Comparing Text-based Onboarding Methods for Virtual Reality Interactive Showcasing

June 9, 2023

Master Thesis Group: cs-23-hci-10-09
Supervisor: Timothy R. Merritt
Anders Jepsen
ajepse17@student.aau.dk
Computer Science Aalborg University

AALBORG UNIVERSITY
STUDENT REPORT

Summary

This research compares two onboarding methods for virtual reality (VR) interactive showcasing: contextual tooltips and traditional tutorial screens. The study used an interactive showcase for an industrial robotics product, the ACOPOS 6D system, to simulate a realistic use case. The primary objective was to investigate the impact of these methods on participants' perceived usability and system satisfaction.

The experiment involved two versions of the showcase. One version employed a contextual tooltip approach, where interaction mechanics were explained to the user in real time. The other version used a traditional tutorial screen method, where users were presented with a block of instructions followed by an exploration phase. A user study was conducted to gauge the effectiveness of these methods in terms of system satisfaction and usability.

The findings of the study were intriguing. Participants experienced significantly higher system satisfaction with the contextual tooltip method. They reported feeling less rushed and less frustrated and performed tasks more successfully when using this method compared to the tutorial screen method. However, no significant difference was found in perceived usability, learnability, or task completion time between the two onboarding methods.

In light of the results, the study encourages further research to understand better what onboarding methods are best suited for interactive showcasing in VR. It also raises the question of whether the system's complexity justifies developing a specific onboarding method. The results suggest that contextual onboarding can be advantageous over traditional tutorial methods. However, developers might find it more beneficial in more straightforward applications to forgo developing an onboarding method and prioritize creating intuitive interaction mechanics that allow users to learn through exploration.

The study acknowledges its limitations. Participants were mainly inexperienced with VR games, which might have influenced their experiences. Additionally, the instruction and exploration phases differed between the two conditions. Future research should investigate these factors and consider different types of VR showcases.

In conclusion, the research provides significant insights into VR interactive showcasing. It underlines the potential value of implementing contextual onboarding methods for improving system satisfaction, a crucial factor for VR showcasing. However, it also highlights that perceived usability might not significantly improve with these methods, suggesting a need for continued investigation.

Contents

1 Introduction **1**

2 Research Contributions **2**

2.1 Empirical Research Contributions 2

2.2 Artifact Contributions 2

3 Discussion **3**

3.1 Challenges and Benefits of Working with the ACOPOS 6D system for a case study . . 3

3.2 Contribution to the Research Community 4

3.3 Results 5

3.4 Study Limitations 6

4 Conclusion **6**

4.1 Future Work 7

4.2 Final Thoughts 7

1 Introduction

Virtual Reality (VR) has become a popular presentation tool for showcasing technology in the industry. Compared to inactive presentation tools, like PowerPoint, VR showcasing engages participants in an interactive experience. As the VR market is expected to grow (Statista, 2023), it is essential to question and explore how effective current onboarding methods within these systems are in helping participants familiarize themselves with the digital product and explicitly focusing on the interaction between users and the tools offered within the VR environment. My thesis project compares two text-based onboarding methods to ascertain how they impact participants' perceived usability, system satisfaction, and task completion time. This thesis project was developed over one semester.

My thesis was centred on a comparative study titled 'Comparing Text-based Onboarding Methods for Virtual Reality Interactive Showcasing'. In this thesis, I developed two onboarding versions of a vr interactive showcase of B&R's ACOPOS 6D system (B&R, 2023). One version employed contextual tooltips, and the other used traditional tutorial screens. By conducting a between-subjects user study involving participants, I assessed the comparative impact of these two text-based onboarding methods on participants' perceived usability, learnability, and system satisfaction.

I worked towards understanding how users could be helped to become familiarized with digital products in virtual reality. For this purpose, I developed a prototype of the ACOPOS 6D system, simulating two real-world applications. The first scenario tasks the participant to set up the virtual ACOPOS 6D system to build a phone, and the second scenario tasks the user to build medicine. I collaborated with Aalborg University's robotics lab since they had the physical ACOPOS 6D system as part of a MADE FAST project (MADE, 2020). The collaboration gave me physical access to the ACOPOS 6D system, which allowed me to photograph and measure it for accurate representation in VR. It also gave me the opportunity to interview both the supervisor of the project and the students researching it. The information gathered was used to inform the development of the VR interactive showcase. Each task scenario was based on real assembly tasks for the system. The system in vr is represented on a 1:1 scale. All interactable objects and UI simulate the system's capabilities. This part of the project served as a foundation, helping me gain insights into the workings of the ACOPOS 6D system and test whether it was accurately represented.

The results revealed that participants experienced significantly higher system satisfaction with the contextual tooltip method as they experienced the task was not as rushed, felt less frustrated, and performed better than the traditional tutorial screen method. However, the contextual tooltip method could have performed better in perceived usability, learnability, or task completion time.

As a result of my work, collaboration, research, and feedback from my user study, this thesis

project has expanded my understanding of VR technology in the industry and shown me as a developer how there is still a need for human-centred designed guidelines to facilitate VR interactive showcasing systems. The findings support the notion that further research into the benefits of VR onboarding methods could help determine when implementing onboarding methods are justified compared to prioritizing the development of intuitive interaction mechanics.

The subsequent sections will elaborate on this thesis project's research contributions and insights. Discussions will encompass the experiences of collaborating with experts, the contributions of this research to the field, intriguing results, and potential limitations. Furthermore, potential avenues for future work and overall reflections on the project will be presented. The detailed study' A Comparison of Text-based Onboarding Between Tutorial Screens and Contextual Tooltips for Virtual Reality Interactive Showcasing' are included as Appendices.

2 Research Contributions

In this study, I have contributed to the field of Human-Computer Interaction (HCI) with two principal types of contributions, as defined in (Wobbrock and Kientz, 2016): Empirical research contributions and artifact contributions.

2.1 Empirical Research Contributions

The empirical research contributions form the bedrock of my study. This project was designed to compare two onboarding methods, tutorial screens and contextual tooltips, within a virtual reality (VR) environment. I gathered my data using a between-subjects study where participants completed a task and answered post-test questionnaires. The subsequent analysis provided new knowledge on the efficacy of the two onboarding methods regarding perceived usability, learnability, and system satisfaction.

The empirical findings are significant for the HCI community as they address an under-explored area of research, providing crucial insights into text-based onboarding methods for VR applications. Furthermore, the questionnaires I used in my user study and analysis have been repeatedly demonstrated to be valid and reliable (Laubheimer, 2018).

2.2 Artifact Contributions

Alongside my empirical research, I have also made notable artifact contributions. As a part of my study, I developed a VR interactive showcase prototype, which served as the platform for the user study. This VR system is an artifact that embodies new possibilities for user interaction within the

virtual environment, and its design was driven by the objective of understanding the comparative effectiveness of two onboarding methods for a realistic case.

While my artifact does not introduce a new system, tool, or technique, it makes an essential contribution by demonstrating a practical application of the text-based onboarding methods tutorial screens and contextual tooltips within a VR environment. The design and implementation of the VR system facilitate new insights into the onboarding process, showcasing an engaging and immersive interaction paradigm for users.

In conclusion, my study has yielded valuable empirical research contributions by exploring VR onboarding methods and artifact contributions through developing a VR interactive showcasing based on a realistic case. These contributions will stimulate further research in the domain of HCI, mainly focusing on VR interactive showcasing for industry technology.

3 Discussion

This section will delve deeper into the implications of the study's findings, the challenges encountered, and the benefits gained during the research process. It also analyses the study's limitations and reflects on how this research contributes to the broader scientific community.

3.1 Challenges and Benefits of Working with the ACOPOS 6D system for a case study

One of the significant challenges I faced during the project was taking on the ACOPOS 6D system as a case. I was motivated to take on the case because it allowed me to work with an exciting new technology and access the people researching it. In the beginning, I discussed project directions for VR training with the supervisor of the MADE FAST project. Due to my inexperience with casework, I later found out through interviewing two researchers of the ACOPOS 6D system that a VR training application for the ACOPOS 6D system took too much work to test with the resources available to me. Afterwards, I did a literature review of four meta-analyses investigating VR training and concluded the potential output for this case was low. Therefore, I decided to pivot my project in a new direction, meaning parts of the early prototype were discarded or reconfigured to suit the new direction. For future projects, I suggest only taking on a case when it can help achieve your goals to avoid lost progress.

Conversely, working with a case can also offer several benefits. Because I took on the case, I had the opportunity to interview the company B&R and gain their industrial perspective on VR interactive showcase real-world application. My access to the ACOPOS 6D system and its researchers also offered diverse perspectives enriching the research process.

Developing a VR interactive showcase of the ACOPOS 6D with full functionality was impossible in the span of this project. Therefore, a simplified prototype of the system and the two tasks of assembling a phone or medicine with the system were developed. The supervisor of the MADE FAST project stated the prototype was a fair representation of the ACOPOS 6D system for a showcase. Besides the prototype's limited capabilities, the supervisor suggested I develop two additional features for the showcase to be a more authentic representation and better display the system's advantages over conventional assembly lines. An advantage of the ACOPOS 6D system is its flexibility in simultaneously building objects with different specifications on the same assembly line depending on demand, e.g., a phone that can be built with one or two fuses. A robot will assemble the phone parts on top of shuttles which move between the robots and designated positions. The current prototype cannot handle multiple shuttles or build different phones. I attempted to program the handling of multiple shuttles, but it proved too complicated an endeavour to undertake given the remaining time of the project at that point. Developing the VR interactive showcase prototype of the ACOPOS 6D system using the game engine Unity (Haas, 2014) was challenging at times. Much of its functionality was derived from Unity's XR Interaction Toolkit (Unity, 2023) or inspired by mechanics for games. Still, available resources for VR functionality relevant to industry cases took a lot of work to come by in my case. I effectively changed my coding methodology from trying to find solutions to instead create them by digging through Unity's Manuel, e.g., the pathfinding and navigation of the shuttle were adapted to function in VR. An interesting observation I made at the beginning of the development was that a lack of visual input was understimulating me. It occurred when I tested my VR application for extended periods. This was counterproductive as it demotivated me to develop my application. Colour, sound, and feedback are often first added later in development, but I prioritised adding them early, which helped in my case.

3.2 Contribution to the Research Community

My study compares text-based onboarding methods for VR interactive showcasing – a topic which has not received much research attention or been extensively examined by researchers. More research must be done to critically investigate the perceived usability, system satisfaction, learnability, and suitability of onboarding methods for VR interactive showcasing of industrial technology. By comparing tutorial screens and contextual tooltips in a VR interactive showcase based on a real industrial case and task, it contributes empirical evidence to the ongoing discussions about effective onboarding methods in VR systems for industry. Given the rising prominence of VR applications in various fields, these findings are valuable to HCI researchers and VR developers aiming to optimize the user experience.

My artifact contributes to the research community by providing a VR interactive showcase of a genuine industry case which informs on the challenges for developing industry showcase solutions in VR and provides an appropriate testing ground for the knowledge collected during my study of the text-based onboarding methods. Currently, the prototype is a standalone solution, but since it is developed in Unity, all its functionality will be compatible and, therefore, transferable to other Unity programs. In my interview with B&R, they mentioned they use Unity for showcasing in 3D (not VR). The VR company SynergyXR also use Unity as their platform, so even though my prototype is standalone, its functionality can easily be transferred to the Unity platform, which companies already use for showcasing.

3.3 Results

This section will delve into unexpected outcomes I encountered during my thesis work. These findings may not represent the core discoveries of my thesis. Instead, they are deviations from my original hypotheses or observations that struck me as unusual.

While the study results show participants experienced a higher system satisfaction with the contextual tooltip method, I observed curious interactions from the participants seen from my very biased perspective. Participants testing the contextual tooltip method are equipped with a control panel on their left arm to control the virtual ACOPOS 6D system. When participants look at the control panel, it explains how to use it and tells them to press a continue button with the trigger button to approve they understand. The problem was participants clicked on the trigger button on their left controller, but they needed to point and click on the continue button with their right controller. Upon reflection, the participants intuitive understanding of the system made more sense and was simpler to execute. The participants had to point at interactable objects with a ray to get contextual tooltips. The weakness of this system is that participants have to hold the ray steadily pointed at the interactable else the tooltip disappears. Many participants struggled to aim their rays accurately. The method originates from 2D applications where the mouse holds steady by itself. For optimal use in VR, the method should be further developed. Participants suggested having a target above the interactable object to aim at. Some participants forgot to use or look at the contextual tooltip textbox anchored on their right controller. Based on my observations, the textbox location could be optimized. Still, the bigger problem is that participants in VR have a 360-degree view, making textboxes harder to place appropriately compared to a confined 2D view. One participant suggested replacing the textbox with audio, and another suggested animation.

For the tutorial screens method, I had two participants state they ignored the tutorial screens and relied on their VR experience to learn through exploration. I did not observe other participants do

this, but other studies report users frequently skip tutorial screens.

3.4 Study Limitations

While my study and development of the VR interactive showcase prototype of the ACOPOS 6D system add beneficial contributions to the research community, I am also mindful of research limitations.

The study was conducted in a controlled environment, which may reflect real-world usage scenarios of the ACOPOS 6D system. Participants' interactions might be different in a less structured setting. The user study had a limited sample size of 21 male and four female students with an average age of 24. A larger, more diverse participant pool might have yielded more generalizable results. Most participants experienced minor bugs, which could have added to their completion time and influenced their perceived usability or system satisfaction. As I was the only facilitator of the study, I had to prioritize the safety of the participants by keeping an eye on them to ensure they would not trip over the headset's wire or walk into a wall. This could have caused me to miss relevant observations.

Given these limitations, it is advisable to interpret the study's findings with a grain of salt. Further research could focus on larger, more diverse participant samples and consider other potential influencing factors like bugs and the number of facilitators.

Despite the mentioned limitations and challenges, this study provides valuable insights into text-based VR onboarding methods. It opens up new avenues for research and practical applications, contributing significantly to the HCI and VR development community. By bridging the gap between academia and industry, the study also underlines the importance of applied research in shaping user-centred technologies.

4 Conclusion

This research project compared two text-based onboarding methods - tutorial screens and contextual tooltips - for VR interactive showcasing. The study was designed to investigate text-based user onboarding in VR interactive showcase applications, contribute valuable insights to the human-computer interaction (HCI) field, and potentially help to create developer guidelines for VR onboarding.

After conducting a user study and analyzing the collected data, my findings suggest that while tutorial screens and contextual tooltips score average in terms of perceived usability and learnability, participants with contextual tooltips demonstrated a higher level of system satisfaction. Despite no significant difference in task completion time between the two methods, it is clear that the nature of

user interaction and satisfaction is influenced by the onboarding method adopted.

4.1 Future Work

I will now present further research opportunities for VR onboarding methods in interactive VR showcases and how they could be relevant in the industry.

In my interview with B&R, they mentioned that presenting customers with a PowerPoint presentation can be disadvantageous if your competitor can showcase their product in VR. They also stated they could see the VR interactive showcase prototype of the ACOPOS 6D useful in sales. Investigating VR interactive showcases' effect on customer attraction and what elements in the system have the most substantial influence, e.g. perceived usability, system satisfaction or immersion.

A mixed reality (MR) headset might have been a better medium for VR industrial showcasing in an industrial setting. If the ACOPOS 6D prototype was implemented in MR, users could set up the system at intended sites, like a production hall. B&R mentioned a weakness of VR interactive showcasing: they had experienced difficulty convincing people to equip the headset if more than five people were present. MR could alleviate this issue as the user can still see the real world. Therefore, it could be interesting to investigate what each medium excels at in the interactive showcasing of industry products.

VR or MR interactive showcasing could also have an application in the metaverse for meetings, virtual showrooms, or product development. Companies with MR or VR product showcases could have a fascinating opportunity in the metaverse for collaboration and to brand themselves. Researching suitable onboarding methods for multiple users in the same virtual world experiencing interactive showcasing could prove relevant.

In addition to these areas for future research, my work promotes further exploration of other onboarding methods, like interactive walkthroughs, guiding markers, or step-by-step learning. The growing market and use of VR technology for industry cases will inevitably give rise to needed guidelines for VR interactive showcasing. This necessitates a comprehensive investigation into the effects of onboarding methods for developers to achieve high perceived usability, learnability, and system satisfaction for their systems.

4.2 Final Thoughts

Reflecting on this research project, I find that the study has achieved its primary goal – to provide a comparative evaluation of two text-based onboarding methods, tutorial screens and contextual tooltips for a VR interactive showcase. While both methods scored equally in perceived usability and

learnability, the contextual tooltips showed a clear edge in enhancing participants' system satisfaction, providing an essential clue to improving user experience and establishing developer guidelines for VR interactive showcasing.

Beyond this key finding, the study highlighted the importance of considering when implementing user onboarding is justified in a VR system. Practical onboarding guidelines will become increasingly critical as the VR market grows, and VR interactive showcases will be an expected presentation tool for industry products. I hope to have contributed to the broader conversation surrounding human-centred design for VR interactive showcasing by investigating this researched area.

Although there remain avenues for further research, this study lays a foundation for future explorations. My research journey has been challenging and enlightening as I navigated the interface between academia and industry, theory and practice, technology and participants. The insights gained through this process will help developers' future work in designing onboarding methods for VR interacting showcases of industrial technology.

I have contributed one artifact for VR interactive showcasing, a prototype of B&R's ACOPOS 6D system. I have also contributed empirical data from my study of text-based onboarding methods showing that contextual tooltips cause less frustration, make tasks feel less rushed, and give the participant a better feeling of performance.

References

B&R. 2023. “B&R varsler starten på flerdimensionel produktion med ACOPOS 6D.”.
URL: *https://www.br-automation.com/da/produkter/mekatroniske-systemer/acopos-6d/*

Haas, John K. 2014. “A history of the unity game engine.”.

Laubheimer, Page. 2018. “Beyond the NPS: Measuring Perceived Usability with the SUS, NASA-TLX, and the Single Ease Question After Tasks and Usability Tests.”.
URL: *https://www.nngroup.com/articles/measuring-perceived-usability/*

MADE. 2020. “Kvart milliard til at løse fremtidens udfordringer i produktionsvirksomheder.”.
URL: *https://www.made.dk/videoer/lose*$_{f}remtidens_{u}dfordringer/$

Statista. 2023. “VR & AR worldwide.”.
URL: *https://www.statista.com/outlook/amo/ar-vr/worldwide*

Unity. 2023. “XR Interaction Toolkit.”.
URL: *https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@2.3/manual/index.html*

Wobbrock, Jacob O. and Julie A. Kientz. 2016. “Research Contributions in Human-Computer Interaction.” *Interactions* 23(3):38–44.
URL: *https://doi.org/10.1145/2907069*

Appendices

A Comparison of Text-based Onboarding Between Tutorial Screens and Contextual Tooltips for Virtual Reality Interactive Showcasing

Anders Manøe Jepsen
Aalborg University - Department of Computer Science
Denmark
ajepse17@student.aau.dk

Abstract

In this comparative study, we evaluated the impact of two text-based onboarding methods - contextual tooltips and traditional tutorial screens - on usability and system satisfaction within a virtual reality (VR) interactive showcasing. The methods were tested on an interactive showcase prototype for an industrial robotics product, ACOPOS 6D. The study revealed that the contextual tooltip method yielded higher system satisfaction as participants felt less rushed and frustrated and demonstrated improved task performance. However, the two methods had no significant difference in perceived usability, learnability, or task completion time. These findings contribute to the ongoing discussion about the best practices for onboarding methods in VR interactive showcases. Further research is needed to improve onboarding intuitiveness and adaptability to the system's complexity.

Keywords: virtual reality; onboarding; tutorial screens; contextual tooltips; interactive showcasing

ACM Reference Format:
Anders Manøe Jepsen. 2023. A Comparison of Text-based Onboarding Between Tutorial Screens and Contextual Tooltips for Virtual Reality Interactive Showcasing. In *Proceedings of Make sure to enter the correct conference title from your rights confirmation emai (IxD 10th semester).* ACM, New York, NY, USA, 9 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Teaching new users a system's interaction mechanics can be complex, yet vital for them to properly utilize the system to complete tasks and maintain a satisfying experience. Traditional tutorials will generally be presented to users at the start of the application. Many learning formats are currently employed, like tooltips, instructional overlays, help buttons, instruction manuals, and interactive learning challenges [2, 18]. The comparative effect of these learning types for virtual reality remains to be determined. This issue could cause developers to use unsuited learning methods for their systems as they might rely on personal experience, intuition, or competitive solutions. Comprehending how learning methods influence users' perceived usability and system satisfaction could assist developers in allocating resources more efficiently for VR interactive showcases [2].

Employing a learning method for software tools is not uncommon or distinct to VR. Instead, it is more dependent on the software's complexity and specialization. The implementation of the training method will be referred to as onboarding. The term onboarding in this paper is defined as *the sum of methods and elements helping a new user to become familiar with the digital product.* The intention of onboarding is not only for the user to learn the interaction mechanics but also to help them determine the system's potential and benefit [8].

As the industrial VR market grows, interactive showcasing has grown in popularity amongst companies for trade shows, meetings, marketing, and drawing in new employees (for instance, [25], [10], [16], [29]). It is increasingly important to investigate what onboarding methods developers can utilize for participants to engage with satisfying and user-friendly interaction mechanics for VR interactive showcasing.

> I always think it is exciting to experience how you can utilize technology(VR). We(B&R) have talked a lot about how fast it is to create setups which can give us an idea of how it could be used and try out some things without using a lot of software hours on it. That works pretty well. I can see a good use of it(the interactive showcase), where it would make it easier to stand in sales and product development situations and could work with this(the interactive showcase prototype). - Interview with B&R

While gaming has been a popular application for VR, there is growing interest in its potential in industrial contexts. VR

IxD 10th semester, HCI Master Thesis, 2023, Aalborg University, DK

ACM ISBN 978-1-4503-XXXX-X/18/06…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

provides a unique platform for showcasing industrial technologies, allowing users to engage with and understand these technologies in an immersive and interactive environment [10].

Similar to VR games, VR showcases necessitate unique interaction mechanics to ensure users can effectively complete tasks with the showcased technologies. Contextual onboarding may be used, providing targeted instruction within the task context. However, while research has been conducted on the effects of such tutorials in VR games [9], their use in VR interactive showcasing for the industry has yet to be explored.

To fill that gap, numerous factors impacting the design of onboarding could be taken into account. Therefore, for this paper's primary research question, it was chosen to concentrate on three onboarding characteristics for comparison: users perceived usability, system satisfaction, and task completion time. The characteristics were measured with the System Usability Scale (SUS) [7], NASA Task Load Index [12], and by measuring participants' task completion time. The significance of these characteristics was determined by a between-subjects study of 25 participants across two interactive showcases based on a real industry case. The key findings of the comparative analysis of the characteristics revealed that the contextual tooltip method led to a significantly higher system satisfaction among participants in VR showcasing. Participants felt less rushed, reported less frustration during tasks, and improved task performance compared to the traditional tutorial screen method. However, the contextual tooltip method did not result in better-perceived usability, improved learnability, or faster task completion times. This suggests that while the contextual tooltip method enhances system satisfaction, further exploration is needed to improve its impact on usability and efficiency in VR showcasing.

The contributions of this study are threefold: (1) It provides empirical evidence supporting the use of text-based contextual tooltips over text-based traditional tutorial screens for onboarding in VR interactive showcasing, emphasising increased system satisfaction. (2) It contributes to the research in onboarding methods for VR interactive showcase applications, a growing domain still need to establish guidelines and best practices. (3) It highlights the need for further research into onboarding methods for perceived usability and learnability in VR interactive showcasing and their development towards intuitiveness.

2 RELATED WORK

This part will address the project's motivational factors and design concepts relevant to the project.

Educating new users on engaging with interactive VR applications can be challenging. This challenge is particularly pronounced because the users are detached from the real world and are expected to operate a system with which they are unfamiliar. As a result, the initial introduction or "onboarding" phase - which involves instructing the user on the application's interactive aspects - becomes highly significant [8].

Nielsen's [21] ten general principles for interaction design have been applied to VR to understand if they are applicable as a good practice for developing virtual reality applications. Furthermore, while it concludes that the standard usability heuristics still apply to VR applications, it also highlights that the medium has much room to grow in user experience [15].

Though traditional showcasing methods such as presentation software, wireframes, simulations, or videos can be used for product showcasing, new innovative interaction methods might be more attractive. Nevertheless, when using the interaction method of VR, it is essential to evaluate the usability of novel control schemes to avoid user frustration and discomfort as encouraged by the manufacturers of the Meta VR head-mounted display (HMD) [20]. Locomotion is an essential aspect of VR since the duality of movement in real space and virtual space can cause motion sickness, especially in users unfamiliar with VR interactions which will generally require time to adjust. Research has indicated that VR movement done by a simple point and teleport system is a suitable locomotion method for users [5].

The benefit of tutorials is primarily accepted for game design [22]. It is used in the SynergyXR application for virtual product demonstrations [25] and in Unity's guide to using their XR interaction toolkit [28]. On the other hand, in user experience research, the effects of tutorials vary from negative to beneficial dependent on how it is implemented and medium [4, 14]. Some applications include instruction screens interrupting the regular demonstration, providing explanations of a mechanic as text and requiring users to confirm they want to continue after the instruction, like Unity's XR toolkit introduction (see Figures 1b), or the application ArcGIS which lets the user learn its functionalities through an interactive step-by-step tutorial (see Figure 1c) Other applications provide information when users require it through context-sensitive messages or symbols like SynergyXR guiding the user through arrows (see Figure 1a) or Photoshop showing the user tooltips when the cursor hovers over a tool (see Figure 1d).

The latter two variants provide contextual help by supplying users with necessary information based on their current state without interrupting them. On the other hand, tutorials employing instruction screens are a more traditional approach to teaching interface mechanics and interaction.

A study investigating the impact of tutorials in games of varying complexity found that contextual tutorials only improved engagement for the most complex games and that it may not be justified to implement tutorials in games where controls can be learned through experimentation [2].

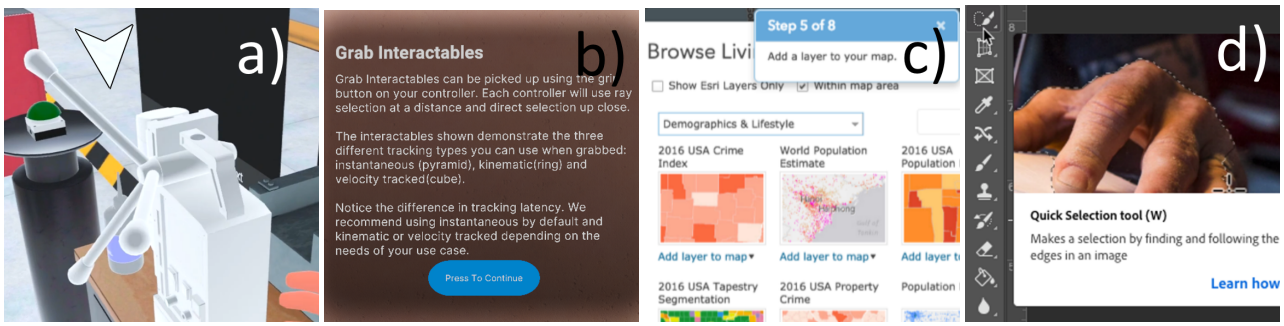

Figure 1. Different methods used for onboarding, e.g. SynergyXR using floating arrows to guide the user towards their next interaction (a) [25], or traditional instruction screens in Unity´s VR tutorial (b) [28], or ArcGIS using step by step tasks as interactive learning (c) [3], or contextual tooltips from Photoshop (d) [1].

This work examines if the results above also apply to the novel domain of VR industrial showcasing. Specifically, how contextual help, compared to traditional tutorials, will impact the usability and task load of the user. The perception of system complexity might vary significantly compared to non-VR demonstrations.

In summary, while the effects of tutorials and contextual help have been documented, research has yet to be conducted on VR interactive industrial showcases. The aim is to examine if the results of previous research can be replicated in this novel domain.

3 CONCEPTUAL FRAMEWORK AND IMPLEMENTATION

This section describes the methodological approach to the conceptual design process. Critical stages are investigated to reach the final design concept.

3.1 Design Approach

A VR interactive showcase prototype of the ACOPOS 6D system from B&R [6] was developed in the game engine Unity and comprised two different onboarding versions to delve into the research question. The prototype was created as a simplified version of an ACOPOS 6D setup created by Aalborg University's robotics lab as a MADE FAST project [19] (see Figure 2c). In this showcase of the ACOPOS 6D system, the users were compelled to complete one of two tasks of the same complexity depending on the version. Both tasks included creating a robotic assembly line to build a phone or medicine. These specific tasks were chosen for their realism as cases for the MADE FAST project inspired them. Users will employ robots to assemble parts into a phone or medicine. The robots, parts, and segments can be directly grabbed with controllers spawning at the user's equivalent real-world hand positions. This kind of input is unique to VR and is often a new experience for players used to traditional non-VR showcasing, making this genre quite suitable for our research.

3.2 Assembly Tasks

The assembly tasks were developed as fitting for a scenario where B&R would showcase the ACOPOS 6D at a trade show (see Figure 2a). It is a single-user experience where the participant is tasked to complete an assembly task to gain an understanding of the system. The scenario is compatible with the Meta Quest 2 headset. Participants can freely move around in a building housing the ACOPOS 6D system in the task. A table is located in the middle of the building for building the assembly line on top of it. The participants spawn in front of the table and will find the needed interactable objects for the assembly line around the table. The task is completed when the participant has created an assembly line capable of constructing a phone or medicine (see Figure 2b). In both cases, the participant must use all three interactable objects and the control panel to complete the setup. The two versions appear in different colours to make them distinguishable.

The participants have four kinds of interactable objects: a shelf of segments, a table of three numbered robots (see Figure 2d), a start and end tile, and a table with three parts (see Figure 3c). The number of available segments equals the number of spaces on the table(6x4=24). The participant can grab all the interactable objects. Segments can be placed on the table to create paths for the shuttle. Parts can be placed on the robots to indicate what part the robots will build. After the robots are placed on the segments, the shuttle will move numerically between them when activated. When the shuttle arrives at a robot, it will build the part placed on it atop the shuttle. The parts will combine themselves when placed atop the shuttle. The shuttle is controlled via a control panel (see Figure 3d). The control panel have two buttons: "Update Pathfinding" and "StartStop Shuttle". Every time the participant moves a segment, the pathfinding must be updated for the shuttle to move across it. The shuttle start or stops moving when the "StartStop Shuttle" is pressed, and a little light on the control panel will indicate whether the shuttle is active or deactivated. After visiting the third robot,

Figure 2. B&R´s ACOPOS 6D (a) [6]. How a task completion looks for the tutorial screens version of this study´s ACOPOS 6D showcase prototype (b), the orange arrows shows the pathing of the shuttle. The ACOPOS 6D setup for mobile phone assembly at Aalborg University's robotics lab (c). The interactable grabbable numbered robots in their start position (d).

the shuttle should have a completed product on top of it and will then proceed to deliver the product at the end tile. After that, the procedure repeats.

3.3 Introduction to Onboarding

Two onboarding variants were implemented to instruct participants about the interactive mechanics of the showcase: traditional tutorial screens and contextual tooltips. Both tutorials use similarly phrased text-based explanations for the interactive mechanics. Figure 3 demonstrates how the same instruction is presented in both versions.

The implementation of the tutorial screens represents a more traditional format. Here, the interaction mechanics are explained in textual form. These instructions are displayed on floating transparent text boxes in the building next to the table (see Figure 3a). This onboarding features two distinct phases: the instructional and exploratory phases. Participants first encounter the tutorial screen in the instructional phase and then transition to the exploratory phase, where they can practice the different mechanics. They encounter all the interactable objects and control panels which can all be used.

Unlike the tutorial screens, the contextual tooltips provide explanations of the interaction mechanics to the participant in real-time as they explore the interactable objects and control panel (see Figure 3b). The instructional phase and practice phase are intertwined. Participants commence in an exploration phase where they gain experience in the interaction mechanics as they engage with the task. The tooltips appear when the participants hover their right controller's ray over an interactable object and feature a transparent text box anchored at the participant's right controller. The text box explains how the interactable can be used to complete the task.

3.4 Implementation

The game engine Unity was chosen as a platform for developing the virtual reality interactive showcase prototype of the ACOPOS 6D system. Unity has an XR Interaction Toolkit package, a component-based interaction system for developing VR experiences. It offers a framework for handling UI and interaction events from the VR headset and controller input. An XR Origin was created to represent the user in the virtual world space. The XR origin handles multiple components, e.g. the Input Action Manager, XR Interaction Manager, XR UI Input Module, Locomotion System, Snap Turn Provider, Teleportation Provider, Tracked Pose Driver, XR Ray Interactor, and XR Controllers. These components allow Unity to track the user's movements, controller inputs, and position and handle the user's interaction with the available interactable objects and UI [13, 27, 28].

The interactable objects used XR Grab Interactable components to allow basic grab functionality and XR Socket Interactor for positioning interactable objects. The control panel used the Tracked Device Graphic Raycaster component to register when the user points and clicks on UI [27].

Nine C# scripts were programmed for the VR interactive showcase to emulate part of the ACOPOS 6D system's functionality, display the tutorial screens, display the contextual tooltips, play sounds, and handle grabbed interactable object placement. The nine scripts comprise 727 lines of code and 81 on average.

The pathfinding of the shuttle uses the A algorithm to navigate the track of segments and find the appropriate tiles (see Figure 2b). Unity's inbuilt navigation system combined with two scripts enables the shuttle to avoid obstacles and update its pathfinding dynamically [26].

4 STUDY

The following subsections will describe frequently used quantitative performance metrics for HCI research. These metrics will be used later in the discussion 6 for evaluating the test results.

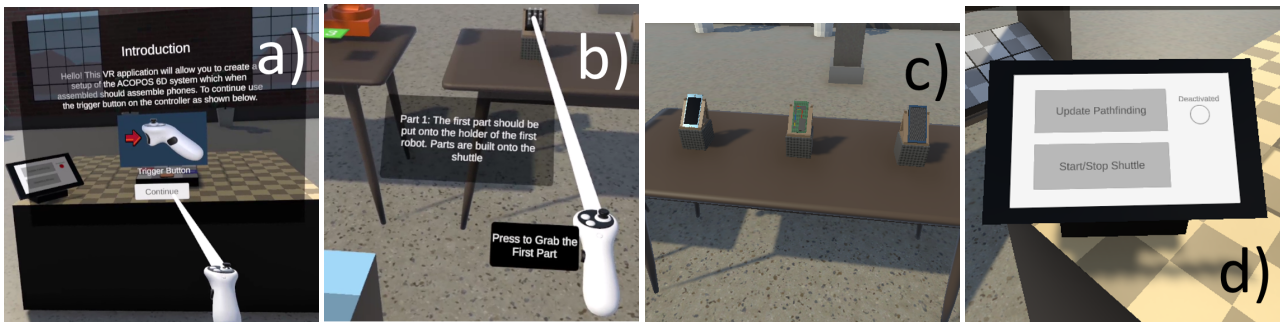

Figure 3. The traditional tutorial screen is used for learning the interaction mechanics of the ACOPOS 6D showcase, where instructions are provided in sequence before participants can explore the mechanics (a). The contextual tooltip offers information in text boxes when the participant hovers over interactable objects (b). The interactable grabbable phone parts in their start position (c). The control panel updates the pathfinding and activates or deactivates the shuttle (d).

4.1 Participants

Twenty-six participants were recruited (21 male and five female). One female participant was excluded from the analysis as she experienced motion sickness during the study. The final sample consisted of 25 participants with an average age of 24.28 (SD = 2.22) years. 2 participants had no experience with VR, ten only had a brief experience with VR (tried 1-2 VR sessions), eight were experienced VR users (tried 3-9 VR sessions), 5 were VR veterans (tried 10+ VR sessions).

4.2 Procedure

Participants were welcomed to a university lab where the study was conducted. Designed as a between-subjects experiment, the study randomly assigned participants to either the Contextual Tooltips or Tutorial Screens condition.

The study began with a brief introduction to the research topic onboarding, followed by participants filling out a consent form and answering a few demographic questions.

Participants were then introduced to the ACOPOS 6D system as a modular assembly line [6]. Throughout the introduction, the participants were made aware of what parts of the ACOPOS 6D showcase would be interactable, like the robots, segments, and parts 2. They were also told the test aimed to simulate an interactive showcase event of the ACOPOS 6D at a trade fair.

Participants were then familiarized with the Meta Quest 2 headset and controllers. They were then instructed how to grip the controllers to access the grip button, trigger button, and joystick. It was explained that the grib button was used for grabbing interactable objects and movement, the trigger button was used to interact with UI, and the joystick was used for manipulating held objects and turning. Participants were then introduced to the task of creating an assembly line capable of constructing either a phone or medicine, dependent on the onboarding condition. How they completed the setup was left up to them, but they were informed they would need to use all robots and parts to complete the task. Participants were informed they could have the controls and goal repeated, and they should ask for help if they felt stuck or motion sick.

After completing their task, they filled out the SUS and NASA-TLX questionnaires and answered four statements. The presentation phase spanned approximately 10 minutes, while the completion of the task also lasted an average of 10 minutes, and the post-questionnaires about 5 minutes. The total duration of the study was about 25 minutes, and participants received a compensation of 1 homemade doughnut.

4.3 Measures

This study utilized several metrics to evaluate the impact of the two onboarding variants.

The NASA Task Load Index (NASA-TLX) is an instrument commonly employed in high-consequence fields, like healthcare, aerospace, and military, to measure the perceived workload of complex tasks. NASA-TLX will effectively evaluate perceived workload across six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration [12]. In this study, participants will complete the NASA-TLX questionnaire after engaging with the VR ACOPOS 6D showcasing. Each participant will answer the six questions on an unlabeled 21-point scale, ranging from "Very Low" to "Very High". Unlike the traditional NASA-TLX, participants will not weigh each category according to their relevance to the task. This modification of the NASA-TLX is referred to as Raw-TLX (RTLX). The Raw-TLX modification was chosen for its easy appliance and because it is equally sensitive, [11].

The System Usability Scale (SUS) is a trusted tool in user experience (UX) research, providing a reliable measure of a system's usability post-testing. After participants in this study had interacted with the VR ACOPOS 6D showcasing, they were asked to complete the SUS questionnaire. This questionnaire consists of 10 Likert-scale questions designed to measure various usability factors. These questions are

general, making the SUS a versatile tool that can be used across various systems and interfaces [7, 17]. The SUS scores range from 0–100. Notably, this score is not equivalent to a percentage score typically seen in an examination setting. Extensive benchmarking of SUS scores by researchers such as Jeff Sauro has found an average SUS score of 68 across 500 studies [23].

Participants' subjective opinions on the onboarding's performance were gathered by soliciting their agreement with three statements: "The onboarding made me understand the controls of the system," "I was easily able to assemble the parts because of the onboarding," and "I thought the onboarding taught me all I needed to know." A fourth question was asked concerning the potential of interactive showcasing: "The onboarding was good at demonstrating how the ACOPOS 6D system works." Participants recorded their agreement on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Lastly, participants could offer qualitative feedback through open-ended comments.

5 Results

Instead of only generating a single overall workload score for the NASA-TLX, the subscale ratings will be analyzed by comparing the two tutorials. The comparison of component ratings will help designers distinguish each tutorial's source of workload problems [11]. The SUS data will be scored by scaling all response values from 0 to 4(with four being the most positive). Adding up all converted responses and multiplying them by 2.5, each participant will have a score from 0-100. The participant's scores are then averaged across all subscales for each test group [23].

5.1 NASA Task Load Index (NASA-TLX)

The NASA-TLX affords a quick and straightforward estimate of participants' system satisfaction [12]. The results of the NASA-TLX show that total system satisfaction was significantly lower for the contextual tooltip version (see Figure 5). Three of the six subscales were significant, all in the contextual tooltip version's favour.

The three subscales are "temporal demand", "performance", and "frustration", which can be seen comparatively on the bar chart in Figure 6. Participants felt the pace of the task in the tutorial screen version to be considerably more hurried, even though the difference in median completion time for each version is only 1.4% (see Figure 9). Participants experienced their performance to be much more successful in accomplishing their task in the contextual tooltip version. Lastly, participants needed more support when using the tutorial screen version.

5.2 System Usability Scale (SUS)

The SUS provides a detailed usability analysis, which is crucial for this study, where the nuances of VR interaction are

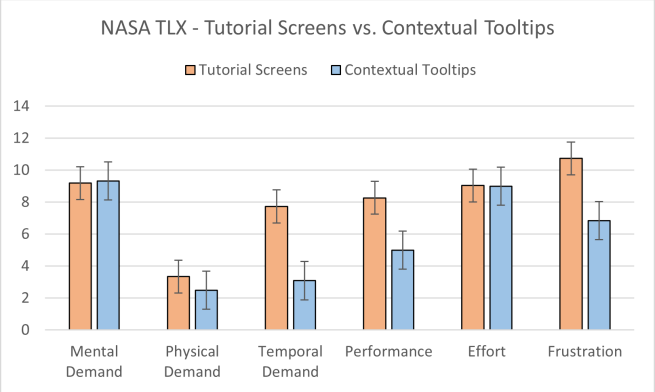

Figure 4. Bar chart comparison of the NASA TLX measurements from the two versions, showing their difference in participant demand.

Measure	Mdn (TS)	Mdn (CT)	t-value	p-value
Mental Demand	9,19	9,33	-0,097	.923
Physical Demand	3,35	2,5	1,255	.222
Temporal Demand	7,73	3,08	3,359	.003
Performance	8,27	3,08	3,068	.006
Effort	9,04	8,65	0,212	.834
Frustration	10,73	6,83	2,134	.044
Total	8,05	5,96	2,099	.047

Figure 5. Table showing the medians of each version and significance(2-tailed) of the NASA-TLX data(TS: tutorial screens, CT: contextual tooltips).

in focus. The gathered usability insights can guide the refinement of this system [7].

The total SUS score of the tutorial screens onboarding version was 68.077, and the contextual tooltip onboarding version was 67.5. Since the average SUS score is 68, the tutorial screens version was just above average, meaning it has higher perceived usability than 50% of all products tested. On the other hand, the contextual tooltip version scores just below average. Both versions are graded C in the percentile range of 41-59 [24]. The difference between the two versions of the SUS questionnaire scores was insignificant (see Figure 7).

By looking at the bar chart of the SUS questionnaire data in Figure 6, the more considerable differences between the two versions can be found by comparing each question's grade and error bars. Noteworthy differences:

- Use frequency in the contextual tooltip version graded B- was in the percentile range of 65-69, while the tutorial screens version graded C- was in the 35-40 percentile range.
- Need support was graded B+ for the tutorial screens version putting it in the percentile range of 80-84, which was considerably higher than the contextual

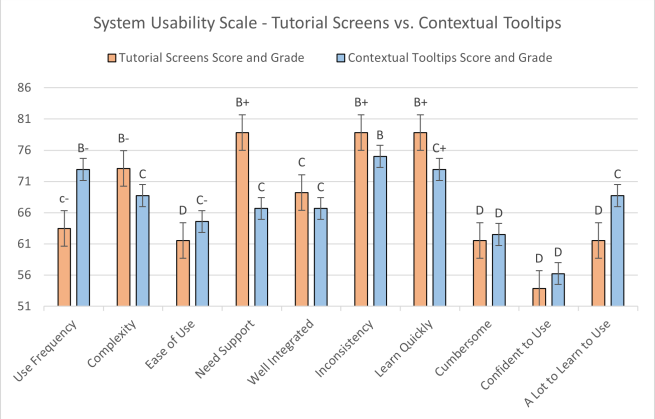

Figure 6. Bar chart comparison of the SUS measurements from the two versions, showing areas of strength by score per qts and grade

Measure	Mdn (TS)	Mdn (CT)	t-value	p-value
Use Frequency	2,54	2,92	-0,963	.346
Complexity	2,92	2,75	0,431	.671
Ease of Use	2,46	2,58	-0,31	.759
Need Support	3,15	2,67	1,059	.300
Well Integrated	2,77	2,67	0,268	.791
Inconsistency	3,15	3	0,35	.729
Learn Quickly	3,15	2,92	0,573	.572
Cumbersome	2,46	2,5	-0,09	.929
Confident to Use	2,15	2,25	-0,182	.857
A Lot to Learn to Use	2,46	2,75	-0,537	.597
Total	2,72	2,7	0,149	.883

Figure 7. Table showing the medians of each condition and significance readings(2-tailed) of the SUS data(TS: tutorial screens, CT: contextual tooltips).

Measure: The onboarding...	Mdn (TS)	Mdn (CT)	t-value	p-value
taught me the controls	5,15	4,92	0,425	.674
enabled me to assemble the parts	4,15	4,42	-0,443	.662
taught me all I needed	4,23	4,08	0,203	.840
was a good showcasing of ACOPOS	4,23	4,17	0,105	.918
Total	4,44	4,4	0,112	.912

Figure 8. Medians and test statistics show no significant differences between the subjective performance measures related to the conditions (TS: tutorial screens, CT: contextual tooltips).

Measure	Mdn (TS)	Mdn (CT)	t-value	p-value
Completion Time	516 sec.	508,83 sec.	0,159	.874

Figure 9. Table showing the medians and significance readings(2-tailed) of the completion time for the two conditions(TS: tutorial screens, CT: contextual tooltips).

tooltip version graded C putting it in the 41-59 percentile range.

- Learn quickly was also graded B+ in the tutorial screen version, while the contextual tooltip version graded C+ in the 60-64 percentile.
- A lot to learn to use in the contextual version graded c. On the other hand, the tutorial screens version graded D putting it in the 15-34 percentile range.

The results of the SUS show that overall the two onboarding methods were both measured to provide an average system satisfaction. The fourth and tenth subscales present the learnability aspect. A noteworthy difference was detected in both subscales. The tutorial screens performed better in the subscale "need support", while the contextual tooltip performed better in the subscale "a lot to learn to use", resulting in no clear winner for the learnability aspect. The rest of the subscales present the usability aspect. In this aspect, the first and seventh subscales had noteworthy differences where contextual tooltips were perceived as more likely to be used. Still, the tutorial screens were perceived to be faster to learn.

6 DISCUSSION

This section is a reflection on the work process and a discussion of the research's future implications.

This study's findings indicate that contextual tooltips for onboarding foster more positive emotions in users by causing less frustration and higher success in task performance while minimizing the feeling of the task being rushed compared to traditional tutorial screens in VR showcasing. However, the choice of onboarding style did not significantly impact how mentally and physically demanding the task was or the effort participants had to put in to accomplish the task. Performance and frustration are meaningful subscales for VR interactive showcases since users should find them helpful and satisfying, unlike games which benefit from being challenging. The feeling of frustration could be linked to the level of performance.

These results echo previous findings suggesting contextual onboarding can enhance users' game experience [2, 9]. Interestingly, one study showed these effects only apply to complex games, while the other found similar outcomes for a simple virtual reality game. As the interactive showcase tested in this study can arguably be comparable to a simple VR game, it somewhat cooperates with those findings.

The results would suggest that the choice of onboarding method for VR showcasing could have a meaningful impact on system satisfaction. Consequently, the factors that positively impact users onboarding in the VR interactive showcase domain warrant additional exploration. On the other hand, this study's findings regarding perceived usability and learnability were not significant.

One study points out that participants who read tutorials experience tasks as more complicated if there are no clear advantages regarding task completion time compared to

participants who skip the tutorials [14]. While this study did not test an onboarding method which was not text-based, it could help explain why the contextual tooltip method scored better in the NASA-TLX, as the onboarding was less forced upon the participants. Another point of the study was that onboarding could be resource heavy to develop, and for more straightforward applications, the resources would be better spent on intuitive UI. This could explain why none of the onboarding versions scored well on the SUS and why they scored similarly.

Another study investigated onboarding in augmented reality and concluded that applications benefit from contextual information or interactive walkthrough for guiding users' experience [4]. This study did not find a similar result to a significant degree. Still, this study did not employ an interactive walkthrough onboarding method, creating an exciting investigation avenue as AR shares many similarities with VR.

This study supports the value of implementing contextual onboarding for system satisfaction, which is crucial for VR showcasing. This study cannot, however, support evidence for contextual tooltips compared to traditional tutorial screens being perceived to have higher usability. Given that VR is a new and growing frontier for interactive showcasing, users and developers must acclimate to the medium. Hence, guidelines could make choosing an onboarding method suited for VR showcases challenging for developers. Further investigation of the suitability of onboarding methods could enrich future VR development.

6.1 Limitations

Several limitations should be acknowledged when interpreting these results. The participants in this study were mainly inexperienced with VR games. This could have created a more favourable experience. However, this study investigated which onboarding method would be the most effective for teaching interaction mechanics in VR showcasing. It is reasonable to assume that onboarding should offer a satisfying and intuitive experience for novices who require a solid introduction to the mechanics of an interactive showcase.

The sequencing of instruction and exploration phases differed between the contextual tooltip and tutorial screen conditions. While the tutorial screen offered a block of instructions followed by an exploration phase, the contextual tooltip was a mix of these phases.

Furthermore, this study compared two interactive showcase interfaces and their impact on perceived usability and system satisfaction.

6.2 Future works

Finally, a single interactive showcase was investigated in a specific domain (VR showcase) and genre (industry). Further studies are needed to confirm if similar effects can be expected in other VR showcases. However, it seems plausible to assume that using the method of contextual tooltips for onboarding would lead to higher system satisfaction in VR showcases featuring similar interaction mechanics, such as Unity's XR toolkit and a VR headset similar to the Meta Quest 2. This setup should allow for a similar contextual tooltip onboarding. The effects should be independent of what is being showcased as long as the mechanics of the interaction are the same and the presentation method of text-based instructions.

7 CONCLUSION

This study investigated the usability and system satisfaction of two text-based onboarding methods for VR interactive showcasing. The ACOPOS 6D showcase prototype was an interactive showcase for an industrial robotics product. The prototype designed in this study was developed to mimic an actual use case of the ACOPOS 6D system. Two versions of the interactive showcase were developed for a comparative analysis of onboarding methods: a contextual tooltip version that explains interaction mechanics to the user in real time and a traditional tutorial screen version. A user study was conducted to analyze the impact of these onboarding methods on participants' perceived usability and system satisfaction. The findings revealed that participants experienced significantly higher system satisfaction from the contextual tooltip method as they felt the task was less rushed, performed better, and were less frustrated than the tutorial screens method. However, the contextual tooltip method did not perform better in perceived usability, learnability, or task completion time. Further research is needed to understand what onboarding methods are best suited for interactive showcasing and how they can be developed to be intuitive. While the current results suggest that contextual onboarding can be advantageous over traditional tutorial onboarding, a developer should consider if implementing an onboarding method is justified based on the system's complexity. If not, it could be better to forgo the development of an onboarding method and prioritize creating intuitive interaction mechanics allowing the user to learn through exploration.

Acknowledgments

I would like to thank the participating interviewees for sharing their experiences, Postdoc Casper Schou from AAU, and the company B&R for their collaboration on this project. Lastly, I want to thank my supervisor Tim Merritt, Associate Professor, Ph.D., for supervising and supporting my Master's Thesis.

References

[1] Adobe. 2023. *Photoshop.* https://www.adobe.com/dk/products/photoshop.html

[2] Erik Andersen, Eleanor O'Rourke, Yun-En Liu, Rich Snider, Jeff Lowdermilk, David Truong, Seth Cooper, and Zoran Popovic. 2012. The Impact of Tutorials on Games of Varying Complexity *(CHI '12)*. Association for Computing Machinery, New York, NY, USA, 59–68. https://doi.org/10.1145/2207676.2207687

[3] ArcGIS. 2023. *ArcGIS Online*. https://www.arcgis.com/index.html

[4] Sana Behnam and Raluca Budiu. 2022. *AR-Onboarding Walkthroughs in Mobile Apps*. https://www.nngroup.com/articles/ar-walkthroughs/

[5] Evren Bozgeyikli, Andrew Raij, Srinivas Katkoori, and Rajiv Dubey. 2016. Point and Teleport Locomotion Technique for Virtual Reality. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play* (Austin, Texas, USA) *(CHI PLAY '16)*. Association for Computing Machinery, New York, NY, USA, 205–216. https://doi.org/10.1145/2967934.2968105

[6] B&R. 2023. *B&R varsler starten på flerdimensionel produktion med ACOPOS 6D*. https://www.br-automation.com/da/produkter/mekatroniske-systemer/acopos-6d/

[7] John Brooke. 1995. SUS: A quick and dirty usability scale. *Usability Eval. Ind.* 189 (11 1995).

[8] Edwige Chauvergne, Martin Hachet, and Arnaud Prouzeau. 2023. User Onboarding in Virtual Reality: An Investigation of Current Practices. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg, Germany) *(CHI '23)*. Association for Computing Machinery, New York, NY, USA, Article 711, 15 pages. https://doi.org/10.1145/3544548.3581211

[9] Julian Frommel, Kim Fahlbusch, Julia Brich, and Michael Weber. 2017. The Effects of Context-Sensitive Tutorials in Virtual Reality Games. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play* (Amsterdam, The Netherlands) *(CHI PLAY '17)*. Association for Computing Machinery, New York, NY, USA, 367–375. https://doi.org/10.1145/3116595.3116610

[10] Nestor Gilbert. 2023. *74 Virtual Reality Statistics You Must Know in 2023: Adoption, Usage & Market Share*. https://financesonline.com/virtual-reality-statistics/

[11] Sandra Hart. 2006. Nasa-task load index (Nasa-TLX); 20 years later. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 50. https://doi.org/10.1177/154193120605000909

[12] Sandra G. Hart and Lowell E. Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In *Human Mental Workload*, Peter A. Hancock and Najmedin Meshkati (Eds.). Advances in Psychology, Vol. 52. North-Holland, 139–183. https://doi.org/10.1016/S0166-4115(08)62386-9

[13] Jason Jerald, Peter Giokaris, Danny Woodall, Arno Hartholt, Anish Chandak, and Sébastien Kuntz. 2014. Developing virtual reality applications with Unity. In *2014 IEEE Virtual Reality (VR)*. 1–3. https://doi.org/10.1109/VR.2014.6802117

[14] Alita Joyce. 2020. *Mobile Tutorials: Wasted Effort or Efficiency Boost?* https://www.nngroup.com/articles/mobile-tutorials/

[15] Alita Joyce. 2021. *10 Usability Heuristics Applied to Virtual Reality*. https://www.nngroup.com/articles/usability-heuristics-virtual-reality/

[16] KHORA. 2023. *Virtual Reality and Augmented Reality Marketing Cases*. https://khora.com/marketing/

[17] Page Laubheimer. 2018. *Beyond the NPS: Measuring Perceived Usability with the SUS, NASA-TLX, and the Single Ease Question After Tasks and Usability Tests*. https://www.nngroup.com/articles/measuring-perceived-usability/

[18] Page Laubheimer. 2023. *Onboarding Tutorials vs. Contextual Help*. https://www.nngroup.com/articles/onboarding-tutorials/

[19] MADE. 2020. *Kvart milliard til at løse fremtidens udfordringer i produktionsvirksomheder*. https://www.made.dk/videoer/lose_fremtidens_udfordringer/

[20] MetaQuest. 2023. *Best Practices*. https://developer.oculus.com/resources/hands-design-bp/

[21] Jakob Nielsen. 1994. *10 Usability Heuristics for User Interface Design*. https://www.nngroup.com/articles/ten-usability-heuristics/

[22] Richard Rouse and Steve Ogden. 2000. *Game Design Theory and Practice* (2nd ed.). Wordware Publishing Inc., USA.

[23] Jeff Sauro. 2011. *Measuring Usability with the System Usability Scale*. https://measuringu.com/sus/

[24] Jeff Sauro. 2018. *5 Ways to Interpret a SUS Score*. https://measuringu.com/interpret-sus-score/

[25] SynergyXR. 2023. *SynergyXR demo experiences*. https://synergyxr.com/synergyxr-demo-experiences/

[26] Unity. 2023. *Navigation and Pathfinding*. https://docs.unity3d.com/Manual/Navigation.html

[27] Unity. 2023. *XR Interaction Toolkit*. https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@2.3/manual/index.html

[28] Unity-Technologies. 2023. *XR-Interaction-Toolkit-Examples*. https://github.com/Unity-Technologies/XR-Interaction-Toolkit-Examples

[29] Virsabi. 2023. *Sjovt VR-spil tiltrækker nye studerende*. https://virsabi.dk/pipe-packers/