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How to Prepare High-Level Massive Online Open Courses for the Metaverse: Tools and Needs †

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Abstract: The adoption of methodologies and practices from distance learning (MOOC) and gamification is a promising basis to facilitate the design of a new generation of MOOCs (massive online open courses) and well suited for XR-based immersive shared social spaces, i.e., educational metaverses. Therefore, we discuss the tools and requirements to assist teachers to acquire two levels of competence, "beginner-level creator" and "advanced-level creator", within the current ecosystem of metaverses. The adoption of such tools and XR platforms within STEM university educational settings is discussed to introduce the novel concept of the edu-metaverse.

Keywords: interoperability; metaverse; gamification; e-learning; stem education; MOOC; XR platforms; edu-metaverse

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1. Introduction

It is now required to discuss how to prepare for the new needs created by the announcement of the ethereal and self-defined "metaverse" of Facebook/Meta [1]. The metaverse first took its shape as a concept of Science Fiction in 1992 by Neal Stephenson in "Snow Crash" [2]. Subsequently, the Acceleration Studies Foundation announced in 2006 a roadmap identifying it as a result of the encounter of Web 2.0 with the world of video games [3] as observed by Kye et al. [4]. It deals with our digital life by adding, ironically, rules of real-life physics (and beyond) [5] and the possibilities of ubiquity. The concept is still "in its infancy" despite its mature roots, in the same way as Qualcomm theorized about Extended Reality (XR) technology in 2017 [6]. Kye et al. analyzed the possibilities of the metaverse in the world of education by extrapolating an interesting definition:

"Metaverse means a world in which virtual and reality interact and co-evolve, and in it social, economic and cultural activities take place to create value."

This study focuses on the importance of interoperability and gamification concerning the design of a new generation of MOOCs (massive online open courses) that are well suited for XR-based immersive shared social spaces, i.e., educational metaverses. According to Hwang and Lee [7], the main features of the emerging ecosystem of metaverses can be described using the recently proposed SPICE model. This model uses seamlessness, presence, interoperability, concurrence, and economic flow, as depicted in Figure 1, to capture the factors, customer satisfaction, and purchase intention of users within metaverses.

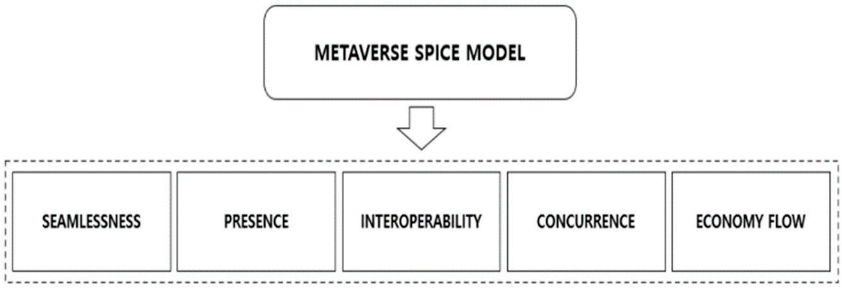

Figure 1. SPICE model of a metaverse [7].

Smart et al. in 2007 defined four different types of metaverse: Augmented Reality, Life Logging, Mirror World, and Virtual Reality. Each of these metaverses has dimensions that can be identified with a reality already in place, but which exist precisely and separately. Augmented Reality and Virtual Reality are well-established research fields for the scientific community, and Life Logging means recording one's life using smart or wearable devices and software platforms such as current users do on Instagram and Facebook. Mirror World is referred to as a more or less faithful reflection of the real world in the metaverse, defined as an "efficient expansion", i.e., a virtual place where certain tasks are performed efficiently to improve the players' quality of life. It is worth noting how interconnected these four types of metaverse can be and how much thery are so, thanks to technological innovation. According to this classification, there are platforms developed in the last decade to which it is legitimate to apply the "metaverse" label. For example, gamified social learning platforms such as Mondly [8] can be listed as augmented reality, virtual reality, and lifelogging metaverses.

Moreover, educational settings in schools and campuses have been successfully mirrored into metaverses [4], allowing to recreate educational contexts and situations. The idea of having multiple interconnected real/augmented/mixed/virtual worlds would lead us to think about the necessity of a holistic continuum of educational experiences; hence, interoperability is a key aspect. If we look at the recent definition given by the Meta group through a training course on Coursera [9], specific aspects are highlighted to understand the metaverse. "A series of immersive and interconnected digital spaces and an embodied Internet" is, therefore, presented as an Internet 3.0 that is mostly used with virtual reality or mixed reality viewers, the use of which gradually decreases as they approach widely used tools such as computers and smartphones.

Hence, again, the key aspect to interconnecting real to virtual and vice versa through the user's embodiment is interoperability, which requires heterogeneous platforms to refer to a unique ID from several linked IDs (from legal ID cards to biometric fingerprints for a real person, as well as digital identities and avatar IDs). This unique ID, according to Meta's plans, will be used to access any metaverse system.

It is beyond the scope of this study to present a deeper discussion about all the possible philosophical and ethical issues or legal consequences of having one or multiple avatars within a metaverse(s). The general idea of having a unique avatar ID is reasonable to guarantee the same physical body (the real user) has suitable access to every linked platform. For instance, within formal educational institutions, this digital embodiment is necessary to guarantee a proper learning path. On the contrary, within social networks, the possession of multiple identities is widely accepted (even debated) either for practical or more subtle reasons. Again, interoperability among platforms allows real users to access their different avatars to manage different social contexts (such as, in real life, wearing different suits in different life situations).

It is therefore evident that interoperability is the key element to implementing the convergence of different metaverses into one. The potential of this new metaverse accessed through a single "gate", as highlighted by Zhong and Zheng [10], is "a sort of educational environment beyond reality, which has the immersive characteristics of the real world and the open and free characteristics of the virtual world. It supports students to carry out interdisciplinary, interregional, and shared learning activities instantly using the avatar", that is, an edu-metaverse.

In this perspective, a research question is raised about the specific issues of creating an innovative educational MOOC experience, methodologically and technically valuable and embodied into an engaging XR experience. Gaming and gamification seem to be a natural support for metaverse experiences because most software implements them in the gaming world. Gamification theory [11] can be used to define different types of "learners as gamers". Even if this proposal is criticized in a traditional teaching framework, there is long-lasting evidence from situated learning [12] and GBL methodologies that the adoption of different gaming patterns is effective in an edu-metaverse context, where each proposed learning activity can be easily perceived as an engaging gaming situation. The best way is to convey this feeling of positive engagement by identifying the type of learners through the Bartle test [13], which gives teachers an idea of how to build privilege gamification-based approaches connected to four categories of gamers: achievers, explorers, killers, and socializers, as depicted in Figure 2. We investigated the application of gamification techniques in an e-learning setting [14–16], and it is reasonable to expect experiments on this topic within current metaverses.

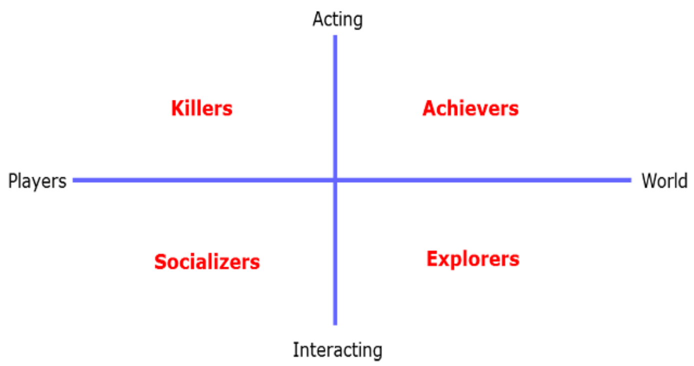

Figure 2. Bartle model of player types.

2. MOOCs and the Edu-Metaverse

A key pillar of early MOOCs (also known as cMOOCs) when they appeared in 2008 [17] was connectivism pedagogy. Taking its roots from the open educational resources (OER) movement with the MIT Open Courseware project and the Open University, the methodological approach was primarily based on the aggregation of reusable multimedia content and learning resources. The paradigmatic course on "Connectivism and Connective Knowledge" (CCK08) at Athabasca University, led by George and Stephen in 2008, enrolled 2200 online students based on active learning methodologies applied on the open-source e-learning platform Moodle [18] and the virtual world Second Life [19]. So far, the importance of a shared virtual immersive environment has been highlighted from the very beginning to promote engagement, communication, and the social sense of presence. On the other hand, starting in 2011, the emergent ecosystem of e-learning platforms offering MOOCs emphasized the importance of self-paced personalized learning, imposing a "de facto" model for less interactive and more narration-centered courses. This shift from connectivism to digital storytelling led to the so-called xMOOCs (extended MOOCs), where the most used pedagogical approach is a syllabus of self-paced or session-based well-defined lists of recorded video lectures intertwined with self-assessment interactive activities (quizzes/tests/choices).

In the last three years, during the COVID-19 pandemic period, another huge shift happened on a global level: the global adoption of distance learning platforms at every educational level. During the tragic lockdown period in March 2020, more than 1.3 billion students moved in 1 month from traditional classrooms to online platforms [20]. Most lectures became conference calls managed by millions of teachers, suddenly pushed from face-to-face to online teaching. Even if e-learning platforms and online/blended courses were already available and used worldwide in almost all universities before the pandemic, the number of people enrolled on MOOCs exploded as a sustainable educational scaffold. The long-term impact of this shift needs to be deeply analyzed at pedagogical and organizational levels. As a matter of fact, another emerging consequence of the pandemic put forward in 2021 is the idea of an educational metaverse, or edu-metaverse [4,21].

According to Kye et al., the educational possibilities of the mirror world, i.e., “a type of simulation of the external world that refers to an informationally enhanced virtual model of reflection of the real world” [3], arise from realistic digital reproductions of educational settings such as laboratories and classrooms. Video-conferencing systems are playing the role of classrooms for synchronous communication, but they are not yet well suited for recreating socially shared spaces. One of the most interesting examples is Gathertown, based on a 2D pixel art RPG style. The simplified interface and the automatic activation of audio–video connections (in case of virtual proximal distances in-between players) represent effective well-known methods to promote social interactions.

Another interesting aspect of metaverses from an educational perspective is that “the design of metaverse in education has evolved over generations, where generation Z is more targeted with AI (and XR) technologies compared to generation X or Y” [22]. In this bibliometric analysis, the findings provide a roadmap of future research directions to foster an effective edu-metaverse. Most studies on edu-metaverses still rely on virtual-world-based educational settings, where the reduced availability of low-cost 3D HMDs is a key limiting factor to widespread adoption. Hence, a new “digital divide” is emerging related to having an adequate set of digital devices for XR. Many university institutions, which are also strongly committed to the expansion of STEM disciplines, must take into adequate consideration the investment necessary to allow their students (regardless of gender, ethnicity, social conditions, and disabilities) access to these new types of virtual educational spaces.

3. Tools and Needs

3.1. Softwares

We define two levels of competence as “beginner-level creator” and “advanced-level creator”. Beginner-level creators are, for instance, teachers who are trying to adopt new teaching methods but lack the skills needed to create something with highly personalized content from scratch. Tools such as Wikitude [23] and Zappar [24] represent acceptable solutions for them. These software have online studio creators that allow a beginner to create simple marker-based and object-based augmented reality experiences, adding informative layers, videos, or sounds to the target object. Zappar starts with two types of starting tools called Studio and Designer, and Wikitude adds the possibility of World Track and Face tracking. To create augmentation based on 3D objects, the simplest choice is to use 3D libraries such as Sketchfab or CGtrader that provide a large number of meshes, with a free section which is ready to use.

Currently, the simplest platform to create metaverse-like experiences without requiring great effort is Eon XR [25], which promises the possibility to create multi-object environments explorable in “walking and talking” modes, starting with the creation of avatars and creating the metaverse environment. The metaverse builder video demo shows how it is possible to create a simple environment and add objects, enabling voice research between internal and external libraries such as Sketchfab. Furthermore, taking advantage of the AI integrated into the builder, all notes inserted and translated based on the context give suggestions and recommendations to propose elements or information to insert in the scene.

“Advanced-level creators” are teachers with specific competence in digital tools, knowledge, or programming. They handle more complex tools. Trying to define a scale of complexity, they create with all previous tools in a deeper way and look forward to more complex tools. A preliminary example of a more complex software is Cospaces Edu [26], which allows the creation of an experience with visual code or script code and sharing XR lessons with students in metaverse-like environments. In some ways, we can assume that the structure is an "easy mode" of game engines such as Unreal [27] and Unity [28]. Furthermore, similar to Eon XR, it provides class management and assignment management.

In general, game engines have the highest possibilities of personalization for metaverse experiences, but at the cost of greater effort. Quixel MetaHumans and the Megascan free library for Epic customers are a big leap forward, and game engines offer the chance to make use of digital twins [29], which are an important block for the creation of deeper experiences in extended reality, giving strength and consistency to the metaverse concept. For instance, the new Unreal Engine 5 is making a big leap forward in reproducing the reality of virtual environments. Unreal with the brand new nanite system allows hand meshing with millions of polygons, considerably optimizing the real-time rendering system. In Unreal 5, the documentation explains that Nanite mesh is still essentially a triangle mesh at its core with a high level of detail and compression applied to its data. This optimization allows complex meshes with less optimization work to be created and directly imported into the engine. For instance, a photogrammetry mesh is recorded and recreated from the original object or original environment such as an antique sculpture or an entire heritage site. The Open XR standard is another tool for the interoperability of XR experiences, and it fits into the mission of an accessible and inclusive metaverse.

3.2. Gamification as Tool

As previously anticipated, gamification can be expected in the metaverse experience, and MOOCs are not excluded. Gamification can be considered in a middle space between tools and methodology, but in any case, we prefer to classify it as a tool, because it is affordable in the right context and not for every situation.

Why gamification? It is a strong tool to increase learners' engagement. There is a possibility at a certain point that the initial push of the "metaverse wow-effect" will run out, and thus maintaining engagement can be an issue, so gamification is a valid and complementary option. Motivation can be empowered. Deci and Ryan [30] developed a comprehensive approach to human motivation, called self-determination theory (SDT), which describes a motivational spectrum. Amotivation or total indifference to an activity is the first element of the motivational spectrum of SDT. Amotivation is followed by four levels of extrinsic motivation. In the first level, the behavior is regulated externally, which means that it is motivated by a request from external sources or by a reward imposed by external sources. Introjection is the next level of extrinsic motivation. People act to maintain or enhance their self-esteem or to reduce social pressure. A more self-determined form of extrinsic motivation enables the identification of activities that are important to the individual. Integrating a person's goals with the activity is the most self-determined form of extrinsic motivation. The person wants to perform the activity not because of a fondness for the activity. Intrinsic motivation is the final step, enhanced by conditions that lead to psychological need satisfaction, whereas it is undermined by conditions tending to thwart need satisfaction.

Gamification techniques specifically aim to create a path through the spectrum and change the learning motivation from extrinsic to the nearest step of intrinsic motivation. Werbach and Hunter, Chou, and Kapp well described how to achieve these goals with different types of gamification approaches [11,31,32].

4. Criticism and Conclusions

A recent study [33] has shown how seemingly simple it is to exploit software platforms to commit sexual misconduct, inducing mental distress in harassed users and causing them to feel less at ease in the metaverse. MIT has already confirmed that these incidents are not just isolated cases. In the future, this will be an issue to constantly deal with and solutions will need to be found to prevent these episodes from being crucial [34]. Ensuring the preservation of the digital uniqueness of learner and teacher avatars is still an open issue, and the ethical and legal aspects must be deeply investigated. This is not only to guarantee tools to monitor and ensure the safety of users, but also to protect them from bullying and impractical behavior. AI, Machine Learning, and Deep Learning techniques can be useful to detect and classify possible threats through sentiment analysis, for example. In every educational and social setting, real or virtual, these misbehaviors and cybercrime incidents can be reduced, but not a priori excluded. Following the approach of Wang et al., within the edu-metaverse, each participant must have the right to revoke their image and digital body even if it is granted, which is a problem that is already having implications in the use/abuse of deep fakes.

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