Enhancing User Onboarding in Virtual Reality Educational Applications: Evaluating the Effectiveness of Pre-Training User Onboarding Method

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Abstract: Virtual Reality (VR) offers immersive and engaging educational experiences, but students often face challenges when first interacting with these environments, making effective onboarding essential. This study evaluates the effectiveness of pre-training as a method for onboarding users in VR educational applications. We conducted a user evaluation survey with 36 participants, primarily university students, to assess their experiences with pre-training. The results indicate that while pre-training improves users' ability to navigate and moderately enhances overall satisfaction, it is less effective in building user confidence. Participants showed a strong preference for interactive tutorials over static pre-training slides, suggesting that more engaging and interactive methods may better support user onboarding. These findings highlight the need for more dynamic onboarding approaches to improve user experience and learning outcomes in VR educational tools.

1 INTRODUCTION

Virtual Reality (VR) offers immersive and interactive learning experiences in education(Freina and Ott, 2015; Di Natale et al., 2020). Through VR, students can explore complex concepts and scenarios interactively, enhancing both the enjoyment and efficacy of learning (Freina and Ott, 2015; Merchant et al., 2014). While VR enhances educational experiences, its integration presents challenges, including a learning curve requiring students to adapt to virtual settings and controls before engaging with content. Addressing this adjustment phase is key to maximizing VR's effectiveness in education (Marougkas et al., 2024; Hamilton et al., 2021).

Initial interactions with VR can be challenging, as many students struggle to navigate and interact within virtual environments, which can hinder their learning (Mikropoulos and Natsis, 2011). This highlights the importance of onboarding—the process of acclimating users to the VR environment and controls before engaging with the main content.

Despite its importance, limited research has examined how pre-training improves user clarity, confidence, and satisfaction in VR educational applications, emphasizing the need for further investigation.

User onboarding in VR is a process designed to guide users in understanding both the technical and conceptual aspects of a VR experience, ensuring successful participation and immersion. It helps users effectively engage with the application and realize its full potential (Chauvergne et al., 2023; Whittaker, 2023). In education, effective onboarding minimizes confusion, allowing students to focus on learning rather than grappling with technology (Jensen and Konradsen, 2018).

There are several onboarding methods in VR, including integrated tutorials that provide step-by-step guidance within the virtual environment, interactive demos that encourage discovery-based learning, context-sensitive instructions delivered at the moment of need. There are also human-assisted onboarding methods, which can include Pre-Training and real-time guidance((Chauvergne et al., 2023; Whittaker, 2023).

The Pre-Training User Onboarding Method is de-

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scribed under various names in the academic literature, reflecting its widespread recognition and application. Terms such as "Pre-Training Interventions", "Pre-Exposure", "Familiarization Training", and "Induction Training", are commonly used to describe the process of preparing users to interact with new or complex systems (Meyer et al., 2019; Tichon and Burgess-Limerick, 2011; Jensen and Konradsen, 2018; Farra et al., 2015).

While the terms may differ, they all refer to the same essential process of preparing users to interact with new or complex systems. These variations highlight a shared focus on ensuring users are properly prepared before they begin using the application. In this study, we define the Pre-Training User Onboarding Method as a structured process conducted outside of the VR application. This method is designed to teach users how to effectively use the app by providing foundational knowledge about its purpose, controls, navigation, and special features. The process involves external presentations, human support, or other forms of guidance, such as instructional videos or printed manuals, to systematically introduce users to the basic controls and navigation within the VR environment. The purpose of Pre-Training is to ensure that users understand how to interact with and operate the application, as well as comprehend its purpose and key features, before engaging in independent use. The effectiveness of pre-training has been explored in various contexts. Meyer, Omdahl, and Makransky conducted a study in 2019 on the impact of pre-training on learning through immersive VR and video. Their findings indicate that pre-training significantly improves user performance and learning outcomes by reducing cognitive load and increasing familiarity with the VR environment. The study showed positive effects on knowledge, transfer, and self-efficacy in the immersive VR condition, but not in the video condition (Meyer et al., 2019). Our presented study aims to build on these findings by collecting insights on pre-training as an onboarding method in VR educational applications. To do so, we conducted user studies where we evaluated our pre-training method through a survey, focusing on user experience, clarity, confidence, and overall satisfaction.

This study addresses how pre-training supports VR onboarding in education, focusing on user experience, confidence, and satisfaction, guided by the following research questions:

Overarching Research Question. What is the general user experience of our Pre-Training onboarding method?

More specifically, we focused on the following research questions:

- **RQ1.** How effective is the pre-training method in terms of clarity, helpfulness, and building user confidence?
- **RQ2.** How does the pre-training method influence overall user satisfaction and their perceived support during the onboarding process?
- **RQ3.** What alternative onboarding methods do users prefer, and how do these preferences compare to their satisfaction with the current method?
- **RQ4.** How do user familiarity with video games, VR technology, and computer skills impact their perceived effectiveness of the pre-training method and their overall satisfaction?
- **RQ5.** What improvements can be made to the pre-training method based on user feedback and their preferences for alternative onboarding methods?

2 LITERATURE REVIEW

2.1 The Role of Virtual Reality in Education

VR has gained attention in education for creating immersive, interactive environments that enable experiential learning often beyond traditional methods (Freina and Ott, 2015; Merchant et al., 2014). Research shows VR enhances student engagement, motivation, and retention (Makransky and Lilleholt, 2018). Situated Learning Theory emphasizes contextual and authentic learning, which VR effectively supports (Lave, 1991).

2.2 Challenges of Implementing VR in Education

Implementing VR in education faces challenges like high costs and limited hardware availability (Radianti et al., 2020). Additionally, the steep learning curve of VR can hinder students' ability to navigate and engage effectively, affecting their educational experience (Mikropoulos and Natsis, 2011). Addressing both overt and subtle challenges is key to successful integration.

2.3 Onboarding and Pre-Training in VR

Onboarding helps ease VR's steep learning curve, making it more accessible for students by familiarizing them with the interface and controls before engaging with content (Jensen and Konradsen, 2018).

Methods include guided tutorials, step-by-step instructions, interactive demos, and pre-training. Pre-training is particularly effective, covering basic controls and interactions to help users focus on educational content (Di Natale et al., 2020).

2.4 Effectiveness of Pre-Training in VR

Pre-training has been studied in professional and technical contexts. Meyer et al. (2019) found that pre-training significantly improved knowledge, transfer, and self-efficacy in immersive VR but not in video formats, highlighting its benefits in high-immersion environments (Meyer et al., 2019). Similarly, Radianti stressed its role in improving VR usability and effectiveness in higher education (Radianti et al., 2020). Building on these findings, our research focuses on pre-training from a user experience perspective.

Key variables influencing pre-training effectiveness in VR include clarity and helpfulness of instructions. Clear materials make navigation intuitive and enhance onboarding (Sweller, 1988; Jensen and Konradsen, 2018). Helpfulness reflects how well materials prepare users for independent operation and problem-solving, directly impacting engagement and learning outcomes (Meyer et al., 2019; Klein et al., 2015).

User confidence is a critical factor, as effective pre-training builds confidence in using VR systems, directly influencing learning outcomes. Makransky found that confidence-enhancing onboarding improves performance and adjustment to new systems (Makransky and Lilleholt, 2018). Confidence is also tied to satisfaction, with Farra showing that supported users feel more prepared and satisfied (Farra et al., 2015). Aligning training with users' needs and learning styles fosters confidence, satisfaction, and engagement (Klein et al., 2015). Clarity, helpfulness, and confidence are essential metrics for evaluating the effectiveness of onboarding methods (Baek and Bramwell, 2016).

3 METHODOLOGY

3.1 Study Design

This study aimed to explore the user experience of pre-training as an onboarding method in VR educational applications. .

3.2 Participants

This study included 36 participants from a university setting with varying familiarity with VR technology. The group comprised 9 geography students, 8 other university students, 9 researchers, and individuals from diverse backgrounds. None had prior experience with the GeoVR application (citation removed for anonymity). To ensure diversity, participants were selected based on their likelihood of using the app, including those with and without VR experience. Familiarity with VR was self-rated on a 1-to-5 scale (1: no experience, 5: extensive experience). This diversity enabled a comprehensive evaluation of the pre-training's effectiveness across different educational levels and VR familiarity.

3.3 Testing App

The app we are using in our study is GeoVR, an immersive virtual reality educational application designed to facilitate geographical learning (Sabah et al., 2024). It allows users to explore and analyze terrain features through interactive 3D models. The application supports both individual and collaborative learning experiences, making it a valuable tool for education in fields like geography and environmental studies.

Procedure Overview Participants were greeted and briefed on the study. In Phase 1 (see Phase 1: Pre-App Usage), the participants were introduced to the GeoVR application and the Hardware used to run it. They also received guidance on the app's features and controls. In Phase 2 (see Phase 2: Support from Outside the App), expert support was available for additional assistance. After onboarding, participants were grouped to use the GeoVR application together. Finally, they completed a survey to provide feedback, concluding the session.

3.4 Pre-Training

3.4.1 Phase 1: Pre-App Usage

During the initial onboarding phase, participants were introduced to the GeoVR application and Meta Quest 2 headsets through a live presentation with text and images via an external projector. Questions were encouraged during and after the presentation to ensure clarity. The session covered the app's purpose, key features, VR controller instructions, and navigation within the app (see figure 1).

Afterward, participants were grouped into sets of five to use the GeoVR application. The experimenter

observed and noted any challenges or difficulties during the onboarding process.

Figure 1: a slide of the onboarding method introducing the system.

3.5 Phase 2: External Support

During this phase, participants had ongoing access to the experimenter for any questions or concerns related to using the GeoVR app. This additional support ensured that participants could resolve any uncertainties or difficulties encountered during the onboarding process, providing a continuous layer of assistance beyond the initial presentation.

3.6 Data Collection

Data were collected through a paper-based survey immediately after participants completed the VR app and Pre-Training. Conducted in a controlled environment, the survey allowed participants to seek clarification if needed. Written in German, it included multiple-choice and 5-point Likert-scale questions (1: "not at all applicable" to 5: "fully applicable") designed by the authors to assess the onboarding experience. The survey focused on clarity, helpfulness, and confidence-building, key factors in evaluating the effectiveness of the pre-training method.

3.7 User Evaluation Survey

1. **User Familiarity and Experience:**
   - Do users play video games?
   - Are users familiar with VR technology and applications?
   - How do users rate their general computer skills?
2. **Effectiveness of the Onboarding First Phase and User Confidence After It:**
   - **Clarity and Appeal of the Slides.** Questions assessed whether the slides were clear, easy to follow, visually appealing, and appropriately paced. For clarity, we had 4 questions asking if the slides were clear, easy to follow, etc.
   - **Helpfulness of the Slides.** Participants evaluated how well the slides prepared them to navigate the VR app, covered necessary information, and motivated further exploration. For helpfulness, we had 4 questions.
   - **User Confidence.** Questions determined how confident participants felt using the VR app after viewing the slides, whether the slides matched their learning style, and if the slides helped them learn to use the app independently. For confidence, we had 3 questions.
3. **Alternative Onboarding Methods:**
   - **Preferred Alternatives.** Participants evaluated alternatives to slides, including interactive tutorials, video tutorials, one-on-one training, and user manuals, and could also suggest other preferred methods.
     . Participants also had the opportunity to provide feedback and suggest other methods they might prefer.
4. **Overall Satisfaction and Support During Onboarding:**
   - **Satisfaction with the Onboarding Experience.** Participants were asked to rate their overall satisfaction with the onboarding experience provided by the slides.
   - **Perceived Support.** Participants also evaluated whether they felt adequately supported throughout the entire onboarding process.

4 RESULTS

4.1 Participant Demographics

A total of 36 participants took part in this study. The survey assessed their familiarity with video games, VR technology, and general computer skills (see Table 1). The responses were rated on a 5-point scale, where 1 indicated "does not apply at all" and 5 indicated "fully applies".

Table 1: Participant Demographics.

Category	Mean	SD
Familiarity with Video Games	3.38	1.39
Familiarity with VR	2.94	1.60
Computer Skills	4.11	0.94

4.2 Effectiveness of Pre-Training Method

Participants evaluated the pre-training materials on various aspects, including clarity, appeal, helpfulness, comprehensiveness, organization, ease of following, confidence, and independence. The responses were rated on a 5-point scale, where 1 indicated "does not apply at all" and 5 indicated "fully applies" (see Table 2).

Table 2: Effectiveness of Pre-training Method.

Category	Mean	SD
Clarity	3.83	0.84
Helpfulness	3.44	0.98
Confidence	2.98	1.16

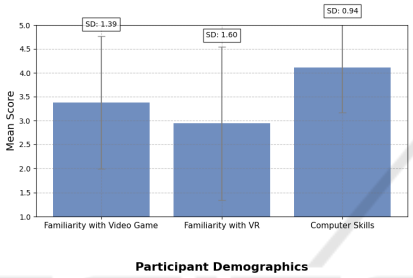

Figure 2: Participant demographics.

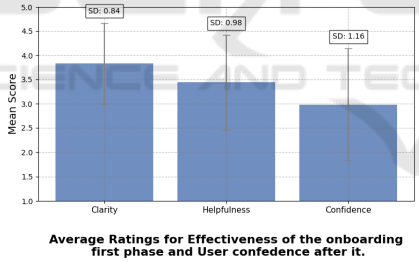

Figure 3: Ratings for effectiveness and confidence.

4.3 Alternative Onboarding Methods

Participants rated alternative onboarding methods—interactive tutorials, video tutorials, one-on-one training, and user manuals—on a 5-point scale (1: "does not apply at all," 5: "fully applies," see Table 3). The data showed a preference for these methods over current pre-training. Participants also provided feedback on other approaches to improve the onboarding experience, offering insights into preferred solutions.

4.4 Overall Satisfaction

Participants' satisfaction with the onboarding process was evaluated alongside their perceived level of support during the experience, both rated on a 5-point scale (1: "very dissatisfied"/"poor support," 5: "very satisfied"/"excellent support," see Table 4). These results offer a comprehensive view of user sentiment, including support adequacy and overall contentment.

Table 3: Alternative Onboarding Methods.

Method	Mean	SD
Interactive Tutorials	3.94	1.09
Video Tutorials	4.38	0.83
Individual Training	3.55	1.18
User Manual	3.00	1.06
Other Methods	2.16	1.27

Table 4: Overall Satisfaction and Support During Onboarding.

Category	Mean	SD
Overall Satisfaction	3.27	0.88
Support During Onboarding	4.11	0.74

To evaluate how user familiarity with video games, VR technology, and computer skills influenced both the perceived effectiveness of the pre-training method and overall satisfaction, we conducted a **correlation analysis**. This analysis was chosen to examine the strength and direction of relationships between these familiarity variables and the dependent measures of effectiveness and satisfaction.

Effectiveness was calculated as the average of three key factors—*clarity*, *helpfulness*, and *confidence*—which were derived from participant responses to specific survey questions. **Overall Satisfaction** was measured using a single question asking participants to rate their satisfaction with the onboarding process.

The correlation analysis measured how familiarity factors (video games, VR, and computer skills) relate to *Effectiveness* and *Overall Satisfaction*, with positive correlations indicating higher familiarity improves perceptions, and negative correlations suggesting the opposite.

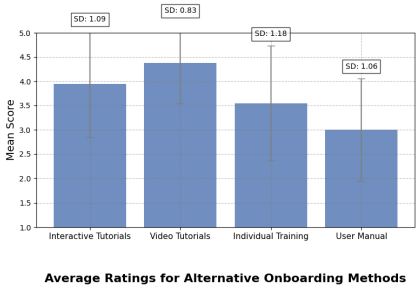

Figure 4: Ratings for Alternative Onboarding Methods.

4.5 Correlation Analysis

A **Pearson correlation analysis** was conducted to explore the relationship between user familiarity with

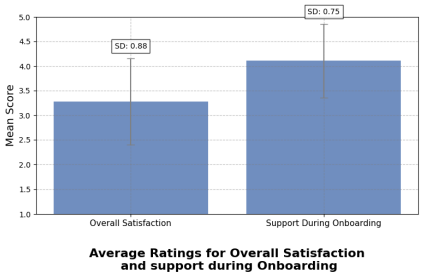

Figure 5: Overall Satisfaction.

video games, VR technology, and computer skills with both the perceived effectiveness of the pre-training method and overall satisfaction. Effectiveness was calculated as the average score of clarity, helpfulness, and confidence, while Overall Satisfaction was assessed through a single survey item.

Video Game Familiarity. There was a weak, negative correlation between *Video Game Familiarity* and *Effectiveness*, $r(34) = -0.045, p > .05$, indicating that familiarity with video games had little impact on how effective participants found the pre-training method. A weak, positive correlation with *Overall Satisfaction*, $r(34) = 0.040, p > .05$, suggests a slight but non-significant increase in satisfaction among participants familiar with video games.

VR Familiarity. A weak, positive correlation was found between *VR Familiarity* and *Effectiveness*, $r(34) = 0.110, p > .05$, suggesting that participants with more VR experience perceived the pre-training as slightly more effective. The correlation between *VR Familiarity* and *Overall Satisfaction* was close to zero, $r(34) = -0.008, p > .05$, showing no meaningful relationship.

Computer Skills. A weak, negative correlation was found between *Computer Skills* and *Effectiveness*, $r(34) = -0.122, p > .05$, indicating that higher computer skills did not result in better perceptions of the pre-training method's effectiveness. However, there was a significant, moderate negative correlation between *Computer Skills* and *Overall Satisfaction*, $r(34) = -0.482, p < .01$, suggesting that participants with greater computer skills were less satisfied with the onboarding experience.

Table 5: Effectiveness and Overall Satisfaction based on Familiarity.

Category	Effectiveness	Satisfaction
Game Familiarity	-0.045	0.040
VR Familiarity	0.110	-0.008
Computer Skills	-0.122	-0.482

5 DISCUSSION

In this section, we address the research questions posed in our study by synthesizing the findings from the data collected.

RQ1: How effective is the pre-training method in terms of clarity, helpfulness, and building user confidence?

The effectiveness of the pre-training method in this study was evaluated in terms of clarity, helpfulness, and its ability to build user confidence. The clarity of the materials received a relatively high mean score of 3.83 (SD = 0.84), indicating that participants generally found the content clear, though there was some variability in their experiences. Helpfulness scored slightly lower, with a mean score of 3.44 (SD = 0.98), suggesting that while the materials were useful, they could be improved to better prepare users for navigating the VR app.

Confidence, was where the pre-training method was least effective, with a mean score of 2.98 (SD = 1.16). This lower confidence score indicates that many participants did not feel sufficiently prepared after the pre-training. Overall, while the pre-training method demonstrated some effectiveness in terms of clarity and helpfulness, it falls short in fostering user confidence. This underscores the need for more interactive or tailored training approaches to better support and empower users in mastering the VR app.

RQ2: How does the pre-training method influence overall user satisfaction and their perceived support during the onboarding process?

The analysis of RQ2 focused on how the pre-training method influenced overall user satisfaction and perceived support during the onboarding process. Participants rated their overall satisfaction with a mean score of 3.27 (SD = 0.88), indicating a moderate level of satisfaction, though there was noticeable variability in responses. Perceived support during onboarding received a higher mean score of 4.11 (SD = 0.74), suggesting that participants generally felt well-supported throughout the process, with more consistency in their experiences. The lower satisfaction score, compared to the higher perceived support, implies that while the pre-training method was effective in providing support, it may not have fully met participants' expectations or needs, leading to only moderate overall satisfaction. This highlights an opportunity to enhance the onboarding experience by addressing areas beyond support, potentially through improving the content, relevance, or delivery of the pre-training to better align with user expectations and foster greater satisfaction.

RQ3: What alternative onboarding methods would users prefer, and how do these preferences compare to their satisfaction with the current method?
The analysis of RQ3 examined participants' preferences for alternative onboarding methods, including interactive tutorials, video tutorials, one-on-one training, and user manuals. Participants rated these methods on a 5-point scale, with a mean score of 3.94 (SD = 1.09), indicating a general preference for more interactive, engaging, and personalized approaches over the current pre-training method.

The variability (SD = 1.09) suggests differing user needs and learning styles, highlighting that a one-size-fits-all approach may not be effective. These preferences emphasize the need for tailored onboarding solutions to better address diverse user requirements. The results signal an opportunity for developers and trainers to adopt more dynamic, user-centered methods to improve satisfaction and enhance the overall onboarding experience.

RQ4: How do user familiarity with video games, VR technology, and computer skills impact their perceived effectiveness of the pre-training method and their overall satisfaction?
Here's a shorter version that preserves the original meaning:

The findings indicate that familiarity with video games, VR technology, and computer skills influences interactions with the pre-training method. VR familiarity improves perceived clarity and helpfulness but does not significantly increase overall satisfaction, suggesting a gap in the holistic onboarding experience.

Users with advanced computer skills may find the training redundant or less engaging, reducing perceived effectiveness and satisfaction. In contrast, video game familiarity has only a marginal impact, likely due to the generalized nature of gaming compared to VR-specific tasks.

These results highlight the need for adaptable, personalized training methods that cater to varying skill levels, ensuring effectiveness and satisfaction across diverse user backgrounds.

RQ5: What improvements can be made to the pre-training method based on user feedback and their preferences for alternative onboarding methods?
The data highlight a preference for interactive and immersive onboarding methods, with interactive tutorials rated highest (M = 4.38, SD = 0.83). Incorporating dynamic, hands-on experiences within the VR environment could enhance engagement and satisfaction. Personalized methods, such as human-assisted support, would also benefit users needing individualized guidance.

Feedback suggests improving the slide-based approach by integrating video content, such as demonstrations of VR controller use. Tailored onboarding processes, starting with an assessment of users' VR familiarity and technical skills, could provide customized tracks for varying experience levels. Structured content delivery with clear instructions and scenario-based tasks can progressively build confidence. Regular feedback and refinement will ensure onboarding remains effective and responsive to diverse user needs.

6 LIMITATIONS AND FUTURE RESEARCH

This study provides valuable insights into the role of pre-training in VR educational applications, but certain limitations should be noted. The controlled environment of the study does not fully replicate real-world usage conditions, where distractions or technical issues could influence the effectiveness of onboarding methods.

One key finding of this study is that the static slides used in pre-training did not significantly enhance user confidence. Exploring more interactive or immersive onboarding methods, such as in-app tutorials, could address this issue and better support user needs. Furthermore, future work could compare different onboarding strategies to evaluate their effectiveness for diverse user groups and VR learning applications, paving the way for more tailored and effective approaches.

By focusing on these directions, future research can contribute to developing onboarding strategies that better align with the varied needs of VR users and applications.

7 CONCLUSION

This study examined how pre-training onboarding supports VR use in education, focusing on clarity, helpfulness, and confidence. The results showed that while the training was clear and helpful, it did not increase user confidence when using the VR application.

This means it could improve at making users feel confident to help users feel more sure about using VR on their own.

Users who had used VR before found the training more useful in terms of clarity and helpfulness. But even though they understood the training better, this

did not make them more confident or satisfied with the overall experience. Users with strong computer skills felt that the training was not interesting enough, and those familiar with video games did not seem to be affected much by the training. This shows that different users need different types of training to make sure that it works well for everyone.

Many users said they would prefer more interactive and hands-on training methods, such as video tutorials or instructions built into the VR itself. They thought these methods would be more interesting and helpful than just looking at slides. Because of this, it seems that future onboarding methods should be more interactive and engaging.

Although pre-training was good at being clear and supportive, overall user satisfaction was only average. This suggests that we need to improve the onboarding process to better fit the needs of different users, especially when it comes to making them feel confident.

Making the onboarding process more interactive, personalized, and fun can help make VR educational tools easier to use and more enjoyable for a wider range of users.

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