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Piloting a Virtual Reality Cybersecurity Game for Neurodivergent Adults: Findings from a User-Centered Formative Evaluation

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Abstract. The uSucceed project aims to support neurodiverse individuals in the STEM workforce by utilizing Virtual Reality (VR) to deliver a customized training curriculum in CyberSecurity. This short paper delves into the design and methodology implemented by the uSucceed learning system. Preliminary usability test evaluations by neurodiverse individuals (n = 8) reveal critical insights into user experience, particularly regarding cybersickness and the usability of the uSucceed VR learning system. Usability findings revealed positive feedback on the immersive environment but highlighted issues with task navigation and inconsistent responses from the AI-driven pedagogical agent. Cybersickness levels ranged from low to moderate, with dizziness and eyestrain being the most reported symptoms. These results serve as a framework for further refining of the curriculum and system design to enhance usability. As the project evolves, it is moving towards the enhancement phase of the learning system's development, with a focus on further advancement of the context-driven AI pedagogical agent.

Keywords: Virtual Reality, Game-Based Learning, Cybersecurity, Neurodiverse Learners.

1 Introduction

Neurodiversity refers to the range of variations in human brain function (e.g., autism, ADHD, epilepsy, etc) with approximately 20% of the global population being neurodivergent [1]. Globally, people with disabilities are more likely to face unemployment, lower wages, and part-time or temporary work compared to neurotypicals [2]. Neurodivergent individuals are also frequently underrepresented in STEM fields [3], a gap that stems from educational systems and workforce structures that inadequately support diverse learning needs [4]. This underrepresentation is especially pronounced in highly technical fields like cybersecurity, where conventional educational barriers—such as rigid teaching methods [5] and environments that overwhelm sensory sensitivities [6] —hinder meaningful participation.

Meanwhile, with technology advancing rapidly and cybersecurity threats becoming increasingly sophisticated, the demand for skilled cybersecurity professionals is surging [7]. In parallel, neurodivergent individuals often have a natural affinity for technology and possess strengths such as attention to detail, problem-solving, and innovative thinking, which not only align well with the demands of the tech sector but also create valuable opportunities for them to contribute meaningfully to this field [3]. To better prepare neurodivergent individuals to join the technology workforce, particularly in cybersecurity, there is a critical need to provide support and resources to them, ensuring they can be successfully integrated into the workforce[4].

This paper presents the uSucceed learning system, developed to support neurodiverse individuals in the STEM workforce by utilizing Virtual Reality (VR) to deliver a customized training curriculum in CyberSecurity. The learning system utilized the participatory design approach, where neurodivergent individuals were actively involved in the design and development process [8]. This paper presents a usability evaluation, including an assessment of cybersickness—a major issue that affects 80% of the VR users and has a strong impact on the experience and safety of neurodivergent individuals [9]. The guiding research questions are:

- RQ1: How do neurodivergent individuals perceive the usability of the uSucceed VR learning system?
- RQ2: What are the experiences and characteristics of cybersickness for neurodivergent individuals when using the uSucceed VR learning system?

2 Background

This literature review first examines the role of VR in supporting neurodiverse learners and how pedagogical agents enhance these experiences (Section 2.1), followed by an exploration of the use of VR games for cybersecurity training, focusing on immersive environments and AI-driven agents to support learning and engagement (Section 2.2).

2.1 Virtual Reality for Neurodiverse Learners

VR offers structured, tailored learning environments that cater to the needs of neurodiverse learners, leveraging their affinity for visuality stimulating and affinity to computers 3]. VR has been used to teach skills such as public transportation [12], social skills [13], and emotion recognition through facial expression systems [14]. Early studies demonstrated the feasibility and acceptability of VR for autistic individuals [11] and more recent research shows its ability to create safe, controlled spaces for practicing social interactions without real-world pressure, helping neurodivergent individuals develop skills and confidence [7-8].

VR-based interventions have shown promise in improving focus, organizational skills, and impulse control through repeated exposure to social scenarios and real-world tasks [9-10]. These interventions can also reduce sensory overload by providing individualized, distraction-free environments. VR enhances engagement and retention by aligning with neurodiverse learning preferences [19]. It also aids neurodivergent learners in grasping complex concepts through interactive virtual experiences [16]].

While the benefits of VR learning environments for neurodiverse learners has been broadly explored, reports of effectiveness remain ambiguous [12]. Limited knowledge exists on the ideal application of VR for neurodiverse individuals, including their perceptions, reactions, and potential concerns [12-13]. Challenges of designing VR include prohibitive hardware costs [21] and the lack of technical expertise [22] to create complex adaptable and individualized VR, thus, limiting access to these promising interventions [23]. Additionally, researchers also pointed out the challenges alongside the potential of using VR for learning, for instance, the lack of adaptive instructions during the VR experience. In response to this limitation, educational designers and developers integrate intelligent conversational agents, "Pedagogical Agents (PAs)", to enhance student learning [24]. AI-driven PAs offer additional support to address these challenges, enabling real-time, adaptive guidance [25] that fosters inclusivity and improves learning outcomes for neurodiverse students [26] creating more conducive learning environments [27], thus assisting students in the learning process [28]. By integrating these learning agents in immersive, customizable, and controlled experiences, VR can address the unique cognitive and emotional needs of neurodiverse individuals, making learning and skill development more accessible [25].

2.2 CyberSecurity VR Games

The escalating prevalence of cyber attacks highlights the critical need for comprehensive cybersecurity education [29]. Traditional methods often lack the practical, hands-on training necessary to effectively counter these threats, necessitating innovative approaches that combine theoretical knowledge with practical skills [30]. By leveraging VR learning environments to design cyber attack simulations and integrating game-like hands-on training [31], these learners can be trained on various cybersecurity tasks, such as identifying vulnerabilities [32], patching systems, and responding to cyber-attacks [33]. Additionally, these learning environments can be personalized to learner needs, offering a flexible educational experience [34]. Cybersecurity-focused VR learning environments can range from introduction to complex scenarios [35], evaluated through hybrid methodologies with pre/post-event questionnaires [36]. Immersive metaverse environments that simulate various attacks further highlight the effectiveness of gamified learning [37]. The NUCLEO framework, for example, exemplifies how problem-based scenarios can be transformed into interactive gameplay within a learning management system [38], offering social recognition and personalized learning experiences [39].

Integration of AI-driven PAs in game-like cybersecurity-focused VR learning environments further enhances the learning experience by providing a guided, pedagogy-supported learning environment. For instance, integrating machine learning algorithms in cyber security learning environments simulate cyber threats and adjust training paths based on learner performance [40]. Another approach to integrating AI-driven PAs was to employ them as “agent-partners” to promote experiential learning through decision-making tasks related to phishing detection [41]. While AI technologies, such as Open AI’s ChatGPT offer ways to create pedagogy-supportive PAs, there is a knowledge gap regarding how to effectively integrate such agents into VR environments for education. Furthermore, responses from PAs can be vague or broad to provide meaningful guidance, highlighting the need for well-trained adaptive PAs to support learners in the VR environments. By integrating a fine-tuned PA in VR-based education, as we aim to do in uSucceed, learners can receive personalized guidance and feedback maintaining the balance of learner engagement and knowledge retention.

3 Learning System Design

In this section, we outline the system architecture and focus on three aspects: The system design and the Design of the curriculum.

3.1 System Architecture

The uSucceed VRLE is built using the Unity version 2022.3.9f1 utilizing several assets and packages from the Unity Asset Store including UltimateXR [42] and Meta XR All-in-one SDK [43]. The VR Environment employs an individualized learning experience by initiating one-on-one learner interactions, accessed through the MetaQuest 2 headsets. At the heart of the VR environment is the PA that guides the learners through the learning experience. Leveraging AI-based technology trained on Dialog Flow [44], the PA seamlessly integrates assistance, adapting to the unique needs of users, thus, creating a personalized approach for neurodiverse individuals.

3.2 Design of Curriculum

uSucceed follows a three-stage pedagogical approach: (1) Learners are introduced to cybersecurity topics in a scaffolded curriculum, (2) Learners explore the VR environment comprised of interactive cybersecurity games, and (3) Learners complete authentic cybersecurity lab exercises that take the abstract ideas of uSucceed VR and bring them to life in practical settings (Fig. 1).

In uSucceed, learners will engage in a robust cybersecurity and workforce development training program to learn from a range of cybersecurity scenarios and a number of concepts related to software engineering and data analysis. The curriculum is delivered through an immersive approach that exploits the affordances of VR and game-based learning to provide a uniquely individualized learning experience under the guidance and support of an AI-powered PA. Orientation day acts as an introductory session where the learners are provided with a foundational understanding of navigation in VR and cybersecurity fundamentals including, interactions in VR, recognition and response to visual cues, understanding rules and requirements for secure navigation and mainly, cybersecurity basics.

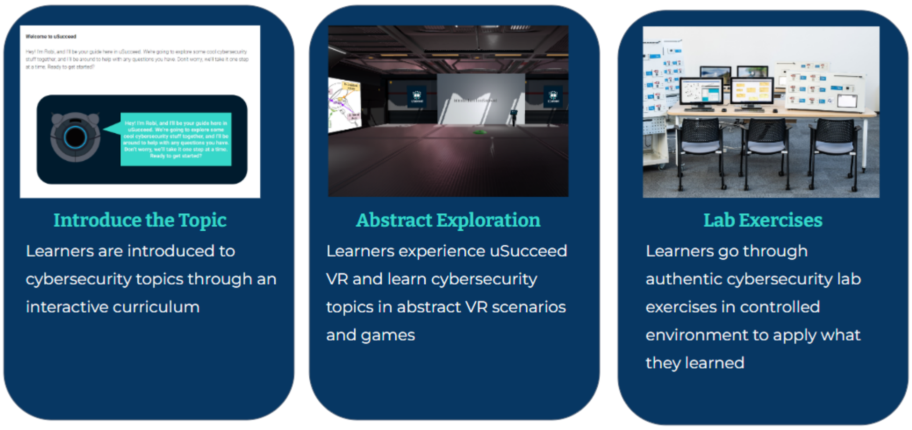

Fig. 1.: Three-stage Pedagogical Approach to uSucceed.

3.3 Orientation Unit Design and Interaction

In the uSucceed orientation unit, participants are gradually introduced to system controls, icons, and features within a futuristic space station environment. The learners are introduced to Robi, the AI-powered PA, and each station and the tasks in every station are introduced by Robi as they move around in the VR environment. As they become familiar with the interface, an unexpected event disrupts their learning—the station comes under attack.

A video feed is suddenly interrupted, an alarm goes off, and the atmosphere shifts to signal an urgent cybersecurity breach. Guided by Robi, learners are instructed to scan the system files, where they uncover evidence of a sniffing attack. To mitigate the threat, they must take decisive action—identifying and blocking the attacker's IP addresses and removing malicious files from the system. This hands-on sequence not only reinforces their understanding of cybersecurity threats but also immerses them in an interactive problem-solving scenario, setting the stage for more advanced challenges in the full training experience.

4 Methods

This study focuses on the initial prototype of the uSucceed learning system, and is a part of the longitudinal design-based research (DBR) project [8] (see Table 1). In this paper, we present the design, development, and evaluation of the initial prototype of the uSucceed learning system. Our study includes a usability assessment and a cybersickness measurement, aiming to gain comprehensive insights into understanding users' overall user experiences.

4.1 Participants

Given the study's focus on a specific group of participants, along with the challenges of accessing the general population, we have adopted purposive sampling and snowball sampling for this research [45]. The participants include adults who identify as neurodiverse, and are 18 years or older. Eight participants (*n* =8) were recruited through a variety of methods, including campus mailing list, campus community board, and in partnership with developmental disability services and centers. The chosen sample size aligns with established research on determining appropriate participant numbers for usability studies [46]. A key criterion for participation is that individuals must be receiving some form of support for their neurodiverse conditions, whether it be medical, educational, or otherwise. See Table 2 for participant demographics.

Table 1. The current study phase in the DBR process**.**

Meso-cycle 1		
Descriptions & Citation	DBR Phase	Synopsis
Empathy-driven design paper (withheld for blind review., 2024)	Analysis & Exploration	This design paper utilized an empathy-design approach (i.e., empathy interview, empathy mapping and personas development) to identify the initial design principles for constructing the prototype of VR learning system (n=4). Findings suggest several design principles including inclusivity, authenticity, collaboration, customization, and co-design.
Current usability study	Evaluation and Reflection	This paper presents preliminary results from an early phase user test of the uSucceed Orientation Unit. Usability and cybersickness was explored to examine overall user experiences of the uSucceed learning system (n=8).

Table 2. uSucceed Participant Demographics.

Pseudonym & ID	Gender	Race/Ethnicity	Age	Conditions	VR experience (0-7)
James (P1)	Male	Multi-racial: Southeast Asian & White	21	ADHD	5
Joey (P2)	Male	White	29	ADHD	2
Chelsea (P3)	Female	White	41	ADHD & ASD	1
Tim (P4)	Unspecified	White	21	ASD	2
William (P5)	Male	White	24	ADHD & ASD	4

Jerry (P6)	Male	White	28	ASD	6
Tony (P7)	Male	Black	32	ASD	3
Eddie (P8)	Male	White	25	ADHD	2

4.2 Data Sources and Analysis

This study incorporates a variety of data sources to provide a comprehensive assessment of the user experience within the VR environment (See Table 3). During the VR session, we collected several types of data, including (1) screen recordings of participants' interactions with the VR system, (2) audio recordings of comments made while participants were using the system, and (3) field notes. The qualitative data was transcribed for analysis, while the notes were utilized for triangulating the data.

After the VR session, we employed several assessment instruments, including the System Usability Scale (SUS) [47, 48] to measure usability, as well as a Cybersickness (CS) measurement tool [49] to evaluate participants' comfort levels. The SUS is a 10-item survey with a 5-point Likert scale ranging from “strongly disagree” to “strongly agree”. The CS measurement is a 6-item survey with a 7-point Likert scale that ranges from “absent feeling” to “extreme feeling”. The maximum score for the CS is 42 points, which indicates a severe sensation of cybersickness across all symptoms, while a minimum score of 6 points reflects an absence of cybersickness. Additionally, a semi-structured interview was conducted at the end of the VR session to gather insights about user experiences, posing questions such as “How was your overall user experience in using the uSucceed VR learning system?” and “Did you encounter any difficulties or confusion at any points, and if so, what were they?”. These interviews were audio-recorded and subsequently transcribed and qualitatively analyzed. For our preliminary analysis, major usability issues were discussed and presented as a small non-honkin report [50].

Table 3. Research Questions and Data Source.

Research question	Data source	Analysis Technique
RQ1: How do neurodivergent individuals perceive the usability of the uSucceed VR learning system?	Think-aloud, Screen recording, Observation notes, SUS survey, post-VR session interview	SUS calculation as according to the measure[48]; Descriptives Big Honkin' Test [50]
RQ2: What are the experiences and characteristics of cybersickness for neurodivergent individuals when using the uSucceed VR learning system?	Think-aloud, Screen recording, Observation notes, CS measurement, Post-VR session interview	Descriptives CS score [49]; Small non-honkin report [50]

5 Results

In this section, we present the usability study results that offer insights into neurodivergent individuals' perceptions of the ease of use of uSucceed VR learning system. We also explore the cybersickness experiences, if any, during and after the VR experience. Multiple methods and multiple data sets are used to triangulate findings.

5.1 RQ1: How do neurodivergent individuals perceive the usability of the uSucceed VR learning system?

Findings from our qualitative analysis have revealed users' satisfaction with using the VR learning system, and the points of concern. Some participants appreciated the novelty of the VR experience, particularly enjoying the sci-fi environment and the presence of a robot companion. For instance, Joey mentioned “It is always cool when I put it [the headset] on… Maybe just on the novelty aspect. It's kind of fun to do it, especially if you haven't ever done VR like I would tell someone to go do it”. Chelsea particularly enjoyed exploring the sci-fi environment and the PA: “the environment looks really cool, I enjoyed being able to look around. I really liked the stars up there, that was really cool…I liked the way he (the PA) looked especially like when he popped up and like it was a really cool thing.”, as well as a sense of digital companion: “That was kind of Star Wars ish like, you know, that feel of like I get a personal robot, too.” Similarly, Tony enjoyed the environment as it resonates with the Halo game he used to play, “I would use this environment frequently because I like the environment, part of it because it reminds me of some video games I like…. So I think that a lot of (neurodiverse) people will really appreciate the environment being like Halo or Destiny or was the other one…But yeah, I really like that a lot. I could stay in that environment for a while. you know". However, it is important to note that participants largely encountered usability issues that affected their experience. All participants found interactions with Robi were inconsistent, there was a delay in responses which were either too vague (did not provide task-specific responses) or too lengthy (long responses for a simple question like "What is Cybersecurity?"). Other significant issues included insufficient instructions for the learning tasks and navigation, a lack of system feedback during gameplay, distracting elements, technical glitches, and so on. Additionally, participants noted discomfort while wearing the headset. Table 4 below synthesizes the usability issues.

Table 4. uSucceed Orientation Usability Issues.

Identified usability issues	Observed by	Improvement / Solution
Interactions with the PA were not intuitive (e.g., no indication that the PA listened to the request and, delayed and insufficient response to the user's request)	P1, P2, P3, P5, P6, P7	Enhance user interactions with the PA by training the algorithm on a detailed list of questions and dialogue attempts, thereby providing better support and a more engaging conversational experience.
Interactions in VR were confusing (e.g., picking up objects, navigation, glitches in movement)	P2, P3	Enhance the navigation training to add further clarity on different interactions.
Users did not find it intuitive to use multiple buttons at different times to interact with PA (e.g., press the A button to call PA and the B button to ask a question).	P2, P5	Simplify the interaction by consolidating the calling and conversation functions into a single button or using clearer visual cues for each action.
Distracting assets in the VR environment (e.g., high transparency of the instructional panel allowed users to see through to the learning environment, which can be distracting and reduce focus)	P1, P3	Increase the opaqueness of instructional panels, employ the iterative design process to re-visit all sections to minimize distractions and enhance user focus.
Struggles to associate the "exit door" model with the real-world concept of "exit," leading to difficulty in locating the actual exit.	P3	Make the exit more prominent consider replacing the 3D model of the door; Consider substituting the existing door model with a more engaging design to increase user interest and visibility; Incorporate arrows or guiding symbols that lead users toward the exit, reinforcing its location.
The spawning position of the PA overlaps with instructional content, causing confusion and making it difficult for users to focus on either element.	P2, P3	Implement a collider for the PA to create a tangible interaction point, and adjust the layer order to prioritize the PA's visibility.
Inconsistency of the font sizes in the instructional panels.	P3	Resize the font size to be consistent with the rest of the instructional contents.
Unclear instructions on gameplay and the next tasks (e.g., participant was not sure how to start the game, and did not know which game button was clicked due to the lack of the system feedback).	P2, P3, P4, P5, P6, P8	Provide more explicit instructions prior to gameplay and enhance system feedback mechanisms. This will help users understand their objectives and current status within the environment.
Discomfort from VR headset (e.g., headset was heavy and uncomfortable, especially for individuals wearing glasses)	P2, P3	Provide small breaks during the VR experience; encourage users to use contact lenses for the VR experience, consider replacing the headset strap to the one with an external battery to balance the weight of the headset, ensure proper fit of the headset when the person first wears it.

Physical discomfort while in VR (e.g., excess brightness of multimedia elements caused headaches and distractions)	P1, P6	Adjust the brightness levels of multimedia components to ensure they are visually comfortable and harmonize better with the overall environment. If possible, Introduce adjustable brightness settings that allow users to customize their experience based on personal preferences.
Technical glitches caused confusion (e.g, the looping video setup created uncertainty about the next steps required for completion, as the video played continuously without interruption)	P1, P2, P5	Configure VR environment to remove glitches, such as, disable video loop, remove corrupted function; and improve the logic of the gameplay

Participants evaluated the uSucceed VR learning system in terms of ease of use (Table 5). Overall, the mean computed SUS score across all participants was 65.94 (SD = 15.23), suggesting an overall "OK" usability of the uSucceed VR learning system. Among all the scores, the lowest mean is 37.5 and the highest mean is 90, indicating significant discrepancies in system usability across users with varying levels of VR experiences. For instance, Chelsea (P3), who had the least favorable VR experience, faced challenges with interactions and navigation, leading to a lower usability score compared to more experienced users. Conversely, although James (P1) and Jerry (P6) had similar levels of VR experiences, individual differences still impacted their perceived usability of the VR learning system.

Table 5. uSucceed SUS Results.

Participant	SUS Score	Benchmark
James (P1)	90	Excellent
Joey (P2)	60	OK
Chelsea (P3)	37.5	Poor
Tim (P4)	60	OK
William (P5)	72.5	Good
Jerry (P6)	62.5	OK
Tony (P7)	77.5	Good
Eddie (P8)	65	Good
SUS Average	65.94	OK

5.2 RQ2: What are the experiences and characteristics of cybersickness for neurodivergent individuals when using the uSucceed VR learning system?

Findings indicate that cybersickness was evident for most participants. For instance, Joey needed to take small breaks during the VR experience. He explained, "There was not a specific thing that made it happen. I think it is because of the time thing [exposure time]. I mean mostly walking around. Turning and walking around. Being physically in the world. Those parts made me feel a little bit clammy. Videos are fine… some of them might be because they [the headset] are quite heavy in front of my face. But I don't know." After the VR experience, Joey also mentioned that the post-effect is still lingering, "I actually still feel a little bit right now. A little bit jittery." Similarly, William added that the VR exposure time might be related to the sickness experience, "that the longer I was in the VR, the more I can feel it". On the contrary, for James, the brightness of the multimedia seems to be related to cybersickness, "for me it is the brightness [of the multimedia]. Movement is fine for me. I did not get so disoriented." Additionally, Chelsea reported experiencing tension around her eyes and her temples from wearing glasses inside the VR headset, which were believed to lead to discomfort for her eyes and blurred vision: "I do feel a little bit of eyestrain already…it might be the glasses… it might be that I tried to focus, because it's getting blurry because of my glasses... Yea, I wish I had contacts."

Participants also reported the level of cybersickness during the VR experience (See Table 6). The grand mean of the sum score is 13.38 points (out of 42 points), indicating an overall medium-low level of cybersickness. However, there was significant individual variation, with scores ranging from no cybersickness (SUM = 6) to medium-high levels (SUM = 23). Across the different cybersickness symptoms, for most participants, the experience of dizziness was the most severe (MEAN = 2.63), followed by nausea (MEAN = 2.38), disorientation (MEAN = 2.25). Visually discomfort such as feelings of tiredness, were reported by one participant (P3). Eyestrain, blurred vision, and headache were majorly reported by two participants (P3, P8).

Table 6. uSucceed Cybersickness (CS) results.

Participant	SUM	*MEAN*	*SD*
James (P1)	9	1.5	0.55
Joey (P2)	18	3	1.9
Chelsea (P3)	16	2.67	1.37
Tim (P4)	13	2.17	0.67
William (P5)	12	2	0.89
Jerry (P6)	10	1.67	0.82
Tony (P7)	6	1	0
Eddie (P8)	23	3.83	1.17
GRAND AVG.	13.38	-	-

6 Discussion

In this paper, we presented "uSucceed", a VR learning environment for neurodiverse learners for hands-on cybersecurity training. Eight neurodiverse individuals participated in the preliminary usability tests and the findings from this study reveal critical insights into user experience, particularly regarding cybersickness and the novelty effect associated with the uSucceed VR learning system.

Overall, participants enjoyed the sci-fi ambience and the outer space theme, supporting findings from Smith et al [6] which suggest that visually stimulating and immersive VR settings enhance learner engagement. The discrepancies in the SUS scores, ranging from 37.5 (poor) to 90 (excellent), highlight variability in user experience, particularly among neurodiverse individuals, whose responses to virtual environments can differ widely based on sensory, cognitive and emotional factors [12]. This variability highlights the potential of AI-driven personalization to address individual needs more effectively by dynamically adjusting the learning environments in response to real-time data [15]. This suggests that while the system has potential, further development to integrate adaptive features such as monitoring biofeedback could enable the system to detect signs of discomfort or engagement and adjust the environment accordingly [44]. Such an integration could potentially address issues faced by the participants with respect to the VR world, particularly, the visibility of the instructional panel, directional cues, item brightness, and technical glitches must be addressed to create a seamless user experience [45]. While participants faced issues with usability, they valued the immersive aspects of the VR system and acknowledged its potential. This enthusiasm, when matched with strategies to mitigate discomfort and enhance usability, will enhance the user-centered design of uSucceed.

The integration of an AI-driven PA was received with interest but the participants expressed frustration with the PA's lack of timely responses and its unintuitive controls, indicating that the interaction mechanisms require refinement. While previous research shows AI-driven PAs can enhance learning outcomes by providing real-time guidance and support [25], our findings reveal a disconnect between the expected functionality and the user experience. Participants found the PA to be unhelpful, often opting to skip interacting with the PA altogether. This outcome highlights the need for more refined and responsive AI-driven PAs that align more closely with the expectations of learners that must be systematically addressed to ensure users' satisfaction with the VR system. With the focus on design and development of an intuitive, fine-tuned PA, we are designing a Natural Language Processing (NLP)-powered PA to enable efficient question-answering with features like Document Parsing (to ensure effective training for unit-focused content-based queries), and Natural Language Understanding. Additionally, in an effort to assist with context-based queries, we are developing add-on features for Robi to hold information on the learner's current location in the VR environment and details of the completed, current and future tasks.

Our findings on cybersickness among neurodiverse individuals align with previous research indicating the need for structured, controlled VR environments [16]. Participants reported a mean cybersickness score of 13.38, indicating a medium-to-low level of sickness, with dizziness emerging as the most pronounced symptom (*MEAN*

= 2.63). Some users experienced moderate levels of discomfort, leading them to take breaks during their sessions, yet all users ultimately completed their interactions with the system. This might indicate resilience or commitment among users, despite the discomfort they encountered. Interestingly, some users highlighted the correlation between prolonged VR exposure and the onset of cybersickness symptoms. Schmidt et al.[20] proposed a structured, stepwise process to minimize adverse cybersickness symptoms when using head-mounted VR systems, emphasizing gradual acclimation and controlled exposure to the VR learning environments. The process suggests that neurodiverse learners benefit from shorter, progressively longer sessions that help them adapt to the immersive environment without overwhelming their sensory systems. Our findings corroborate the need for this gradual exposure as several participants report increased discomfort with prolonged use. Additionally, some participants also experienced tension and discomfort related to wearing glasses within the VR headset, which contributed to eye strain. Our latest efforts have explored using MetaQuest 3S and our in-house tests have presented that users wearing glasses find it more comfortable to engage in the VR environments when compared to their experience with Metaquest 2. In an effort to address the cybersickness symptoms, we have made design changes to the VR environment including the reduction of speed of movement, removing the functionality to use a button to turn in-place and the inclusion of seamless scene teleporting, in addition to the invisible colliders to avoid users from free-falling in the VR environment.

The findings from this study highlight the potential of VR in education, particularly for neurodiverse learners. The immersive and engaging nature of VR offers significant opportunities for enhancing learning outcomes. A user-centered approach to the design and development of a VR learning environment ensures that the technology is tailored to meet the diverse needs of all learners, ultimately fostering a more inclusive and personalized learning experience.

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