



The Metaverse: A Systematic Literature Review to Map Scholarly Definitions

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ABSTRACT

Metaverse is the new buzz word in the field of technology, particularly in the media and industry. Studies of virtual spaces have been going on in academia for decades, and industry has been creating such spaces as commercial products. However, the specific term "metaverse" has been used sparingly, and when used, the definitions have been inconsistent. In an effort to understand how researchers are using this term, we conducted a systematic literature review and reviewed articles that used and defined the term metaverse. We categorized the main characteristics that researchers have defined as being properties of the metaverse, finding broad overlaps but divergence in details.

CCS CONCEPTS

• **General and reference** → Surveys and overviews; • **Human-centered computing** → *Mixed / augmented reality*.

KEYWORDS

Metaverse; virtual worlds; virtual reality; systematic literature review

ACM Reference Format:

Mashael Yousef Almoqbel, Azadeh Naderi, Donghee Yvette Wohn, and Nitesh Goyal. 2022. The Metaverse: A Systematic Literature Review to Map Scholarly Definitions. In *Companion Computer Supported Cooperative Work and Social Computing (CSCW'22 Companion)*, November 8–22, 2022, Virtual Event, Taiwan. ACM, New York, NY, USA, 5 pages. <https://doi.org/10.1145/3500868.3559448>

1 INTRODUCTION

The term "metaverse", was first described in author Neal Stephenson's science fiction novel "Snow Crash" published in 1992 which is about a character who, although spending the most of his time mentally in a virtual environment named Metaverse, lives in Los

Angeles in the early 21st century [37]. Following the novel, CitySpace [2] ran from 1993 to 1996 as one of the earliest virtual worlds. Following CitySpace [2], numerous other metaverses such as Active Worlds [36] and There (www.there.com) have since been explored [27]. Soon these metaverses became popular especially between game enthusiasts and the most popular ones such as Second Life¹ were introduced. Second Life, developed by Linden Lab in 2003, is an online multimedia platform that allows people to create an avatar for themselves and have a second life in an online virtual world. Over two decades, more than 900k users have been part of this virtual world.

Owing to the more recent popularity of the phrase "metaverse", this work questions if a "metaverse" is different from a virtual world? Many scholars have been studying virtual worlds in all shapes and forms for decades, yet it is unclear how the term metaverse as a common noun (and not the world described in Snow Crash) is similar or different from other terminology that describe immersive virtual spaces. Our initial literature review points to inconsistency in how the term metaverse has been. For example, one of the earliest articles tried to construct transparent boundaries between real and virtual spaces [3], followed by other studies that were focused on definition and characteristics of the metaverse, its challenges, and its different applications on education [1], entertainment [4] or in business and economics [5]. By doing a simple search in the literature, we see since the introduction of the term, many researchers, scholars, and tech professionals have attempted to use the term and explain what it means. Despite some similarities, definitions of metaverse are inconsistent. In a recent workshop conducted by the HCI and the ACM community, [15] scholars reflected on a lack of common definition for metaverse. The inconsistent and colloquial usage of the term leads to further disorientation in scholarship, therefore, it is important to identify how the term has been used previously.

2 LITERATURE REVIEW

2.1 Defining Metaverse

By reviewing the literature, we found that there are many descriptions and definitions but there is no consistency between them. In this regard, Lee et al. [22] stated that since its first appearance, the metaverse as a computer-generated universe has been defined

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CSCW'22 Companion, November 8–22, 2022, Virtual Event, Taiwan
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ACM ISBN 978-1-4503-9190-0/22/11.
<https://doi.org/10.1145/3500868.3559448>

¹<https://secondlife.com>

through vastly diversified concepts, such as lifelogging, collective space in virtuality, embodied Internet/spatial Internet, a mirror world, and an omniverse: a venue of simulation and collaboration. While this framework has been popularly used in the media, it does not align consistently with academic definitions of the space—for example, lifelogging has long been an area of research that has no virtual component. Further, other frameworks are also being circulated in industry and popular media, such as Jon Radoff's 7 layers of metaverse, which he describes as experience, discovery, creator economy, spatial computing, decentralization, human interface, and infrastructure². However, this would mean that the metaverse does not exist yet, since none of the current operating virtual worlds are decentralized sufficiently, and very few support creator economy. Other confusing examples include definitions in industry about metaverse which includes interoperability—again, this would mean that the metaverse does not exist yet as none of the current known virtual worlds are interoperable³. Even if these definitions are ideal visions of what the metaverse could be, then what are the metaverses that scholars have been referring to and studying for the past few decades? How do these reconcile? It is thus important to understand how scholars have been conceptualizing and operationalizing the term metaverse.

3 METHODS

This research was conducted using a systematic literature review process. We started the process of collecting papers that have explicitly used the word metaverse. The inclusion criteria are the availability of a definition for metaverse and the explicit use of the term “metaverse” in any place in the article such as the title, abstract, or body of the paper. Four authors went through several rounds of data collection that spanned 6 weeks. A meeting was held every week to discuss and evaluate the progress of the data collection endeavor. The researchers used databases such as the ACM digital library, SCOPUS, IEEEExplore, and also searched Google scholar to cover wider options. After the second week of data collection, when the total number of papers reached 40, the authors began the process of analyzing metaverse definitions using open-coding. The inter-rater reliability was not calculated; however, researchers would discuss the coding every week until they reach total agreement. Each week, the document would be updated to augment existing themes or add new sets of codes. Over the weeks these codes were clustered into five primary themes that are presented next. These themes are based on the review of 158 papers.

4 RESULTS

The results show what elements were used in metaverse definitions, which are the properties of the metaverse in scholars' definitions of the term. The section includes a preliminary diagram of the metaverse elements based on systematic literature review, highlighting the classification with short description of themes.

4.1 Activities

This theme refers to the kind of domains that metaverse has been defined to be used in primarily. Activities theme was used 24% of

the time. This theme had two high level codes: Entertainment and Social Interaction, as discussed below:

- **Entertainment:** Majority of the papers found focused on concepts of gaming and leisure which is expected given the large available gaming platforms and their popularity. Some researchers consider the metaverse as a player world, stating that the metaverse is: “a combination of real and online worlds wherein players can collaborate to create content” [18]. Other papers looked at entertainment from a different perspective than gaming. For example, in [4], the authors discuss the metaverse in the context of tourism: “metaverse in Tourism uses physical reality combined with MR”.
- **Social Interaction:** Another widely used theme to express the metaverse in the definitions we analyzed was social interaction. We define it as any way to have a communication with another individual/s virtually through what the authors describe as the metaverse. For instance, Orgaz et al. [31] claims that: “people can interact freely using the metaphor of their real lives in a non-limited world”.

4.2 Content Creation

Based on the surveyed metaverse definitions, this theme refers to who is creating content that inhabits metaverse. Content creation was used as a theme 10.3% of the time. This theme had three high level codes: User-generated, Computer-generated, and Co-constructed content:

- **User-generated content:** It mainly focuses on creating content using avatars. Each user can interact with user-generated 3D content [24]. It allows players to produce content and edit the world while collaborating with each other [18, 30]. Users can create their own experiences by creating their own content [22], usually by going beyond text-based content-generation [26].
- **Computer-generated content:** It refers to the content created by computer software or hardware. Such virtual content can be delivered through a variety of perceptual information channels, including audio, images, scent, and haptics [28].
- **Co-constructed content:** In this perspective, authors merge the two categories above and indicate that the content is co-constructed by users using their imagination [6] and digital or physical content that has been generated by a computer [22].

4.3 Users and their Roles

This category refers to active or passive user engagement in metaverse. This means explicit/implicit actions (eg. Agency) and user representation types (eg. avatars or self) performing such actions. In the data coding process, this theme was used to code 14.9% of the data.

- **Agency:** Users' agency was mentioned in some definitions in a subtle way. Users empowered with agency, will be responsible to initiate all activities and the avatar would have no ability to act solely. We found that most definitions claimed that users of the metaverse have an active agency. For example, in [33], authors discuss how users can carry out their

²<https://venturebeat.com/2022/01/26/understanding-the-7-layers-of-the-metaverse/>

³<https://ai.facebook.com/events/inside-the-lab/>

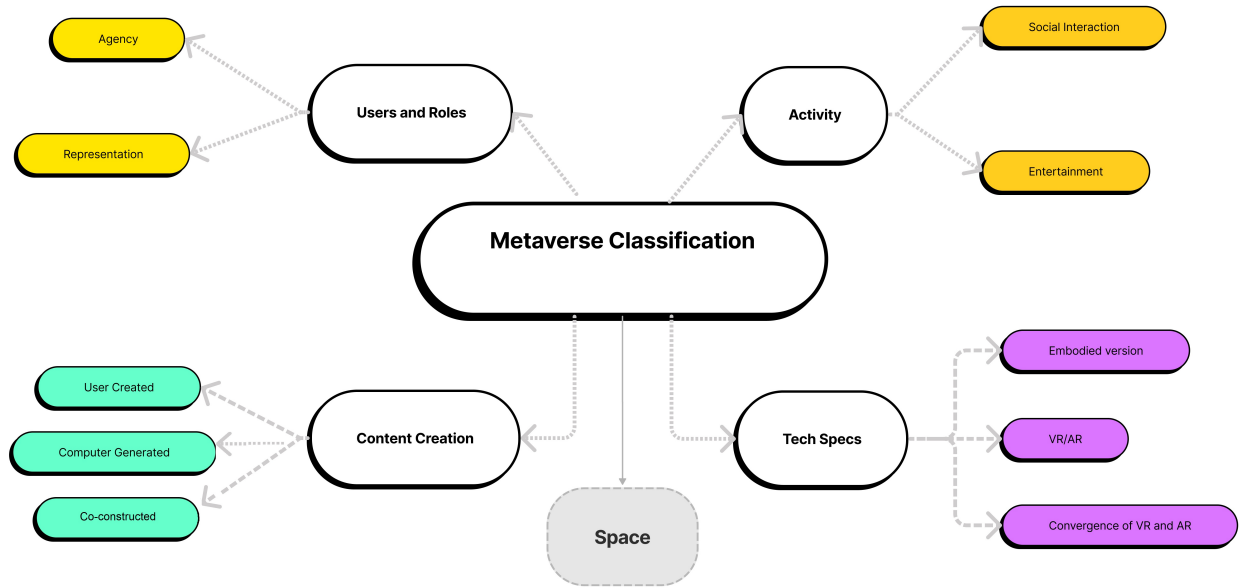


Figure 1: Metaverse definitions classification

real-life activities in the metaverse, suggesting an active role of the user.

- **Representation:** Users are able to choose how to represent themselves on the metaverse. Certain papers stated that users either choose to represent their own self, meaning they mirror their reality into the metaverse. Or, users can choose to represent their alter-ego, where they might look and/or act completely different from their physical representation in the real world. For example, in [12], authors inferred a realist representation of the self in the metaverse and said: “where [users] meet, socialize, play, and do almost anything they want as in the real world through virtual personifications of themselves called avatars.”

4.4 Tech Specs

This section gives a brief description of perspectives on different kinds of technical challenges that are needed to be overcome to support the above categories. This theme was used 15.4% of the time.

- **Embodied Version:** Similar to “representation” in the previous section, some scholars have responded to technological needs required to create embodiment by creating avatars [19], or even an embodied version of the entire Internet where avatars may navigate freely [29, 35]. Such an embodied Internet would require technology to facilitate interactions between users. This would raise technological infrastructural challenges. For example, should such metaverse be centralized or reimaged as decentralized ecosystems [25]. Further infrastructural needs discussed include creating

these 3-D interconnected spaces as persistent and accessible spaces [8].

- **Convergence of VR/AR into Mixed/Extended Reality:** Recent works are repositioning metaverse as a shared 3D world built using mixed technologies beyond VR/AR [9, 11, 13, 16, 17, 21, 21, 23, 38]. As a fusion of both, this allows users to experience it as a joint amalgam [10, 20]. Similarly, other scholars consider this mixed reality to support mechanisms like lifelogging [7]. More recent work has also centered on how metaverse can become a medium that connects the on/offline post-pandemic realms [32] converging virtually enhanced physical reality, and physically persistent virtual space [34].

4.5 Space

Space as a theme was used to code the largest portion of data (35.4%). Going back to Figure 1, we see space as a category in a grey and dimmed shape. It is because this was the hardest category to define and is one of the most inconsistent parts among different definitions gathered from the reviewed papers. Space here is regarded as the relationship between metaverse and the real world. Several papers discussed the metaverse being a parallel to the real world in which it uses ambient intelligence to enhance physical spaces, products and services [4], and where the real estate, advertising, entertainment, commerce, and capitalism rules are applied [14]. Others defined it as an exact mirror of what we are living, minus the obvious boundaries of regulations, religion, sex, and others.

We also found some other perspectives such as some papers stating that the metaverse is a combination of real and online worlds

[18]. Such definitions increase the significance of further investigation in the space dimension. These would lie within the notions of realism vs fantasy which would broaden the boundaries of the metaverse. In this regard, it is still not clear if the researchers assume metaverse to be fantasy or real? Considering that realism is one of the four design requirements of the metaverse [30], this points to an inconsistency. So, we leave this category dimmed as we think a scholarly conversation would help guide the authors into how to better shape this into a clearer, more construct understanding.

5 DISCUSSION

We found that some definitions described a sense of virtual boundary in the metaverse [16]. This could be understood as the end of a landscape or the limited number of lands in a neighborhood available for sale on the metaverse. However, it is not clear if this limitation would extend to other physical boundaries such as gender and age. According to [31], people are not bound to their born-in sex or their current age. For example, going into the metaverse one would have an identity that they can freely choose, but once that identity is established, possible physical boundaries would be automatically casted on that avatar, even though it was initially created with no boundaries.

Parsing nature of the relationship between physical and virtual worlds of metaverse remains entangled at best. It remains unclear how resources created in metaverse would impact those outside, and vice versa. For example, Avatars in the metaverse are able to monetize their world by buying land, building spaces, and creating relationships. All of which could add to the worth and value of an individual in the real world. How though would such worth be evaluated? Especially, if this were to be a decentralized ecosystem as suggested in some definitions. Further, would this world naturally cascade back to the metaverse? Therefore, it is unrealistic to believe the metaverse offers a limited, less alternative world. But even so, how would the world as we know it engage with metaverse and its inhabitants?

6 CONCLUSION AND FUTURE WORK

The expression metaverse has been extensively used recently. While one may get the general meaning of the term from the context and from 'hearsay', it is difficult to infer a specific and universal meaning of the term. Reviewing literature primarily in the field of HCI and computing, we found a general agreement that there is no unanimous understanding of the expression. In this work, we attempted to create a high-level classification schema to understand the main categories scholars have used to define the metaverse starting from the year the term was coined in early 1992. We intend to review more literature from other fields to increase the depth of the schema and expand the key words beyond metaverse to terms such as virtual social reality and online games to see where there are overlaps and what the conceptual boundaries could be.

ACKNOWLEDGMENTS

We would like to thank undergraduate researchers in the SocialXLab for the initial help in data collection and organization.

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