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Citation for final published version:

Almutairi, Alhanouf, Al-Amri, Mohammad and Button, Kate 2024. A preliminary evaluation of a virtual reality-based physiotherapy prototype toolkit: a usability study, content analysis of user feedback. *Osteoarthritis and Cartilage* 32 , S565-S566. 10.1016/j.joca.2024.02.836

Publishers page: <http://dx.doi.org/10.1016/j.joca.2024.02.836>

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Abstract

A Preliminary Evaluation of a Virtual Reality-based Physiotherapy Prototype Toolkit: A Usability Study, Content Analysis of User Feedback

Purpose:

The primary objective of this research was to examine and gain a thorough understanding of the usability of a Virtual Reality (VR) Prototype Toolkit for therapeutic exercise. The toolkit consists of a laptop with in-house developed VR software, an Azure Kinect DK sensor connected to the laptop, and a big monitor to display the game's scenario in higher resolution for knee therapeutic exercises. The study aimed to acquire valuable insights from two distinct participant groups - those who suffer from knee pain and those who are in good health.

Methods:

This study was open to healthy adults aged 18 years or older, as well as individuals who experiencing knee pain for more than three months related to physical activity and morning stiffness that lasts no longer than 30 minutes. A total of 13 participants were recruited for the session; nine participants with knee pain and five healthy participants performed five VR-based exercise scenarios that included marching on the spot, high stepping, weight shifting, forward step and sit-to-stand. To gain an understanding of usability, we used the "think aloud" method by taking notes and writing down participant feedback while playing five VR scenarios. This enabled participants to vocalize their thoughts, emotions, and difficulties while using the VR toolkit. Quantitative content analysis was conducted to categorize, quantify, and interpret the feedback received. The first author coded the data, which was then reviewed by K.B. and M.AL.

Results:

Two themes formed from the content analysis. Theme one was Usability and Instruction which was defined as the ease of use and clarity of instructions provided by the toolkit. Theme two was User Experience and Engagement which was defined as users' overall experience while interacting with the toolkit and their level of engagement with the provided activities. These are detailed in Table 1, along with sub-theme categories and the frequency (number of repeated codes).

Table 1 Content Analysis themes

Theme	Categories	Frequency
Usability and Instruction	Clarity and Instruction	17
	Technical and Tracking Issues	9
	Safety	5
	Inclusivity and Accessibility	2
	Visual and Graphics	5
User Experience and Engagement	Positive opinion and Enjoyment	6
	Challenges and Progression	7
	Game Design	11
	Movement and Physical Elements	8
	Engagement and Interest	16
	Age-related Preferences and Challenges	4

	Audio	1
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Theme 1: Usability and Instruction:

- *Clarity and Instruction:* Participants often highlighted their need for more precise guidance when navigating the toolkit. It became evident that clearer instruction was essential for users to maximise their interaction with the toolkit (17 mentions).
- *Technical and Tracking Issues:* Participants frequently cited disruptions in tracking, system glitches, and limitations in the toolkit's tracking capabilities. A recurrent issue was the camera's inconsistent ability to track users' movements accurately.
- *Safety, Inclusivity, Accessibility, and Visual/Graphics:* Safety concerns, predominantly linked to the risk of tripping or physical harm, were mentioned five times. The inclusivity and accessibility feedback (2 mentions) shed light on the toolkit's scenario suitability, especially concerning adults. Additionally, some users appreciated the design, while others hoped for better representation and modern graphics.

Theme 2: User Experience and Engagement:

- *Engagement and Interest:* The VR toolkit's design, interactive elements, and content managed to engage most of the participants. However, some participants expressed disinterest or disconnect, often attributed to technical glitches, high difficulty levels, or unclear instructions (16 mentions).
- *Game Design:* The game design elements of the VR toolkit played a pivotal role in shaping user experience, as evidenced by 11 mentions. While many participants found the design engaging and effective, some felt the instructions for movement were insufficient, thereby obstructing gameplay. Feedback also emphasized the importance of personalization, age-appropriate design, and the integration of both mental and physical challenges to enhance engagement.
- *Other Categories:* Various other aspects of the VR toolkit were touched upon by participants. However, challenges were noted in the physical and mental demands posed by the toolkit.

Conclusions:

The VR toolkit has received positive feedback for its innovative design and engaging experience but requires improvement in terms of instructions, technical challenges, and safety concerns. These areas of feedback need to be addressed for the next iteration of the toolkit. To ensure safe and effective use of the toolkit, users will receive manual instructions on how to navigate it, especially regarding foot placement and other movement-related instructions. In case of technical challenges such as disruptions in tracking, system glitches or limitations in the toolkit's tracking capabilities, the camera setup and data collection location

will be adjusted to minimize such issues. Safety concerns related to the risk of tripping or physical harm will be addressed to ensure the toolkit's safety.