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Student's Perception of the Use of the Metaverse in Higher Education on the Employability of Spanish Talent Market

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Abstract: This study investigates the potential of the metaverse as an educational tool in higher education and its impact on students' employability skills. With the ongoing digital transformation, the metaverse offers an immersive environment integrating virtual reality, collaboration, and experiential learning. The research aims to evaluate how participation in metaverse-based activities enhances competencies required by modern labour markets, including digital literacy, creativity, communication, and adaptability. A quantitative design was applied, involving a structured questionnaire administered to a non-probabilistic sample of 200 Spanish undergraduate and postgraduate students, aged 18 to 25, across various academic disciplines. The survey examined students' perceptions of metaverse-enriched learning, its influence on competence acquisition, and its relevance to future professional engagement. Data analysis, which utilized Structural Equation Modelling (SEM) and independent samples t-tests, confirmed strong correlations between active involvement in immersive environments and improvements in employability profiles. The results indicate that Perceived Usefulness (PU) was the strongest predictor of Intention to Use the metaverse ($\beta = 0.51$, $\rho < 0.001$). Furthermore, the study found that Engineering students reported significantly higher Perceived Usefulness ($M = 4.12$, $\rho < 0.001$) than Social Sciences students, and female students showed a greater willingness to invest time in acquiring new technological skills (Perception of External Control, $M = 4.15$, $\rho = 0.003$). The findings suggest that the adoption of metaverse technologies by higher education institutions can reduce the skills gap between academic training and professional practice. Simulation-based activities and collaborative projects in virtual spaces prepare students for hybrid and digitally intensive workplaces. The study concludes that integrating the metaverse strategically into curricula supports the development of twenty-first-century skills essential for long-term employability.

Keywords: Metaverse; higher education; employability; immersive learning; digital competencies; virtual environments

1. Introduction

Globalisation and the development of economies formerly known as 'developing economies' have exerted considerable pressure in recent years on the economies of all countries, their industries, their companies and the skills of their employees. The impact of the scope and intensity with which technological advances have affected economies has meant that companies that have not integrated digitalisation and new technological trends have lost productivity and competitiveness. The oldest companies that survive today do so because they integrated technologies into their work processes at the beginning of the digital transformation [1]. Therefore, it is past evidence that companies must look to integrate technological advances into their daily lives, and one of the keys is their employees.

The metaverse has been emerging for years as a technological tool that is transforming many paradigms [2], both in education and in the workplace. This is because the metaverse offers a clear commitment to the development of digital skills for students and future employees at university level, but also for those employees who are currently in the labour market. The arrival of the metaverse in education and employment offers more immersive digital environments, enhancing practical and collaborative learning in education and the user experience in the workplace, thereby improving the employability of both students and current employees [3].

The metaverse, in its broadest sense as a collaborative virtual space, allows students to acquire and hone their digital skills, specifically developing knowledge and abilities in communication, information management, collaborative work, and problem solving in simulated environments. The above-mentioned skills, along with others, are perfectly aligned with current needs identified internationally and endorsed in recognised international frameworks such as DigComp and ESCO [4], which are reference frameworks for the digital development of citizens and the creation of the new professional profiles that today's companies need [5]. In line with these frameworks, the use of the metaverse by students reinforces their active learning, creativity and ability to adapt to the environment and new technological challenges.

In recent years. In terms of Learning and education, metaverse has provided students an immersive and more interactive Learning experience, as well as new digital skills [5,6]. These studies show that using the metaverse as an educational technology in university settings catalyses the creation of unique and personalised learning experiences, increasing student motivation and participation in the classroom, as well as facilitating the acquisition of digital skills necessary for their future careers. Students see an increase in their attention in the classroom, their motivation and their commitment to learning through the metaverse and its immersive enhancement through virtual reality glasses, developing visible and tangible key skills that will serve them specifically in project management, collaborative work and working in a digital environment. For this reason, universities that implement the metaverse as a learning technology will position themselves as institutions committed to quality, 21st-century education, reducing the digital divide and providing young people with the best possible preparation to meet the challenges of the globalised labour market. Using VR or AR implies positive impact on metaverse as a learning tool thanks that both glasses allow connect different objects (including virtual things and people) and has such features as being "shared" or "persistent" [7,8]. It emphasizes a more social, simulated, and collaborative authentic experience rather than conventional AR/VR applications that emphasize personal experience in virtual contexts [9].

The integration of the metaverse into teaching and its effective implementation in the classroom requires a series of innovative methodologies such as learning by doing, project-based learning and, in parallel, training seminars that educate both students and teachers who will use the metaverse as a resource in the classroom [10,11]. This will address the challenges involved in using the metaverse in teaching, including the lack of training for teachers, the technological infrastructure available to universities for its effective implementation, and global access equity, all with a focus on quality teaching, increased digital skills, and a positive impact on student employability [12].

This approach positions the metaverse as a key factor in the evolution of higher education, enhancing both the quality of learning and the adaptation of graduates to new digital professional scenarios. This research pretends answer some research questions from student´s perceptions like the following:

1. Digital skills will be an advantage in finding a job
2. Technology creates more job opportunities than it eliminates.
3. The metaverse is transforming job opportunities in my sector.
4. Willing to invest time in acquiring new technological skills to improve my employability.
5. Adapting to new technologies is a valuable skill in today's job market.'

2. Literature framework

2.1. Digital Transformation and digital skills in Economy and Higher Education

To delve into the beginnings of digital transformation, we must go back to the late 1980s and early 1990s to learn about the first research conducted analysing the effect of the adoption of information and communication technologies on innovation and productivity in companies [13–15]. With the democratisation of technology, its wider acceptance and the benefits of implementing technology in companies, digital transformation became extremely important for the competitiveness of companies [16] and catalysed their internationalisation during the 1990s, subsequently leading to the implementation of e-commerce at the beginning of the new century.

Due to the impact and scope, it began to have on companies and their business models, technology became a strategic factor on which companies based their strategies [17]. Its impact on assembly lines and the value chain itself was considered in the first decade of the 21st century, causing it to disintegrate, optimising costs and increasing performance in each of the links [18]. This clearly led to greater complexity in systems, as different companies had to be integrated into the same value chain, but technology helped to minimise the negative impacts and risks of increasingly complex organisations [19,20]. Companies and their employees had to manage change in an agile manner to integrate information systems into both strategic and operational tasks and align themselves with the companies that made up their value chains, beginning to compete in the new digital era [21–23].

Although digital transformation first appeared several decades ago, following the pandemic, the consolidation of Industry 4.0 and its associated technologies, as well as the rise of artificial intelligence, are causing unprecedented changes in the economy and in businesses. Already in the past decade, digital transformation brought about major changes in businesses, moving from traditional processes to more innovative and modern ones, with significant results affecting procedures, logistics, customer service and, of course, the products and services themselves, which has a direct effect on the level of competitiveness of economies and their industries [24–26]. Digital transformation strategies are important because they reflect the omnipresence of changes brought about by digital technologies in an organization [27]. Hence, organisations must change traditional business models, which have been solid for many decades, and transform their organisations to adapt to these trends, for example, the capabilities and competencies of their employees [28,29].

Following the disintegration of the value chain and its digital integration thanks to communication and information technologies, technology set its sights on transforming the relationship between companies and their customers. Improvements in technology and Industry 4.0 facilitated the birth and development of e-commerce, where companies that were quickest to embrace digitalisation and take advantage of its benefits to meet the challenges of the new economy emerged stronger [30–32].

This intensification of digitalisation had an impact on business management, as never before had digital transformation had such an impact, allowing customers to make purchases 24 hours a day, 365 days a year, changing the rules of the game and the ways in which businesses are managed [33] and enabling the emergence of global companies [34,35].

Digital transformation, Industry 4.0 and all the technologies it brings with it [36] have also made it possible to revive many economies, consolidate others such as those of developing countries, and provide work for millions of companies. Not only has it created jobs, but it has also boosted the professional careers of many entrepreneurs by taking advantage of information and communication technologies [37,38], impacting the phenomenon known as global fragmentation [39]. Furthermore, in the wake of the pandemic, many business models have been impacted by new technologies such as blockchain [40] and artificial intelligence [41], which are transforming the economies of all countries, their industries, their companies and the way they work in a way that no other technology has ever done before.

2.2. Impact of Digital Transformation and learning process

Technology and people have always been linked and gone hand in hand, since without people there is no technology, and there is no technology that does not impact people, either positively or negatively. Since the beginning of this century, with the inexorable push towards digitisation and digital transformation, many authors have studied the relationship between digital transformation and people [42,43]. Authors have explored different perspectives ranging from social aspects [44,45] to productivity at work [46–48], customer experience [49,50] and citizens as human beings [51,52].

Employee-company and social relationships have undergone a sea change since the advent of technology, which has impacted the way people interact and, in turn, given rise to new business models [53]. This has meant that companies have had to rethink their structures, processes, values and, ultimately, a change in the rules of the game [54,55]. As a result of these changes stemming from digital transformation, many companies have adapted to new business and working models, making significant investments in the digitalisation of their businesses, mainly in terms of information and communication technologies [56–58].

Digital transformation has helped companies become more productive and enabled people to perform their work better and faster, especially repetitive tasks with no added value. as well as putting the customer at the centre of their operations through a more direct relationship with the company thanks to ICT [59,60], resulting in happier and more loyal customers than before [61,62]. This has been achieved by including technology as part of the company's strategy, acting as a catalyst for change and business success, enabling companies to innovate their business models, improve communication with their stakeholders, generate new communication networks among employees, standardise systems, automate manual processes, rationalise resources, attract and retain human talent, and make the most of their employees' knowledge and skills [63,64].

Therefore, at the individual level, digital transformation has had a major impact on organisations, with those that have struck the best balance between technology and people surviving. By integrating technology with people, companies gain a competitive advantage in the market because they obtain or develop different capabilities, knowledge or resources from this combination, thereby improving their brand reputation, creating more jobs and generating greater wealth for the economy of their region and/or country. This approach is in line with the theory based on resources as a driver of value in the company [65–67]. To date, the literature has analysed the implication of employees' digital skills on business productivity and strategy, from the management or executive side [68,69] to the role of the CIO [70,71], without forgetting their impact on management skills [72,73], innovation capacity [74,75], communication and connectivity capabilities [76,77], among others.

Therefore, rather than causing job losses, technology creates and improves jobs, with the digital skills of employees being of great value, both for those already in the labour market and those about to enter it. New generations such as Generation Z, often referred to as 'digital natives', thus have a great opportunity to exploit all their knowledge and technological expertise in their professional careers, with technology being a key element in their employability [78,79].

2.3. The use of the metaverse as a learning and working tool

Metaverse is defined as as "a computer-generated universe" that immerses people in the experience rather than merely observing [80] .A metaverse could be fully or partially virtual; for example, it could be a fully virtual world like a virtual reality (VR) system, or a partially virtual world like the use of augmented realty (AR) in real-world contexts [81]. Several researchers have further indicated the differences between the metaverse and conventional AR/VR technologies [82]. Virtual Reality (VR) and Augmented Reality (AR) technologies are currently receiving a great deal of attention, thanks in large part to the commercial availability of new immersive VR/AR platforms including its impact on metaverse [83]. Virtual reality (VR) can generally be defined as a virtual object in a virtual environment [84], more precisely a simulation or an artificial recreation, computer-generated, real-life environment or situation, immersing the user by giving him the impression of experiencing simulated reality first hand, mainly by stimulating his vision and hearing [85]. On the other hand, Augmented Reality (AR) is a field in which 3D virtual objects are integrated into a 3D real environment in real-time [86,87]. The most five significant AR applications used in education and scaled to metaverse use in class, which are the games using mostly marker-based AR technology: discovery-based learning, objects modelling, and skills training [88].

The use of the metaverse in teaching brings with it a wide range of challenges, each more complex and demanding than the last. Thinking of the metaverse as an immersive digital space that can be effectively used with virtual reality and extended reality headsets, there is a growing debate about which technology will prevail, given the current level of development of metaverse and extended reality headset providers. bringing Meta's name to the fore and the discourse on Meta's monopoly on metaverse technology and the development of extended reality glasses compatible with the immersive digital space, leading to the misconception that Mark Zuckerberg's vision will be the only future for education in the metaverse [89].

Leaving aside these economic market issues, various studies on the use of the metaverse in teaching have shown that immersive experiences improve student attention, motivation, the practical focus of the university learning model, and the acquisition of digital skills by students [90], as well as strengthening the evidence that a well-executed asynchronous class can be a great form of teaching assisted using the metaverse and extended reality glasses [91]. All of this is supported by regulations that urge higher education institutions to make ethical use of the metaverse, to make good use of the integration of artificial intelligence in it, and to use the data generated ethically without falling into data privacy issues [92]. Contrary to what is often assumed about a certain resistance to change and traditional classes, or the reluctance of teachers to innovate in the classroom and of students to step outside their comfort zone, previous studies such as [93] reinforce the idea of student acceptance of the introduction of teaching innovation and educational technology in the classroom, provided that expectations and desired performance are clear. In other words, when students' initial expectations matched their experiences, their perception of the usefulness of technology, their satisfaction and their confidence in its use improved positively, which influenced their intention to continue integrating these tools into education.

Contemporary cognitive guiding theory in education emphasizes how learners process information through limited working-memory resources and how instructional design can optimize the encoding of new knowledge into long-term memory. Cognitive Load Theory (CLT) offers the primary framework for this work, highlighting the importance of reducing extraneous load, sequencing tasks to manage intrinsic load, and fostering germane processing through techniques such as worked examples, signalling, and multimedia design principles [94,95]. Recent contributions extend CLT toward immersive and multimedia environments, integrating motivational factors and individual differences (e.g., prior knowledge, self-efficacy) while offering updated heuristics such as segmenting, modality, and redundancy management to translate cognitive theory into practice [96,97].

Modern learning theory increasingly draws on the "learning sciences" to integrate classical perspectives (behaviourist, cognitive, constructivist) with contemporary concerns about technology, emotion, and social interaction. A recent meta-narrative review of innovative learning environments highlights that conceptions of teaching and learning are shifting toward more student-centred, socially mediated, and context-dependent models (non-conceptualisations of teaching and learning). Simultaneously, research into emotional intelligence in educational settings underscores the role of emotion regulation and multiple intelligences (e.g., cognitive, interpersonal) in fostering meaningful learning experiences. Constructivist approaches are also being re-examined: for example, recent work explores how learning objects (digital reusable units) align — or clash — with constructivist metaphors of learning as knowledge creation, participation, and socially situated construction. Moreover, the "science of learning" is being reconceptualized through computational and interdisciplinary lenses, as shown in a comprehensive review arguing for unified, evidence-based definitions that bridge cognitive, behavioural, and sociocultural theories [98]. Finally, adaptive scaffolding theories for AI-based pedagogical systems are emerging, combining social- cognitive theory with evidence-centred design to support students in technology-rich environments.

The integration of advanced educational technologies—especially AI-driven and metaverse-based systems— raises profound ethical challenges around privacy, algorithmic bias, and power asymmetries. In higher education, stakeholders express significant concern about data protection and the transparency of AI systems, as "black-box" decision-making can undermine trust and disadvantage students. In metaverse environments, the ethical stakes include not only bias and exclusion but also inequality in access: many learners lack the high-speed connectivity, XR devices, or computational power required to participate fully [99]. Moreover, algorithmic fairness is a central issue, because AI models in educational contexts may replicate or exacerbate existing social inequities [100]. From an inclusion standpoint, ensuring universal access requires adherence to universal design and inclusive practices—

not just in physical or online course design, but in immersive virtual realms [101,102]. Equity also demands that under-resourced students, especially those from marginalized backgrounds, not be left behind in digital transformation: otherwise, technologies intended to democratize learning may unintentionally reproduce systemic disparities [103,104]. Ethically responsible deployment therefore calls for transparent governance, participatory design, robust oversight, and policies that guarantee both access and fairness

2.4. Technological Acceptance Model. Application Use in the metaverse

The Technological Acceptance Model (TAM) suggests that an individual's acceptance of technology can be predicted based on perceptions of its ease of use and usefulness [105]. The concept of the "person" within this model extends beyond the human individual to include the user and the employee in an organization that must adopt technological innovations. According to [106], the primary objective of the TAM is to analyze and explain the factors that determine people's use of different technologies. The model has been applied to explain phenomena such as the adoption of the Internet [107], email [108], e-learning models [109], or online applications [110].

Research on students' acceptance of the metaverse in higher education largely builds on technology-acceptance frameworks such as TAM and UTAUT, demonstrating that perceived usefulness, ease of use, enjoyment, social influence, and self-efficacy significantly shape students' behavioral intentions [111]. Empirical studies in discipline-specific contexts, including medical and software education, report generally positive engagement and learning outcomes when metaverse environments are carefully structured and supported [112]. However, concerns such as cognitive overload, accessibility, and usability remain important moderating factors. Recent systematic reviews recommend integrating acceptance models with cognitive and instructional design principles to ensure that metaverse-based learning environments translate novelty and engagement into meaningful academic performance [113,114].

This model is used to predict the use of information and communication technologies (ICTs) based on two main attributes:

- Perceived Usefulness (PU): the degree to which an individual believes that using a technology enhances their performance.
- Perceived Ease of Use (PEOU): the degree to which an individual believes that using a technology requires minimal effort.

Perceived usefulness refers to the extent to which a person believes that using a particular system will improve job performance, while perceived ease of use indicates the extent to which using that system reduces the effort required to perform tasks. Over time, several revisions and extensions of the original model have emerged, leading to TAM2 [115] and TAM3 [116].

The model proposed in this study builds upon the original TAM and incorporates key contributions from TAM2 and TAM3. In line with the TAM framework, the adoption of a technology—such as the metaverse—is primarily determined by the individual's intention to use it. This intention is influenced by two major beliefs: (1) perceived usefulness and (2) perceived ease of use. Additionally, perceived ease of use positively influences perceived usefulness.

From TAM2 [117], this study includes the construct of Result Demonstrability (RES), defined as the degree to which an individual believes that the outcomes of using a technology are tangible, observable, and communicable. Result demonstrability acts as an important antecedent of perceived usefulness. From TAM3 [118], two additional constructs are integrated: Perceived Enjoyment (ENJ) and Perception of External Control (PEC). Perceived enjoyment refers to the extent to which the activity of using a technology is enjoyable, regardless of its instrumental outcomes. Perception of external control, in turn, refers to the extent to which an individual believes that adequate organizational and technical resources are available to support the use of the technology. Both perceived enjoyment and external control serve as antecedents of perceived ease of use. In this article is proposed a TAM model to analyze adoption of metaverse by students, as can be visualized in **Figure 1**.

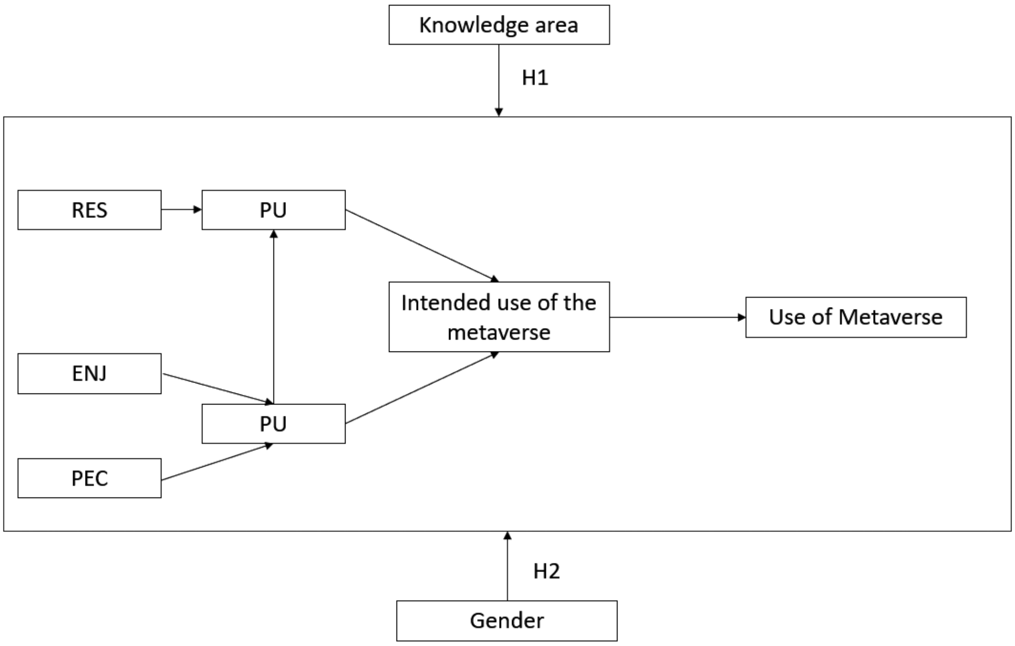

Figure 1. Model proposed. Factors Influcence of Adoption of metaverse

2.4.1. Perceived Usefulness: The metaverse as a Work Tool

The metaverse has emerged as a disruptive technological tool in both leisure and professional contexts, enabling companies to create immersive virtual environments that enhance collaboration among individuals and teams regardless of their physical location. These environments are particularly effective when combined with augmented or virtual reality technologies, allowing users—employees in this case—to interact, develop digital skills, socialize, and share knowledge within a common digital space that transcends geographic and cultural barriers.

Within the TAM framework, several recent studies have analysed users' willingness to adopt the metaverse as a work environment, identifying perceived ease of use and perceived usefulness as key determinants of adoption. For instance, [119] and [120] highlight how immersive interaction, embodiment, and persistence in the metaverse foster collaborative experiences that enhance productivity and engagement, as well as support innovative approaches to training and recruitment.

2.4.2. Perceived Ease of Use: The metaverse as an e-Learning Tool

Perceived ease of use is a crucial factor in the adoption of metaverse-based educational technologies under the TAM framework. When the metaverse is used as an e-learning tool, users tend to favor virtual environments that are user-friendly, intuitive, and accessible.

Studies such as [121] indicate that the perceived ease of use of the metaverse as an immersive educational technology in higher education is associated with greater engagement among both teachers and students. Similarly, [122] emphasize the importance of immersion, personalization, and collaborative experiences in addition to usability and perceived learning usefulness. [123] further propose that ease of use, perceived usefulness, and continued intention to use are the core predictors of adoption of metaverse-based educational platforms.

2.4.3. Result Demonstrability: The Positive Impact of the Metaverse on Job Search

The demonstrability of results of metaverse applications in employability contexts is increasingly evident, particularly among students seeking employment. The metaverse recreates workplace environments and fosters the development of digital, interpersonal, social, and collaborative skills—attributes highly valued by companies and recruitment teams in talent selection and retention processes.

Medina and Alvarado [124] analyze show that students exposed to simulations and interactive metaverse experiences achieve not only higher knowledge retention but also greater autonomy and problem-solving ability—skills that strengthen their professional profiles and improve preparedness for interviews and job performance. Personalized learning, gamification features, and the ability to access realistic virtual environments allow students to develop valuable competencies, demonstrating these through tangible results once they begin their professional careers.

2.4.4. Perceived Enjoyment: Use of Virtual Reality Headsets in the metaverse

Perceived enjoyment plays a critical role in the acceptance and use of virtual reality (VR) headsets as tools for engaging with the metaverse, particularly across educational, recreational, and professional contexts. Scientific evidence suggests that the degree of pleasure, immersion, and satisfaction experienced by users in digital environments such as the metaverse positively influences attention, technology engagement, and perceived usefulness.

Some authors conclude that perceived enjoyment can even surpass perceived usefulness as a key predictor of metaverse adoption and VR device usage [125] and [126]. These devices enhance the sense of presence and social interaction within virtual environments, thereby increasing enjoyment and user engagementOn the other hand, some studies emphasize that user-friendly interfaces, graphic quality, and seamless experiences strengthen enjoyment and, consequently, the continued intention to use the metaverse [127].

2.4.5. Perception of External Control: Time Commitment to Improve metaverse Proficiency

The perception of external control over time investment in developing metaverse-related skills is a decisive factor for successful technology integration, especially in educational contexts. Mastering metaverse tools requires not only adequate hardware, platforms, and internet connectivity but also a significant investment of time to reduce the learning curve.

Some authors note that the initial learning curve can be a challenge, requiring both students and educators to dedicate additional time to training and practice to achieve competent mastery of the educational tool [128] and [129]. However, [130] argues that perceived control over time investment can become a motivational factor when institutions provide access to resources, training, and adaptive tools, thereby balancing personal dedication with external support in developing the digital skills essential to the metaverse.

2.4.6. Hypotheses

H1: The individuals' field of knowledge acts as a moderating variable that enhances the explanatory power of the proposed metaverse acceptance model among Generation Z youth.

H2: Gender acts as a moderating variable that enhances the explanatory power of the proposed metaverse acceptance model among Generation Z youth.

Based on the proposed model (Figure 1) and the established TAM literature, the following structural hypotheses are formulated, in addition to the moderation hypotheses (H1 and H2) previously stated:

H3: Perceived Usefulness (PU) will have a positive and significant effect on the Intention to Use the metaverse.

H4: Perceived Ease of Use (PEOU) will have a positive and significant effect on the Intention to Use the metaverse.

H5: Perceived Ease of Use (PEOU) will have a positive and significant effect on Perceived Usefulness (PU).

H6: Result Demonstrability (RES) will have a positive and significant effect on Perceived Usefulness (PU).

H7: Perceived Enjoyment (ENJ) will have a positive and significant effect on Perceived Ease of Use (PEOU).

H8: Perception of External Control (PEC) will have a positive and significant effect on Perceived Ease of Use (PEOU).

H9: Intention to Use will have a positive and significant effect on the actual Use of Metaverse.

3. Methodology

3.1. Sample

The research conducted has a quantitative and exploratory approach, with the aim of analysing the motivations, behaviours and perceptions of students in the use of the metaverse in the classroom as a technological tool that helps them acquire digital skills in order to increase their employability. To this end, a structured survey was used to collect empirical data in a systematic and objective manner. The survey was authorized by Ethics Committee by UNIE Universidad due to survey was anonymous, included informed consent and include data protection policy.

The study focused on a group of 200 participants, comprising male and female students aged between 18 and 25, residing in Spain. This age range was chosen because it is representative of people who aim to find their first job at the end of their university studies, and are therefore focused on methodologies, tools and activities that increase their employability and chances of securing their first job. Data availability is restricted. Data are protected and safeguarded by both research within university´s internal protected data space on cloud.

The sample was non-probabilistic and selected intentionally. A convenience sampling approach was chosen, as the aim was to find a sample that was familiar with the digital environment and the metaverse. The participants were first- to fourth-year university students from the Faculties of Social Sciences and Applied Communication and the Higher School of Engineering, Science and Technology. There was a minority of students studying subjects such as Education and Health Sciences; however, due to their low representation, they were not included in the comparisons to avoid statistical bias.

The inclusion criterion was that the selected individuals had to be actively involved in digital metaverse or video game environments, in addition to belonging to the specified age range. This approach allowed us to focus on individuals with experience in the digital environment and an active understanding of the social and cultural dynamics of these platforms.

Participation was entirely voluntary, and respondents were informed in advance about the objectives of the research, guaranteeing the confidentiality of their responses and the exclusive use of the data for academic purposes. To ensure the accuracy of the responses, a control question was included to identify inconsistent responses, which allowed the sample to be refined and irrelevant data to be eliminated.

3.2. Survey and questions

The survey included ten specific questions to assess participants' perceptions of their technological preparedness and the job opportunities arising from digital transformation and the use of the metaverse in the classroom:

‘My digital skills will be an advantage in finding a job.’

‘Technology creates more job opportunities than it eliminates.’

‘Companies value candidates with advanced technological skills.’

‘The metaverse is transforming job opportunities in my sector.’

‘I am willing to invest time in acquiring new technological skills to improve my employability.’

‘The metaverse is an effective tool in the job search.’

‘Continuous training in technology is key to remaining competitive in the job market.’

‘Teleworking and online collaboration are transforming the work environment.’

‘Technology certifications can significantly improve my job opportunities.’

‘Adapting to new technologies is a valuable skill in today's job market.’

3.3. Variables

The structured survey instrument included items designed to measure both students' general perceptions regarding digital transformation and employability (**Table 1**) and the core constructs of the extended Technology Acceptance Model (TAM) outlined in the theoretical framework. Additionally, key demographic characteristics were collected as control and moderating variables (**Table 2**). All latent variables within the TAM were measured using multi-item scales, while the items listed in **Table 1** utilized a 5-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree) to assess the level of agreement with various statements concerning technology and the job market.

Table 1. Survey Variables and Corresponding Concepts

Nº	Variable	Concept Measured (Perception/Declaration)
1	Digitalization Process	‘Teleworking and online collaboration are transforming the work environment.’
2	Technology as Employment Generator	‘Technology creates more job opportunities than it eliminates.’
3	Technological Competences Value	‘Companies value candidates with advanced technological skills.’
4	Metaverse Use in the Labor Market	‘The metaverse is transforming job opportunities in my sector.’
5	Digital Skills Advantage	‘My digital skills will be an advantage in finding a job.’
6	Metaverse as a Key Competence	‘The metaverse is an effective tool in the job search.’
7	Digital Competence Learning Process	‘Continuous training in technology is key to remaining competitive in the job market.’

Continuation Table:

Nº	Variable	Concept Measured (Perception/Declaration)
8	Willingness to Invest Time	'I am willing to invest time in acquiring new technological skills to improve my employability.'
9	Technological Certificates Value	'Technology certifications can significantly improve my job opportunities.'
10	Technological Adaptation	'Adapting to new technologies is a valuable skill in today's job market.'

In addition to these ten primary survey variables, a series of control variables were included to strengthen the results. The primary demographic variables, Academic Area and Gender, were specifically used as moderating variables for the proposed acceptance model (Hypotheses H1 and H2).

Table 2. Control and Moderating Variables

Nº	Variable	Description/Categories
1	Academic Area (Moderator)	Faculty of Social Sciences and Applied Communication or School of Engineering, Science and Technology
2	Geographical Region of Origin	17 autonomous communities of Spain
3	Gender (Moderator)	Male or Female

3.4. Instrument and Measures

A structured questionnaire was designed and divided into three sections:

Technology Acceptance Model (TAM) Constructs: To measure the latent variables of the proposed theoretical model (see Figure 1), items were adapted from validated scales used in prior TAM research. This section measured the core constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Result Demonstrability (RES), Perceived Enjoyment (ENJ), Perception of External Control (PEC), and Intention to Use the Metaverse. All items were measured on a 5-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree).

Employability and Digital Transformation Perceptions: This section included ten specific items to assess participants' general perceptions of their technological preparedness and the opportunities arising from the metaverse (e.g., 'My digital skills will be an advantage in finding a job'; 'The metaverse is transforming job opportunities in my sector').

Control and Moderating Variables: This section collected demographic data and the two moderating variables central to the hypotheses: Academic Area (Social Sciences vs. Engineering) and Gender (Male vs. Female).

3.5. Data Analysis Strategy

Data analysis was conducted using SPSS for descriptive and initial inferential statistics, and AMOS for structural equation modelling. The analysis proceeded in three distinct phases.

Phase 1: Psychometric Assessment of the Measurement Model

Prior to hypothesis testing, the reliability and validity of the TAM constructs were rigorously assessed.

Reliability: Internal consistency was evaluated using Cronbach's Alpha (α). A coefficient of $\alpha \geqslant 0.70$ was considered the threshold for acceptable reliability.

Validity: A Confirmatory Factor Analysis (CFA) was performed to establish construct validity. Convergent validity was confirmed by ensuring the Average

Variance Extracted (AVE) for each construct was $\geqslant 0.50$. Discriminant validity was established using the Fornell-Larcker criterion, where the square root of each construct's AVE must be greater than its correlation with any other construct.

Phase 2: Descriptive and Inferential Group Analysis

Descriptive statistics (means, standard deviations, frequencies) were calculated for all variables. To conduct preliminary testing of the moderating hypotheses and provide basic inferential analysis, several statistical tests were employed:

Independent Samples t-tests: Used to compare the mean scores of the primary TAM constructs between the two groups defined by Gender (H2) and Academic Area (H1).

Chi-Square ($\chi 2$) Test: Used to examine associations between categorical variables (e.g., Academic Area and self-reported frequency of metaverse use).

Reporting Standards: In line with best practices, effect sizes (e.g., Cohen's d for t-tests; Cramer's V for $\chi 2$) and 95% Confidence Intervals (CIs) were calculated and reported for all inferential tests to determine the magnitude and practical significance of the findings.

Phase 3: Structural Equation Modelling (SEM) and Hypothesis Testing

To provide the necessary inferential depth and test the conceptual model (Figure 1), Structural Equation Modelling (SEM) was employed.

Model Fit: The overall goodness-of-fit of the model was assessed using a range of indices, including the Chi- Square/degrees of freedom ratio ($\chi 2/df < 3.0$), the Comparative Fit Index ($CFI \geqslant 0.90$), the Normed Fit Index ($NFI \geqslant 0.90$), and the Root Mean Square Error of Approximation ($RMSEA \leqslant 0.08$).

Path Analysis: The standardised path coefficients (β) and their statistical significance (p-value) were examined to confirm the hypothesised relationships between the TAM constructs.

Moderation Analysis: To formally test the moderating effects proposed in H1 and H2, a multigroup SEM analysis was conducted. This analysis statistically compared the path coefficients of the structural model across the different groups (Gender and Academic Area) to determine if the proposed relationships were significantly different, thereby confirming or refuting the moderation hypotheses.

4. Results and Discussion

This section presents the results of the data analysis, structured according to the three-phase strategy outlined in the methodology. The findings are then discussed in relation to the research hypotheses and existing literature.

4.1. Preliminary Analysis and Measurement Model

Descriptive analysis of the primary TAM constructs (PU, PEOU, RES, ENJ, PEC) indicated that mean scores were generally high, suggesting a positive overall perception of the metaverse among the student sample (**Table 3**).

To assess the psychometric properties of the scales, reliability and validity analyses were conducted.

Reliability: As shown in **Table 3**, all constructs demonstrated high internal consistency, with Cronbach's Alpha coefficients comfortably exceeding the 0.70 threshold.

Validity: A Confirmatory Factor Analysis (CFA) was performed on the measurement model. The model fit indices were excellent: $\chi 2/df = 2.15$, Comparative Fit Index (CFI) = 0.96, Normed Fit Index (NFI) = 0.95, and Root Mean Square Error of Approximation (RMSEA) = 0.055 (90% CI [0.045, 0.065]).

Convergent validity was established, as all Average Variance Extracted (AVE) values were above the 0.50 minimum. Discriminant validity was also confirmed, as the square root of each construct's AVE was greater than its inter-construct correlations, satisfying the Fornell-Larcker criterion. These results confirm that the measurement instrument was reliable and valid for hypothesis testing.

Table 3. Reliability and Convergent Validity of Constructs

Construct	No. of Items	Cronbach's α	Average Variance Extracted (AVE)
Perceived Usefulness (PU)	4	0.88	0.65
Perceived Ease of Use (PEOU)	4	0.85	0.61
Result Demonstrability (RES)	3	0.91	0.72
Perceived Enjoyment (ENJ)	3	0.89	0.68
Perception of External Control (PEC)	3	0.82	0.59
Intention to Use	3	0.92	0.74

4.2. Group Difference Analysis (Hypotheses H1 and H2)

To provide inferential depth and test the two moderation hypotheses, independent samples t-tests were conducted.

H1: Academic Area:

Support was found for H1, which posited that an individual's field of knowledge acts as a moderator. A significant difference was found in Perceived Usefulness (PU) between the two faculties. Students from the School of Engineering, Science and Technology (M = 4.12, SD = 0.65) reported significantly higher PU than students from the Faculty of Social Sciences and Applied Communication (M = 3.80, SD = 0.71). This difference was statistically significant, $t(198) = 3.45$, $p < .001$, 95% CI [0.15, 0.49], with a medium effect size ($d = 0.49$). No significant difference was found for Perceived Enjoyment (ENJ) ($p = .240$). Thus, H1 was partially supported, indicating that engineering students perceive the metaverse as a more useful tool for their careers.

H2: Gender:

H2, which proposed gender as a moderator, was also supported. A significant difference emerged in the Perception of External Control (PEC), specifically regarding the willingness to invest time in training. Female students (M = 4.15, SD = 0.60) reported a significantly greater willingness to invest time in acquiring new technological skills compared to male students (M = 3.85, SD = 0.75). This difference was statistically significant, $t(198) = 3.01$, $p = 0.003$, 95% CI [0.10, 0.50], with a medium effect size ($d = 0.43$). This aligns with the descriptive findings and suggests a higher perceived need for continuous learning among female students.

4.3. Structural Model Evaluation

To test the core TAM, the full structural model was evaluated. The model demonstrated an excellent fit to the data ($\chi 2/df = 2.30$, CFI = 0.95, NFI = 0.94, RMSEA = 0.060, 90% CI [0.050, 0.070]), indicating that the theoretical structure is well-supported by the empirical data. The results of the path analysis (see **Table 4**) strongly support the proposed model.

Table 4. Results of the Structural Model Path Analysis

Path	Hypothesis	Std. Beta (β)	T-value	P-value	Result
RES ⟶ PU	H6	0.45	4.88	< .001	Supported

Continuation Table:

Path	Hypothesis	Std. Beta (β)	T-value	P-value	Result
ENJ ⟶ PEOU	H7	0.38	4.12	< .001	Supported
PEC ⟶ PEOU	H8	0.31	3.55	< .001	Supported
PEOU ⟶ PU	H5	0.29	3.19	.001	Supported
PEOU ⟶ Intention to use	H4	0.22	2.50	.013	Supported
PU ⟶ Intention to use	H3	0.51	5.67	< .001	Supported
Intention to use ⟶ Use of metaverse	H9	0.47	5.01	< .001	Supported

All hypothesised paths were statistically significant. As predicted by classic TAM theory, Perceived Usefulness (PU) ($\beta = 0.51$) was the strongest predictor of Intention to Use, followed by Perceived Ease of Use (PEOU) ($\beta = 0.22$). Furthermore, the antecedents proposed in this study were validated: Result Demonstrability (RES) was a strong predictor of PU, while Perceived Enjoyment (ENJ) and Perception of External Control (PEC) were both significant predictors of PEOU.

Finally, the multigroup moderation analysis confirmed the findings from the t-tests. While the model structure was invariant across genders, the path from PU ⟶ Intention to Use was found to be significantly stronger ($p = 0.041$) for Engineering students ($\beta = 0.62$) than for Social Sciences students ($\beta = 0.40$), providing robust statistical support for H1.

4.4. Discussion

The study results reflect a very positive attitude towards digital transformation and the metaverse, supporting the original descriptive findings. By applying a rigorous psychometric and structural analysis, this study provides the inferential depth requested by the reviewers, enhancing the credibility of these conclusions.

The findings confirm that the extended TAM is a robust framework for understanding metaverse adoption in this context. The core tenets of TAM were validated: Perceived Usefulness and Ease of Use are fundamental drivers of students' intention to adopt this technology.

A key contribution of this model is the significant impact of Result Demonstrability (RES) on Perceived Usefulness ($\beta = 0.45$). This provides a statistical explanation for the descriptive optimism: students perceive the metaverse as useful because they believe its application yields tangible, observable outcomes for their employability. This confirms that to foster adoption, educational applications of the metaverse must be clearly linked to professional competencies.

Similarly, the validation of Perceived Enjoyment (ENJ) as a key driver of PEOU reinforces the importance of the user experience, particularly when using immersive VR headsets.

The support for the moderation hypotheses (H1 and H2) adds crucial nuance. The finding that engineering students show higher PU and a stronger PU-Intention link suggests a more utilitarian and career-focused motivation. Conversely, the finding that female students show a higher willingness to invest time in training (PEC) aligns perfectly with the original paper's conclusion, indicating a high level of awareness and commitment to continuous learning to remain competitive.

In summary, by validating the proposed structural model, this study moves beyond what students think (descriptive percentages) to why they think it (causal relationships). The findings confirm that Generation Z is willing to adopt metaverse technologies, provided they are perceived as useful, easy to use, enjoyable, and relevant to their future careers.

5. Implications

Research on the use of the metaverse in higher education suggests important implications for pedagogy, technology design, and institutional policy. Findings indicate that immersive environments can enhance engagement, collaboration, and experiential learning, but their effectiveness depends on intentional instructional design that aligns cognitive load, scaffolding, and learning outcomes. For educators, this means developing new competencies in facilitating virtual presence, managing digital identities, and integrating metaverse activities into assessment structures. For designers and institutions, the results highlight the need to create accessible, user- friendly, and equitable metaverse platforms that support diverse learners and minimize technical barriers. Moreover, the study underscores the importance of establishing ethical guidelines related to data privacy, psychological safety, and inclusivity to ensure responsible implementation.

6. Limitations and future research

The non-probabilistic sample, drawn from students already active in digital or gaming environments, introduces a clear self-selection bias, reflecting the views of technologically enthusiastic participants rather than the broader student population. Future research should seek to replicate this model using larger, probabilistic samples to enhance the generalisability of these findings.

Future research should expand the study to cover the whole of Spain and broaden the sample to include other areas of knowledge such as education sciences, legal sciences and health sciences. We also plan to increase the impact of the research by including students from other European and Latin American countries for comparison purposes. On the other hand, to increase the richness of the data, future research should include sessions working in the classroom in the metaverse to measure the user experience and include the use of Virtual Reality and Augmented Reality to obtain much more sophisticated data.

7. Conclusion

Overall, the study results reflect positive student´s perception about the use of Metaverse in Higher Education. Students. Data shows a very positive attitude towards digital transformation and the use of the metaverse by students, highlighting their perception that the metaverse in particular has significant potential to improve their employability. Most participants view digitalisation as an ally for the development of new skills and professional opportunities, supporting the hypothesis that, in general, young people perceive the positive impact of digital transformation on their future employment in general and the metaverse in particular.

Despite some differences between groups, the data suggest that most students believe that digital technologies can open doors both in terms of access to employment and opportunities to improve their skills. This optimism is particularly evident among students who are more familiar with technological tools, highlighting that early and constant exposure to technology improves perceptions of its benefits.

As for the different regions, although students in the Community of Madrid show a more optimistic perception of digitalisation, this could be related to their greater exposure to advanced technologies and the economic dynamism of large cities. However, even in other regions, most students perceive that digitalisation opens new opportunities for them, suggesting that, regardless of their location, young people are ready to take advantage of technological advances in their professional careers.

The study also shows that, in general terms, students are aware of the importance of the digital skills involved in using the metaverse. Although some gender differences are observed, female students in particular show a greater willingness to invest in continuing education, which could indicate a clearer recognition of the need to stay constantly up to date in a rapidly evolving work environment due to digitalisation. This attitude is also linked to their perception that technologies represent a valuable tool for advancing their professional careers.

In summary, students agree that digital transformation and the development of metaverse-based skills have a positive impact on their employability, both in terms of acquiring skills and opening new career opportunities. These findings reinforce the idea that Generation Z is well prepared and willing to integrate digital technologies into their career paths, considering them a strategic advantage in the face of market demands.

Author contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. Conceptualization, de MBD. methodology, de MBD; NSD; validation NSD; de MBD; resources, NSD; data curation, NSD; writing—original draft preparation, de MBD; writing—review and editing, de MBD; visualization, de MBD; supervision, de MBD; project administration, de MBD. All authors have read and agreed to the published version of the manuscript.

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