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Metaverse Workspaces for Active Learning — Brazilian Oil & Gas Company Case

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Abstract: The digitization of the economy, already quite advanced before 2020, accelerated significantly during the pandemic. Restrictions on holding face-to-face educational events during this period stimulated the development of its virtual and hybrid versions, bringing new challenges to workforce skills development. This paper discusses the use of 3D virtual environments and Metaverse in carrying out workforce training events, including considerations about pre, during or post-event, from the knowledge management perspective and a SWOT based on a multidisciplinary approach. A Brazilian Oil & Gas Company case supports the discussion with lessons learned from three events involving 8,000 people and more than 104,000 man-hours of participation. The findings highlight the democratization of access to knowledge, the innovation's effectiveness in knowledge management with 90% satisfaction among the participants and favourability of 74% regarding the capacity for interaction between the participants in active learning activities.

Key words: active learning, metaverse, knowledge management, conferences, immersive learning

1. Introduction

The term "4.0" has been used to label the new paradigms achieved by this digital transformation on the economy sectors, such as Agriculture 4.0, Industry 4.0, Services 4.0 (Belk, Belanche, & Flavián, 2023) and, more broadly, Economy 4.0 (Łukasiński & Nigbor-Drożdż, 2022), characterizing an era of intense global digitalization of the economy. To be competitive in this digitized economy, it is necessary to develop new skills, as new technologies and processes require new knowledge for their adoption (Bühler, Jelinek, & Nübel, 2022).

A large part of the activities is being automated, replacing human posts with robots and many others being transformed by digital facilities, such as AI resources, for example. In this context, knowledge sharing is an important factor to facilitate the innovation process, and to support transition periods (Karuppiah, Sankaranarayanan, D'Adamo, & Ali, 2023; Ribeiro, Nakano, Muniz Jr, & Oliveira, 2022). Therefore, it is imperative that organizations take an effort to ensure smooth acquisition, sharing and utilization of knowledge between individuals and teams (Ngereja & Hussein, 2021). It's important to investigate key factors and enablers to facilitate knowledge creation and promote knowledge sharing among workers in this new economy. How blue collars engage in learning and knowledge sharing in order to develop new competencies and skills is also an opportunity for research (Ribeiro, Nakano, Muniz Jr, & Oliveira, 2022).

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The covid-19 pandemic also added a new challenge to organizations during the period of social isolation: how to continue creating and sharing knowledge with a more distributed workforce? This challenge has accelerated the search for digital solutions in corporate education to support knowledge management in a hybrid work world, that is, with flexible working hours that combine face-to-face work with remote work. The pandemic period also initiated a great growth of interest in research on the digitization of education (Díaz-García, Montero-Navarro, Rodríguez-Sánchez, & Gallego-Losada, 2022). In this sense, also seeking new solutions on the basis of digital transformation, the area of education, especially higher and workforce training, has also been experimenting with the application of new technologies and strategies for sharing knowledge, coining education 4.0 (Bonfeld, Salter, Longmuir, Benson, & Adachi, 2020).

Education 4.0 is an emergent field, and no standard definition has yet to emerge, but it has been reacting to the use of disruptive technologies, the same as the basis of other economy 4.0 sectors, in education, enabling greater effectiveness in teaching-learning strategies. As developed economies move to mature stages of the fourth industrial revolution, the quality of education needs to keep up with the required technological changes brought about by the digital transformation created by these technologies (Shenkoya & Kim, 2023).

Although distance learning supported by video calls and resource sharing has been a widely used alternative, it is far from desirable in learner engagement, a new and innovative method is needed to immerse them in the learning process, so as to develop their higher order and critical thinking skills and numerous empirical studies have demonstrated the effectiveness of Virtual Reality (VR) technologies on learner immersion and learning outcomes (Wang, Yu, Bell, & Chu, 2022).

Among the applications of VR technologies in the learning process is the creation of immersive environments to promote learning, called edu-metaverses, with the differential of promoting greater contextualization and social collaboration, fundamental aspects for the creation and sharing of knowledge (Guo, Suo, Hu, & Duan, 2022; Ruwodo, Pinomaa, Vesisenaho, Ntinda, & Sutinen, 2022). The edu-metaverses has been explained as a kind of educational environment beyond reality, which has the immersion characteristics of the real world and the open and free characteristics of the virtual world (Zhong & Zheng, 2022). Edu-metaverses provides new possibilities for innovation in learning environments and resources, teaching forms, and educational content, and will promote profound changes in education and empower the future of education. Nonetheless, the theoretical support of the metaverse, the infrastructure construction of new technologies and ethical research still need to be further explored to move together toward a future of deep integration of technology and education (Zhong & Zheng, 2022).

In this exploration, the opinion of users is a relevant aspect for the adoption and evolution of the use of such environments, as well as for evaluating how they contribute to improving knowledge sharing and education in general (Ruwodo, Pinomaa, Vesisenaho, Ntinda, & Sutinen, 2022).

Some academic congresses have already taken place in 3D immersive environments like that (Wang, Yu, Bell, & Chu, 2022). Holding seminars is an example of knowledge management practice in organizations that also began to use this kind of solution. This paper discusses the use of 3D virtual environments and Edu-metaverses in carrying out workforce training events, as seminars events, with the aim of identifying strengths, weaknesses, challenges and opportunities for their use in corporate seminars from the company employee’s perspective.

2. Literature Review

Using Virtual Reality to solve the adult problem in higher education has been researched since 1995 and still going rapidly nowadays (Sunardi & Meyliana, 2022). Applications were initially more present in the implementation of virtual environments, such as laboratories for learning various topics, such as the laboratory for automation systems simulated experiment presented by Schaf, Paladini, & Pereira (2012) and the Virtual Laboratory for teaching Calculus presented in Tarouco, Gorziza, Correa, Amaral, & Muller (2013). In these works, the potential for collaboration provided by virtual reality was already highlighted.

With the technological evolution of 3D virtual environments, making the potential to simulate social relations in such environments more robust, the term metaverse began to be more used to name such environments. Although it is still a concept under construction, the typology for metaverses, presented by Kshetri (2022), shows the evolution of the concept and classifies metaverses into four categories, depending on the degree of control that the user has over the environment and the interface technology (2D or 3D). Table 1 presents the four categories formed by the respective quadrants.

Table 1 Diverse Metaverses: A Typology and Examples.

Decentralized economy based on cryptocurrencies ⇨ 3D VR/AR content. ⇩	**No**	**Yes**
No	[1] 2D virtual meeting spaces (for example, Gather Town)	[2] 2D Web3 games (for example, Reality Chain, Crypto Quest, Osiris[13])
Yes	[3] 3D metaverses in which users are within confines of a centrally controlled environment (for example, Fortnite, Roblox, and Horizon Worlds)	[4] 3D metaverses based on decentralized blockchains (for example, Decentraland and The Sandbox)

This typology of the metaverse can help us understand how different metaverses create value for users in many ways in relation to the importance given to different metaverse features. In physical worlds, for example, participants move fluidly from one conversation to another. A simple 2D metaverse, like cited at first quadrant, can improve this aspect by allowing people to interact more naturally (Kshetri, 2022).

The 3D metaverses bring the benefits of a more realistic manipulation of objective that provides greater potential for use in simulations such as experiences in virtual laboratories (Schaf, Paladini, & Pereira, 2012; Tarouco, Gorziza, Correa, Amaral, & Muller, 2013) and design of products and physical environments (Khansulivong, Wicha, & Temdee, 2022). Other benefits are enhanced motivation, effective communication, flexibility, time, and cost-effectiveness (Häfner, Dücker, Schlatt, & Ovtcharova, 2018). Some universities are creating their campus versions in centralized 3D metaverses, which are being called metaversity (Meta-University). For example, the University of California, Berkeley rebuilt its campus in the sandbox game Minecraft and held an online graduation ceremony. An international virtual campus was created to replicate the dynamics and design of the campuses of the University of California, San Diego (UCSD) in California, USA and Waseda University in Tokyo, Japan (Wang, Yu, Bell, & Chu, 2022).

This metaverse context it is possible to have spatial union, interactive presentations and collaboration work in real time. They can support several aspects of online classrooms with realistic senses, personalized teaching models, realistic 3D identities, interactive communication, and gamified learning (Chen, 2022). Decentralized metaverses are in the early stages of their development and are built on the foundations of blockchain technologies (Wilser, 2022). They are governed through a decentralized autonomous organization (DAO). Users can purchase portions of the environment, which can be used to build marketplaces and applications

(Decentraland, 2022).

As long as the Digital Transformation is here to stay, probably the most promising aspects that are being studied, and will generate more scientific dialogue in the future, is the perception of the DT transformation of higher education by the different stakeholders involved in this change (managers, professors, administrative staff, students, employers, society as a whole…), as they hold very different points of view, but probably all of them are necessary to squeeze all the potential of this technological revolution (Díaz-García, Montero-Navarro, Rodríguez-Sánchez, Gallego-Losada, 2022).

The case study presented in this paper explores the holding of corporate seminars to knowledge-sharing, by the workers view, in immersive environments using a metaversity composed of a 3D immersive environment and a 2D centralized metaverse solution.

3. Methodology

This case study investigates the use of immersive environments and metaverses in knowledge sharing events from the participants' perspective. Three corporate seminars were held in a metaversity composed of centralized 3D and 2D metaverse environments, in a Brazilian Oil & Gas Company. Two questionnaires were applied to assess the satisfaction of the participants and the effectiveness of the experience.

The first questionnaire focused on evaluating the overall satisfaction of the participants and was composed of two questions:

1) How do you evaluate the virtual environment of this event? (5 points scale).

2) Describe the main highlights of this event and the aspects that need to be improved in the next edition (open question).

The second questionnaire focused on the capability of the environment, specifically the 2D metaverse component, regarding the communication and interaction characteristics needed in active learning practices. This second questionnaire consisted of 15 objective questions (Table 5) and 4 open-ended questions:

1) Highlight the main practical benefits perceived over other remote training solutions.

2) Highlight the main practical benefits perceived in relation to face-to-face teaching.

3) Highlight perceived limitations in relation to other teaching modalities.

4) Record here any additional considerations you find relevant.

The answers were analyzed and significant analysis criteria were identified in the view of the participants. This investigation has performed the Strength-Weakness-Opportunity-Threat (SWOT) analysis to evaluate the use of the immersive experiences on sharing knowledge with active learning resources components.

3.1 Context of Study: Immersive Sharing-Knowledge Events

The events were held in an immersive 3D navigation environment and complemented with a 2D metaverse for more interactive activities. They contemplated the realization of several keynotes and panels with the possibility of questions asked by the participants. The program was made up of external speakers, some international, and an internal speaker, sharing good practices implemented in the company. Figure 1 shows the Lobby and the Meeting Rooms Access of one of the events. The case included three events and a total of 8,448 participants and more than 104,000 man-hours of participation. Table 2 summarizes the main data of the events performed.

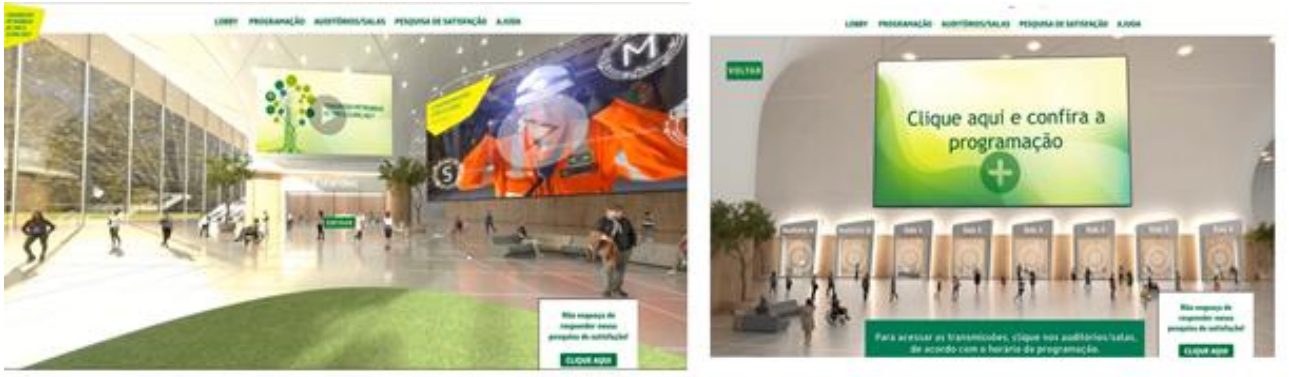

Figure 1 Lobby and Meeting Rooms Access.

Table 2 Held Events.

Title	Year	Subject	Number of participants	Format
Event 1	2021	Health, Safety, Environment and Climate.	4181	Virtual
Event 2	2022	New Methodologies and Technologies for workforce Learning.	1718	Hybrid
Event 3	2022	Soft Skills.	2549	Virtual

All events had booths areas. Contents were made available in these areas in various formats for free exploration and channels of contact and interaction with exhibitors.

Participants were also able to participate in some gamified activities available in the environment. Debates and other active learning methodologies were used in a talk area and at mini-courses with a lot of interaction, using a 2D metaverse environment. The figure 3 illustrates a group dynamic held in a mini-course.

Figure 3 A Group Dynamic in 2D Metaverse Area.

4. Findings

As attendees form the main component of the experience, their feedback offers critical insights for conducting a SWOT analysis. The organization considered in this analysis was the metaversity where the events were held. Thus, strengths and weaknesses refer to metaversity aspects and opportunities and threats refer to other external issues that can impact the success of events held in such environments.

The answers were analyzed and significant analysis criteria were identified in the view of the participants. These criteria were used to classify each item distributed in the SWOT matrix (Table 3).

Table 3 SWOT Analysis.

(Strengths)	(Weaknesses)
Availability: Availability of access to content and programming prior to the event. Increased access to post-event content. Possibility of accessing the contents for those who cannot participate during the event, both the contents that were transmitted synchronously and those made available asynchronously. Access: Wide possibility of participation, without restrictions due to limited physical space. Visual Quality: Visual quality of the 3D environment, allowing a feeling of immersion. Interactivity: Participant's freedom to explore contents and environments. The metaverse feature enabled direct and extended interaction with speakers and other attendees. Organization: Organization of contents, facilitating the identification of information of interest. Architecture: Arrangement of the rooms in the 3D environment. Usability: Ease of navigation through the platform.	Programming: Few resources in programming consultation. Publicity: Lack of resources integrated with other means of communication to promote better publicity of the event. Accessibility: Not having Libras in all communication situations (Synchronous and asynchronous content). Accessibility: Not having a high-quality simultaneous translation both into a foreign language and into Portuguese. Connectivity: There were some access difficulties for employees on board platforms. Interaction in lectures: Interaction with lecturers during lectures was restricted to chats. Delay: The contents of asynchronous streams were not available instantly. In some events they were made available a few days later.
(Opportunities)	(Threats)
Availability: Access at any time and without queues. Geographic Dispersion: Enabled participants from all regions of the company. Globalization: made possible the participation of many international speakers.	Disclosure: Little advance notice of events makes it difficult to reserve agendas for participation. Interaction: Lack of a communication channel with participants before the event. Focus: Some reported greater difficulty concentrating because they were not in an isolated physical environment for the event. It is easier to shift attention to other demands. Agenda: Difficulty prioritizing time at work to participate in events.

The SWOT analysis demonstrates that democratization of access to knowledge and collaboration, due to the high availability and ease of access are more significant strengths, whereas lack of an appropriate accessibility and competition of attention in digital with other demands of work are major challenges in the holding the events.

Table 4 presents the consolidation of the satisfaction assessment regarding the experience in immersive environments, based on the answers to the objective question. The evaluation scale used was from 1 to 5, where 1 represents a bad experience and 5 an excellent experience.

The general evaluation of the experience in the environment was favourable by 90% (grades 4 and 5). In the open questions, recommendations were reported for more intensive use of this resource in the next events, relating it to a greater capacity for interaction and active learning. Event 1, which took place every two years in face-to-face format, had a participation increase of 329%.

Table 4 Attendees' Satisfaction.

	1 (Bad)	2 (Poor)	3 (Average)	4 (Good)	5 (Excellent)
Event 1	0	2%	6%	43%	50%
Event 2	0	3%	16%	31%	50%
Event 3	0	2%	3%	43%	52%
Total Averages	0	2%	8%	39%	51%

As for the sessions held in the 2D Metaverse with avatars, there was great demand, the vacancies were quickly exhausted, showing the interest by the new technology. Table 5 presents the consolidation of the participants' satisfaction assessment regarding the interactivity resources of the 2D metaverse component used for active dynamics.

Table 5 Metaverse 2D Component Evaluation.

Question	1 (Bad)	2 (Poor)	3 (Average)	4 (Good)	5 (Excellent)
Ability to see and hear the presenter/avatar.	1%	6%	10%	28%	54%
Ability to interact with the present/avatar.	4%	6%	12%	28%	49%
Ability to access shared content (videos and documents).	4%	6%	13%	33%	43%
Ability to see and hear the other participants.	3%	8%	14%	23%	53%
Ability to interact with other participants.	6%	5%	15%	21%	53%
Ability to gather in groups.	6%	4%	9%	28%	52%
Ability to move between groups.	6%	6%	10%	27%	51%
Ability to hold informal conversations.	8%	11%	9%	27%	45%
Ability to move through the spaces of the environment.	6%	4%	15%	28%	46%
Ability to understand the way of interaction with people and environments.	7%	4%	12%	31%	45%
Accessibility Features.	8%	9%	15%	27%	41%
Ability to simulate situations that occur in real physical spaces.	9%	3%	26%	26%	35%
Ability to promote informal learning: e.g., Corridor and coffee conversations.	9%	11%	20%	27%	33%
Ability to perform group dynamics, such as World Coffee.	5%	5%	29%	23%	38%
Ability to hold events such as congresses and seminars.	9%	1%	27%	22%	40%

5. Conclusion

The virtual 3D immersive seminars presented in this case achieved high levels of satisfaction on the part of the participants regarding the digital format. The average satisfaction rating was 90%. The visual quality, the interactivity with content and participants, the architecture and ease of navigation in the environments, and especially the availability of access at any time, were highlighted as strengths perceived by the participants. One of the events had a 329% increase in the number of participants compared to the previous edition held in person. The sense of presence was also highlighted and perceived as a motivational factor, generating engagement in knowledge sharing.

In the active activities developed in the 2D metaverse, greater agility in grouping people and less time spent to gather participants in the same place were highlighted. Playfulness and interaction that were more spontaneous and closer to face-to-face were also mentioned. The favourability of 74% was verified regarding the capacity for interaction between the participants.

Among the weak points were the lack of customization in programming access, translations, and mainly the lack of more accessibility resources, such as the use of Libras. In addition to criteria related to the environment, the survey also highlighted some opportunities for threats arising from the adoption of this event format. Among the opportunities, greater ease of international participation was highlighted, favouring the sharing of knowledge globally and the optimization of time. But it was also highlighted that this flexibility can be a threat by making it difficult to prioritize the time for the event due to other demands in the workplace.

This work, however, was restricted to an analysis from the point of view of the participants. Complementary analyses from the point of view of speakers and organizers of the event are recommended for future research.

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