional reference for the consistent application of UD principles.

In terms of practical implications, UD-AI offers multiple benefits: for lecturers, it simplifies the teaching of complex accessibility standards; for students, it promotes independent learning and builds confidence; and for practitioners, it provides a quick-reference system that supports compliance in real projects. By linking theory, compliance, and practice, UD-AI strengthens both educational outcomes and professional standards. Its positive reception also points to policy relevance, as it illustrates how digital tools can make national accessibility standards more usable. Government agencies could adopt such innovations in training programs to improve compliance, while standard-setting bodies may explore similar approaches to translate technical requirements into practical guidance.

The key limitation of this study is that the sample was drawn from a single student cohort, which may restrict generalizability to other programs or institutions. It also relied on self-reported perceptions rather than objective measures of learning outcomes, and did not capture the perspectives of lecturers and professionals who might also benefit from UD-AI. Future research should therefore examine its effectiveness across diverse academic settings, evaluate its impact on actual learning performance and design outcomes, and incorporate the views of educators and industry stakeholders. Comparative studies with alternative digital learning tools would further clarify UD-AI's unique value and guide its refinement as both an educational and professional resource for accessibility compliance.

Overall, the findings confirm that UD-AI is effective in simplifying complex standards, enhancing practical application, and fostering confidence in applying accessibility standards, the MS 1184:2014. With further development, it can contribute significantly to embedding UD and accessibility as a proactive design philosophy, advancing inclusivity in education and practice, and supporting broader goals of sustainable and accessible environments.

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Conflict of Interest Statement

The authors wish to emphasize that this study was conducted purely in the interest of advancing knowledge, with no personal, commercial, or financial gains involved.

Authors' Contributions

HK served as the main author and was responsible for data collection and initial drafting of the manuscript. IMA and NFZ contributed to the critical review and editing of the draft manuscript. All authors reviewed and approved the final version of the paper.

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