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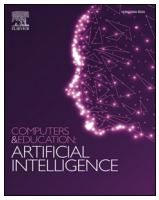

Perceptions and use of metaverse in higher education: A descriptive study in China and Spain

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ABSTRACT

The coronavirus disease – 2019 pandemic has accelerated the proliferation of virtual technologies and had have an enormous impact on education. In this paper, we analyse teachers' perceptions about the use of the metaverse in educational practices and how it contributes to the local development. We focused our study in China and Spain as reference countries in the metaverse, but whose collaboration, in this arena, is not significant. For that purpose, we designed a questionnaire to explore the views of 20 teachers from each of the two universities selected, one in China and the other one in Spain, which applies an innovation and entrepreneurship education. The results show that the educational use of the metaverse is in its initial experimentation phase. Its application in innovation and entrepreneurship education is not limited to teachers' attitudes towards teaching, but rather to how the use of metaverse allows students to acquire real skills, which can contribute to the development of the society and improve international cooperation, thus creating a virtuous circle. Faculty training and university facilities remain limited for its implementation. Further research is needed on the data protection and privacy aspects on the practical educational use of metaverse.

1. Introduction

In the context of globalisation and the emergence of new information and communication technologies (ICTs), the coronavirus disease – 2019 (COVID-19) pandemic has driven the development of virtual content and a significant trend towards the digitalisation of higher education content and e-learning, trying to meet the students' learning and well-being (Ruz-Fuenzalida, 2021).

However, currently, the online modality mostly relies on two-dimensional (2D) platforms struggled with glitchy internet connection. The lack of contextualisation and interactivity in online learning has led to a poor sense of presence and engagement (Alamäki et al., 2021; Chua & Yu, 2023). In this context, there is a growing trend in online education to migrate from 2D to three-dimensional (3D) platforms (Rodríguez Ibáñez, 2018). On the one hand, 3D-based ICTs, such as virtual reality, create computer-generated environments where users can feel immersed and located in a different place, with the ability to interact with digital and physical objects (Slater & Sanchez-Vives, 2016). On the other hand, augmented reality expands the perceptual experience of users by integrating computer-generated virtual information into their visual environment (Gsaxner et al., 2021). Therefore, technologies are facilitating learning environment, that could in turn improve learning outcomes (Alamki et al., 2021).

The metaverse is a combination of "meta" and "verse", where "meta" means "transcendence" and "verse" means "universe" (Chua & Yu, 2023). As a product of the new stage, it will become a new form of next-generation internet (Liu et al., 2021). The metaverse encompasses the integration and overlap of the virtual environment with real worlds, real economies, social life, real identities, and physical assets. This integration involves various technologies, such as high-speed communication networks, augmented reality, virtual reality, mixed reality, Cloud Computing, Edge Computing, the Internet of Things (IoT), Blockchain, Artificial Intelligence (AI), and other technologies (Bhugaonkar et al., 2022; Hernandez et al., 2023). The goal is to bring this digital universe into perfect harmony with reality, so that everything in our real lives can be realised in virtual space (Contreras et al., 2022). As the use of meta-verse campaigns continues to grow, augmented reality has gained recognition in educational contexts (Sunardi et al., 2022). Implementing a meta-learning system, based on digital technologies such as mixed reality, augmented reality, and virtual reality, is a good

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way to develop students' self-awareness and independent learning habits (Violante & Vezzetti, 2015). Therefore, the metaverse is increasingly becoming a vital component of the educational technology sector. Immersive metaverse learning has particular appeal to young people (Kshetri et al., 2022). The combination of metaverse-related technologies in the educational environment enables unprecedented immersive learning experiences. It allows for the gamification of lessons, virtual exploration of history and culture, and engagement with subjects like physics and science in ways never before imagined (Sanglier Contreras et al., 2021).

According to United Nations Educational, Scientific and Cultural Organization (UNESCO), the vast majority of countries and regions have adopted online education to ensure the stability and continuity of education during the COVID-19-induced educational hiatus (UNESCO, 2021). Visual immersive technologies, including virtual reality, extended reality, virtual worlds, and digital twins, which form the foundation of the metaverse, are constantly reshaping online education in terms of learning resources, teaching organization, and system platforms (Liu & Wang, 2020). Using metaverse technology, a university can create a metaverse centre, allowing students, teachers, and other school staff the flexibility to communicate and interact with each other via video calls or conferences as if they were present and together (Moolenaar & Sleegers, 2015). This approach is particularly beneficial for universities that offer all their training online and heavily rely on e-learning, as it humanises the educational experience, despite initial contradiction (Contreras et al., 2022). Thus, thanks to the metaverse, educational institutions can provide a 360° experience to students and workers, while also gaining flexibility and adaptability in the face of unforeseen events (Muijs, 2015).

In recent decades, the metaverse has garnered significant attention worldwide due to technological advancements in education. It is believed that metaverse education will bring about profound changes and empower the future of education. The establishment of metaverse universities presents numerous possibilities for the future of education (GmbH, 2021), including reality synchronisation, high simulation, innovative creation, and open-source development, and continuous dynamic development (Yu, 2021). There have been some preliminary practices and analyses. In China, the year 2021 has been referred to as the 'nascent stage' of the metaverse (Liu et al., 2021). The University of Berkeley, reconstructed its campus in the sandbox video game Minecraft and conducted a graduation ceremony within the game itself (Duan et al., 2021).

In various metaverse-enhanced fields within higher education, such as Journalism and Communication Education (Dai & Liu, 2023), medical schools have created mixed-reality environments to enable medical experiments and teach other subjects. Western Reserve University's medical students wearing HoloLens glasses to observe the organs and systems of the body, mixed-reality environments are replacing traditional anatomy labs filled with cadavers (Griswold, 2016). In the realm of physical education, there are already many projects based on virtual or augmented reality teaching activities currently under development (Yu, 2022). Metaverse technology can be considered valuable in language teaching as it enables participants to interact in a virtual world (Park, 2021). Innovation leads the development of science and technology and society, so innovation and entrepreneurship education (IEE) is very important to train innovative talents (Zhang et al., 2023). When it comes to IEE in the metaverse, virtual reality is the most likely technology to be integrated (Fourtané, 2022). In France, Institut Europeen d'Administration, utilises virtual reality to enhance the teaching process for teachers and to manage student learning. In Spain, metaverse has been applied for exhibitions and tours in the science museums (Contreras et al., 2022). Moreover, interactive case-based sessions have become more effective through virtual reality. For example, in Singapore, students run a juice bar in a virtual space through a virtual reality experience (Kefford, 2022).

According to Global Economy on Track but Not Yet Out of the Woods published in International Monetary Fund Blog 2023, in the Post COVID-19, the problems of increased geo-economic polarisation as the world economy splits up into competing blocs will be particularly damaging to emerging and developing countries, which will become even more dependent on the integrated global economy, international investment and technology transfers for their economic development (Gourinchas, 2023). In this context, Europe is overcoming its geographic and geo-economic heterogeneity to strengthen its co-operation with China (Mouritzen, 2023). Spain is an important country in the European Union and plays an active and significant role in regional and international affairs (Kern, 2023). Spain, as the representative of the Spanish-speaking world, plays an irreplaceable role in globalization. China is a leader in innovation (Blanco, 2019). China and Spain are working together to promote new developments in the comprehensive strategic partnership and make positive contributions to the recovery and growth of the world economy (Ministry of Commerce of the People's Republic of China [MC], 2022). In order to further advance economic development and sustainable development, there is also a need to consider new trends and challenges in how to achieve the Sustainable Development Goals (SDGs) (Kaftan et al., 2023). In this context, entrepreneurship and innovation positively contribute to economic development (Szabo & Herman, 2012). Specifically, IEE is part of SDGs and helps equip youth and adults with the necessary competencies (especially technical and vocational competencies) to gain access to employment, thereby furthering economic and regional development (Qiu et al., 2023).

In this framework, the concept of the metaverse is in the spotlight for everyone (Lin et al., 2022), and five countries or regions that contribute most to these trends through Google searches are Singapore, the Kingdom of Saudi Arabia, China, Hong Kong (China), and Switzerland (Google Trends, 2023). According to the findings of the research conducted in the study titled 'Is Metaverse in education a blessing or curse: a combined content and bibliometric analysis', Spain has more studies on the metaverse in Europe (Tlili et al., 2022). Therefore, China and Spain are reference countries in the metaverse, however, China and Spain have not yet cooperated scientifically in the field of education in the metaverse (Chen et al., 2023). In this study, we compare the use of the metaverse in China and Spain in higher education through public universities in both countries.

1.1. The aim of the study

In this context, we have three objectives: First, to explore the perceptions and use of the metaverse by higher education faculty in innovation and entrepreneurship, in particular, understanding the concept of technology acceptance. In addition, as a consequence of the COVID-19, social isolation and border closures adopted by many countries to control the spread of the virus have affected to the teaching-learning process (Liu & Wang, 2020), our second objective is to learn about the characteristics of the metaverse and its incorporation into IEE from the perspective of experts and teachers to analyse the consequence of the COVID-19 pandemic on IEE. Finally, in the third objective we aim to explore the collaboration and internationalisation between China and Spain in higher education in IEE to promote local development.

2. The metaverse and its applications in higher education

The concept of the metaverse is a novel concept, on the contrary, it has already appeared in Snow Crash, a science fiction novel (Stephenson, 1992). Currently, a unified definition or a definitive form of the metaverse is lacking, and its main areas of application are still centred on social and gaming industries. As a vertical use of the metaverse in the field of education, it can offer a highly immersive and interactive virtual-real teaching environment and experience for participants by sharing, linking, and promoting the representation of learners' thinking (Zheng Z et al., 2022). According to Roblox CEO Baszucki, the metaverse has eight basic characteristics: identity, friends,

immersion, low friction, variety, anywhere, economic system, and civility; and seven dimensions: experience, discovery, maker economy, spatial computing, decentralisation, human-computer interaction, and infrastructure (Zhu, 2021).

The metaverse can bring several advantages to higher education (Kshetri, 2022). The metaverse provides an alternative resource for supporting learning and teaching, making educational resources affordable. For example, it is possible to save a lot of money by replacing a real cadaver, which is difficult to use and maintain repeatedly, and use a virtual cadaver, which does not degrade and is easy to maintain. This metaverse motivates and engages learning (Nashville, 2021). Gamification of learning, with scenarios and experiences, makes immersive learning akin to 'game addiction'. Compared to face-to-face and online education, immersive online education is no less efficient and effective and is even better in terms of presentation, depth of explanation, spatial and temporal breadth, and breadth of connection, so it can help students improve their learning outcomes (Zheng et al., 2022). For example, in recent years the Department of Industrial Engineering at the University of Žilina has been focusing on the field of digital factories. They teach lean management to students through the virtual reality game of the 5 S method, that is created from five Japanese concepts beginning with the letter "S" that were utilized to establish a workplace conducive to visual control and lean production (Muotka et al., 2023), which is a production system proposed by Toyota of Virtual Worlds Platforms (VW) in courses on subjects such as digital business, managing operations, creating production and assembly systems, and designing production processes (Krajčovič et al., 2021). Through a case study of the lean management teaching method in virtual world platforms, where the educational game has high acceptance, it was concluded that the experience of teaching through VW makes learning more entertaining, students more motivated and is a more acceptable method of teaching (Jovanović & Milosavljević, 2022). A metaverse can facilitate experiments difficult to conduct in the real world; for example, there are many more dangerous things to do in a real classroom, such as practically handling an aircraft and doing chemistry experiments. In such cases, immersive simulations of real environments can be created using special equipment to replace practical exercises. Students feel the digital world is real and safe (Kshetri et al., 2022).

More than a decade ago, several authors have conducted research on students' perceptions of technology-enhanced learning and metaverse in higher education (Downie et al., 2021; Hwang et al., 2023; Chen, 2023; De Classe et al., 2023). However, studies analysing teachers' acceptance of technology and their perceptions and approaches to using metaverse have been understudied (Englund et al., 2017; Downie et al., 2021). It was argued that the metaverse could become a space where people could meet and interact socially, which required higher education to be proactive in its use for teaching and learning purposes (Collins, 2008). Several authors consider that the positive nature of teachers' beliefs and conceptions towards the metaverse favours their successful use in the teaching process (Díaz Gandasegui, 2013; Reyes, 2020; Sunardi et al., 2022). Thus, positive attitudes facilitate to drive the development of the metaverse, leading to the integration of technologies such as Industry 4.0 technologies, the Internet of Things, cloud computing, big data, artificial intelligence/machine learning, blockchain and gamification technologies (Hernandez et al., 2023). These technologies are combined with ethical and humanistic areas while providing a more interesting and individualised experience for the learner (Ahmad et al., 2022). However, more case studies are needed to examine learning outcomes, we do not yet know the cost-effectiveness that these technologies can bring, and more importantly, further advances in augmented and virtual reality before the metaverse can become an educational tool (Frith, 2022). However, several aspects need to be considered, especially in educational context where the privacy of the metaverse is one of the biggest challenges at the moment (Ahmad et al., 2022; Ortega-Rodríguez, 2022; TATA Consultancy Services, 2022). Therefore, decentralised technologies (such as blockchain) are needed to ensure the security of educational activities and to protect personal property and data from external modification in the metaverse (Hwang & Chien, 2022; Min & Cai, 2022). Students find themselves in a virtual environment that can deprive them of opportunities to participate in and learn about the real world (Hwang & Chien, 2022). There is the added difficulty of knowing the perceptions and attitudes of innovation and entrepreneurship education teachers in this regard. However, in the era of Web 4.0, the combination of ICT with innovation and entrepreneurship education can improve the efficiency and level of education, and students will be able to master and learn ICT applications, such as cloud computing and metaverse, and strengthen their innovation and entrepreneurship skills (Zhao & Chen, 2021). In addition, other researchers have found that students' perceptions of metaverse use influence their attitudes towards it (Schott, 2013; Shen & Eder, 2008; Shyr et al., 2022).

Nevertheless, the metaverse is still perceived as a social, industrial, technological, and educational revolution, requiring the evolution of the state and its protective measures to adapt to this emerging reality. It is emerging as a socioeconomic and cultural force that may disrupt the current rule of law, transforming it into a collection of autarkic state entities that, although exclusively virtual in appearance, have extensions in natural reality. Consequently, the meta-state is emerging as a social cornerstone. Therefore, it must safeguard its citizens in all spheres and situations and prevent the dilution of the state due to the lack of adaptation of norms during a time when state technification will be practically complete (Ávila, 2022).

2.1. Regulation and educational use of the metaverse in higher education in China

In China, the government places significant importance on the development of the metaverse and related industrial technologies. In October 2022, the Ministry of Industry and Information Technology, along with the Ministry of Education and other departments, released the 'Virtual Simulation Reality and Industry Application Integration Development Plan (2022–2026)' to promote the advancement of core software and hardware for virtual reality. The plan aims to create a new ecological situation for the development of virtual simulation, foster innovation in application integration in industries, promote the upgrade of teaching models to independent experiences in higher education, and establish immersive classrooms that support independent research and collaborative learning (MIIT, 2022).

From a regulatory standpoint in China, the risks associated with the metaverse have raised concerns among various sectors of society and regulators (He, 2023). Users have the ability to create their own digital avatars and engage in various activities as virtual individuals in the metaverse. However, this conflicts with the existing requirements for 'Real name registration for Internet access' administration in China, as stated in the Cybersecurity Law of the People's Republic of China (2017). Currently, there is no systematic planning for the use of educational metaverses in China, and there is a lack of clear development goals, market mechanisms, and specific legal regulations (Teng, 2022). Nevertheless, technological innovation does not require specific legislation or an institutional framework that the law should specifically regulate the metaverse of security risk. This blurs the scope of the basic function of the law, the idea of regulating security risks in the metaverse should follow the general approach of legal response techniques, that is, reinterpret the fundamental concepts and application of existing legal provisions with a focus on process risk prevention (Jingwu, 2022).

Several universities in China are developing their own metaverses for educational purposes. For instance, Tsinghua University is working on the 'Metaverse Special Project', which revolves around the theme 'Metaverse of Arts and Sciences'. This project includes a museum of the future, a museum of future science and technology, a city of the future, cosmic exploration, and cultural heritage (Wen, 2021). The University of Hong Kong (Shenzhen) has developed a prototype of a blockchain-based metaverse system where student behaviours in the

physical world can influence the digital world and vice versa (Duan et al., 2021). The Hong Kong University of Science and Technology has launched MetaHKUST, the world's first metaverse twin campus, which consists of two phases. In the first phase, the university will establish the core infrastructure, including building an extended reality classroom, installing sensors, video cameras, and visualization equipment. Additionally, they will invite all members of the university to contribute to Crowdsourced Scanning of the real campus to provide the necessary images for building the virtual twin campus. Once this ecosystem is operational, members of both universities will have the ability to create their own content in the system, including personal avatars and non-fungible tokens such as virtual world gift vouchers or artworks, some of which can be displayed in the real world using augmented technology (Hong Kong University of Science and Technology, 2022). Following the closure of Shanghai University due to COVID-19 from April to May 2022, a metaverse campus was established to continue holding classes in the metaverse classrooms and even host a graduation ceremony (Xu et al., 2022). Universities are also exploring the structure of the digital library systems in the metaverse era, analysing their functional positioning and service models, and addressing the challenges associated with constructing future metaverse university digital libraries (Rui, 2023).

2.2. Regulation and educational use of the metaverse in higher education in Spain

In the European Union, the European Commission has expressed its intention to continue leading the regulation of the digital space, incorporating the initiatives of the metaverse among its initiatives (European Commission, 2022). For future Digital Services Act and Digital Markets Act Regulations and Users' Rights in the Metaverse, on December 16, 2020, the European Commission published the proposed Digital Services Single Market Regulation ('DSA, Digital Services Act'), which aims to update the regulations that outline the duties and liabilities of digital service providers, particularly online platforms. This Regulation will take the place of Articles 12 to 15 of Directive 2000/31/EC (the e-commerce Directive) and the corresponding national laws. In addition, Europe's General Data Protection Regulation, Anti-Money Laundering guidelines, company disclaimers, self-regulations on personal data protection, ethical guidelines, regulations concerning e-commerce platforms, and the labour regulations of each country where teleworking are allowed in the metaverse (Benavides, 2022).

In Spain, the regulation of metaverse use includes a Charter of Digital Rights. Again, decentralisation may pose a challenge in this respect, even though there are laws such as Organic Law March 2018 (of the State, 2021), which already include the protection of a series of digital rights for individuals. However, this legislation could fall short when applied to a metaverse population. On July 13, 2022, the Ministry of Economic Affairs and Digital Transformation published Order ETD/653/2022 which established the regulatory bases for the granting of aid by the Secretary of State for Telecommunications and Digital Infrastructures and announced the granting of aid for experimental development projects and process innovation through technologies associated with the metaverse and Web 3.0 (Ministry of Economic Affairs and Digital Transformation, 2022).

In this sense, the Declaration of Principles and Rights to Guide Digital Transformation in the EU or the Spanish Charter of Digital Rights can serve as a reference framework for creating and developing regulations to respect and protect the fundamental rights of people within these digital environments (Ayudaley, 2022).

In Spain, several authors have investigated the case and use of the metaverse using the Second Life game (http://secondlife.com), a free online video game whose structural openness makes it attractive as a virtual place for teaching (Peña Arcila, 2014; Pérez Romero, 2016; Sánchez Muñoz, 2021). Francisco Sendra, Professor of Radiology of University of Malaga, has been teaching this subject in his Radiology classes for more than a decade through Second Life, one of the applications that many experts consider to be the 'first metaverse'. According to Linden Lab, Second Life offers a creative environment for educators, especially teachers interested in e-learning, media studies, innovation, and business education (Criado & Thous-Tuset, 2013). However, there are several examples of successful cases with applications developed from the metaverse for education, such as those created by the company Educa 360, which did so as a start-up of the Minerva Programme promoted by the Regional Ministry of University, Research and Innovation in collaboration with Vodafone, with new technology already used by the Pablo de Olavide University and 250 centres throughout Spain (Geniz, 2022). The San Pablo CEU University Foundation based on Minecraft-Education Edition develops a metaverse centre as part of a future educational tool (CEU Universities, 2021), where EEI has launched in its campus as a metaverse for the Executive Education Program (Bosada, 2022).

3. Methods

This study employs a combined methodology comprising fieldwork, quantitative analysis using questionnaires, and a qualitative analysis involving interviews with participants who hold specific opinions. We designed a questionnaire and interview questions based on the work of Dwivedi et al. (2022) who combined the narrative and multi-perspective approach from experts from different disciplinary backgrounds in metaverse and its transformational impact.

For our analysis, we selected two public universities, Polytechnic University of Valencia (UPV) and Nankai University (Nankai), based on their similar positions in the QS 2023 ranking (Nankai ranked 400th and UPV 378th), as well as comparable student-to-professor ratios (11 at Nankai and 8 at UPV). In this study, a total of 40 people participated (20 Chinese and 20 Spanish professors), belonging, in the case of UPV to the institute INGENIO (CSIC-UPV), the Business Management Department and Quality, and the Innovation Management Center of UPV; in the case of Nankai people who belongs to Nankai Business School of Nankai University and Nankai University Binhai College. Interviews were made during the second-semester of the 2022/2023 academic year. We got verbal consent from all participants. In addition, we administered the questionnaire to teachers at the same period of time in both universities, being all teachers specialist in business, social innovation and entrepreneurship. For data collection, we asked the heads of research at the two participating universities to collaborate with us. For this purpose, we shared via email a link to the relevant questionnaires (in Microsoft Forms format) in Spanish or Chinese based on their native language. We chose to use a Microsoft form to collect the data in order to see how long it took each participant to complete the questionnaire and to measure the validity of the responses by completing a time check (Aust et al., 2013), with an average time spent of 12:42. Also, to ensure the validity of the questionnaire, we also used the Consistency checks method (Reips, 2009), whereby when some answers were completely opposite to others, we asked the person to give an explanation, which was explicitly included in the results. As it can be observed in Table 1, there was a balance between teachers' gender and a significant participation of them over 50 years of age.

The content of the questionnaire was validated by experts who have knowledge related to the metaverse, as researchers in the metaverse arena or teachers using metaverse approach in the field of IEE. The experts evaluated the questionnaire topics for relevance and appropriateness using a 7-point Likert scale from 1 strongly agree to 7 significantly disagree when calculating the relevance and appropriateness of the topics in the questionnaire (see Table 2). The average Cohen's kappa coefficient obtained for the questionnaires' relevance and appropriateness was 0.594, indicating a moderate level of agreement. Additionally, the questionnaire exhibited a Cronbach's alpha of 0.877, which demonstrates the reliability of the questionnaire. We employed the statistical software SPSS v.27 to calculate Cronbach's alpha and the Kappa index to

Table 1
Participant characteristics.

Group	Age	Sex	Number
Spain	Under 31	Male	2
		Female	6
	31–40	Male	3
		Female	1
	41–50	Male	0
		Female	2
	Over 50	Male	2
		Female	4
Total			20
China	Under 31	Male	1
		Female	1
	31–40	Male	1
		Female	3
	41–50	Male	4
		Female	1
	Over 50	Male	5
		Female	4
Total			20

Source: Authors' own elaboration.

Table 2
Parts and items of the questionnaire.

Parts	Items	Total
Identifications	1–3	3
Attitudes of acceptance of the metaverse	4–6	3
Attitudes to metaverse use	7–11	5
Educational use of the metaverse in IEE	12–17	6
Support from the university side	18–23	6
Appropriate tools for IEE use of the metaverse	24	1
Internationalisation and local development	25–28	4
Total		28

Source: Authors' own elaboration.

achieve these results.

The questionnaire was designed based on our research objectives, in particulars split in seven sections, two of them covering our first research objective about understanding teachers' perceptions and use of the metaverse and the concept of technology acceptance. "Attitudes of acceptance of the metaverse", "Attitudes to metaverse use"; three of them designed to answer our second research objective the perspective of the characteristics of the metaverse and its application in IEE in order to analyse the impact of the COVID-19 pandemic on IEE "Educational use of the metaverse in IEE", "Support from the university side" and "Appropriate tools for IEE use of the metaverse"; and finally a part dedicated to Internationalisation and local development to answer the third objective about the internationalisation between China and Spain in higher education in IEE to promote local development (see Table 2).

4. Results

This was obtained through the analysis and comparison of the results of a questionnaire conducted with teachers from both universities regarding their perceptions and attitudes towards the use of metaverses in higher education for IEE in China and Spain. It also demonstrates how universities will support the use of the metaverse and identifies the essential tools to make IEE more effective and suitable for the metaverse, based on the opinions of both Chinese and Spanish professors. Ultimately, understanding the opinions on using a metaverse in IEE will promote the local development and internationalisation of IEE.

4.1. Results of acceptance of educational use of the metaverse according to participant profile

The results in Table 3 indicate a tendency towards future education,

Table 3
Level of Acceptance of the use of the metaverse according to the profile of the participants.

Group	Age	Level of accepts	Number	Years ahead	Number
Spain	Under 31	Highly accepted	4	Within 5 years	5
		Fairly accepted	2	5–10 years	3
		Accepted	2	More than 10 years	0
		Regular	0	More than 20 years	0
		Not Accepted	0	–	–
	31–40	Highly accepted	0	Within 5 years	1
		Fairly accepted	1	5–10 years	1
		Accepted	2	More than 10 years	2
		Regular	1	More than 20 years	0
		Not Accepted	0	–	–
	41–50	Highly accepted	1	Within 5 years	1
		Fairly accepted	0	5–10 years	0
		Accepted	1	More than 10 years	1
		Regular	0	More than 20 years	0
		Not Accepted	0	–	–
	Over 50	Highly accepted	2	Within 5 years	2
		Fairly accepted	1	5–10 years	1
		Accepted	3	More than 10 years	3
		Regular	0	More than 20 years	0
		Not Accepted	0	–	–
Total			20		20
China	Under 31	Highly accepted	1	Within 5 years	0
		Fairly accepted	0	5–10 years	1
		Accepted	1	More than 10 years	1
		Regular	0	More than 20 years	0
		Not Accepted	0	–	–
	31–40	Highly accepted	2	Within 5 years	0
		Fairly accepted	1	5–10 years	1
		Accepted	1	More than 10 years	1
		Regular	0	More than 20 years	0
		Not Accepted	0	–	–
	41–50	Highly accepted	1	Within 5 years	1
		Fairly accepted	3	5–10 years	1
		Accepted	1	More than 10 years	2
		Regular	0	More than 20 years	1
		Not Accepted	0	–	–
	Over 50	Highly accepted	0	Within 5 years	1
		Fairly accepted	4	5–10 years	2
		Accepted	5	More than 10 years	3
		Regular	0	More than 20 years	3
		Not Accepted	0	–	–
Total			20		20

Source: Authors' own elaboration.

as the use of the metaverse is positively perceived in IEE. The level of acceptance is greatly influenced by age, as the youngest anticipate an early implementation of the metaverse in education and show a higher frequency of acceptance.

4.2. Results on the perceptions and attitude toward the educational use of the metaverse in IEE

Table 4 shows that, on the one hand, in regard to the question of whether 'The metaverse has the potential to be a platform where individuals can gather and engage in social interactions, allowing higher education institutions to actively incorporate it into their teaching and learning methods.' (Question 1), and 'It would provide students with a richer and more individualised experience' (Question 2), 100% Spanish selected 'Agree' and 90% Chinese chose 'Agree', and 10% selected 'Disagree'.

In total, 5% of Spanish university participants and 10% of their Chinese counterparts selected 'Disagree' regarding whether 'The metaverse will also help foster innovation and, with dynamic markets and an ever-evolving business environment, all companies will have a significant chance to utilize the metaverse, leading to a transformation in all sectors. Therefore, education must adapt to these changes' (Question 3). According to the interviews with the participants who 'Disagree', they believe that the metaverse cannot transform all sectors.

Whereas, 'New opportunities for education providers have emerged as a result of pedagogical approaches, leading to the development of AI-based adaptive learning systems.' (Question 4), 5% of the Chinese selected 'Strongly Disagree' and 10% chose 'Disagree', the evaluation of Spaniards is positive (60% 'Agree' and 40% and 'Strongly Agree'). However, 'Privacy is the biggest concern for all those involved in the metaverse' (Question 5), 15% of the Spanish participants disagreed on whether privacy is a challenge because they stated that the metaverse uses blockchain technology, which is conceptually secure (Lecuit, 2019).

Table 5 shows the attitude towards the educational use of the metaverse, regarding the question, 10% of participants from both countries selected 'Disagree' regarding 'Educators must improve their pedagogical methods and course syllabi to adapt to teaching in the metaverse' (Question 1). All participants of Chinese 'Agreed' for the question, 'Design and elaborate special didactic materials on innovation and entrepreneurship education, such as design thinking, the CANVA model, bootcamps, innovation management tools, and SWOT analysis' (Question 2), but 10% of Spanish 'Disagree' (60% 'Agree' and 30% 'Strongly Agree').

Whereas, 'Make innovation and entrepreneurship education activities more motivating' (Question 6), 10% of Spanish 'Disagree' (55% 'Agree' and 35% 'Strongly Agree'), all participants of Chinese 'Agreed' for the question.

Regarding the question, 'This meta-verse allows educators to extract information about the responses and interactions of learners in the classroom. For example, learners participated in a project to discuss simple and difficult problems. During the sessions, the blinks of each learner were recorded' (Question 3), 100% of Spanish 'Agree' (55% 'Agree' and 45% and 'Strongly Agree' that it is higher), but 15% of Chinese 'Disagree' (40% 'Agree' and 45% 'Strongly Agree' that it is higher). Regarding 'Management tasks, attendance monitoring, student tracking using AI, and multimodal data analysis will provide educators with a wide range of information on students' (Question 4) reactions to learning materials and approaches, 5% of Chinese 'Disagree' (65% 'Agree' and 30%'Strongly Agree'), 5% of Spanish 'Disagree' (70% 'Agree' and 25%'Strongly Agree').

More than 90% of the Chinese and Spanish participants considered the educational use of the metaverse in the IEE as positive because 100% of Chinese agreed that the 'Gamification of digital tools for education in innovation and entrepreneurship, for example, self-awareness and entrepreneurial skills' (Question 5) had very positive values (70% 'Agree' and 30% 'Strongly Agree'). Among Spaniards, only 10% gave negative ratings (55% 'Agree' and 35% 'Strongly Agree').

4.3. University support results

Table 6 shows the attitude of the respondents towards the support of the university promoting the use of the metaverse in IEE. We observe that approximately 90% of the Spanish and Chinese participants 'Agree' that it would be better if the university provided more opportunities (Question 1), and 'Dedicate the efforts and resources necessary for the acquisition and renewal of computer equipment and other tools to adapt the metaverse' (Question 2). They also 40% of Spanish and 45% of Chinese respondents 'Strongly Agree' that more training should be provided for teachers to use the metaverse in IEE (Question 3). However, 'Providing new technical equipment and mentoring educational teachers in innovation and entrepreneurship to develop teaching materials' (Question 4), where 5% of Chinese 'Disagree' (65% 'Agree' and 30% 'Strongly Agree'), 5% of Spanish 'Strongly Disagree' (15% 'Disagree', 50% 'Agree' and 30% 'Strongly Agree'). 'Advises teachers in innovation and entrepreneurship education to develop teaching materials' (Question 5), 5% of Spanish respondents 'Strongly Disagree' (15% 'Disagree', 45% 'Agree' and 35% 'Strongly Agree') and 5% of Chinese respondents 'Strongly Disagree' (10% 'Disagree', 60% 'Agree' and 25% 'Strongly Agree'). 5% of Spanish respondents 'Strongly Disagree' (10% 'Disagree', 55% 'Agree' and 30% 'Strongly Agree') and 35% of Chinese respondents 'Disagree' (55% 'Agree' and 10% 'Strongly Agree') to 'Create a metaverse centre at the university' (Question 6).

Table 7 shows that both China and Spain consider 'Organization and teamwork' and 'Business plan' as the most effective essential IEE tools per metaverse, while 'Entrepreneurial culture' and 'Learning resources' are considered as low. They also indicate that 'Self-awareness and entrepreneurial skills', 'Communication', 'Operation management', 'Marketing', and 'Business management' may be appropriate tools.

4.4. Internationalisation and local development results for the use of the metaverse in the IEE

According to Table 8, most participants believe that the metaverse

Table 4
Teachers' attitude towards the use of Metaverse (See Appendix A for questions).

		Question 1	Question 2	Question 3	Question 4	Question 5
Spain	Strongly disagree	0	0	0	0	0
	Disagree	0	0	0.05	0	0.15
	Agree	0.85	0.8	0.7	0.6	0.5
	Strongly Agree	0.15	0.2	0.25	0.4	0.35
China	Strongly disagree	0	0	0	0.05	0
	Disagree	0	0.1	0.1	0.1	0
	Agree	0.75	0.65	0.65	0.55	0.7
	Strongly Agree	0.25	0.25	0.25	0.3	0.3

Source: Authors' own elaboration.

Table 5
Attitude towards the educational use of the metaverse (See Appendix A for questions).

		Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Spain	Strongly disagree	0	0	0	0	0	0
	Disagree	0.1	0.1	0	0.05	0.1	0.1
	Agree	0.6	0.6	0.55	0.7	0.55	0.55
	Strongly Agree	0.3	0.3	0.45	0.25	0.35	0.35
China	Strongly disagree	0	0	0	0	0	0
	Disagree	0.1	0	0.15	0.05	0.05	0
	Agree	0.7	0.55	0.4	0.65	0.75	0.7
	Strongly Agree	0.2	0.45	0.45	0.3	0.2	0.3

Source: Authors' own elaboration.

Table 6
Attitude towards the university.

		Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
Spain	Strongly disagree	0.05	0.05	0.05	0.05	0.05	0.05
	Disagree	0.05	0	0.05	0.15	0.15	0.1
	Agree	0.65	0.7	0.5	0.5	0.45	0.55
	Strongly Agree	0.25	0.25	0.4	0.3	0.35	0.3
China	Strongly disagree	0	0	0	0	0.05	0
	Disagree	0.05	0.05	0.05	0.05	0.1	0.35
	Agree	0.8	0.8	0.5	0.65	0.6	0.55
	Strongly Agree	0.15	0.15	0.45	0.3	0.25	0.1

Source: Authors' own elaboration.

Table 7
Attitude towards the essential tools for innovation and entrepreneurship education.

Tools	Spain	China
Self-awareness and entrepreneurial skills	10	16
Entrepreneurial culture	4	6
Business plan	11	17
Organization and teamwork	13	17
Communication	10	15
Finance and accounting	7	10
Didactic resources	5	7
Business management	9	15
Operational management	10	14
Marketing	9	11

Source: Authors' own elaboration.

Table 8
Attitude towards internationalisation (See Appendix A for questions).

		Question 1	Question 2	Question 3	Question 4
Spain	Strongly disagree	0	0	0	0
	Disagree	0.1	0.1	0.05	0.05
	Agree	0.8	0.65	0.6	0.6
	Strongly Agree	0.1	0.25	0.35	0.35
China	Strongly disagree	0.05	0	0.15	0
	Disagree	0.35	0	0.25	0
	Agree	0.55	0.65	0.55	0.7
	Strongly Agree	0.05	0.35	0.05	0.3

Source: Authors' own elaboration.

will facilitate the creation of virtual experiences between among different cultures (Question 1), although only 10% of Spanish respondents 'Disagree', 35% of Chinese respondents 'Disagree', and 5% of Chinese respondents 'Strongly Disagree'. Whereas, regarding enabling international students to connect and interact with domestic students through novel and advanced methods that will serve as the foundations of this metaverse (Question 2), 10% of Spanish respondents 'Disagree', while 100% Chinese respondents chose 'Agree' and 'Strongly Agree'.

On the topic of companies involved in fashion, shopping, digital design, and entertainment having huge significant opportunities to benefit from a futuristic platform (Question 4), 60% of Spaniards 'Agree' and 35% 'Strongly Agree', while 55 % Chinese 'Agree' and 5% 'Strongly Agree'. However, regarding the question of promoting international entrepreneurship among national and international students (Question 3), 15% of the Chinese respondents 'Strongly Disagree' and 25% 'Disagree'. Spaniards view it more positively as 60% 'Agree' and 35% 'Strongly Agree' with it.

5. Discussion and conclusion

The study hopes to provide a relatively dialectical reference for teachers in choosing future teaching models, especially in the field of IEE whether and how to choose the use of metaverse for teaching and learning. Understanding the concept of technology acceptance its perceptions and approaches by teachers of higher education have been understudied (Englund et al., 2017; Downie et al., 2021). For that purpose, we designed questionnaires and interviews to experts in the field of IEE in two public universities in Spain and China. The aim of determining the collaboration and internationalisation of China and Spain in higher education for IEE by comparing two universities, UPV in Spain and Nankai in China, as well as comparing Chinese and Spanish laws and regulations regarding the metaverse in the literature review to understand the level of government concern and regulatory approach to the current problems in the use of the metaverse, and how it contributes to local development through the use of the metaverse by comparing the views of university experts from both countries to promote regional development through technology. Although this study is focussed on the attitudes of teachers of metaverse in education as applied in the field of IEE, it can be referenced for all disciplines in order to effectively promote the use of metaverse in teaching and learning in higher education. Our study can motivate teachers to innovate and become more efficient in their use of metaverse by understanding their attitudes, and this is particularly relevant to the increased reliance on digital modes of teaching and learning that we have seen with Post-COVID-19. Our

recognition of teachers' inconsistent perceptions of each other's levels of technology and confidence can also help to overcome and prevent barriers that may arise when teachers use of metaverse, this facilitates a more targeted approach to meeting their needs, additionally ever-improving laws and regulations will slowly clear the way for teachers' concerns of use of metaverse. Regarding the first objective, which focuses on the perceptions and positive attitude towards the use of the metaverse in IEE and the proactive measures needed to apply the metaverse in IEE. Research supports the use of the metaverse for teaching and learning purposes (Collins, 2008), complemented with other authors in papers specialising in students as research subjects to argue for teachers' attitudes. The acceptance of the use of the metaverse in IEE was high in both China and Spain across all age groups. In addition, positive attitudes facilitate its future use, as teachers hold positive beliefs and conceptions of the metaverse, favouring its successful integration into the teaching process (Díaz Gandasegui, 2013; Reyes, 2020; Sunardi et al., 2022). Teachers agreed on the need to design and develop special teaching material and tools for incorporating innovation and entrepreneurship into the metaverse, which can enhance students' learning experiences. However, concerns exist regarding AI-based adaptive learning systems and the privacy of metaverse users, which aligns with studies highlighting privacy as a major challenge within the metaverse community (Ahmad et al., 2022; Ortega-Rodríguez, 2022). Nevertheless, many professors believe that the metaverse is more secure due to its use of blockchain technology, which is conceptually very secure technology (Lecuit, 2019).

Regarding the second objective, although metaverse education has been a very popular subject in recent years, the educational use of the metaverse is currently in its early stages of development and testing (Lee & Jo, 2023). Especially, the IEE field has yet to be examined in depth (Fourtané, 2022). The COVID-19 pandemic, the proliferation of virtual technologies, and the technological advancements had a significant impact on education (Kye et al., 2021; Zeng et al., 2022). The metaverse can be integrated with various sectors and has the potential to generate substantial value, such as through the use of virtual reality, cloud computing, and artificial intelligence. However, integrating the metaverse into IEE would require significant investment from universities. Therefore, it is not surprising to see a strong consensus ('Strongly Agree') in favour of providing more training for faculty to use the metaverse in IEE and allocating the necessary efforts and resources to the acquire and update hardware and other tools for metaverse adaption. Additionally, teachers should invest more in designing and developing special IEE teaching materials. Educators should be able to extract information about students' responses and interactions in the classroom when using the metaverse for tasks such as management, attendance monitoring, student tracking using AI, and multimodal data analysis.

Regarding the last objective, in hybrid teaching and learning environments, where the boundaries between face-to-face and remote are blurred, the metaverse can be an option. Based on the basic characteristic of extending the real world into virtual worlds, the metaverse becomes a favourable approach for students and teachers to interact in hybrid teaching (De Classe et al., 2023). In that case, the metaverse enables virtual experiences between different cultures, fostering international cooperation and stimulating local development in both countries. This is the biggest difference between this article and others, through the perception of teachers, we hope that the use of the metaverse in IEE is not limited to the attitude of teachers towards teaching, but whether higher education allows students to acquire real skills, which are capable of advancing the society in order to create a virtuous circle. The use of the metaverse in creating international companies can be considered as an economic and efficient platform, depending on sector-specific needs, as it can promote growth. Therefore, incorporating the metaverse into IEE will foster local development.

6. Research limitations and recommendations

The limitations of this study include: First, the non-probabilistic sample selection due to the initial phase of metaverse use in IEE and the timing of the questionnaire administration coinciding with the summer period. Second, our questionnaire was completed in only about a week after it was sent to the teachers, and these, although most of them had knowledge of the metaverse, e.g., they were teachers of courses related to the metaverse, especially the theoretical aspects, had very little experience of actually teaching through the metaverse. Third, the samples were recruited from only one university in China and one in Spain, the generalisability of this study may be limited, and the results may be representative of only some of the teachers in these two higher education institutions. In addition, they are just teachers from areas such as economic management innovation. To further explore the factors that influence teachers' perceptions, future research could conduct in-depth interviews to explore teachers' concerns related to the virtual universe of higher education, and not just limited to a few universities or in a specific knowledge area.

Finally, the challenge that metaverse education still faces is the need for more appropriate regulation from the relevant authorities. There are still relatively few cases of use of the metaverse in IEE, and it is hoped that future researchers will conduct more case studies to further understand the parts that need to be optimised in the use of the metaverse of IEE. The study is addressing teachers' perceptions, but it would be valuable to get additional perceptions from students, institutional representatives, policy makers and civic society which help us to analyse the impact of the use of metaverse in education and society.

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Statements on open data and ethics

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Author contributions

Yinglong Qiu: Conceptualization, Methodology, Software, Data curation, Formal analysis, Writing- Original draft preparation. Rosa Isusi-Fagoaga: Visualization, Investigation. Supervision, Software, Validation, Writing- Reviewing and Editing, Funding acquisition. Adela García-Aracil: Project administration, Methodology, Supervision, Software, Validation, Writing- Reviewing and Editing. All authors have read and agreed to the published version of the manuscript.

Data availability

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. QUESTIONNAIRE FOR TEACHERS

1. Age: Under 31, 31–40, 41–50, over 51.
2. Sex: Male, Female.
3. Education: Bachelor, Master, Doctorate, other.
4. Can you accept the use of Metaverse in education? Yes, No.
5. What is the level of acceptance of the use of metaverses in education? Highly accepted, fairly accepted, Accepted, Accepted, Fair, Not accepted.
6. How many years have you thought that the use of the metaverse would be common in education? Within 5 years, 5–10 years, >10, and >20 years. Please rate each of the parameters on a scale of 1–4: 1. Strongly disagree, 2. Disagree, 3. Agree, 4. Strongly agree. **Teachers' attitude towards the use of Metaverse.**
7. The metaverse has the potential to be a platform where individuals can gather and engage in social interactions, allowing higher education institutions to actively incorporate it into their teaching and learning methods.
8. It would provide students with a richer and more individualised experience.
9. The metaverse will also help foster innovation and, with dynamic markets and an ever-evolving business environment, all companies will have a significant chance to utilize the metaverse, leading to a transformation in all sectors. Therefore, education must adapt to these changes.
10. New opportunities for education providers have emerged as a result of pedagogical approaches, leading to the development of AI-based adaptive learning systems.
11. Privacy is the biggest concern for all those involved in the metaverse.

Please rate each of the following parameters on a scale of 1–4: 1. Strongly disagree, 2. Disagree, 3. Agree and 4. Strongly agree. **Attitude towards the educational use of the metaverse.**

12. Educators must improve their pedagogical methods and course syllabi to adapt to teaching in the metaverse.
13. Design and elaborate special didactic materials on innovation and entrepreneurship education, such as design thinking, the CANVA model, bootcamps, innovation management tools, and SWOT analysis.
14. This meta-verse allows educators to extract information about the responses and interactions of learners in the classroom. For example, learners participated in a project to discuss simple and difficult problems. During the sessions, the blinks of each learner were recorded.
15. Management tasks, attendance monitoring, student tracking using AI, and multimodal data analysis will provide educators with a wide range of information on students' reactions to learning materials and approaches.
16. Gamification of digital education tools in innovation and entrepreneurship–for example, self-awareness and entrepreneurial skills.
17. They make innovation and entrepreneurship education activities more motivating. Please rate each of the parameters on a scale of 1–4: 1. Strongly disagree, 2. Disagree, 3. Agree and 4. Strongly agree. **Attitude towards the university.**
18. Offers opportunities for education in innovation and entrepreneurship in the use of the metaverse.
19. Dedicate the efforts and resources necessary for the acquisition and renewal of computer equipment and other tools to adapt the metaverse.
20. Offers more training for teachers to use metaverse in innovation and entrepreneurship education.
21. Provide new technical equipment and train educators on serving students on a metaverse basis.
22. Advises teachers in innovation and entrepreneurship education to develop teaching materials.
23. Create a metaverse centre at the university.
24. The essential tools for innovation and entrepreneurship education are most effective for the metaverse (marked with X): innovation and entrepreneurship education tools.
25. The metaverse will facilitate the creation of virtual experiences between different cultures.
26. Allowing international students to connect and interact with national students through novel and advanced forms is the basis of this metaverse.
27 Encouraging the creation of international companies between national and international students.
28. Companies involved in fashion, shopping, digital design, and entertainment have enormous opportunities to exploit futuristic platforms.

List of acronyms and full names

Full names	*Acronyms*
COVID-19	The coronavirus disease – 2019
IEE	Innovation and entrepreneurship education
ICTs	Information and communication technologies
2D	Two-dimensional
3D	Three-dimensional
IoT	Edge Computing, the Internet of Things
AI	Artificial Intelligence
UNESCO	United Nations Educational, Scientific and Cultural Organization
SDGs	Sustainable Development Goals
MC	Ministry of Commerce of the People's Republic of China
VW	Virtual Worlds Platforms
TATA	TATA Consultancy Services
MIIT	Minstry of industry and information technology of the People's Republic of China
DSA	Digital Services Act
UPV	Polytechnic University of Valencia
Nankai	Nankai University
SWOT analysis	Strengths, Weaknesses, Opportunities, and Threats analysis

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