Comparison of Different User Interfaces for 360-Degree Videos in VR-Based Healthcare Education

Yan Hu[1][a], Jessica Berner[2][b], Veronica Sundstedt[1][c] and Ivan Perlesi[3]

[1] *Department of Computer Science, Blekinge Institute of Technology, Karlskrona, Sweden*

[2] *Department of Built Environment, Eindhoven University of Technology, Netherlands*

[3] *Virotea AB, Malmö, Sweden*

Keywords: Virtual Reality, Education, Healthcare, Interface Design, 360-Degree Videos, Older Adults.

Abstract: Extended reality (XR) technology has been increasingly used in many areas, one being healthcare. This paper presents a pilot study comparing two 360-degree virtual reality (VR) healthcare applications. The applications were evaluated by eight nursing students who evaluated both interfaces based on the User Experience Questionnaire (UEQ), the System Usability Scale (SUS), and the Simulator Sickness Questionnaire (SSQ). Results show that both applications could provide a positive user experience and high usability, with some improvements shown in the second version of the application. The SSQ scores also showed that minimal motion sickness occurred. Overall, all participants thought the VR-based education provided an innovative alternative to traditional education scenarios.

1 INTRODUCTION

An ageing population is a relatively new problem from a historical point of view; the population aged 65 years and over is estimated to be around 40% in 2050, but mainly, the ratio of older adults compared to adolescents will be on the increase (Rudnicka et al., 2020). One priority will be to support healthy ageing through age-friendly environments that enable the person to continue living independently for as long as possible and doing things they value. Furthermore, combatting ageism is a priority, and actions from the World Health Organization (WHO) have been taken to change how people feel and think toward older adults (DESA, 2020).

Providing good health care for the ageing population is essential. Many older adults require a comprehensive set of services to maintain health and prevent or slow down both physical and mental decline. Technology in the home and/or health care facility (for those in long-term care) is a solution that is already in place, where health care professionals can support the older person much better. For example, in long-term care, often a team of specialized care professionals, such as dieticians, geriatricians, nurses, and physical therapists, is now only available through the help of technology. Information and communication technology (ICT) helps maintain patient communication, and technology can help manage chronic conditions such as diabetes, help manage taking medicine, and also, through regular contact, improve physical and cognitive function (Choi et al., 2024).

Much needs to go into the carers' and healthcare professionals' education/view on aligning health systems with healthy ageing. A general lack of dementia training and education is often reported by healthcare providers (Zhao et al., 2021). Poor staff skills, knowledge and attitudes are reported to contribute to the low standard of care for persons with dementia (Hutch et al., 2023). Often, smaller workshops or educational programs can increase understanding of the illness or give basic tools to care for an older adult. It is noted that the nurses' confidence usually increases after such learning sessions, which is needed.

Information on older people's health status and functioning is lacking. Some known aspects, such as lack of social support and socioeconomic status, often affect long-term health. Underlying healthcare conditions, impairments, and contextual factors (such as socio-economic status) affect health. Furthermore, there is less available data on older adults than other people and many countries (in Europe alone) differ

[a] https://orcid.org/0000-0003-1908-4892
[b] https://orcid.org/0000-0002-2848-2377
[c] https://orcid.org/0000-0003-3639-9327

Hu, Y., Berner, J., Sundstedt, V. and Perlesi, I.
Comparison of Different User Interfaces for 360-Degree Videos in VR-Based Healthcare Education.
DOI: 10.5220/0013366900003911

In *Proceedings of the 18th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2025) - Volume 2: HEALTHINF*, pages 890-897
ISBN: 978-989-758-731-3; ISSN: 2184-4305

in how people age. Identifying the needs of older adults can be difficult; for example, screening methods of defining and measuring frailty and pre-frailty are not consistent (Lagiewka, 2012). Social characteristics are even scarcer, yet are considered part of health today.

1.1 Education in Health Providers in Older Adults

The competence of healthcare providers influences the quality of care for older adults with dementia. Nurses are key in maintaining respect and dignity for their patients and recognizing their inherent worth (Holmberg et al., 2020). Additionally, it is crucial to respect patients' autonomy, involving them in decisions about their care as much as possible. Dementia care prioritizes well-being, considering the patient holistically alongside the needs of their family and care providers. Addressing care providers' mental health, for instance, can reduce costs by preventing depression and anxiety among them. Physical activity and regular exercise help cognitive function across the lifespan (Jean and Dotson, 2024). Physical exercise has been shown to help protect against Alzheimer's disease, and nurses support this by encouraging activity and providing additional guidance on health topics like nutrition and smoking cessation.

Professionals often benefit from education in the workplace, but continuing education must allow for flexible schedules and the ability to deliver remotely (Scerbe et al., 2019). Nurses must be familiar with technology to guide patients using digital applications supporting health and autonomy. Healthcare digitization aims to provide more personalized care by offering tailored solutions. Many healthcare leaders are implementing digital tools to drive improvements, often with government support, such as in Sweden, which has promoted artificial intelligence (AI) in healthcare since 2018 (OECD, 2018).

New technologies, including remote monitoring and digital patient records, enable patients to be more involved in their care and foster collaboration among healthcare professionals. However, for digital solutions to be effective, they must be accessible, easy to use, and inclusive, ensuring that all patient groups benefit from advancements.

Many education programs work with mannequins that are more or less advanced. Mainly, "high fidelity" mannequins increase learning outcomes (Sherwood and Francis, 2018). They have features such as voice, skin, and other installations that recreate a person. Nursing students learn to put on a catheter, take blood samples, talk to the doll, administer transfusion and perform evaluation for acute care. The idea is to increase learning outcomes by being able to touch and practice on the doll/mannequin. However, there is still a lack of practice in attitude, reality, and handling patients in specific situations, which increases the nurses' readiness to enter working life. Personal, clinical, organisational and relational characteristics all come into play. With older adults with dementia, the relational aspect can be challenging, especially as it can take years to understand the illness and be able to handle the patient properly. The aim often is to move the student from novice to critical thinking and behavioural response (Munjas, 1985).

1.2 Virtual Reality

VR technology creates a simulated experience, providing an alternative to the real world. This immersive environment is typically displayed through a head-mounted device (HMD), allowing users to interact in a virtual space (Kardong-Edgren et al., 2019). VR has been utilized in various fields, including gaming, education, manufacturing, and tourism. Among these, healthcare has rapidly developed as a significant application area. The primary uses of VR in healthcare include prevention, treatment, medical education, and training (Fu et al., 2022).

VR has been proven to support healthcare professionals and help them advance in understanding situations and people better through simulation videos. Nursing programmes often gain experience through both practical and theoretical moments. A well-thought-through academic programme is usually one side of the degree. Meeting people is also key in the nursing profession, so scenarios and simulations are extremely helpful in gaining confidence and preparing students for various situations.

1.3 Paper Overview

This study presents a pilot case of a VR-based educational application for healthcare education in older adults. The main aim is to assess two versions of the VR-based educational application interface and discover the nursing students' learning experience through immersive VR. The evaluation focuses on usability, user experience, simulator sickness, and participants' feedback to open-ended questions.

Section 2 describes the related work in healthcare education in VR and user interface design in VR applications. Section 3 is about the method on how we conduct our pilot study. The results are presented in Section 4 and discussed in Section 5. Section 6 concludes the study and proposes future work.

2 RELATED WORK

2.1 Healthcare Education in VR

Gorman et al. early on proposed using VR for medical professionals to provide training and education before entering the real patient scenario (Gorman et al., 2000). Peng et al. also allowed nursing students to watch a movie about dementia and take part in a virtual detention tour in which they got to experience a scenario more closely to a person with the condition, which was shown to increase their empathy toward demented elders (Peng et al., 2020).

The described related work below focuses on VR healthcare education and training for nurses or care providers, particularly for older people. A previous scoping review has explored opportunities and challenges for using VR/AR in aged care and proposes, based on the literature, that these new technologies can have several health benefits, like overall well-being, decreased loneliness, increased relaxation, alertness and balance (To-Miles et al., 2022). Another review focuses on using MR technology for fall prevention among older adults with a positive effect on their physical health (Nishchyk et al., 2021). In (Bauer and Andringa, 2020), VR has been used to train cognitive functions for the elderly.

XR has recently been suggested to allow medical staff to sense how it is to be sick (Shaikh et al., 2022). VR technology has also recently been used for training empathy for elderly care staff (McCalla et al., 2023; Zhang, 2024). In another study, VR was used to educate healthcare practitioners about different medical conditions like diabetes, disabilities, and elderly abuse and neglect (Beverly et al., 2023). VR has also been used to train nursing students in human anatomy courses to improve students' learning (Jallad, 2024). Oral health can be a problem for the elderly, and a VR simulation was proposed to train care providers to brush their teeth more effectively with an improved result in brushing skills (Mouri et al., 2023).

Previous work has also explored how VR can educate medical students on the 4Ms in geriatric care: What Matters, Medication, Mentation, and Mobility as part of the Age-Friendly Health System (AFHS) framework (Tewary et al., 2024). In this VR scenario, the students learned about triaging a hip fracture and treating patients from admission to discharge, showing experience in AFHS. Overall, this study also showed potential for using VR technology, highlighting the importance of further clinical trials.

2.2 User Interface Design in VR Applications

There are standard guidelines for traditional user interface design. One of the most well-known is the ten usability heuristics proposed by Nielsen (Nielsen, 2005). However, when it comes to VR applications, the focus shifts to 3D user interface design rather than 2D user interface design. The development of 3D user interface design principles is not as advanced as that of standard 2D user interfaces. There is no standard for 3D user interfaces (3D UIs) until now. Developing such standards is difficult due to various input devices, display technologies and interactions. At the same time, human-computer interaction principles, such as Nielsen's heuristics, continue to be relevant in 3D user interface design (LaViola Jr et al., 2017).

3D UIs enable users to interact with virtual objects, environments, or information through direct 3D input within physical and virtual spaces (Bowman et al., 2008). The field of 3D UI design offers a variety of interaction techniques for tasks like selection, manipulation, and spatial navigation (Riecke et al., 2018). Many existing techniques can be easily adapted for new applications. While many techniques in 3D UI design have been established, there is still room for innovation. New technologies, like the Leap Motion device and biosignal interface, offer fresh interaction possibilities. Additionally, techniques can be tailored for specific tasks across different application domains.

Bowman et al. proposed eight guidelines for user-friendly 3D interaction techniques. These include floating objects as exceptions, ensuring objects do not interpenetrate, and requiring interaction only with visible objects (Bowman et al., 2008). Additionally, Alves et al. identified a set of guidelines for graphical user interfaces in VR games. Among them, offering depth cues, maintaining a comfortable distance for displayed content, ensuring text is easily readable, and avoiding issues related to scale and spacing in the interactive elements of the VR game UI are the most common ones (Alves et al., 2020).

Recently, another study also proposed some recommendations for 3D UI design for VR. First, matching devices to interactions and tasks in 3D environments is essential. This means ensuring the input methods' dimensionality corresponds with the virtual outcomes. Second, reducing degrees of freedom (DoFs) and imposing constraints when possible is better. This can be accomplished using input devices with fewer DOFs, ignoring some input DOFs, or applying physical or virtual constraints. Finally, there

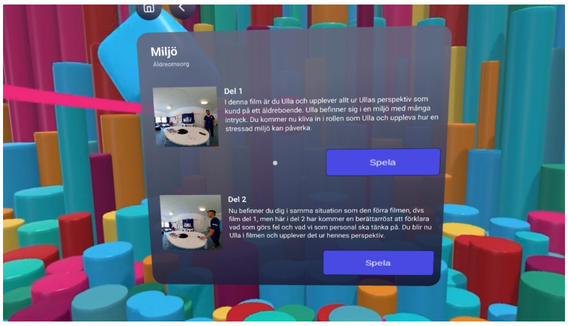

Figure 1: The screenshot of the older version V1.

Figure 2: The screenshot of the improved version V2.

is no single best interaction technique. The effectiveness of VR interaction techniques depends on the nature of the tasks. Since there is no one-size-fits-all solution, it's suggested to evaluate the dimensional characteristics of each task and choose the most suitable interaction method or a combination of techniques accordingly (Yeo et al., 2024).

3 METHODS

A health tech company in Malmö, Sweden, developed the VR application used in this study. It is specifically for training care workers in caring for older adults and supporting individuals with certain functional impairments (referred to as LSS in Swedish). The training program utilizes the Pico Neo 3 headset, an affordable choice. By wearing the VR headset, care providers can immerse themselves in everyday situations from the perspective of the care recipients, allowing them to gain a deeper understanding of the challenges these individuals face. This study used two versions (V1 and V2) for user evaluation. V1 is the version with simpler interfaces and 360-degree videos, while V2 has updated graphic user interfaces (GUIs), summarising each scenario's theoretical knowledge after the videos and adding more scenarios. In addition, there have also been improvements to the video resolution and text rendering, which make the interface more legible and aim to reduce eye strain. The size of the components has also been adjusted, allowing the user to fit the entire menu inside the viewport comfortably. The new version also allows the user to move closer or back away from the interface to view it comfortably. The screenshots from V1 and V2 are shown in Figure 1 and 2.

As a pilot study, we recruited eight nursing students from our university to test two different versions, V1 and V2. The participants came on the same day. Before the study started, the instructions were provided in both written and oral format. Next, the participants signed consent forms. Each participant began by reading various scenarios related to healthcare for older adults, which were presented in paper-based descriptions. After the reading, the participants began the VR education program. Before they wore the HMD, they completed a pre-survey that gathered information on their age, gender, previous experience with extended reality (XR), and their responses to the Simulator Sickness Questionnaire (SSQ). The SSQ is a widely recognized tool used to assess symptoms of simulator sickness across various dimensions, including nausea, oculomotor and disorientation.

The VR-based education program contains a series of short 360° videos that present various simulation scenarios related to everyday care for older adults. Each scenario is divided into two parts: the first describes the situation, while the second offers suggested approaches for addressing it.

Participants began with V1. Upon completing V1, they were asked to fill out several questionnaires, including the User Experience Questionnaire (UEQ), the System Usability Scale (SUS), and the Simulator Sickness Questionnaire (SSQ). The UEQ questionnaire gathers user feedback on their experiences with a product, service, or system, focusing on aspects like usability, satisfaction, and overall user experience (Laugwitz et al., 2008). The SUS is a widely recognized tool for evaluating system usability, comprising ten statements that participants respond to using a 5-point scale ranging from "Strongly Disagree" to "Strongly Agree" (Brooke et al., 1996). After completing these questionnaires, the participants took a brief break before setting up the headset to test V2. They were asked to fill out the same questionnaires again after finishing V2.

After completing both versions, the participants were required to answer the final five open-ended questions. These questions addressed other educational methods they had experienced in their education, their preferred teaching-learning methods, their perspective on using VR-based videos for group education, their preferences between V1 and V2, and any

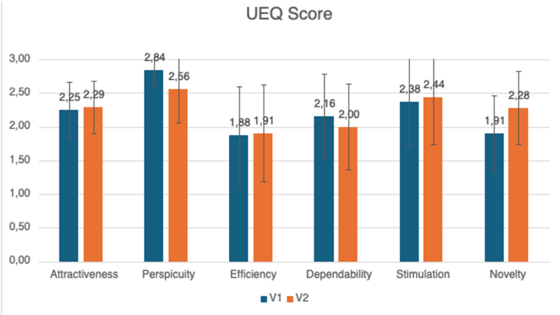

Figure 3: The UEQ score from different versions with different aspects.

additional feedback regarding the VR application.

4 RESULTS

We recruited eight current nursing students at our university for our pilot study. The participants range in age from 20 to 44, with an average age of 27.75. There are five female participants and three male participants. Regarding their previous experience with XR, five out of the eight participants have used VR applications occasionally.

4.1 UEQ

The UEQ questionnaire consists of 26 items categorized into six distinct aspects of user experience: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. Attractiveness is the overall impression of the product, indicating if the user likes or does not like the product. Perspicuity evaluates if it is easy to get familiar with the product. Efficiency means how efficiently the user can solve his or her tasks. Dependability is the feeling of control of the interaction. Stimulation measures how users are motivated to use the product. Novelty is about the innovation and creativity of the product. Each item is rated on a scale from -3 to +3. Scores within the range of -0.8 to 0.8 represent a neutral evaluation, while scores exceeding 0.8 indicate a positive evaluation. Conversely, scores below -0.8 suggest a negative evaluation. Figure 3 shows that both versions have high scores, and all the aspects are above 1.5. V1 has higher perspicuity and dependability, while V2 has a higher score in attractiveness, efficiency, stimulation, and novelty. However, the differences are not significant due to the small sample size. Furthermore, the perspicuity of V2 is a bit lower than that of V1, but it still gets the highest score (2.56) among all six aspects.

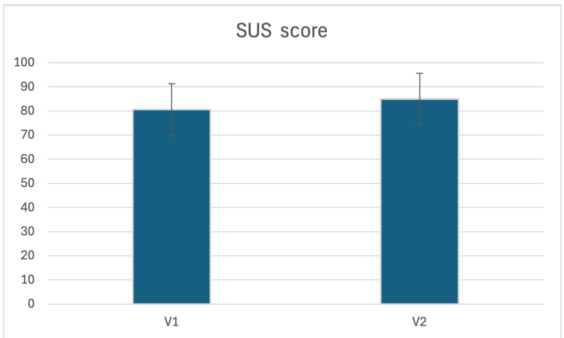

Figure 4: The SUS score from different versions.

4.2 SUS

The System Usability Scale (SUS) is a questionnaire consisting of 10 items, where each question is scored between 0 (strongly disagree) and 4 (strongly agree). The overall score is calculated by multiplying the sum of the scores from the ten questions by 2.5, resulting in a final score that ranges from 0 to 100. According to Bangor et al. (Bangor et al., 2009), the adjective ratings of SUS classified above 85 are associated with "Excellent", "Good" is just above average at 71, and "OK" scores at 51. In this pilot study, the SUS score for V1 is 80.6, while the SUS score for V2 is 85.0. Both versions have relatively high SUS scores. Based on the adjective ratings, the usability of V1 is rated as good, whereas the usability of V2 is rated as excellent, shown in Figure 5.

4.3 SSQ

The SSQ included 16 symptoms, organized into three distinct categories: Nausea (N), Oculomotor (O), and Disorientation (D). Participants assessed the severity of each symptom using a scale ranging from 0 (none) to 3 (severe). These individual scores were then aggregated to create scores for each symptom cluster. The cluster scores were subsequently weighted to yield a total score (TS). Figure 5 indicates that all three symptom clusters (N, O, D) and the total score (TS) are relatively low. Moreover, all the scores after V1 are lower than those before it. There is only a slight increase when comparing the scores after V2 to those after V1, leading to a minor rise in the total score. The SSQ score from this study shows that exposure to both versions of our VR training application has a very limited effect on motion sickness.

4.4 Free Text Answers

The free text questions explore five different aspects: (1) the educational methods typically used to teach

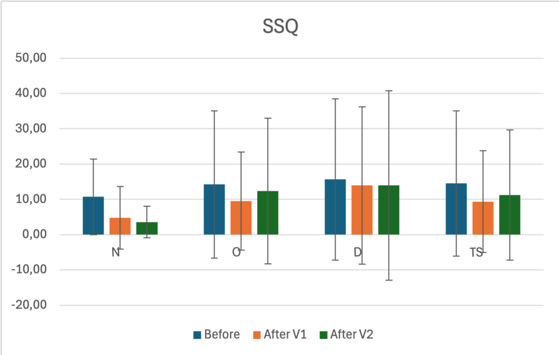

Figure 5: The SSQ score before, after V1 and after V2.

students about various health conditions; (2) preferences for learning methods, including VR-based videos, paper-based reading, and current health education, along with the reasons for these preferences; (3) options of VR-based videos as a tool for group training among healthcare providers; (4) preferences between V1 and V2, including the rationale behind their choices; and (5) any additional comments related to the VR application.

The typical methods currently used in nursing education include lectures, literature, watching videos, and practising with puppets. All participants liked the VR-based videos; some reasons mentioned were exciting and more interactive and could help prevent confusion during learning. Some also empathise that VR-based videos enhance their understanding of patient's behaviours and experiences. One participant also appreciated that the three learning options could be combined, allowing nursing students to get a better picture of what they are learning by allowing them to learn from different perspectives. Another participant mentioned that VR could effectively serve as a valuable complement to traditional methods.

When considering the VR-based video on group training for healthcare providers, all participants agreed it is a practical educational approach. They found it instructive, innovative, and an interesting way to train many healthcare providers. Three participants preferred V2 due to its aesthetic design, fun, and usefulness, as people could see from different perspectives and situations. The rest prefer V1. This could potentially be because it returns to the menu automatically when the video is over, while V2 needs to click an extra button.

The participants of this pilot study hope the VR-based video method could be implemented soon in nursing education because they think it is very innovative for the basic training of healthcare providers. Additionally, one user reported that it provides a safe learning environment and improves accessibility. Furthermore, to improve the user experience, it is suggested that interactions in VR-based training be increased.

5 DISCUSSION

Although the number of participants in this pilot study is small, some interesting findings still exist. V2 in this study had improved the GUIs, which aligned with some guidelines, such as a comfortable distance and making texts easy to read. However, 3D UIs can be pretty expressive and facilitate complex tasks; not every task in a 3D UI requires advanced interaction methods. When users have straightforward goals, designers must focus on offering simple and intuitive techniques. From this study, we also found when assigning physical buttons to commands, it is essential to resist the urge to create a new button for each command (McKay, 2013). Users often struggle to recall numerous buttons, and it can become challenging to remember the relationships between buttons and functions. In this case, only one extra button made users feel less control over the interaction, and it took work to get familiar with the application, which directly affected the user experience.

Empathy is considered a critical component in relationships. It enables healthcare professionals to improve patient health, which makes it essential to incorporate it into the curriculum to teach health professionals to be more responsive to patient needs (Wen et al., 2024). It also helps healthcare professionals to focus on patient-centered care. Therefore, it is essential to develop empathy, a key element of patient-centered care. It includes cognitive and affective aspects which allow a person to respond to verbal and non-verbal cues. It has also been shown to deliver better care: less anxiety and distress, fewer medical errors and better patient adherence to medication (Peng et al., 2020). To reach this goal, one way is to improve communication skills; experimental learning and simulation-based education are appropriate for teaching empathy (Cho and Kim, 2024). This study found that VR could increase the motivation for learning and understanding due to its dependability and perspicuity. The SUS indicated high scores in both versions, supporting the development of empathy. The participants expressed that VR made learning exciting and interactive, with less room for error, which was also mentioned by Jallad (Jallad, 2024). Building confidence through virtual videos offers care providers a rare opportunity to experience older adults hands-on, improving the care providers' understanding of demented persons. As the population of older adults increases globally, VR could serve as an effective tool for understanding and providing care for individuals with dementia.

The applications we used in this study, V1 and V2, involve minimal interaction. The only interaction required is clicking buttons to control the menu. Some participants suggested that more interactive elements could be added in the future, bringing potential trends in VR-based education. In addition to using 360-degree videos in VR, interacting with virtual avatars could be another effective method for training healthcare providers to engage in various situations. This study demonstrates that all participants have a favourable view of VR-based education in healthcare, even with group training. However, traditional healthcare education methods remain significant in nursing education. In the future, the most effective approach will likely involve a combination of VR-based methods and other educational methods.

6 CONCLUSIONS AND FUTURE WORK

This pilot study evaluates two different interfaces of 360-degree VR-based healthcare education applications. V1 is the initial interface, while V2 incorporates improvements to certain interface features based on design principles. The study involved eight participants, all currently nursing students at the university. The results indicate that both versions provide a positive user experience and high usability. The system usability of V1 was rated as good and for V2 it was rated as excellent. Additionally, the SSQ scores post-testing reveal that both versions cause minimal motion sickness, indicating that the side effects of motion sickness do not significantly impact this VR-based application. All the participants in this study think VR-based video is an interactive and innovative healthcare education method. Some users also indicate that it could complement traditional methods like lectures and readings. All participants reported that it could also be an effective method for group training. The simplicity of the design could be one of the main factors influencing the user experience; in this case, it is an extra button. However, the number of evaluators in this study was low, and more users are needed to draw statistical conclusions. In the future, more interaction in VR-based education applications is expected. Personalization will be another emerging direction in the future development of these applications. It would be interesting to explore how tailoring the education experience to individual learners can enhance engagement and improve learning outcomes.

ACKNOWLEDGEMENTS

This research was funded partly by the Knowledge Foundation, Sweden, through the Human-Centered Intelligent Realities (HINTS) Profile Project (contract 20220068). This study has ethical approval by the Swedish Ethical Review Authority (Dnr: 2023-03019-01).

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