MAPPING THE VIRTUAL EDUCATIONAL TOURS FROM AN ECOSYSTEM PERSPECTIVE

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Abstract: *Context:* This research analyzes virtual environments as an ecosystem for learning activities. We accomplish this by addressing three fundamental research topics. - What are the required assets that outline an educational virtual world? What are the exploration techniques used in an immersive educational environment? Finally, what is the student's perception of using virtual educational environments? *Objective:* The current research intends to establish an understanding of how virtual worlds might be integrated into educational activities, as well as the technologies underlying their configuration and students' perceptions after exploring these environments. *Method:* This study's purpose is to conduct a systematic review based on scientific articles that give us insights into virtual tours' impact on educational environments and the most used technologies behind their configuration. *Results:* 2464 studies were extracted using custom strings after the first filtering process. Throughout the semi-automatic and remove duplicates process, 1252 articles gained visibility as being more specific topics for our study. 30 were selected to be included in the mapping, after three manual filter processes based on title, abstract, and content have been applied. *Conclusion*: From the conducted research, we outline the idea that the future of education consists of customizable, versatile approaches that include virtual environments as means of technology-enhanced learning. By reaching students ubiquitously, traditional learning methods are complemented by additional assets, that encourage learning engagement..

Keywords: *virtual tour, virtual environment, virtual world, education, exploration techniques, students' opinion*

I. INTRODUCTION AND PREMISES

Academic mobility has become of the primary activity to provide students with the opportunity of studying at a foreign university. The worldwide mobility of students and faculty, the training periods abroad at foreign universities, and the international semesters have shaped a pervasive commonplace in Europe [1]. As a result, international organizations, national education ministry officials, top institutions, and professors agree on the trend of developing international joint and double degree programs based on university networks.

Web-based platforms operated is the most straightforward approach for the shared e-learning environment. However, this model is frequently unpleasant for the partners, mainly because academics are averse to hosting their electronic courses on various distributed web environment [1]. A virtual enrvironment, as a dedicated shared 3D environment, may facilitate interaction and engagement in educational activities, compared to traditional learning platforms.

In recent years, virtual environments implemented through Extended Reality (xR), such as Augmented/Virtual/Mixed Reality (AR/VR/MX), have become applicable to various sectors, including medical, architecture, entertainment, and engineering. In addition, VR has been used for illustration, visualization, gaming, and social interaction. Research has been conducted to assess the substantial communication potential of VR [2]. To develop a healthy virtual social environment, it is vital to give users communication signals, such as visual, vocal, and nonverbal cues, to boost their sense of belonging in the virtual world. Virtual worlds may appear similar to video games, but they are not, as activities in these worlds may have real-world effects, such as cash generation.

Users of virtual environments may develop their own worlds and identities, establish social interactions and communities. These worlds offer distinct options for economical, social, fantastical, and physical pursuits, including learning processes. Students can construct their personas as avatars, experience new modes of mobility, such as flying and find new realms of wonder [3]. Virtual worlds offer a new learning dimension in an engaging and entertaining environment.

Following the above premises, the current work proposes a systematic mapping study to assess educational virtual tours from an ecosystem perspective. Section 2 provides background concepts for virtual environments that provide the pillars for an ecosystem-based perspective. Section 3 presents the systematic protocol proposed to assess virtual educational tours from an integrated viewpoint. Following the selected studies, section 4 reviews the research design by discussing the research questions. Section 5 presents the conclusions of the conducted study.

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II. BACKGROUND AND RELATED WORK

A virtual educational environment has one or more instructional objectives. Teaching and learning metaphors provide students and teachers with experiences they could not otherwise have in the physical world and lead to the achievement of specific learning outcomes [4]. These areas employ numerous technological approaches, yet very few pedagogical ones. In general, a minority of study focuses on the virtual reality characteristics that virtual educational environments exploit. Consequently, the essential traits that distinguish virtual reality and stitching technologies as potential and potent instructional tools are not yet well understood.

A. Configurations of virtual environments

Virtual tours of 360° panoramic scenes are presented as the leading "broadcaster" environments for remote access to sites, given that they best serve several unique requirements. They can describe both color and texture features of the architectural surfaces, combine external documents, which results in visual communication that is realistic.

Nonetheless, these virtual tours could be combined with more elaborate 3D reality-based and computer-based models, either in the form of digital products directly accessible via hotspots or, alternatively, as elaboration tools for developing data and results, which are then schematically displayed within the tours [5]. Virtual panoramas create immersive visualizations of real-world surroundings. These 360-degree panoramas enhance the user's view of the real world by incorporating multiple layers of information, including audio, text, video, and two-dimensional and three-dimensional objects. By delivering a realistic simulation of exploring a particular region, the panoramic photographs and videos enable users to navigate across an environment without physically being there. The user can navigate in a variety of specified directions to explore the site's virtual depiction.

New technologies have streamlined the process of image and video capture, transforming it from a complex robotic photography system to a simple hand-held camera or smartphone capable of producing images in a few seconds. In addition, automated software has simplified the editing process, requiring minimal work to generate multidirectional scenes with the capacity for user movement [6].

On the other hand, artificial environments and virtual worlds online can host user communities. Not only among people but also in enterprises and organizations, interest in virtual worlds is growing [1]. Three-dimensional environments permit wandering in vast spaces and are a suitable platform for various applications for teams of users, such as team training. Although such augmented reality or virtual reality-implemented team applications offer many advantages over their real-world counterparts, such as a flexible selection of environments, the ability to repeat the same events, and the availability of different perspectives and implementations, they are just as susceptible to scheduling conflicts and team member availability issues as their real-world counterparts. Virtual reality, in contrast to the real world, can provide a novel solution to the shortage of team members by replacing computer-controlled virtual agents for human users [8].

Users interact socially with avatars (virtual representations controlled by individuals) and agents to justify their use in such settings (virtual representations controlled by computer algorithms).

It is essential to create realistic movement and behavior of human-like entities in virtual environments for several virtual reality applications, such as training simulators, entertainment, and gaming.

B. Evolution and usage of virtual worlds

Users build the universe, its objects, and their behaviors in virtual worlds, which are open-ended environments. Virtual worlds can therefore be applied in any scenario.

The analogies driving the building of virtual worlds are immensely diverse, ranging from actual institution reproductions to faraway planets [14]. Three Dimensional virtual worlds are highly immersive and scalable 3D settings; humans enter these worlds using an avatar, which is their representation in that area and move their avatar as if walking or, in some cases, flying [15].

The use of Virtual Worlds in the instructional experience is significant not only for Web-based Education scholars [16], but also for educators interested in applying Information and Communication Technologies in the school environment [17][18].

C. Importance of human characteristics when designing characters

Virtual characters communicate information to people on a cognitive-analytic and emotional processing level [9], so it is possible to assert that humans may grasp interactions with virtual characters, and anthropomorphic virtual characters may even elicit a sense of social presence [10]. However, while examining human emotion and behavior in human–virtual character contact settings, we often ignore the influence of other senses on the interaction process. [11].

The appearance of a character may affect how a message is transmitted; for example, the intensity of an emotional issue may be judged irrelevant if portrayed by an artificial virtual persona. This could have significant repercussions for professions such as medicine and education where data quality is vital [12].

Prior research has shown that human-like agents can elicit social responses, increase the user's sense of presence in the virtual environment, and produce realistic interactions between agents and avatars [13].

III. RESEARCH DESIGN

A. Research method and questions

This paper aims to map educational virtual tours from an ecosystem perspective. To this objective, we propose a systematic mapping study focused on the following research questions:

- RQ1. What are the required assets that outline an educational virtual world?
- RQ2. What are the exploration techniques used in an immersive educational environment?
- RQ3. What is the student's perception of using virtual educational environments?

B. The review process and literature search method

Systematic literature reviews (SLRs), mapping studies (MSs), and cognitive mapping are all evidence-based methods for structuring, organizing, and classifying primary studies in software engineering. SLRs were pioneered in 2004 as a means of systematic reviewing process, and have become a research practice in recent years, with an increase in interest in developing tertiary studies. Kitchenham's [32] contribution to the software engineering (SE) discipline has been significant, as it has been the compilation and analysis of existing systematic literature reviews and meta-analyses. Through literature criteria cited by SLR and MS research, quality improvements [31] have been documented, though many studies still do not include an evaluation of the quality of the initial studies. Despite the wide use of large-scale reviews, the majority of large-scale systematic assessments in software engineering and IT are still categorized as mapping studies (MS) [33]. To tackle this issue, Petersen [30] proposed an adaptation of Kitchenham's [34] principles for generating systematic maps in SE, while assessing MSs produced from existing SLRs.

This research approach efficiently circumvents the difficulties of conducting large-scale randomized controlled trials. However, the inclusion of studies with biases or insufficiently examined evidence quality in systematic reviews and meta-analyses may lead to erroneous findings [19].

A search query following a Boolean syntax has been proposed and applied to 2 academic databeses: IEEE and ScienceDirect, with the purpose of extracting candidates for the discussion.

- Q1_IEEE: ((("All Metadata": immersive reality) OR ("All Metadata": virtual reality) OR ("All Metadata": augmented reality) OR ("All Metadata": virtual platform) OR ("All Metadata": virtual tour)) AND (("All Metadata": university) OR ("All Metadata": school) OR ("All Metadata": campus)) AND (("All Metadata": asset) OR ("All Metadata": resources) OR ("All Metadata": necessary)) AND ("All Metadata": education))
- Q1_Science Direct: ("immersive reality" OR "augmented reality" OR "virtual platform" OR "virtual tour") AND (university OR school OR campus) AND (asset) AND (education)
- Q2_IEEE: (("All Metadata": immersive reality) OR ("All Metadata": virtual reality) OR ("All Metadata": augmented reality) OR ("All Metadata": virtual platform) OR ("All Metadata": virtual tour)) AND (("All Metadata": exploration techniques) OR ("All Metadata": stitching techniques)) AND (("All Metadata": education) OR ("All Metadata": school) OR ("All Metadata": campus))
- Q2_Science Direct: ("immersive reality" OR "augmented reality" OR "virtual platform" OR "virtual tour") AND (university OR school OR campus) AND ("exploration techniques" OR "stitching techniques")
- Q3_IEEE: (("All Metadata": immersive reality) OR ("All Metadata": virtual platform) OR ("All Metadata": virtual tour)) AND (("All Metadata": student perception) OR ("All Metadata": student feedback)) AND (("All Metadata": education) OR ("All Metadata": school) OR ("All Metadata": campus))
- Q3_Science Direct: ("immersive reality" OR "virtual platform" OR "virtual tour") AND (university OR school OR campus) AND ("student feedback" OR "student perception")

A total number of 2464 studies resulted and were processed according to the systematic mapping protocol. An initial screening to remove off the subject studies has been conducted as an initial phase. Inclusion and exclusion criteria has been applied to extract studies that have been validated through a peer-review process and published in the English language. Resulting studies have been furtherly manually filtered to depict those that are relevant to the topic. A total number of 30 studies have been included in the mapping. A summary of the screening process is presented in Figure 1.

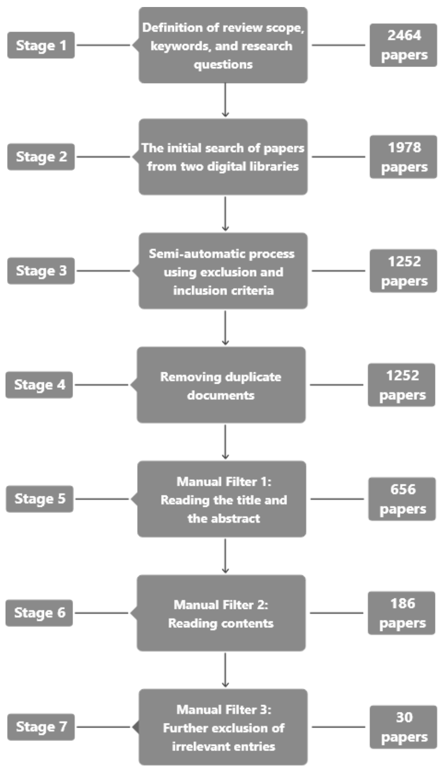

Figure 1. Summary of the selection process.

IV. RESULTS AND DISCUSSION

A primary mapping intends to position the interest in the field according to the past 10 years' timeline, as well as according to the type of study.

The distribution presented in Figure 2 outlines a growing interest in the field between 2020 - 2021, that may be explained due to the context set by the COVID-19 pandemic.

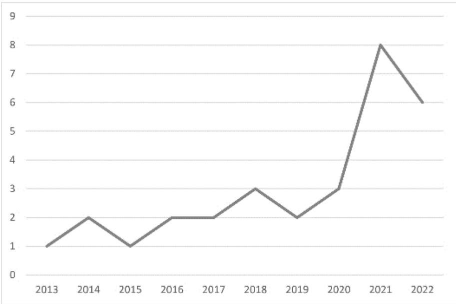

Figure 2. Evolution of interest in the topic of research.

Among the 30 selected studies, 3 types of study types were identified, according to the classification proposed by Wieringa et al. [35]: validation research, opinion papers and philosophical papers.

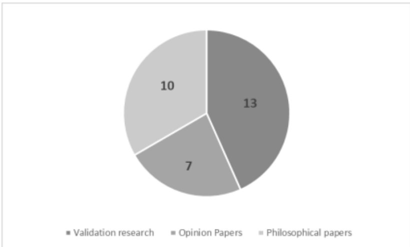

Figure 3. Distribution according to the type of study, according to Wieringa et al.[35].

- RQ1 1: What are the required assets that outline an educational virtual world?

The most frequent concepts following a keyword analysis associated to this RQ are mapped in Figure 4.

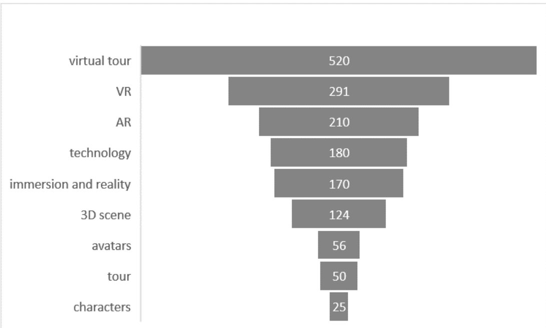

Figure 4. Keywording frequency according to RQ1.

Given the expansion of the virtual world technology, a focus on scene modelling and 3D implementation is required. The existing definition of 3D functions within a poly-identity system working in the physical and 3D virtual realms is a positive contribution in this area. However, future research in this field will benefit from extending the current analyses to digital domains other than 3D virtual worlds (such as social networking sites, digital gaming) to comprehend the dynamics of new, multifaceted systems of identity operating across the physical world and a complex array of 2D and 3D platforms [20].

Virtual Reality (VR) settings are recognized as an emerging instructional approach in school curricula and corporate training, as their interest in the market is rapidly increasing.

Immersive tools are essential in situations where behavior and photorealism are crucial, enhancing students' spatial and practical knowledge via avatars, virtual worlds, and virtual reality systems. Studies have shown that the generation of 3D avatars from 3D scans of human subjects is an important area of research, and the current trend is to develop low-cost, quick, and flexible solutions using 3D cameras for human shape 3D acquisition and the ability to rapidly generate the subject's dynamics to generate a seamless animated virtual character [29].

- Question 2: What exploration techniques are used in immersive educational environments?

The most frequent concepts following a keyword analysis associated to RQ2 are mapped in Figure 4, where the correlations between the concepts is presented in Figure. 5.

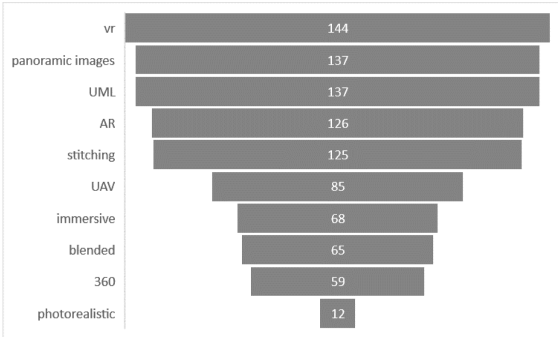

Figure 5. Keywording frequency according to RQ2.

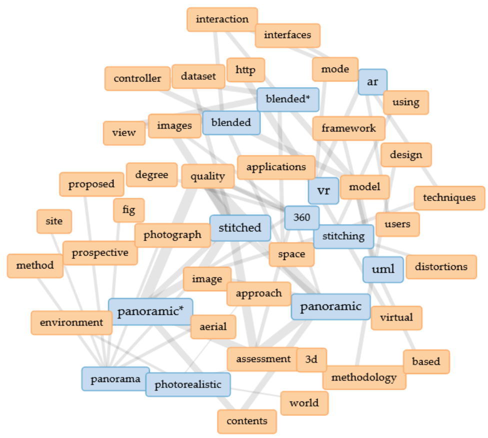

Figure 6. Keywords correlations within RQ2 concepts.

The selected studies included in the mapping have shown that in Photorealistic Environments, users may examine the tunnel's structure without being physically present [26]. In contrast to other types of environments, this environment cannot be generated procedurally due to the presence of numerous 2D and 3D objects that cannot be generated randomly. These must be strategically placed for the environment to resemble the real world [27].

When referring to a Unity3D world, the included sample scene has default configurations that can be easily modified using the editor's exposed parameters. "Redirected User" is the root game object's name that contains the user's representation and the tracking space. This game object's position and orientation change when redirection is applied, and by inheritance, so do the user and tracking area. The redirected user is the real world's origin relative to the virtual world [28].

- What is the student's perception of using virtual educational environments?

The most frequent concepts following a keyword analysis associated to RQ3 are mapped in Figure 6, where the correlations between the concepts is presented in Figure. 7.

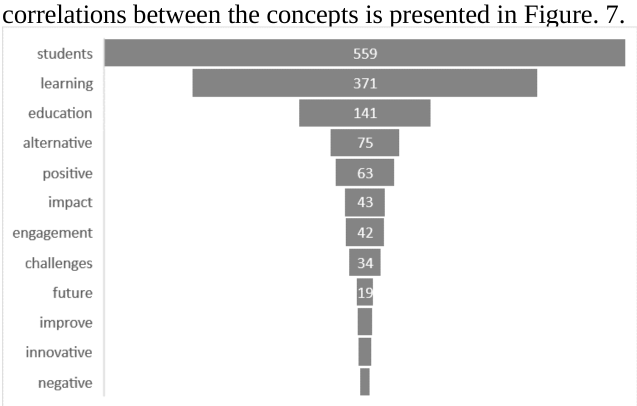

Figure 7. Keywording frequency according to RQ2

Figure 8. Keywords correlations within RQ3 concepts

According to the outcomes and findings the selected studies, the students viewed the instructional intervention of Virtual Worlds as overwhelmingly beneficial. Negative perceptions centered primarily on technology faults and the inadequacy of virtual reality to suit all students. Students with visual impairments, for instance, had difficulty accessing the VR content [24]. Thus, they could benefit from a 2D video option or an on-screen Virtual Tour. In addition, according to the study's findings, students evaluated the Virtual World immersive education intervention as a tool that can improve their comprehension of taxation principles.

The use of immersive VR in education can enhance cognitive abilities. The findings reveal that immersion in VR provides with alternative assessment methods and co-creation features [25]. Furthermore, the responses reveal that traditional teaching techniques have a high error rate, and students may respond with basic information or understanding. In contrast, the teaching methods in immersive environments provide students with a more detailed and visual understanding that may help in knowledge processes (creation, retention etc).

V. CONCLUSIONS

The conducted mapping study enhanced the premise that new digital technologies such immersive exploration and virtual environments may be adopted for self-studying or structured education settings, contributing to a more engaging active learning. VR becomes a notable candidate for alternative instructional tools due to its availability to the audience and its high degree usability and interactivity. The preliminary assessment that has been proposed within this work provides the premises for furtherly developing a systematic literature review.

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