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THE METAVERSE APPLIED TO EDUCATION
Systematic Review of Scientific Knowledge Published in Spain

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KEYWORDS

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Visual culture
Digital competence
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Methodology
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ABSTRACT

The concept of the metaverse has gained significant traction over the past decade, particularly following the rebranding of Facebook as Meta. The aim of this article is to conduct a systematic review of the scientific literature in Spain related to the metaverse and education. A total of 69 publications were identified within the specified time frame of 2008-2024. In general, the scientific quality of a significant proportion of the publications was found to be low, particularly in regard to the lack of information provided on methodology and sample. The findings of this review indicate a necessity for enhancements in the quantity and quality of research on the metaverse and education in Spain.

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1. Introduction

The use of digital spaces related to virtual, augmented or extended reality is becoming increasingly prevalent, with proposals suggesting their potential to enhance, complement or even replace various tasks in everyday life (Conde Melguizo, R., & Alonso Martínez, D, 2022; Estébanez, 2024; Fuente et al., 2024; INMERSIVA, 2024; Urbano, 2023). The ESCiT research group at UDIT has a particular interest in the potential of these spaces and technologies in educational contexts, including formal, informal and informal learning environments. It is of particular importance to establish design standards for the creation of virtual spaces dedicated to education, cultural and scientific dissemination. In response to this need, the DEED (Diseño de Espacios virtuales para objetivos Educativos y de Divulgación) project, Design of Virtual Spaces for Educational and Dissemination Objectives (Conde Melguizo, R. et al., 2024), has been initiated. The project's primary objective is to establish a design standard that integrates the principles of pedagogy and didactics with the fundamentals of interactive space design. This will facilitate the optimal design and development of virtual spaces for education and cultural and scientific dissemination.

In order to achieve the main objective, the project has established a series of specific objectives, including a bibliographical review of the publications associated with the application of these technologies in educational spaces in recent years. The aim of this review is to analyze the state of the art in research in Spain on the application of metaverse technology in education.

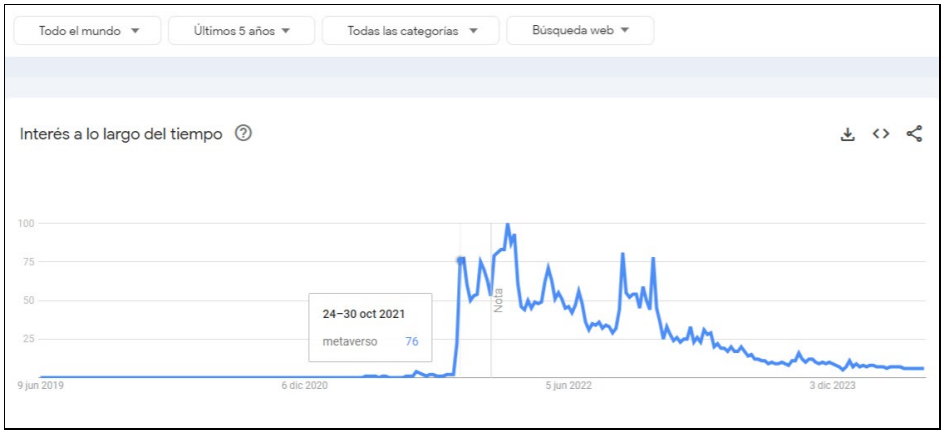
1.1. What Do We Understand by Metaverse?

The term 'metaverse' was disseminated in the media following Facebook's announcement on 28 October 2021 to change its name to Meta, reflecting the company's strategic shift towards developing its own metaverse, known as Horizon Worlds (Meta, 2021). The term metaverse, however, has its origins in the science fiction work Snow Crash, authored by Neal Stephenson and published in 1992 (Stephenson, 1992). Although some earlier references can be found in science fiction literature (Asimov, 1957; Bradbury, 1951; Gibson, 1984; Weinbaum, 1935),, it is in Stephenson's work that the metaverse is described for the first time in the way that it is currently understood: as a virtual world where human beings interact beyond their physical presence, introducing the concept of avatar for this interaction. Subsequently, the term 'metaverse' has been employed to describe a variety of virtual spaces for interaction, including Second Life and numerous video games that facilitate online interaction, such as World of Warcraft, Roblox, Fortnite, and others (Ball, 2022).

Outside the video game and interactive design industry, the general interest in the term coincides with the communicative impact of Facebook's strategic shift to Meta. The impact of this corporate communication event can be evaluated through a series of advanced searches in tools such as Google Trends or Verba.

A review of the search history of the term 'metaverse' on Google Trends revealed a sudden surge in global searches during the week commencing 24 October 2021. This coincides with the announcement by Facebook, the aforementioned company, as illustrated in Figure 1.

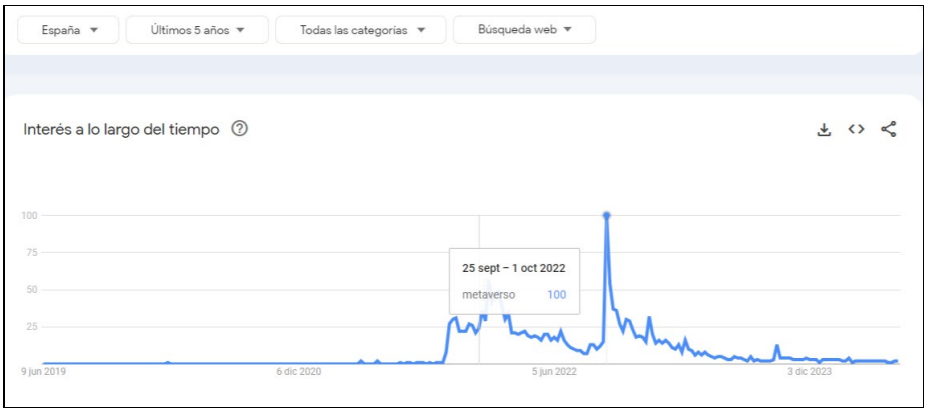
Figure 1. *Google Trends Global* results for "Metaverse".



Source: own elaboration, 2024.

Figure 2 illustrates that in the case of Spain, there was a sudden rise in searches for the term 'metaverse' on the same dates, followed by a peak one year later. This occurred around the time when the financial problems of Meta's metaverse project, the restructuring of the company and the hiring of new personnel due to poor economic projections began to be announced.

Figure 2. *Google Trends* Spain results for "Metaverse".

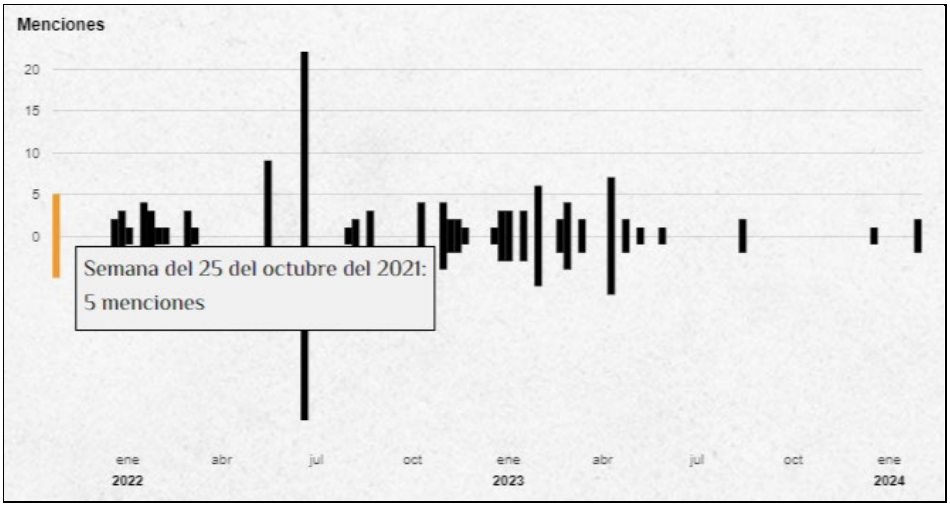


Source: own elaboration, 2024.

In view of the focus of the present study on publications on the metaverse and education in Spain, a second search for the term 'metaverse' has been conducted using the Verba tool. Verba is an online application developed by the CIVIO Foundation that enables the monitoring of a given term's appearance in the news programs of Radio Televisión Española from 2014 to the present day.

The results obtained and illustrated in Figure 3 corroborate the assertion that the term 'metaverse' first emerged in RTVE news on the week of 25 October 2021. This coincides with the period during which Google Trends documented a notable surge in search activity.

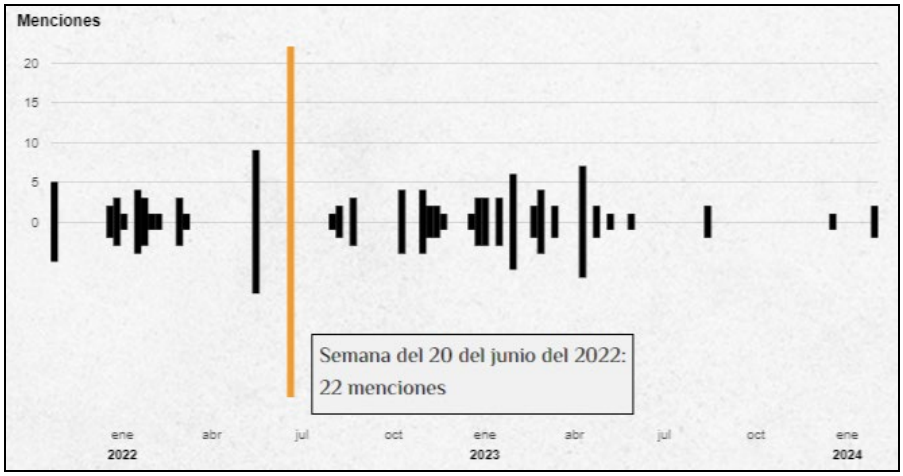
Figure 3. Verba results for "Metaverse", highlighting first results.



Source: own elaboration, 2024.

Additionally, an increase in the frequency of mentions of the term was observed during the week of 20 June 2022, as illustrated in Figure 4. In this instance, the observed deviation can be attributed to the broadcast of a special report on the subject matter.

Figure 4. Verba results for "Metaverse", highlighting the highest score.



Source: own elaboration, 2024.

1.2. Metaverse and Education

Once the period in which the concept of the metaverse has become a significant presence in social spaces has been defined, it is also necessary to determine its potential impact on educational spaces. The rationale behind the DEED project's examination of existing literature on the utilization of the metaverse in an educational context emerges from the implementation of Organic Law 3/2020, of 29 December 2020, which amends Organic Law 2/2006, of 3 May 2006, on Education, otherwise known as LOMLOE (BOE, 2020). In the rationale behind the legislative text, it is argued that the pervasive use of novel forms of technology to access information has precipitated profound shifts in everyday life. In accordance with the legislation, these developments necessitate a shift in perspective that encompasses the examination of the psychological and social implications of technology within the context of digital competence for both students and educators. The LOMLOE maintains the inclusion of digital competence as one of the seven fundamental competencies that all students must develop during the compulsory educational stages. This competence must be integrated into all subjects in a cross-cutting manner. The initial obligatory descriptor for all students who have completed their compulsory education in Spain is particularly noteworthy in this competence, which is worded as follows: "Performs Internet searches in accordance with criteria of validity, quality, timeliness and reliability, selecting the results critically and filing them, in order to retrieve, reference and reuse them, respecting intellectual property" (Ministry of Education, Vocational Training and Sport, 2020). Subsequently, the legislation emphasizes that this digital competence should extend beyond the utilization of devices and software and should equip students with the skills to navigate the digital landscape of learning, relationships, consumption and leisure that characterizes the lives of the younger generation.

The implementation of the LOMLOE in all stages of compulsory education is reflected in the approval of MECES levels (BOE, 2011) of Royal Decree 822/2021, of 28 September, which establishes the organization of university education and the procedure for quality assurance (BOE, 2021). RD 822/2021 establishes the guiding principles of university curricula and highlights in its preamble the necessity for reform of the university system due to the social changes that have been facilitated by the technological revolution, which has brought innovation in information and communication systems through their digitalization (BOE, 2021).

Conversely, the emergency situation resulting from the advent of the global pandemic of 2019 (Covid-19) has had a profound impact on the way in which we view the world. Education has been one of the areas most affected, with the sudden necessity for remote teaching becoming one of the greatest challenges ever faced by education systems around the world (Portolés, 2022; ECLAC & UNESCO, 2020). This was due to the sudden impossibility of utilizing traditional face-to-face systems. This situation highlighted the necessity to integrate ICT (Information and Communication Technologies) and digital devices into the educational process (ECLAC & UNESCO, 2020).

In light of recent developments, the educational community has demonstrated a growing receptivity to integrating diverse digital technologies and didactic systems that enhance teaching (Contreras

Manrique, R.D et al., 2021). Virtual worlds, for instance, have emerged as a promising avenue for this integration. In this regard, there is a notable endeavor to progressively reposition the metaverse within the educational domain, shifting it from its original domain of entertainment (López-Belmonte et al., 2023).

It seems reasonable to posit that preliminary evaluations of the metaverse in an educational context would suggest that it has significant potential as an educational tool. Based on the aforementioned texts, which form part of this analysis, it is possible to identify several characteristics that can be observed in the first column of Table 1. Conversely, as no teaching system can be considered perfect a priori, it seems reasonable to posit that these advantages have inherent counterparts, given the nature of the metaverse. The second column of the table lists some of the potential disadvantages that could affect the implementation of the metaverse in an educational context.

Table 1. Potential advantages and disadvantages of using the metaverse in education.

Advantages	Disadvantages
The immersive experiences it provides, as well as its similarity to video games, give it an additional appeal, especially for the younger generation, potentially fostering motivation and interest in its use.	Its ability to overcome geographical barriers, thanks to the support of communications networks, carries with it the risk of security risks in the transit of information over the Internet, and even cyber-attacks themselves.
The interactivity it offers, together with the possibility of generating *feedback* in real time, could help correct errors and favour learning processes, improving information retention, comprehension and contextual understanding.	The content to be generated could be complex and costly, requiring a design that makes it pedagogically appropriate and attractive, as well as using a response and *feedback* system that is of real use to users.
A virtual environment is adaptable to multiple fields and educational needs, especially when artificial intelligence elements are incorporated, which would allow for a personalised experience for each student, in addition to overcoming the barriers traditionally faced by people with some kind of disability.	The technology on which it is based, especially if it is virtual, augmented or extended reality, is not necessarily within the reach of all users at present, although the trend in this respect points to an improvement over time, favoured, among other things, by the ever-increasing consumption of a product such as video games, to which it is closely related.
Its very nature allows it to be used on a global scale, which makes it highly accessible as it is not restricted to the workplace, in addition to the **flexible timetable for its use.**	The miscalculated use of virtual platforms as a teaching tool could lead to possible social isolation of students, potential addiction problems arising from their use, and other problems inherent to the intensive use of these technologies, such as eyestrain, stress or occasional feelings of dizziness when working with virtual reality.

Source: Own elaboration, 2024.

Consequently, there has been a notable surge in interest in metaverse technology across society, accompanied by an educational reform that emphasizes the necessity of integrating these technologies and the ethical, social, cultural and learning considerations they raise within the classroom.

1.3. Objective and Research Question

The principal aim of this research is to assess the scientific rigour of the literature published in Spain on the metaverse and education, spanning the period between 2008 and 2024. This objective is pertinent given the necessity to accumulate knowledge produced by research on the impact of the metaverse on education to implement this technology adequately within the education system. It is essential to evaluate the scientific quality of the knowledge produced in order to guarantee its validity.

This necessity gives rise to the following research question: what is the accumulated scientific knowledge in Spain on the use of the metaverse in education, and what scientific validity does it possess?

2. Methodology

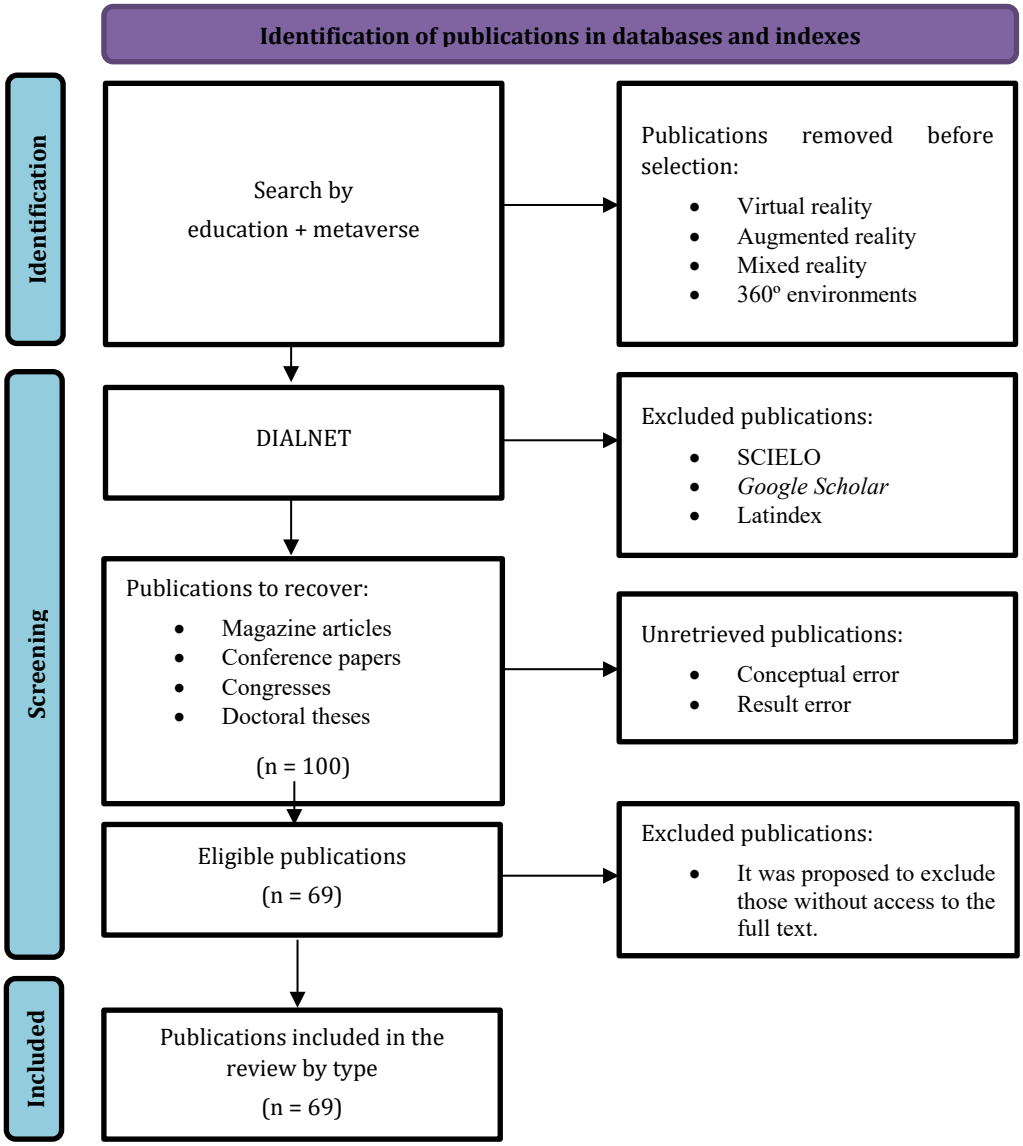
This study has been conducted through a systematic analysis of publications pertaining to the metaverse and education, with its design based on the recommendations set forth by the PRISMA statement (Page et al., 2021). PRISMA is a model designed for meta-analyses in the field of health sciences. To facilitate the application of this methodology to other research topics and studies related to the use of technologies in the educational system, it has been redefined (Archila, 2023; Conde Melguizo et al., 2020).

In accordance with the workflow delineated by PRISMA for the phased selection of publications to be reviewed (Page et al., 2021), the following decisions were made:

- Identification phase. A list of search terms was compiled for the purpose of identifying relevant publications. Following a series of iterations, it was determined that the terms "education" and "metaverse" should be searched together when they appear in the title, abstract, keywords, or full text of a given article. Other terms, such as virtual reality, augmented reality, extended reality, and so forth, yielded repetitive search results, as several of them were included in the same article. Additionally, some of the results were not directly related to education, which made them inaccurate.
- In the filtering phase, the following three filters were established consecutively:
    1. The first filter was based on the various search engines tested, and DIALNET was chosen because it provided the best and most operational access to information for our research. The following search engines were tested and subsequently discarded:
        a. SCIELO, as it returned a negligible number of publications in Spain in comparison to DIALNET.
        b. Google Scholar did not permit the information to be filtered in the same operational manner as DIALNET, thus preventing the data from being entered into the PRISMA workflow. Furthermore, a content analysis revealed that the Scholar results included a considerable number of irrelevant results, which were unsuitable for our purposes.
        c. The Latindex database prioritizes searches by full journal title rather than by article, which proved difficult to operationalize within our methodology.
    2. A search of DIALNET for publications related to metaverse and education returned 100 results. Of the identified publications, 32 were excluded due to the presence of conceptual and outcome errors.
        a. Conceptual errors were defined as publications where the terms 'metaverse' and 'education' were discussed, yet the references to these terms did not align with the research objectives. For instance, articles were excluded if the term 'metaverse' was employed as a description of a socio-political situation, but not as a reference to technology.
        b. In addition, a further category of results was identified, namely those publications where, despite the search engine having been instructed to match the terms, it became evident upon reading the text that they were not related to education.
    3. Finally, the possibility of excluding articles that did not allow access to the full text was considered. However, they were ultimately included in the analysis if the accessible information permitted their classification within our model.
- In the inclusion phase, 69 publications were identified and entered into an online database, where information about each article was recorded with respect to ten fields:
    1. Type of publication
    2. Language of publication
    3. Access to the text
    4. Object of study
    5. Methodology
    6. Sample
    7. Research techniques
    8. Technology analyzed

9. Presence of accessibility in the study
10. Other information of interest

Figure 5. Phases of the PRISMA workflow applied to the research objectives.



Source: Own elaboration, 2024 (based on workflow published in Page et al., 2021).

3. Results

The principal findings of the analysis are presented below. For each of the elements under analysis, the criteria employed in the analysis, the raw data (or totals), and the data expressed as a percentage are provided in a table. Furthermore, the data is complemented by at least one illustrative graph, accompanied by a concise description of the most salient findings. The subsequent discussion point addresses the conclusions obtained.

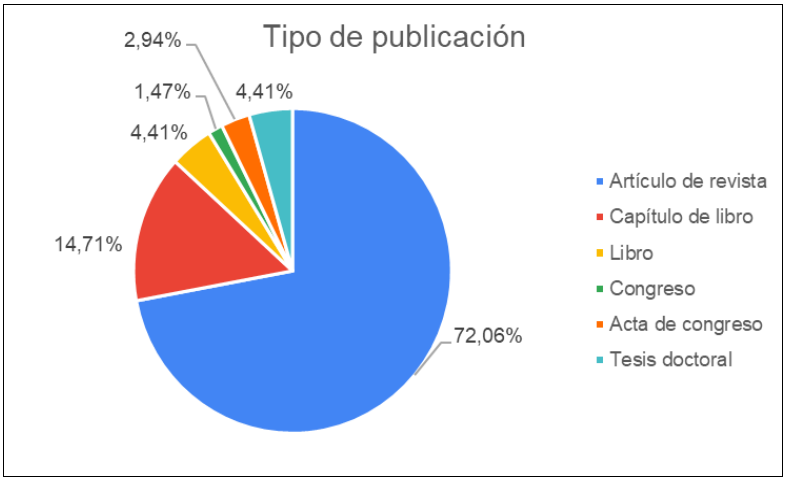
The initial step involved an examination of the types of publications included in the review. As illustrated in Table 2 and Figure 6, the data set exhibits a certain degree of diversity. However, the majority of the entries are journal articles (72.06%), with books also featuring, either as complete publications (4.41%) or as specific chapters (14.71%).

Table 2. Publications by type of publication.

Type of publication	N	%
Magazine article	49	72,06%
Book chapter	10	14,71%
Book	3	4,41%
Congress	1	1,47%
Minutes of the congress	2	2,94%
Doctoral thesis	3	4,41%

Source: Own elaboration, 2024.

Figure 6. Analysis of publications by type of publication.



Source: Own elaboration, 2024.

In terms of publication dates, there is an upward trend in the number of publications during the two years prior to 2024, as evidenced by the data presented in tables 3 and 4, together with Figure 7. Following a clear increase in 2011 (8), there is a significantly higher increase in 2022 (17) and 2023 (28). This may be attributed to the growing prevalence of the term 'metaverse' in the media, particularly following Facebook's announcement on 28 October 2021 to change its name to Meta, and its increasing usage in educational contexts, due to the implementation of Organic Law 3/2020 of 29 December.

Table 3. Number of publications by year of publication.

Year	No. of publications
2024	2
2023	28
2022	17
2019	3
2017	1
2016	2
2014	2
2013	2
2011	8
2010	1
2008	3

Source: Own elaboration, 2024.

Table 4. Number of publications by year of publication, with period 2018-2008 unified.

Year	No. of publications
2024	2
2023	28
2022	17
2021	0
2020	0
2019	3
2018-2008	19

Source: Own elaboration, 2024.

Figure 7. Analysis of the number of publications by year of publication, with period 2018-2008 unified.

Source: Own elaboration, 2024.

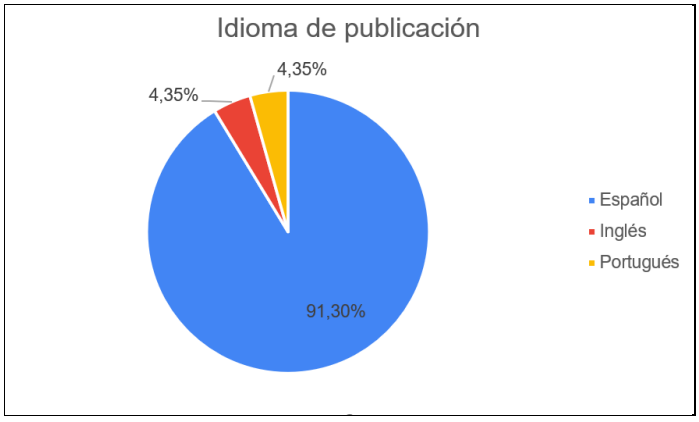
Regarding the languages used in the publications analyzed, as illustrated in Table 5 and Figure 8, it can be observed that Spanish is the predominant language, accounting for 91.3% of the total. A mere handful of publications were identified in English (4.35%) and Portuguese (4.35%).

Table 5. Publications by language of publication.

Language	N	%
English	63	91,30%
English	3	4,35%
Portuguese	3	4,35%

Source: Own elaboration, 2024.

Figure 8. Analysis of publications by language of publication.



Source: Own elaboration, 2024.

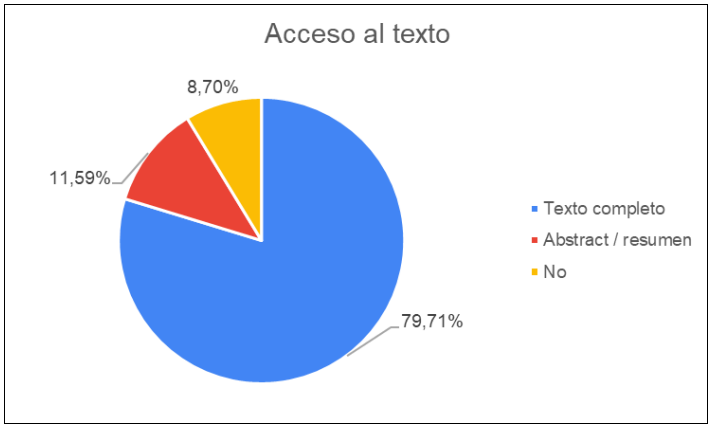
In consideration of the potential for obtaining the complete text, the authors' general transparency is noteworthy. As illustrated in Table 6 and Figure 9, most of the analyzed publications (79.71%) permit access to the full text, whereas a minority percentage (8.70%) does not provide access to any portion of the text beyond the title retrieved from the search engine.

Table 6. Publications by possibility of access to the full text.

Access	N	%
Full text	55	79,71%
Abstract/abstract	8	11,59%
No	6	8,70%

Source: Own elaboration, 2024.

Figure 9. Analysis of publications by possibility of access to the full text.



Source: Own elaboration, 2024.

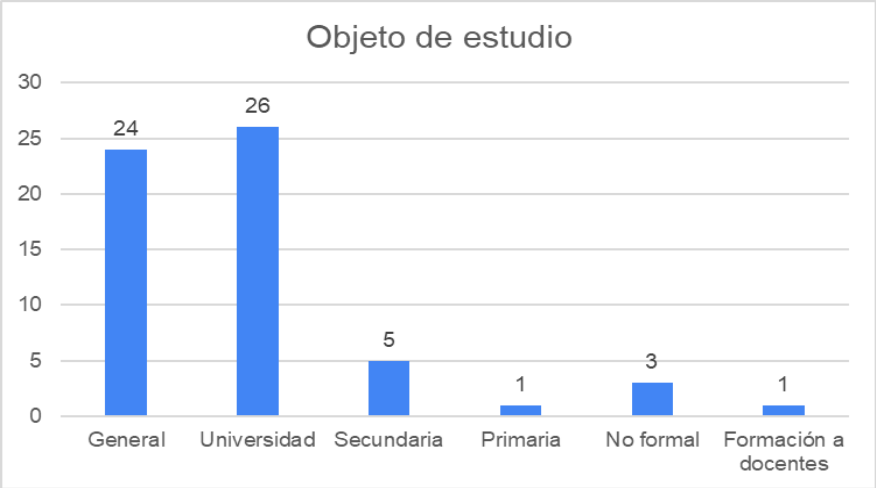
With regard to the object of study, Table 7 and Figures 10 and 11 demonstrate that the majority of the texts analyzed pertain to educational applications at the university level (43.33%) or for the general population (40%). The remaining categories of education are represented to a lesser extent in the reviewed publications, except for primary education, which accounts for only 1.67% of the total.

Table 7. Publications by object of study.

Object of study	N	%
General	24	40,00%
University	26	43,33%
Secondary	5	8,33%
Primary	1	1,67%
Non-formal	3	5,00%
Teacher training	1	1,67%

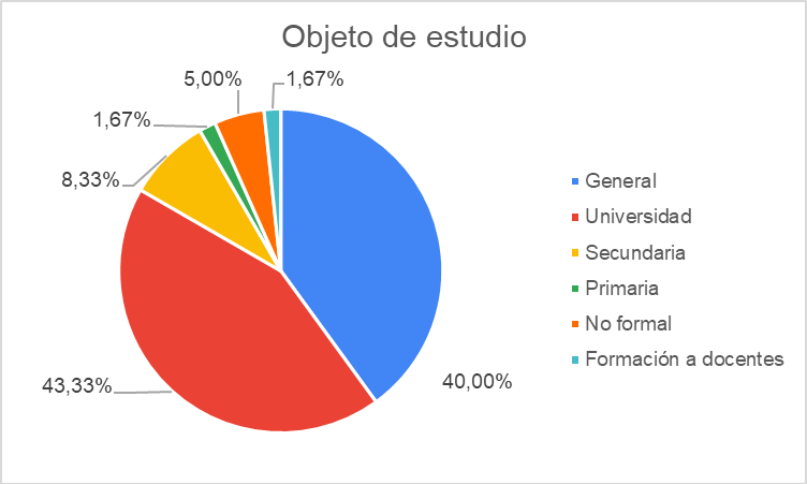
Source: Own elaboration, 2024.

Figure 10. Analysis of publications by object of study in aggregated data.



Source: Own elaboration, 2024.

Figure 11. Analysis of publications by object of study in percentages.



Source: Own elaboration, 2024.

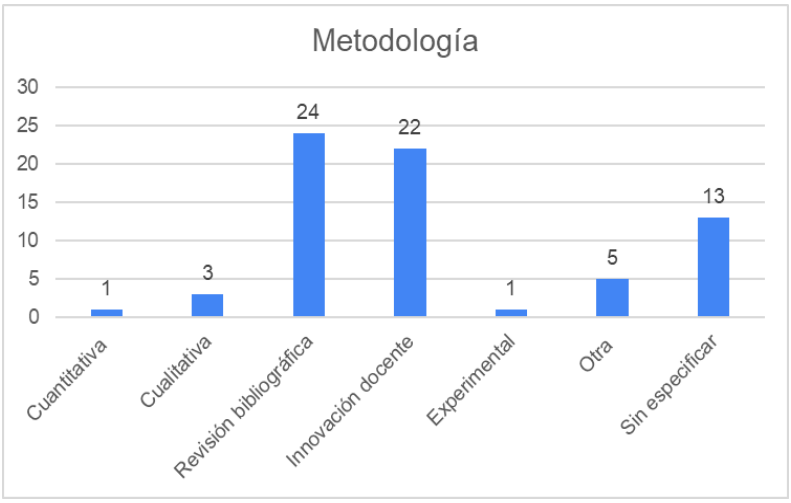
In terms of the classification of the methodology employed in the reviewed publications, two notable outcomes emerge, as illustrated in Table 8 and Figures 12 and 13. Firstly, it is notable that a considerable proportion of studies do not provide a detailed account of the methodology employed, accounting for 18.84% of the total. Secondly, of those that do specify the methodology used, the majority are literature reviews (34.78%), followed by teaching innovation projects (31.88%). It is notable that traditional scientific methodologies, including quantitative (1.45%), qualitative (4.35%), and experimental (1.45%) approaches, are under-represented in the reviewed publications.

Table 8. Publications by methodology.

Methodology	N	%
Quantitative	1	1,45%
Qualitative	3	4,35%
Literature review	24	34,78%
Teaching innovation	22	31,88%
Experimental	1	1,45%
Another	5	7,25%
Not specified	13	18,84%

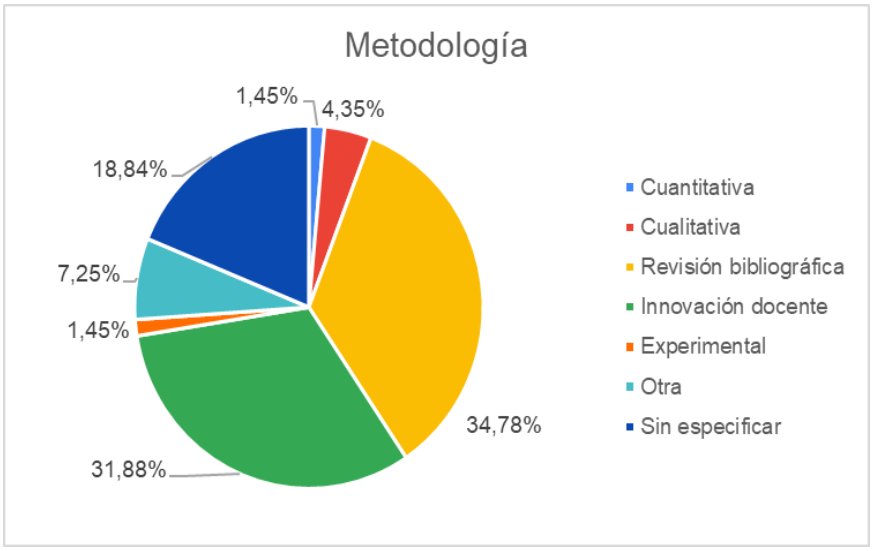
Source: Own elaboration, 2024.

Figure 12. Analysis of publications by methodology in aggregated data.



Source: Own elaboration, 2024.

Figure 13. Analysis of publications by methodology in percentages.



Source: Own elaboration, 2024.

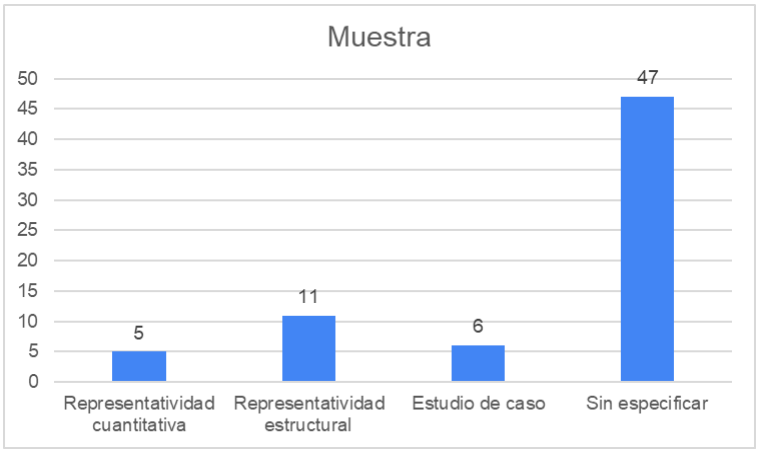
The analysis of the work sample, as presented in Table 9 and Figures 14 and 15, reveals a strikingly high proportion of publications that do not specify the sample used in their study (68.12%). This finding is statistically significant. The remaining publications primarily employ structural representativeness (15.94%).

Table 9. Publications by representativeness of the sample.

Representativeness of the sample	N	%
Quantitative representativeness	5	7,25%
Structural representativeness	11	15,94%
Case study	6	8,70%
Not specified	47	68,12%

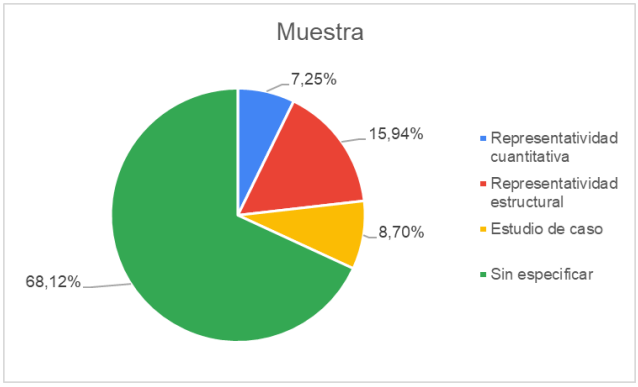
Source: Own elaboration, 2024.

Figure 14. Analysis of publications by representativeness of the sample in aggregated data.



Source: Own elaboration, 2024.

Figure 15. Analysis of publications by representativeness of the sample in percentages.



Source: Own elaboration, 2024.

With regard to the technology employed in the study described in the analyzed publications, as illustrated in Table 10 and Figures 16 and 17, the primary finding is once again a dearth of information in the reviewed texts. The highest percentage of data pertains to studies that do not mention the technology used, accounting for 38.57% of the total. Of the publications that do specify the technology related to the metaverse, virtual reality is the most frequently utilized type of technology in the studies carried out (37.14%). It is noteworthy that other related technologies have also emerged, including 360-degree environments (7.14%) and augmented reality (10%). It is also noteworthy that a considerable number of the studies in question explicitly state that they do not employ any tools whatsoever (11.43%).

It should be noted that some articles cite the use of multiple technologies, which are therefore counted on more than one occasion. However, the denominator for calculating the percentages is the sample of 69 texts.

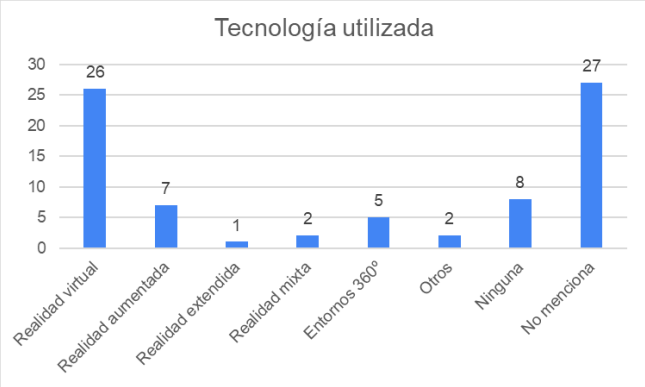
Table 10. Publications by technology used.

Technology used	N	%
Virtual reality	26	37,14%
Augmented reality	7	10,00%
Extended reality	1	1,43%
Mixed reality	2	2,86%
360º environments	5	7,14%
Other	2	2,86%
None	8	11,43%

No mention of	27	38,57%

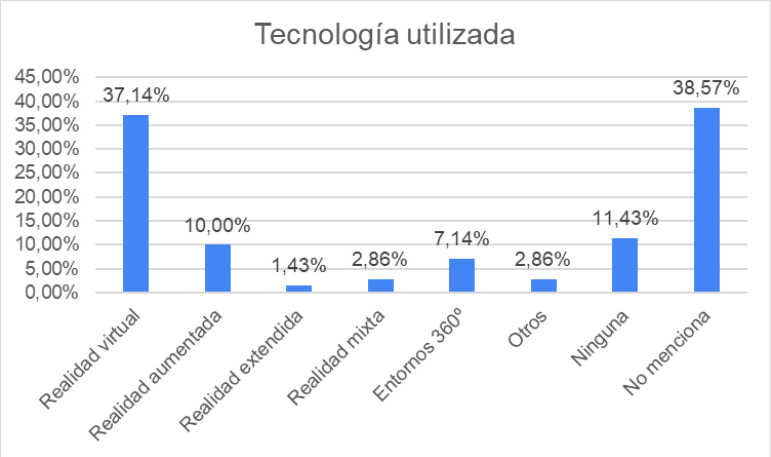
Source: Own elaboration, 2024.

Figure 16. Analysis of publications by technology used in research in aggregated data.



Source: Own elaboration, 2024.

Figure 17. Analysis of publications by technology used in the research in percentages.



Source: Own elaboration, 2024.

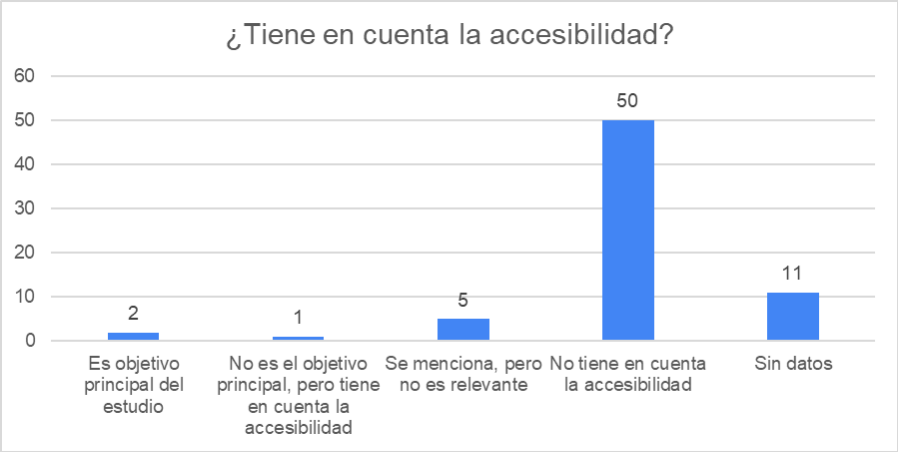
Table 11 and figures 18 and 19 demonstrate that the overwhelming majority of the studies reviewed fail to consider the concept of accessibility (72.46%). Among the studies that do address accessibility, some do not accord to it sufficient relevance (7.25%). It is only referenced as the primary focus of the study in a somewhat incidental manner (2.9%). The remainder of the texts address the topic of accessibility, albeit in a secondary capacity (1.45%).

Table 11. Publications according to accessibility analysis.

Accessibility analysis	N	%
The main objective of the study is to	2	2,90%
It is not the main objective, but it takes accessibility into account.	1	1,45%
Mentioned, but not relevant	5	7,25%
Does not take accessibility into account	50	72,46%
No data	11	15,94%

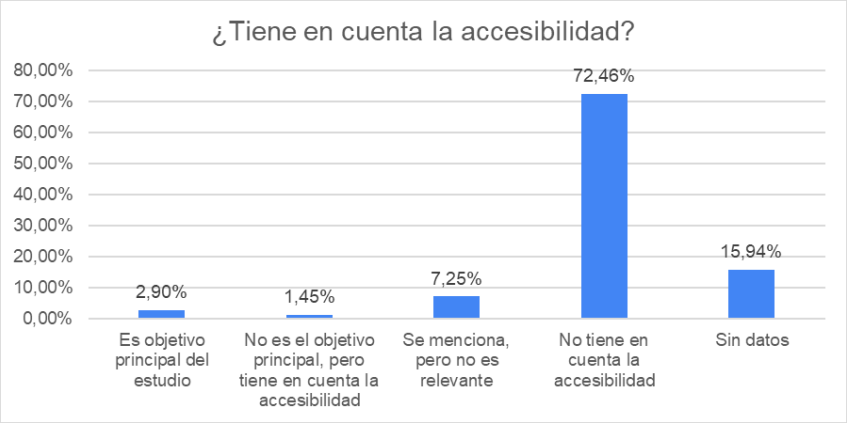
Source: Own elaboration, 2024.

Figure 18. Analysis of publications in terms of accessibility analysis in aggregated data.



Source: Own elaboration, 2024.

Figure 19. Analysis of publications according to accessibility analysis in percentages.



Source: Own elaboration, 2024.

4. Discussion

The data obtained from the review allows for the following reflections to be formulated.

Regarding the type of publication, it is notable that most of these publications are in journals. It is noteworthy that the publication of doctoral theses is more prevalent than that of conference proceedings, or at the very least, on par with it. This is particularly intriguing given that a thesis's primary objective is to delve into and expand upon existing knowledge, which is a characteristic that sets it apart from the dynamic and evolving nature of conferences. It appears that the concept of the metaverse has become a prominent topic of discussion within the academic community, yet it has not yet gained significant traction across the entire field of education. This conclusion is further supported by an analysis of the publication years, which date back to 2008. From this date onwards, we observe a relatively flat and low-level trend in publications on metaverse and education, except for two peaks in publication: one in 2011, the origin of which is unclear, and another between 2022 and 2023, which may reflect the socio-technological conditions of the time. These conditions include, on the one hand, research conducted during the pandemic, which investigated distance learning models, and, on the other hand, the popularization of the term 'metaverse' by companies such as Meta. A long tradition is observable, though with minimal density, except at times when the term is popularized in society at large.

In terms of the projected trajectory of the analyzed publications, several key points emerge. It is encouraging to note that most of the publications are accessible for consultation. This indicates a commitment to advancing knowledge and disseminating findings, which facilitates continuous and

incremental progress in related research. However, it is also possible to identify a number of negative aspects. Firstly, there is a notable absence of international projection, as evidenced by the exceedingly low percentage of publications in English.

In terms of quality, there are several negative elements to be identified. A notable proportion of studies lack sufficient detail regarding the methodology employed. This figure is even more pronounced when the studies that do not specify the sample are included, which account for over half of the total. This may be attributed to the fact that most of the publications are teaching experiences, which are valuable contributions to the field but lack the experimental or inferential rigour of other study designs.

Another noteworthy aspect is the specific educational stage at which the research is concentrated. Most studies are focused on university education, as many of them deal with practical simulation applications of professional areas, such as the recreation of professional spaces or situations, which is more closely aligned with the university environment due to the nature of the studies. This focus is also evident in the technology employed, with most studies that specify their technology of choice utilizing virtual reality, which is particularly associated with the aforementioned applications.

In conclusion, in accordance with the standard set forth by the W3C, accessibility is a critical component in the assessment of any digital technology, as it enables the widest possible user base (W3C, 2023). Considering the universal nature of compulsory education in Spain (BOE, 2020), accessibility represents a crucial aspect for consideration in this analysis, as any barrier to accessibility ultimately impedes the very universality of educational activity. It is notable, however, that most studies do not incorporate accessibility measures. Moreover, among the minority of studies that do consider accessibility, it is evident that this is limited to those that focus on the specific needs of populations with disabilities. In light of the accessibility principles set forth by the W3C, further investigation is warranted in this domain.

5. Conclusions

The objective of the research has been achieved, as the sampling and subsequent analysis have permitted an evaluation of the scientific quality of the papers published in Spain on the metaverse and education during the period 2008-2024.

In response to the formulated research question, it has been possible to address both the existing scientific knowledge and its quality. Regarding the latter question of scientific quality, the following conclusions can be drawn from the data observed:

- There is a need to explore the possibilities of the metaverse within the educational world from an international and generalizable approach, rather than a local one.
- There is a need to improve the scientific rigour of publications. It would be beneficial to continue publishing teaching experiences, but it would be more beneficial to have a greater number of publications with quantitative, qualitative or experimental methodologies.
- It is of particular importance to note that all publications should include specific details regarding the sample, the methodology, and the particular fieldwork techniques employed.
- It would be beneficial to investigate the potential applications of the metaverse at various educational levels and the diverse functions that this technology can offer, with the aim of increasing the number of studies conducted at the compulsory educational stages.
- It is imperative to incorporate novel perspectives, such as universal design, to expand the potential applications and adapt the technology to the needs of most of the population.
- A systematic review of publications on a regular basis is essential to assess the evolution of these indicators of the scientific quality of the state of the art in research in Spain on the application of metaverse technology in education.
- It appears that educators who wish to integrate the metaverse into their teaching methodologies would benefit from adequate training in this field. This training should extend beyond the mere application of the metaverse in teaching methodologies and assessment systems. It should also encompass scientifically based methodologies and techniques that allow educators to evaluate and validate the learning impact of their educational activities in a well-founded manner.

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