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Frustrations Associated with Using Commercially Available Virtual Reality Platforms for Productivity

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Abstract

It is likely that in the near future, immersive platforms such as virtual reality (VR) will be considered effective productivity tools. By exploring how individuals make use of commercially available platforms and features needed for collaboration, VR developers can better understand user experience and usability interaction requirements. To investigate the use of VR as a productivity tool, a within subject design approach was used to explore five tasks (Relocation, Communications, Handwriting, Typing, and Web-browsing) within four commercially available VR platforms (Horizon Workrooms, Spatial.io, Engage, and Mozilla Hubs). The Human IMPAC-T Lab recruited twentytwo (N=22) individuals via campus-wide solicitation seeking potential end-users of varying levels of VR familiarity. Data was collected in two forms: quantitatively using time on task and qualitatively using the Usability Metric for User Experience (UMUX) and System Usability Scale (SUS) to analyze user frustration associated with performing productivity-related tasks in VR. The outcomes suggest that the preferred VR platform is highly dependent upon a user's experience, preferences, and the task at hand. The use of immersive technology has the potential to revolutionize productivity, although user-friendly improvements are necessary for it to become the standard tool for collaborative workspaces. To minimize user frustration, it is recommended that VR platforms engage in iterative design updates focused on functionality and, more importantly, the graphical user interface (GUI) as a means to reduce user frustration. If achieved, it may solidify virtual environments as a mainstream tool for collaborative teamwork.

Keywords
Virtual Reality Platforms, Immersive Tools, Productivity, User Experience (UX), Usability

1. Introduction

With the emergence of distant collaborative technology and the onset of the COVID-19 pandemic, individuals were forced to rethink how they engaged socially at a distance. This led to services like Zoom becoming an unexpected daily routine that greatly impacted people's daily lives and productivity. Zoom allows people to connect and collaborate with their coworkers, friends, or teachers while remaining safe at home. Consequently, as reported by Wiederhold, the widespread availability and ease-of-use of Zoom have significantly increased the frequency of meetings, extending the average workweek by four hours. This has put immense strain on employees, leading to widespread burnout and "Zoom fatigue". The majority of software used today is 2D-based, and often makes communication feel "flat"; such software cannot replace face-to-face interactions [1]. The integration of immersive virtual environments (VEs) helps bridge the gap by enabling individuals or groups to participate in more meaningful interactions and, in turn, increase productivity. More importantly, such platforms allow for effective collaboration between team members within customizable and engaging atmospheres. However, the premature release of certain VE platforms due to pressing demands has resulted in a significant amount of user confusion leading to frustration regarding the intended usage of these platforms.

VEs can be considered software components experienced by a user through a hardware virtual reality (VR) head-mounted display. VEs hold great potential for various industries, such as business, education, entertainment, and other fields yet to be explored. However, currently, very few VE applications are used outside of academic research due to restrictive cost of the VR hardware, slow and ineffective system performance, and limitations in user interactivity.

Although VEs functionality is impressive, user interaction is inconsistent and ineffective across platforms [2]. This stems from designers neglecting user interface (UI) design principles and the scarcity of evaluation techniques for VR interfaces. As VR has gained popularity, it has drawn the interest of many UX researchers, fueling the need for user experience (UX) evaluation methods suited for VEs. However, this has proven to be difficult because of the intricate nature of the VE's isolated user interface and VR's blending of physical ergonomics with interface usability [3]. In order for VEs to advance from research to real-world applications, having user-friendly interfaces for these systems will become increasingly critical.

The current goal is to explore how users make use of commercially available VR platforms and their features to better understand user experience and usability interaction requirements. The larger study was split into two aspects: Study A-Open Exploration and Study B-Structured Exploration. Study A is an ongoing pilot study intended to investigate the effectiveness of collaboration by providing VR (Oculus Quest 2) to teams with freedom on how and when they utilize a VE as a tool for team productivity. In contrast, Study B (aspects reported here) focuses on individual performances within VEs to identify sources of user frustration and improvement. With that in mind, it is hypothesized that the users will perceive the VEs in question as being unproductive and frustrating. The goal is to raise awareness about the urgent need to further improve the user interfaces of VEs, and to stress the need to reduce frustrations associated with using VR applications in attempts to replace 2D video-conferencing with VEs as a mainstream tool for professional productivity.

2. Problem Description

The pandemic has caused a surge in the demand for remote work, resulting in a greater dependence on video conferencing platforms, like Zoom and Microsoft Teams, for remote collaboration and communication. In order for an individual to be an effective member of the team, at a distance, individuals are required to perform their specific tasks to a level of efficiency to then in turn contribute to the team's overall productivity. Although virtual communication tools have been extremely useful for companies during the pandemic, they were not originally created to fully replicate the experience of in-person social interactions. The limitations of their 2D nature can sometimes result in meetings feeling lacking in depth and engagement, which can ultimately contribute to burnout among employees [1]. VR and VEs hold potential as a solution, motivating productivity by offering immersive and engaging experiences. Yet, the widespread adoption of VR has been limited by restrictive equipment costs and slow inefficient hardware. Additionally, the blending of physical ergonomics with interface usability in VR introduces new challenges for UX researchers, making it difficult to evaluate and improve the user experience in VR applications. The problem explored and reported in this paper is the questionable usability of various VE experienced by a user through VR while the goal is to suggest improvements that would VEs a more usable and efficient tool for productivity.

3. Related Research

Ever since the pandemic, the reliance on technology has increased significantly [1]. To combat the rising issue of Zoom fatigue, there is a need to replace 2D video conferencing with VEs to promote fully immersive experience with depth and presence, creating more collaborative and natural interactions. VEs' ability to provide a fully immersive experience such as having an avatar that can show facial expression, gesture, body language would prove to enhance social presence, thus increasing interactivity and motivation for productivity. In the paper, Heuristic Evaluation for Virtual Reality Systems, the author explained that the increase in popularity of VR has led to a growing need for methods to evaluate UX relevant to VR interfaces. Evaluating VR interfaces has proven difficult due to its blend of physical ergonomics with interface usability, which introduces issues beyond traditional user interface (UI) analysis, such as physical comfort, sense of immersion, and feelings of illness [3]. The study aimed to develop new heuristic evaluation methods specific to VR that will benefit future VR software and hardware developers in creating more user-friendly VEs. Furthermore, the author stresses that the lack of guidelines pertaining to UI software in 3D virtual environments escalates the complexity and interactivity of VR and VE applications, which in turn is contributing to issues with UI design [2]. In order to make fully immersive online meetings possible, commercial VE user interfaces must continuously improve their guidelines as a means of becoming an effective productivity tool, in the near future, for a diverse set of end-users.

Cybersickness (CS), commonly known as simulation sickness, is a major challenge for immersive technology, as it impairs the usability and user experience of immersive platforms. For example, the use of joystick locomotion can result in CS due to conflicting movement cues from different senses, including proprioception, vestibular sense, and vision. This occurs when the eyes perceive motion, but the inner ear, which is responsible for detecting acceleration and orientation, does not receive corresponding information, or sometimes none at all. This discrepancy is identified as the primary cause of CS [4]. To address this issue, Botha conducted a study to assess the level of cybersickness associated with two different locomotion methods in VR, namely the omnidirectional treadmill (ODT) and touch controllers. The results showed that ODT slightly reduced CS symptoms and improved UX, but more research and innovation are necessary to achieve a satisfying and safe immersive VR experience [5]. The study "Occasional Users' Experiences of Visiting a Virtual Environment" revealed that all participants were impressed by the VEs and enjoyed visiting it. However, they experienced difficulty with movement during their initial visit, struggling to understand how to navigate through different applications. Additionally, they reported experiencing physical symptoms such as dizziness and eye fatigue when viewing 3D graphics. These challenges could potentially be addressed through the development of better technology for the UI, such as new navigation tools [6]. These findings highlight the importance of improving the user experience of VEs, particularly for occasional users, through technological advancements.

4. Methodology

In an attempt to recruit a diverse population of potential end-users, a campus-wide solicitation email and qualification survey was distributed using a listserv. Interested participants completed a solicitation survey via QuestionPro where they confirmed consent and answered demographic and VR familiarity questionnaires. The thirteen-item survey took approximately 10 minutes to complete. The first three questions consisted of demographic information such as name, age, and gender. The rest of the questionnaire focused on their familiarity with VR (i.e., Have you used a VR before? What VR headsets have you used? What did you use it for? How often do you use VR? On a scale of 1 to 5, how much technical support do you think you need to use this system? and how would you rate your experience with virtual reality?). Once the participant completed the solicitation survey, participants were prompted to provide their availability for participation. A total of twenty-three (N=23) participants were recruited to participate in this study; one participant data was omitted due to cyber sickness and was not able to complete the study. The survey respondents consisted of undergraduate and graduate students of age 18 or older at a university in southwest Virginia.

Prior to the study, the researchers ensured that the VR headset, Oculus Quest 2, and its applications were up to date, cleaned thoroughly via a Clean-Box, and fully charged to avoid interruptions during data collection. Additionally, all QuestionPro surveys (post-platform survey, post-study survey, and post-task facilitator survey) were pre-loaded onto the experimental computer. When participants arrived, they were informed of the goal and motivation of the study by the researchers and provided an opportunity to ask questions. Thereafter, they were instructed on how to properly equip the VR headset, and to check and confirm that the safety passthrough features and the recording features are all working as intended. Prior to beginning data collection, participants were afforded time, in a neutral space, to become acclimated with the controls. Throughout data collection, time on task was defined as the time (in seconds) it takes to complete each task per platform. The researcher used verbal cues to capture the time on task, which started when the participants were given the instruction to “start” and ended when the participant verbally indicated "task-complete”. While observational notes were recorded based on the comments made regarding the intuitiveness and frustrations of the system. Participants were tasked with performing five productivity-related tasks (relocation, communications, handwriting, typing, and web-browsing) in each of the four commercially available VR platforms (Horizon Workrooms, Mozilla Hubs, Spatial.IO, and Engage). Note that typing and web-browsing task data was not collected on Mozilla Hub's platform due to its limitations in currently available functionalities. Lastly, randomization of presentation was based on platform with each participant performing each task in the following order: (1) relocation; (2) communication; (3) handwriting; (4) typing; and (5) web-browsing.

Participants were instructed to join a specified platform, based on their assigned randomization, and prompted to begin their tasks. After each task, participants were asked to verbally respond to the post-task survey to control for unintended frustration of constant removal of the VR interface between tasks. The post-task UMUX questionnaires were on a Likert scale of 1 to 7 (7 being ‘strongly agree’). Questions were presented as (1) This feature’s capabilities meet my requirements; (2) Using this feature is a frustrating experience; (3) This feature is easy to use; and (4) I have to spend too much time correcting things with this feature. After completing all five tasks within a given platform, participants were asked if they experienced cyber sickness and were given an option to take a five-minute break or to continue with the study. Participants were prompted to complete a post-platform survey, in the form of digital System Usability Scale (SUS) questionnaire, on a scale from 1 to 5 (5 being ‘strongly agree’). In addition, yet not reported in the current paper, participants completed a NASA TLX to provide feedback regarding perceived cognitive workload. All post-platform surveys, SUS, were administered on an iPad. After completing all tasks within all the platforms, participants were then asked to complete a final survey, the post-study survey, which consisted of 10 questions that asked participants to rank each platform based on "most like" or "least liked". During the debrief, participants were asked a preference question (i.e., Would you rather utilize VEs as the primary means of attending video conference meetings over Zoom?). The study took no longer than two hours to complete and participants who successfully completed the entire study were compensated via a digital $10 Amazon gift card for their time.

5. Results

Average age of participants ranged from 18-22 years old and consisted of 13 males, 8 females, and 1 participant reporting as other. In terms of VR-related experience level, on a scale of 1 to 5, participants reported an average of 1.74. The UMUX, SUS, and time on task scoring rubrics were applied in Excel to analyze the data on which platforms participants found to be most satisfying in terms of task efficiency and usability. UMUX data revealed that Engage scored the highest with respect to handwriting and web-browsing tasks, Horizon Workrooms scored the highest in communications, Spatial.io scored the highest in the typing task, and Mozilla Hubs scored the highest in relocation task as illustrated in Table 1 below. These results imply that the Engage platform had the greatest satisfaction and efficiency rating based on functions which scored highest. Time on task suggested that Mozilla Hubs scored the highest in relocation task, Horizon Workrooms for communications task, Engage for web-browsing task, and Spatial.io for the handwriting and typing research tasks as illustrated in Table 2 below. These results imply that the Spatial.io platform had the greatest satisfaction and efficiency rating based on functions which were completed quickest. Lastly, SUS data suggested that participants felt Horizon Workrooms was the best platform overall and Spatial.io was the worst overall in terms of user experience as illustrated in Table 3 below. It should be noted that relationships could be misleading since Mozilla Hubs was not evaluated in terms of typing and web-browsing tasks.

Table 1: Usability Metric for User Experience (UMUX) scale scores.

Platforms/Task	*Relocation*	*Comm.*	*Handwriting*	*Typing*	*Web-browsing*
Engage	77.7	93.8	**72.0***	62.9	**86.6***
Horizon Workrooms	76.1	**95.8***	62.9	66	80.4
Spatial.io	75.4	93.7	67.2	**71.6***	71.6
Mozilla Hubs	**79.5***	93.8	53.6		

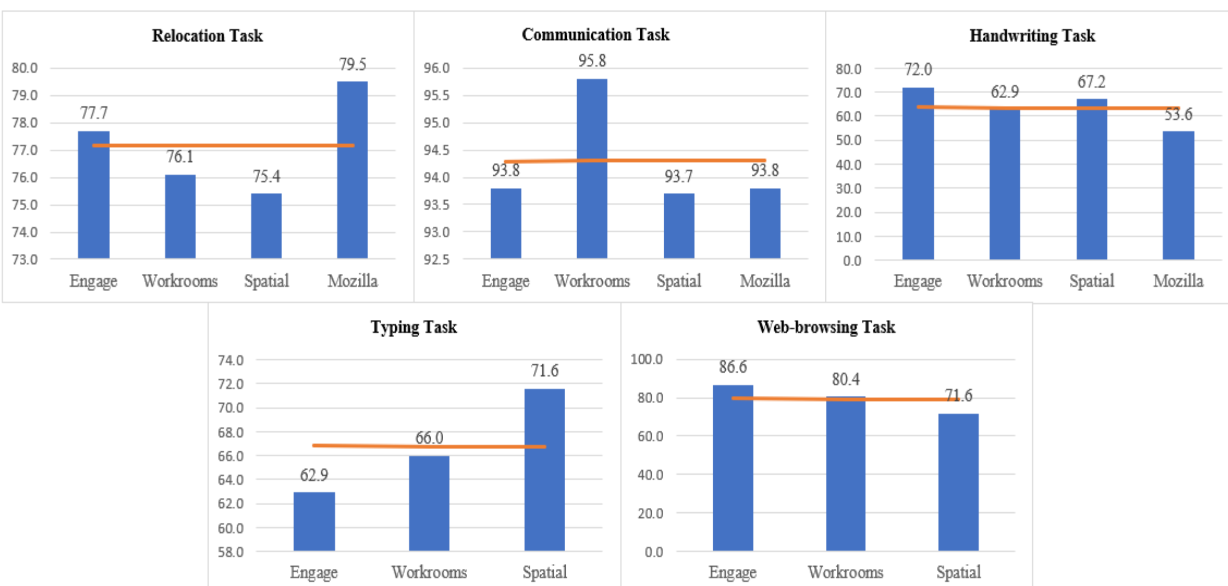

Figure 1: Bar graph illustrating overall average UMUX scale scores based on task with a line indicating task usability score threshold.

Table 2: Average Time (seconds) on task based on platforms.

Time-on-Task	*Relocation*	*Comm.*	*Handwriting*	*Typing*	*Web-browsing*	*Platform Average*
Engage	55.07	15.80	74.93	106.49	**26.55***	**55.77***
Horizon Workrooms	60.086	**15.38***	150.77	85.31	33.57	69.02
Spatial.io	60.92	16.91	**60.94***	**72.98***	179.28	78.21
Mozilla Hubs	**39.36***	17.25	125.02			60.55

Table 3: System Usability Scale (SUS) scores.

Platforms	*Average SUS score*
Engage	65.3
Horizon Workrooms	66.6
Spatial.io	45
Mozilla Hubs	51.9

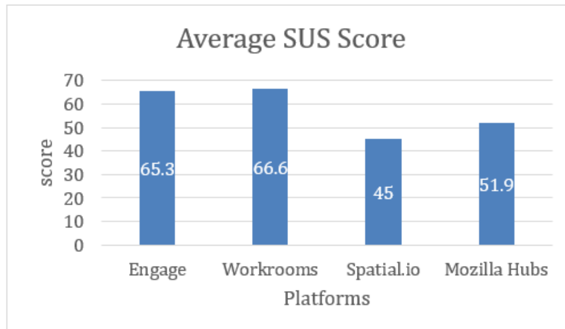

Figure 3: A bar graph illustrating the final SUS scores based on platform and across tasks performed.

6. Equations

During data coding, the following equations were used to calculate composite scores for each dependent variable explored: UMUX Score = ((SUM (Q1-1, 7-Q2, Q3-1, 7-Q4)/24) *100, SUS Average= ((Q1-1) +(5-Q2) +(Q3-1) +(5-Q4) +(Q5-1) +(5-Q6) +(Q7-1) +(5-Q8) +(Q9-1) +(5-Q10)) *2.5. It should be noted that the UMUX and SUS scores represent users' ability to perform given tasks and their overall experience while performing such tasks, respectively.

7. Conclusions and Discussions

In conclusion, within limitation, the current study provides evidence that commercially available VR platforms do not meet expected standards, therefore, researchers fail to reject the null hypothesis that the users will perceive the VEs in question as being unproductive and frustrating. According to the findings, Mozilla Hubs demonstrated the highest level of proficiency in the relocation task. This result may be attributed to the implementation of joystick locomotion, which was perceived as more intuitive by users. Since this method is consistent with the navigation systems commonly used in modern video games, users may have found it easier to adapt to. Moreover, participants expressed a preference for joystick locomotion over teleportation, due to a greater degree of freedom and accuracy. The latter was deemed less favorable due to the need for additional control steps, which were not always apparent to users, resulting in a less intuitive experience. One of the drawbacks of using joystick locomotion is the occurrence of CS. As previously mentioned, one participant withdrew from the experiment due to experiencing CS on the platform. Horizon Workrooms was identified to be the best in terms of communication. This could be because the UI (i.e., mute/unmute button) was intuitive and directly in sight while detailed avatars allowed for nonverbal communications via body language interpretation. Next, Engage was identified to be the best in terms of handwriting. This may be because the ability to scribe on a chalkboard located at the front of a virtual lecture hall was very favorable amongst participants. In terms of typing task, Spatial.io was identified as the top-performing platform, although this only applied to its notes typing feature. Ironically, further analysis revealed that the web-browsing typing feature of Spatial.io was frustrating due to frequent errors. As a result, Engage should be considered the best platform for both typing and web-browsing tasks. While there were no positive comments regarding Engage's performance in the web-browsing task, it caused the least amount of frustration among all platforms tested. Overall, web-browsing was identified as a challenging task across all platforms (i.e., multiple clicks necessary to access the internet, systemic errors when accessing the search engine digital keyboard, and the physical keyboard not being perfectly in sync with the virtual keyboard, resulting in users having to look down and ensure their hands were on the correct spot on the keyboard). Based on the UMUX data, although many functionalities in these platforms fail to surpass the threshold level, Engage should be considered the best commercially available VE based on the exploration of the current study since it was observed to have the highest scoring UX functionalities. While the time on task data supported the majority of the UMUX data results, it contradicted the conclusion that the Engage platform was optimal for the handwriting task when in fact Spatial.io performed better. This could be because participants reported feeling frustrated on how inaccurate writing felt due to little control over its legibility. On the other hand, despite the fact that a SUS score above 68 would be considered above average and anything below 68 is below average, Horizon Workrooms should be considered the best commercially available VE platform out of the four since it achieved the highest score for usability. Since all four platform’s SUS score fell under the standard level of 68, this supports our theory that VEs are not up to the standards and further warrants the need for continued assessment using evolving methods and tools.

It should be noted that these relationships could be misleading since Mozilla Hubs was not evaluated in terms of typing and web-browsing. Based on participant feedback, although most users would like to see VEs replace current tools for distant team collaboration to promote interactivity and the feeling of being present, substantial improvements are needed prior to VR’s wide adaptation within corporate and academic domains. It is recommended that VR platforms engage in continuous updates of their functionalities and, more importantly, the UI as a means to reduce user frustration and secure the future of VEs as a mainstream tool for collaborative teamwork.

8. Future Research

Now that some aspects of user frustration have been identified, researchers can begin to scope out and investigate the effectiveness of collaborative teams within a given immersive environment. As mentioned, Study A of the larger research seeks to explore these possibilities and will be reported when appropriate. Additionally, from the debrief, participants noted that VEs required too much mental workload compared to Zoom and doubted that they can stay in VEs for longer than 30 minutes for team meetings without feeling cyber sickness. The extent of these statements will be better understood upon the analysis of the obtained NASA TLX data. Lastly, supplemental data collected throughout the study such as interview, focus group and other survey metrics not reported in this paper will be analyzed and reported at a later date to support empirical findings, and identify additional aspects needing investigation.

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