The Metaverse through the Eyes of University Students

Giuseppe D'Ambrosio[1], Daniele De Vinco[1,*]

[1]Università degli Studi di Salerno, Via Giovanni Paolo II, 132, Fisciano, Salerno, Italy, 84084

Abstract

The Metaverse is perceived as a promising approach that can possibly transform HCI guaranteeing high engagement and promoting participation and cooperation even at a distance. Its adoption is increasing in the last few years, with different areas and domains starting to use it and exploring if the Metaverse can be beneficial for them. This article explores university students' opinions regarding contexts and applications that can take advantage of the Metaverse and which benefits can be achieved. According to the results, students are aligned with the literature, considering the Metaverse useful in many application contexts thanks to its immersiveness and engaging environment promoting high-quality collaboration. However, their optimistic point of view should be mitigated by making them aware of the challenges the Metaverse poses in terms of (economic) sustainability and security concerns.

CCS CONCEPTS Empirical studies in collaborative and social computing, Open source software

Keywords

Metaverse, survey, university, student, application, context, advantages, challenges

1. Introduction

Since the first appearance of the term Metaverse in 1992, multiple definitions have been proposed without reaching an agreement [1]. Among them, some common aspects exist, including the possibility of experiencing embodied online and virtual worlds where people can work collaboratively and socialize with avatars [2], promoting cooperation and interaction [3], sharing experiences and creating new value without any time and space constraint [4]. The Metaverse gained significant importance in the last years thanks to some of its peculiarities. For instance, it allows achieving a higher engagement than traditional tools [5], providing a sense of reality even in remote settings through immersive environments [6, 1]. The perception of immersion is obtained with a combination of digital technologies like augmented reality, Virtual Reality (VR), and mixed reality [7]. Specifically, the Metaverse creates a virtual environment without space and time constraints granting users a multi-sensory experience merging the physical world and virtual reality [8]. This multi-dimensional environment has proven to increase users' motivation and stimulate interactions, resulting in better knowledge acquisition and in-depth understanding [5].

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*Corresponding author.

gdambrosio@unisa.it (G. D'Ambrosio); ddevinco@unisa.it (D. D. Vinco)

0000-0002-9102-2525 (G. D'Ambrosio); 0000-0003-0781-3744 (D. D. Vinco)

The Metaverse creates a profoundly connected and interactive, immersive spatial platform surrounding the real world, the virtual world, and people thanks to its immersiveness, enhanced spatial temporality, and high interactivity [9]. Nowadays, the Metaverse is reshaping how Human-Computer Interaction (HCI) is conceived, enabling users to interact with physical and virtual objects in a multi-dimensional environment of an online network of virtual worlds and revolutionizing how users interface and control the computer and digital objects. In the Metaverse, the mouse and keyboard become almost useless, and users act mainly using gesture control or eye movement [10]. Using wearable devices and headsets, users are placed in a virtual reality where digital objects and information materialize and enhance the real world. The Metaverse realizes a full-immersive experience involving audio, images, and haptic feedback to involve different senses and provide an augmented reality where users can feel and act as in the real world. These characteristics also enhance communication with other users enabling high interactivity thanks to the possibility to replicate facial expressions and track body movements using avatars [11]. Finally, any spatial and time constraint is removed, enabling the interconnection of users residing anywhere in the world.

Thanks to its key characteristics and the ability to enable massive multi-user online interactions, the Metaverse has been recognized as a helpful technology in different fields and contexts already permeated of HCI elements, ranging from healthcare [12], education [13, 5, 14], and training [15, 16], to tourism [17] and customer experience [18, 19].

This contribution explores the Metaverse through the eyes of university students, those who will be called to have direct experience of the Metaverse as end-users or even programmers. We analyzed their opinions regarding contexts and applications that can take advantage of the Metaverse and which benefits can be achieved. According to the results, students are aligned. 26 university students belonging to Computer Science or Humanistic departments have been challenged to hypothesize application contexts and tasks that can exploit the Metaverse to the best. While the experimentation is reported in Section 2, results are presented in Section 3 and discussed in Section 4, showing that the participants implicitly characterized the advantages of experiencing the Metaverse. However, their optimistic point of view does not consider the challenges and obstacles of the Metaverse, which are reported in Section 5.

2. Experiment - Data exploration in the Metaverse

In the context of this experiment, we propose a data exploration and presentation via the Metaverse using a VR-based application accessing already available data structured as Knowledge Graphs (KGs). A KG represents a network of real-world entities, such as objects, events, and concepts, connected by named relationships modeled as edges [20]. The application places the users in a Metaverse where they can navigate and explore the KG collaboratively, having real-time interaction with other users (represented by avatars) using gestures and voice communication. Participants are invited to explore the proposed application and then reply to a single-question survey to collect application contexts that can take advantage of the Metaverse.

Participants A total of 26 participants joined the survey, 30% females. All of them are university students enrolled in Computer Science or Communication degree with knowledge about KGs. While Computer Science students know graphs as a data modeling approach, Communication students recognize KGs as an approach to represent knowledge semantically. Most of the participants approached VR for the first time. None experienced the use of a VR headset for educational purposes. Participants' ages were heterogeneous, with mean M=24 years, maximum equals 35 years, minimum equals 21 years, and standard deviation SD=4.06. Interested participants voluntarily joined the survey for free. A total of three researchers moderated the evaluation. They anonymously collected the answers to meet data protection requirements and constraints. The evaluation took place in April 2023 as in-person activity.

Tool The survey employed in this study is based on the participant's experience using a VR application that transports users in a thematic virtual room where they can collaboratively explore and present data in the form of KG, called `VRKG-CollaborativeExploration` [1,2] [21]. In detail, the application has been developed for the Meta Quest Pro, a VR headset consisting of a lightweight head-mounted device. Launching `VRKG-CollaborativeExploration`, users enter a meta-world where they can join a thematic room. Each room contains a 3D KG modeling a topic of interest. For example, the room involved in this experimentation includes data about Van Gogh's life retrieved using DBpedia. Within the room, users can examine the KG content, inspect nodes to access their details, navigate their relations (materialized as edges), and physically move the graph to better use it as a shared object of discussion. The `VRKG-CollaborativeExploration` also provides collaborative functionalities to enable real-time interactions using gestures and voice communication when users are in the same virtual room. The application has two usage modes: i) the exploration mode that allows users to explore the KG freely; ii) the presentation mode where the navigation is preconfigured as a node path resembling an order of slides intended to be shown to an audience. Figure 1 shows users who joined a thematic virtual room where they can collaboratively discuss using a 3D representation of the KG. The screen projects what each participant can see.

Procedure First, the moderator introduces the survey notifying that by joining, participants agree on the usage of collected data in anonymous form for research purposes. Second, the moderator introduces the survey goal, i.e., collect participants' opinions concerning which contexts can take advantage of the Metaverse in general and the proposed collaborative exploration in particular. Then, the moderator configures the environment by opening the Van Gogh room first in exploration and then in the presentation mode. Each participant explored the graph, envisioning the collaborative options, assisted by the moderator when needed. The demo session took ten minutes per person, five minutes in exploration mode, and five minutes in presentation mode.

2.1. Data collection

A single open-question questionnaire was administered to collect participants' opinions about contexts that can take advantage of the Metaverse or a VR collaborative exploration of KGs.

[1] `VRKG-CollaborativeExploration` Source code: https://github.com/DanieleBubb/VRKG-CollaborativeExploration
[2] `VRKG-CollaborativeExploration` APK: http://www.isislab.it:12280/submission/VRKG.apk

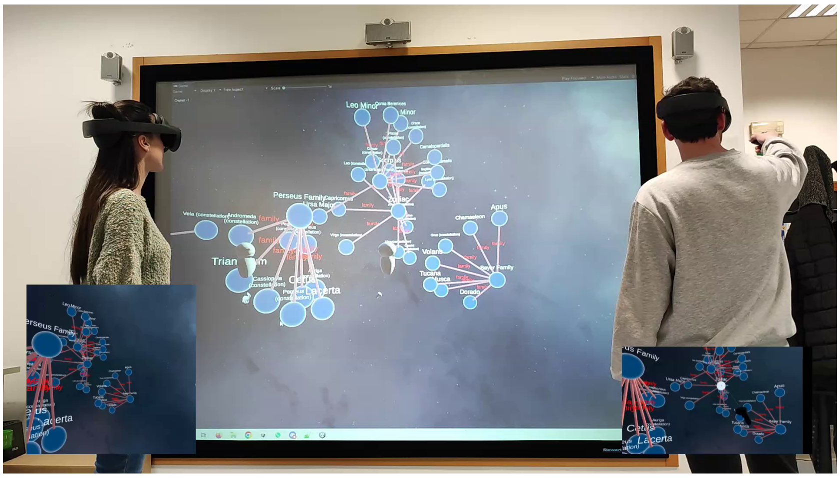

Figure 1: Example of two users using the `VRKG-CollaborativeExploration`. The screen projects what each participant can see.

Participants replied by writing a short text in English or their native language resulting in 26 answers. Two researchers collaboratively processed the data. First, they translated the replies in English with the support of a translation tool. Then, the researchers proceeded manually and iteratively with their tokenization until reaching an agreed outcome. They collaboratively identified the keywords within the text and uniformed them, aggregating diverse words with the same meaning in a single token.

3. Results

The tokens extracted by the open-question survey are reported in Figure 2. Word size reflects the rate of use of each word. We clustered tokens according to application contexts and tasks that can take advantage of the Metaverse by analyzing verbs in the participants' replies and the envisioned advantages of the Metaverse experience by analyzing adjectives used in their replies. Figure 3 reports a quantitative overview of the tokens' occurrence, split by gender, and organized in terms of application contexts, tasks, and expected advantages.

4. Discussion

4.1. Application contexts

Participants perceive the proposed approach as particularly suitable for formal learning in educational contexts, both at school and university levels, and in informal learning, such as in visiting museums. They also report interesting use in dissemination activities, mainly related to academia, like conferences or project presentations in the workplace, such as during product placement and advertisement.

Applications contexts are strictly related to enabled tasks. Participants consider the Metaverse suitable for presenting lessons and content, mainly in educational settings. Furthermore, they

Figure 2: Word cloud representing tokens extracted by participants' replies related to contexts that can take advantage of the Metaverse and the envisioned gain.

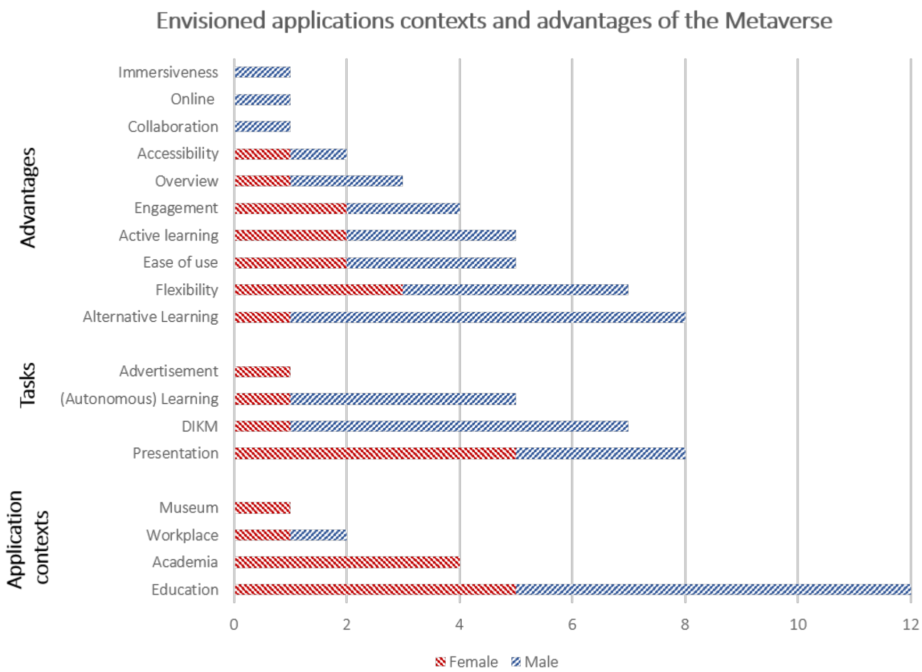

Figure 3: Bar chart representing the number of occurrences of each token, split by gender, and organized in terms of application contexts, tasks, and envisioned advantages.

acknowledge the utility of presenting data via the Metaverse, enabling data presentation, information extraction, and knowledge acquisition (shortened as DIKM in Figure 3 referring to the data-information-knowledge pyramid). Besides learning moderated by an educator, they envisioned autonomous learning, also in an informal setting, such as the one experienced in museums. Finally, product advertisement is strictly related to the workplace.

It is interesting to look at the distribution of opinions split by gender. They agree on the role played by the Metaverse in education and the workplace, coherently with current developments of the Metaverse. However, females envisioned more application contexts than males demonstrating the ability to think out of the box. It is worth noting that while males mainly belong to computer science, females belong to humanistic departments. Hence, it is interesting to see how they try to bring the Metaverse into their field, such as proposing to exploit it in museums.

4.2. Advantages

Alternative learning. The most recurrent advantage, mainly underlined by males, is the opportunity to explore and present content in an alternative and innovative way by enhancing the overall experience. It is reported in 8/26 cases. A participant literally stated "*An interesting context might be to show a particular information or data in several ways, to better highlight certain characteristics that might be missed with traditional tools.*". This benefit is strictly connected to the enhanced accessibility provided to people with attention deficit and the ability to easily engage participants, reported as further advantages. Some participants explicitly reported the game-based approach offered by the Metaverse as a promising alternative learning method.

Flexibility. In 7/26 cases, participants appreciated the flexibility of the Metaverse, easily adaptable to any content and application. It is evident that education is the most recurrent application context. Participants recognize the usefulness of the Metaverse in any subject, explicitly reporting art and history as examples, probably biased by the experienced KG in the evaluation, i.e., Van Gogh's life. It is worth noting that the literature widely reflects this feeling [13, 5, 14].

Absence of barriers. Participants perceived the Metaverse as easy to use, able to welcome users with disabilities, and supporting accessibility and inclusiveness. This is crucial since accessibility is one of the critical aspects of social sustainability [22, 23]. Looking at Figure 2, participants explicitly stated that people with disabilities can easily access and take advantage of the Metaverse. By using it, firstly, people are not constrained by their geographical location or motor disabilities. Secondly, access to haptic sensors, audio, and images allows applications to be designed for hearing or visually-impaired persons. Finally, the increased engagement granted by augmented reality enhances interactions with others or the environment, possibly making it easier to keep attention high in users with neurodevelopmental disorders like ADHD. Thanks to these advantages, the Metaverse can positively impact education, enhancing the experience of distance learning, training, and remote therapy, making cultural activities more accessible, and allowing more and more people to access museums and exhibitions.

Active contribution rather than passive. Participants agree on the possibility of experiencing the Metaverse in the first person as an active contributor rather than a passive spectator. The Metaverse supports free and collaborative exploration and interactions with others without physical or geographical constraints.

Engaging experience. Ease of use, active learning, and alternative access modes make the Metaverse extremely engaging, more than traditional means. Looking at Figure 2, we merged in this advantage all the adjectives stating that it is an interesting, enjoyable, or useful experience. The results show a strong utility in data and content presentation in different situations. Participants reported contexts like workplace and product placement, project presentations, teaching activities, including formal learning at school and university or informal learning at museums, and dissemination activities during conferences. Moreover, they explicitly highlighted the advantage of the high immersiveness and engagement of the environment, granting the audience a clear overview of the topic of interest and the possibility of exploring details on demand. This result might be justified by their personal experience during the pandemic, where keeping engagement and attention high was challenging during remote activities.

Overall vision and complexity management. By removing barriers related to 2D desktop applications, participants perceive that they have more possibility to deal with data complexity, such as 3D objects or big amounts of data, by overviewing both data and content. Some of them explicitly referred to the utility of dealing with enormous KGs via incremental exploration of relations in a multifacet and multimedial fashion.

Collaboration. Surprisingly, collaboration is explicitly cited only once. Our feeling is that it has been given for granted in the context of the Metaverse, as it is implicitly collaborative. Moreover, during the experiments, the moderators repeatedly stressed that the exploration could be collaborative and that the graph would be a shared object among all the participants. Hence, we hypothesize that they do not consider it necessary to explicitly state it in the questionnaire. However, further effort should be invested in exploring it better in future directions.

Immersiveness. As for collaboration, also the immersiveness is probably given for granted. It is reported only once.

Online nature. Explicitly stated only once, users have the possibility to join a virtual room without the need to be physically co-located and can easily interact with each other via audio streams.

5. Conclusions and Open Challenges

The Metaverse is trying to become the next revolutionary step in HCI thanks to enhanced immersiveness, spatial temporality, and high interactivity. Different areas are already successfully adopting this technology, finding advantages like increased engagement, more personal interactions, and removing geographical constraints. Education, training, collaboration, and information presentation are some contexts where the Metaverse brings meaningful benefits. This article explores the envisioned application contexts and advantages of the Metaverse via university students' eyes. The results of the survey are coherent with most of the advantages of Metaverse reported in the literature. Participants refer to the application contexts already taking advantage of the Metaverse, mainly related to education and workplace. They correctly identified all the advantages supported by the Metaverse, such as inclusiveness, the ability to provide an engaging environment even in online settings, the possibility to offer an immersive and enjoyable experience, and a precise and valuable method to visualize complex concepts. However, *not everything that glitters is gold*. The optimistic feeling of participants should be mitigated by the open challenges of the Metaverse that must be addressed. We summarize them in the following.

Sustainability. The Metaverse poses some challenges in terms of sustainability since it involves advanced technologies not always easy to use. Moreover, the equipment needed to access the Metaverse is still expensive, needing a reliable, high-speed, and high-bandwidth Internet connection and becoming a critical economic barrier.

Sickness and alienation. Additional concerns regard physical and psychological health. The Metaverse can cause a disconnection from reality, affecting users' mental health, which could lead to addiction and social isolation. The Metaverse application's prolonged use may lead to discomforts like motion sickness and headache. Some studies are already investigating guidelines to avoid such physical issues [24, 25]. Zhihan et al. [26] found a correlation between the performance of the virtual world and sociality; the more the Metaverse is similar to the real world, the more users behave like in a real environment.

Security. Privacy and security may be one of the major limiting factors for adopting the Metaverse due to the amount and type of information the devices collect during use. In addition to the data collected by sensors like microphones and cameras, the Metaverse has access to additional biometric data leading to the need for an even more secure protocol to protect the data [11, 1, 9]. On the one hand, the Metaverse must provide reliable built-in security protocols that the developers can implement in their applications easily. On the other hand, companies developing Metaverse-based applications must ensure users that their sensitive data are secured at any time. Data breaches are already a big issue; with the amount and kind of data collected by Metaverse devices, they can become even harsher to deal with.

Limitations of the study and future directions The study presented in this article has some limitations. The number of participants is not very high, resulting in a limited sample size, and the very specific context involved in the survey is familiar to them. Moreover, the researchers could have influenced the data processing procedure, although not in an impactful manner. As proposed, the questionnaire asking about the advantages and constraints of the Metaverse may only partially capture reflections on collaboration. A future direction is to study how the Metaverse influences collaboration, what opportunities are grasped and missed, and if this new environment relates to or promises an enriched learning experience.

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