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A systematic examination of metaverse technologies, with emphasis on second life as a pedagogical instrument

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Abstract

This systematic review determines the impacts of the Second Life which is being used as a Metaverse environment. The primary objective is to identify and summarize the most recent research concerning the use of Second Life as a teaching tool in higher education. In this context, the PICO Framework was used to findj 24 articles published after the COVID-19 pandemic from peer-reviewed publications in the Web of Science, Scopus, and ERIC databases between November 2019 and May 2023. The papers focused on Second Life as a teaching tool in higher education. The study assessed both the positive and negative aspects of Second Life's influence. The results indicated that the research on Second Life varied, with findings related to enhancing skills and creativity, positive effects on learning and engagement, subject-specific learning, language acquisition, perceived advantages of virtual reality, and the transition to virtual teaching. The review identified positive aspects such as improved radiological anatomy knowledge, enhanced creativity in art and design, better collaborative skills in chemistry, enriched cultural and language learning, and increased nursing practice readiness, alongside challenges like increased anxiety, technical difficulties, and usability issues. Additionally, limitations of the chosen databases, including potential biases due to their coverage were discussed. In future research, the use of metaverse technologies in education should be increased, technological and usability challenges should be addressed, and more research on different learning environments and user interactions should be done by educators and researchers.

Keywords Empirical Research · Higher Education · Metaverse · Second Life · Systematic Review

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Introduction

The rapid development of technology has brought changes and developments in many areas of our lives. Education is one of the areas that is rapidly being affected and changed by technology. Metaverse technology, which removes the lines between the real world and the virtual one (Kim, 2021), has been one of the most significant innovations in education in recent years. A persistent, continuous, multi-user Metaverse universe (Mystakidis, 2022) that combines physical reality and digital virtuality brings a different educational perspective and offers many advantages over traditional learning environments and models (Livingstone et al., 2008).

The virtual world created by Linden Lab, known as Second Life, is one environment that benefits from Metaverse technologies and can be utilized as an educational environment. People can connect in real time on Second Life, a sizable 3D-generated virtual environment and platform full of user-generated content. Social interaction, user-generated content, and user freedom are the three main focuses of Second Life. Linden Lab emphasizes that Second Life is not a game, and there is no purpose in the virtual world of Second Life. Users create a digital avatar to represent themselves, explore the world, meet other users, and create digital content. Moreover, they are free to trade in goods and services with the world currency, the Linden dollar. In short, Second Life is a three-dimensional computer-simulated online world where users may communicate with one another using avatars for a variety of reasons, including commerce, entertainment, and education (Mehran et al., 2017).

In particular, educators are increasingly using Second Life, a virtual environment that debuted in 2003, to instruct students, hold classes, and investigate the unique opportunities that virtual environments may bring for teaching and learning (Inman et al., 2010). Furthermore, Second Life is a popular choice among educators because it enables manipulation of space and time that is only constrained by the user's imagination (Vogel et al., 2008). It offers high realism with little risk and is an ideal setting for unstructured learning scenarios (Pence, 2007).

Many researchers concluded that using Second Life as an educational learning environment contributes positively to teaching and learning. For instance, Cooper (2007) examined student perceptions of the usefulness of the video game "Nutrition Game," which was developed in Second Life, and discovered that the majority of students had a favorable opinion of it. Furthermore, Hew and Cheung (2010) found that instructors use virtual worlds as hands-on learning environments. Kemp and Livingstone (2006) concluded that immersive 3D worlds offer synchronous communication and collaboration opportunities. Similarly, Martinez, Martinez, and Warkentin (2007) held a lecture on Second Life and then polled their students on the effectiveness of the lecture location. The majority of the students responded that they liked it since using Second Life was a novel.

The literature is replete with research that uses the virtual world of Second Life as a teaching aid. A systematic review was done in conjunction with this study to examine the current effects of these studies. A literature review was done

before this systematic review. The literature review forms the basis for systematic reviews, and therefore, the quality of the literature review is critical to the overall quality of the systematic review (McGowan et al., 2016). The literature review was done by determining the search terms, and as a result of this, the studies to be used in this research were determined.

A commonly used strategy for determining search terms is the PICO framework, which originates from evidence-based medicine (Sharma et al., 2015). In this framework, "P" stands for the people or group, "I" stands for the intervention, "C" stands for a comparison intervention or group, and "O" stands for an outcome(s). Based on the PICO technique, the research question for this systematic review was developed, and it connected to the PICO model of population, intervention, comparison, and outcome. This review's research is based on.

- What possible effects may utilizing Second Life as a teaching tool have in various academic settings in higher education?
- What is the aim of using Second Life as a tool for teaching and learning in higher education?
- What is the status of the study on Second Life's application in higher education as a teaching tool?

According to Richardson et al. (1995), dividing a clinical question into its four anatomical parts—problem/population, intervention, comparison, and outcome (PICO)—facilitates the search for a precise answer, as shown in Table 1.

This systematic review's primary goal is to investigate the effects of Second Life, a Metaverse that has been used. The possible effects, the objectives of the studies mentioned in the research, and the current status of research on using Second Life as an educational tool in higher education are all determined by conducting a thorough analysis of relevant studies. By summarizing the chosen studies regarding research questions, this systematic review offers a thorough picture of the current Second Life educational landscape. This study highlights gaps in the available literature and offers ideas for future research.

Method

This study focuses on Second Life's impact on education through a systematic review. According to Gough et al., (2017, p. 4), a systematic review is a study of current research that uses clear, traceable, and rigorous research methodologies. In order to obtain a thorough overview of the relevant literature, doing a systematic review is a highly beneficial activity (Zawacki-Richter et al., 2020, p. xii). In this context, the purpose of this research is to determine the effects of Second Life, used as a Metaverse environment, on education. The PRISMA Statement, which may be used to analyze systematic review and meta-analysis research critically, was utilized to report the study (Moher et al., 2009). This statement is intended to assist writers in providing better systematic review and meta-analysis reporting (PRISMA, 2023).

Table 1 PICO Framework for structuring research

PICO Framework components		Second life examples and consideration
Population	Which populations are we interested in?	Higher education learners
Intervention	Which intervention or approach should be used?	Using Second Life as an educational tool
Comparison	What are the main alternatives to the intervention under consideration?	Different educational settings that are not using Second Life as an educational tool
Outcome	What are the outcomes?	Potential impacts of using Second Life as an educational tool

Search strategy

This systematic review examined the Web of Science (WoS), Scopus, and ERIC databases. More than 19,000 scientific records from various fields are included in Clarivate's Web of Science database, which exclusively includes peer-reviewed international scientific publications published in international journals (Clarivate, 2023). On the other hand, another well-known global publisher is the Elsevier-owned Scopus database. ERIC, which offers access to bibliographic references to educational literature and sources from 1964 to the present (ERIC, 2023), was the final database utilized in this systematic study. WoS and Scopus are regarded as the most significant databases globally since they compile noteworthy and scientifically relevant papers (Aksnes & Sivertsen, 2019). Additionally, they index all authors, institutional addresses, and bibliographic references for every paper and include all article kinds (Mongeon & Paul-Hus, 2016). Another reason these databases were chosen is that they are thought to include the most relevant publications on educational technology (Lampropoulos et al., 2022; Mystakidis et al., 2022).

Selection of search concepts

In this systematic review, search terms were determined to identify the articles to be selected from the databases to answer the research questions, and these were grouped into three parts, as shown in Fig. 1.

With these search terms, a comprehensive computerized database search of full-text articles published in English from November 2019 to May 2023 was carried out using Web of Science, Scopus, and ERIC databases. The reason for choosing this date range is that the adoption and use of online learning have considerably expanded due to the COVID-19 pandemic (Koh & Daniel, 2022). Searches for specific terms are limited to titles, abstracts, and keywords, and they were screened with logical connectors (AND, OR) to determine whether all articles in the databases met the more detailed inclusion criteria. The search structures of the Web of Science, Scopus, and ERIC databases differ, so different search strings are used in each search. Given this study's review aims, the search strings in titles, keywords, and abstracts were used to first search the Web of Science academic database for relevant literature, followed by two other databases: Scopus and ERIC. Figure 2 shows an example of the "Topic" search lines, which

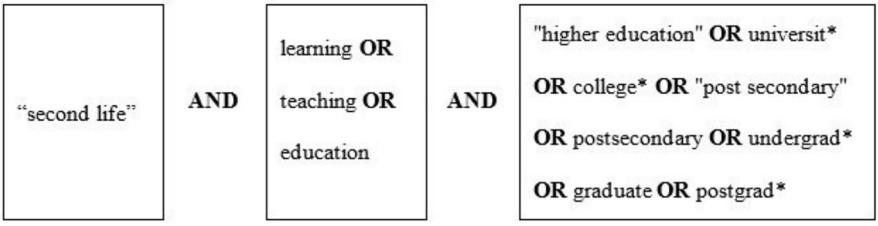

Fig. 1 Search terms for the systematic review

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TS=("second life") AND TS=(teaching OR learning OR education) AND TS=("higher
education" OR universit* OR college* OR "post secondary" OR postsecondary OR
undergrad* OR graduate OR postgrad*)
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Fig. 2 Search lines in the web of science database

include search *title, abstract, author keywords,* and *keywords plus* in the Web of Science. Similarly, Fig. 3 shows an example of a search within the article *title, abstract,* and *keywords* in Scopus, and lastly, Fig. 4 shows an example of search lines in the ERIC. Due to the search structure of ERIC, string code was searched in all texts of the studies in this database, and the studies that were not included in the search string code in the title, summary, and keywords were eliminated.

The string code in Fig. 2 allowed Web of Science database searches to locate 431 records. Of these studies, proceeding papers, book chapters, review articles, early access, and editorial material studies were excluded, and 281 articles remained. Nineteen non-English studies were eliminated, so 262 English articles remained. Reducing the number of studies to post-COVID-19 studies, 22 remained. Of the remaining studies, one was eliminated as a bibliometric study, one as a retracted article, and two as unrelated. As a result, 18 articles from the Web of Science database were included in the study.

Searching with string code in Fig. 3 yielded 577 results in the Scopus database. From these studies, proceeding papers, book chapters, review articles, early access, and editorial material studies were excluded, and 258 articles remained. After eliminating the non-English articles, 247 articles remain. When the studies after COVID-19 were separated, 23 studies remained. Of the remaining studies, a

```
( TITLE-ABS-KEY ( "second life" ) AND TITLE-ABS-KEY ( teaching OR learning OR
education ) AND TITLE-ABS-KEY ( "higher education" OR universit* OR college* OR
"post secondary" OR postsecondary OR undergrad* OR graduate OR postgrad* ) )
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Fig. 3 Search lines in the scopus database

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"second life" AND (teaching OR learning OR education) AND ("higher education" OR
universit* OR college* OR "post secondary" OR postsecondary OR undergrad* OR
graduate OR postgrad*)
```

Fig. 4 Search lines in the ERIC database

bibliometric study and six unrelated ones were eliminated, leaving 16 studies in total.

Due to the structure of the ERIC database, the entire texts of articles were searched with the search terms in Fig. 4, and 232 results were obtained. After the 116 results were eliminated before COVID-19, 19 results remained. Keywords were searched in the *title, abstract,* and *keywords* sections of these articles. The articles did not include these words, two bibliographic studies, and irrelevant ones were eliminated. As a result, 13 studies remained.

Eligibility criteria

In all systematic reviews, reviewers must decide which research studies to include in their review (Newman & Gough, 2020). To do this systematically and transparently, they develop rules for which studies can be selected for review and establish selection criteria and limitations for the review (Newman & Gough, 2020). According to Petticrew and Roberts (2006), inclusion criteria should not be biased or intentionally or unintentionally exclude unintended or imprecise results. After considering these key points, this study's research questions and scope were clearly defined, and inclusion and exclusion criteria were developed to select the primary studies listed in Table 2. Only the studies that met these criteria were considered for this systematic review to ensure the quality of the included studies, and the others were excluded. In this review, 24 articles met the inclusion criteria, and a quality assessment was performed for each article in the included studies, reviewing the research questions, coherence between research questions, methodology, results, and interpretation.

Data selection process and classification

Once the articles have been identified, the number of sources included and excluded at each stage should be tabulated. One way of presenting this information is shown in Fig. 5 from the PRISMA flowchart (Liberati et al., 2009). The results of the

Table 2 Eligibility criteria

Inclusion criteria	Exclusion criteria
• Articles published after COVID-19 Pandemic (November 2019-May 2023) • Scholarly articles of original research published in peer-reviewed journals • The research focused primarily on Second Life studies • Articles published in English • Studies with the search terms in the title, abstract, and keywords • Full-text studies • Answering at least one of the research questions	• Articles not published between November 2019 and May 2023 • Book, book chapters, conference papers, thesis, dissertations, or proceedings • Articles that do not include Second Life studies • Articles not published in English • Not full-text studies

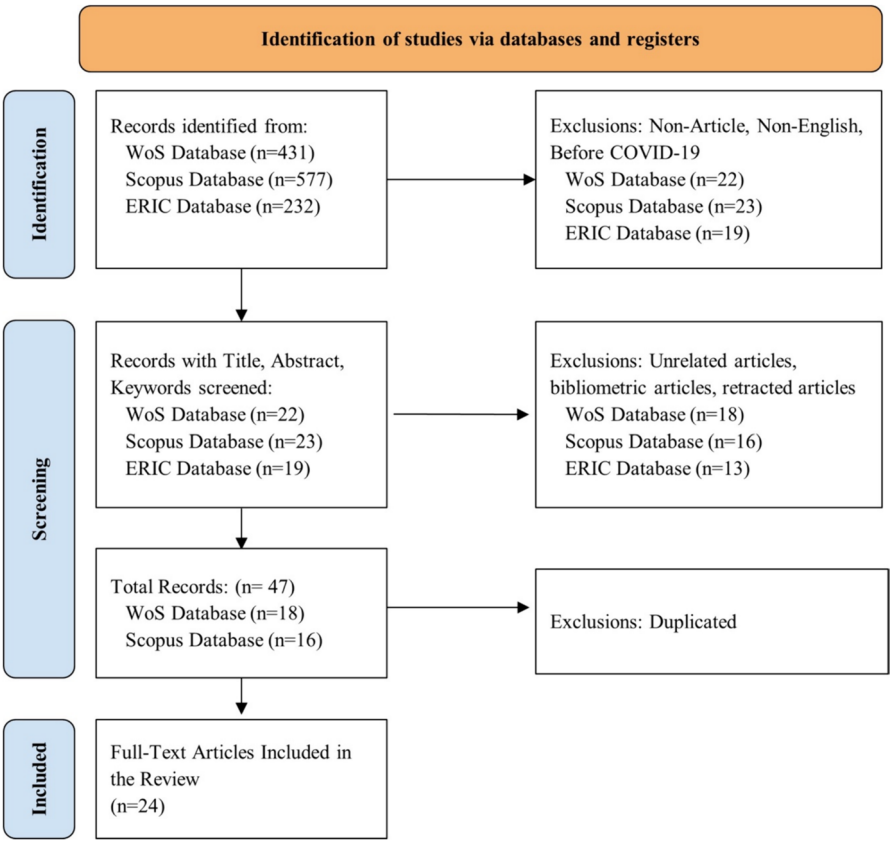

Fig. 5 Data selection process based on PRISMA

literature search are shown in Fig. 5, following the guidelines of the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (Moher et al., 2009), with minor adjustments to fit the purpose of the study.

An initial search on Web of Science found 431 articles, Scopus found 577 articles, and ERIC found 232 articles. In this study, only original research articles published in English-language are targeted, so the non-English studies were excluded to ensure the quality and effectiveness of the review. Moreover, proceeding papers, book chapters, review articles, early access, and editorial material studies were excluded. Pre-COVID-19 pandemic studies were also eliminated. During the screening process, the abstracts of the articles were reviewed, and unrelated articles and retracted ones that did not meet the inclusion criteria were also eliminated. After removing the duplicates, 24 articles remained for analysis, and these remaining ones were thoroughly analyzed.

The data set consists of 24 articles due to the selection and elimination process mentioned above. The data collection type depends mainly on the original research questions (Okoli ve Schabram, 2010). Based on research questions, nine determined

titles have been identified for articles in the dataset given in Table 3. These titles are the citation of the articles, year of publication, research aim, research method, the participant of the studies, country of the studies, research area, data collection method, and results of the studies. With the help of these titles, research questions can be answered.

Results

A total of 24 articles were identified using the above strategy, which was screened using the eligibility criteria listed in Table 2 and shown in the flowchart (Fig. 5). After screening the titles, abstracts, and full texts, the full reports of 24 studies were selected for further screening based on study design.

Descriptive information of studies

Research aims and research design

In this systematic research, which is mainly about Second Life (SL) research, the purpose of all reviewed studies was classified into nine groups as listed in Table 4. The 1st group includes 12 studies on the effects of SL environment, 2nd group includes three studies on participants' perspective of SL, 3rd group includes one study on teacher presence in SL, 4th group includes one study on SL education, 5th group includes six studies on participants' perception of SL, 6th group includes

Table 3 An example line for nine titles based on the research questions

Titles	Values
Citation	Han, S., & Resta, P. E. (2020). Virtually Authentic: Graduate Students' Perspective Changes toward Authentic Learning while Collaborating in a Virtual World. Online Learning, 24(4), 5–27
Publication year	2020
Research aim	To investigate graduate students' perspective changes apropos their cross-national collaborative learning experience while participating in an online teaching and learning course jointly taught by graduate schools in the United States and Israel
Research method	A qualitative case study
Participants	12 students
Country	USA
Research area	Authentic Learning, Collaborative Learning
Data collection method	Semi-structured interview
Results	Participants' construction of new knowledge resulted in authentic learning from the standpoints of social constructivism and online collaborative learning theory and further discuss the factors that enabled the participants' authentic learning experience

Table 4 Sources corresponding to research aims

Research aims	Sources
SL Effects	Ceylan Dadakoğlu & Özsoy, 2020; Ghanbarzadeh & Ghapanchi, 2020; Lorenzo-Alvarez et al., 2020; Yu et al., 2020; Fisher & Baird, 2020; Glassman et al., 2021; Kruk, 2021; Morsink et al., 2021; Rudolphi-Solero et al., 2021; Alblehai, 2022; Aydogan & Aras, 2022; Irwin et al., 2022
Participants' perspective of SL	Han & Resta, 2020; Morsink et al., 2021; Ceylan Dadakoglu, 2022
Teacher presence in SL	Kuznetcova et al., 2021
SL Education	Kuznetcova & Glassman, 2020
Participants' perception of SL	Lorenzo-Alvarez et al., 2020; Wang et al., 2021; Rudolphi-Solero et al., 2021; Rudolphi-Solero et al., 2022; Yurieva et al., 2021; Valencia et al., 2022
Learning gains	Winkelman et al., 2020; Fisher & Baird, 2020; Kruk, 2021
SL Comparison with other contexts	Winkelman et al., 2020; Glassman et al., 2021; Wijeysingha et al., 2021; Valencia et al., 2022; Dai et al., 2023; Rudolphi-Solero et al., 2021
SL Experience	Yurieva et al., 2021; Sancar-Tokmak & Dogusoy, 2020
Participants' attitudes	Winkelman et al., 2020

Some studies may have more than one aim

three studies on learning gains, 7th group includes six studies on SL comparison with other contexts; 8th group includes two studies on SL experience, 9th group includes one study on participants' attitudes. This table, which is about the aim of the research, is related to the second research question of this study.

For a systematic review, a robust study design is crucial because it reduces bias, enhances repeatability, synthesizes extensive evidence, enhances validity and reliability, and encourages transparency and accountability. In this systematic review, studies of research designs are categorized in Table 5.

According to this table, the first line category (Ceylan Dadakoglu, 2022; Ceylan Dadakoglu & Özsoy, 2020; Dai et al., 2023; Glassmanet et al., 2021; Han & Resta, 2020; Irwin et al., 2022; Kuznetcova & Glassman, 2020; Morsinket et al., 2021; Sancar-Tokmak & Dogusoy, 2020) represents studies that used qualitative research methods. These studies focused on understanding subjective experiences, meanings, and social phenomena through interviews, observations, blog posts, chat logs, focus groups, forms, document analysis, comments, or group reports. The second line category (Alblehai, 2022; Aydogan & Aras, 2022; Fisher & Baird, 2020; Ghanbarzadeh & Ghapanchi, 2020; Kuznetcova et al., 2021; Rudolphi-Solero et al., 2021; Valencia et al., 2022) refers to research studies that use quantitative research methods. These studies collect and analyze numerical data by questionnaire, survey, students' blog posts, or tests, often using statistical techniques to examine relationships, patterns, or cause-and-effect relationships. The third-line sources listed under this category (Kruk, 2021; Lorenzo-Alvarez et al., 2020; Rudolphi-Solero et al., 2022; Wang et al., 2021; Wijeysingha et al., 2021; Winkelmann et al., 2020; Yu et al., 2020; Yurieva et al., 2021) represent studies that employed mixed methods research designs. To fully comprehend the

Table 5 Sources corresponding to research design

Research design	Sources
Qualitative design	Ceylan Dadakoglu & Özsoy, 2020; Han & Resta, 2020; Sancar-Tokmak & Dogusoy, 2020; Kuznetcova & Glassman, 2020; Glassmanet et al., 2021; Morsinket et al., 2021; Ceylan Dadakoglu, 2022; Irwin et al., 2022; Dai et al., 2023
Quantitative design	Ghanbarzadeh & Ghapanchi, 2020; Fisher & Baird, 2020; Kuznetcova et al., 2021; Rudolphi-Solero et al., 2021; Alblehai, 2022; Aydogan & Aras, 2022; Valencia et al., 2022
Mixed methods	Lorenzo-Alvarez et al., 2020; Winkelmann et al., 2020; Yu et al., 2020; Kruk, 2021; Wang et al., 2021; Wijeysingha et al., 2021; Yurieva et al., 2021; Rudolphi-Solero et al., 2022

study subject, data was collected by comments, questionnaires, surveys, student grades, pre and post-speaking tests, interviews, session logs, and assessments; these investigations used the advantages of both using qualitative and quantitative methods.

The empirical studies' methodological approaches were investigated to examine if there were any differences in the methodologies adopted by studies in various disciplinary areas. In order to gain a better understanding of the nature of the research, 24 empirical articles were categorized as qualitative, quantitative, and mixed methods. Among these 24 studies, nine studies were qualitative, seven studies were quantitative, and eight studies were mixed-method designs, as shown in Table 5. Moreover, Fig. 6 displays the distribution of articles across the various study aims and the types of research methodologies used for each. The results show that the most popular research focus was measuring the effects of the Second Life environment, followed by participants' perceptions of Second Life and Second Life comparison with other contexts. One study on teacher presence (Kuznetcova et al., 2021) has exclusively adopted a quantitative method. In contrast, the three studies on participants' perspectives of Second Life (Ceylan Dadakoglu, 2022; Han & Resta, 2020; Morsink et al., 2021) and one study on Second Life education (Kuznetcova & Glassman, 2020) adopted qualitative methods. One study on participants' attitudes toward Second Life (Winkelman et al., 2020) adopted a mixed-method design. Studies on Second Life comparison with other contexts (Dai et al., 2023; Glassman et al., 2021; Rudolphi-Solero et al., 2021; Valencia et al., 2022; Wijeysingha et al., 2021; Winkelman et al., 2020) and Second Life effects (Alblehai, 2022; Aydogan & Aras, 2022; Ceylan Dadakoğlu & Özsoy, 2020; Fisher & Baird, 2020; Ghanbarzadeh & Ghapanchi, 2020; Glassman et al., 2021; Irwin et al., 2022; Kruk, 2021; Lorenzo-Alvarez et al., 2020; Morsink et al., 2021; Rudolphi-Solero et al., 2021; Yu et al., 2020) used qualitative, quantitative, and mixed method research design. Studies on participants' perception of Second Life (Lorenzo-Alvarez et al., 2020; Rudolphi-Solero et al., 2021, 2022; Valencia et al., 2022; Wang et al., 2021; Yurieva et al., 2021) and learning gains (Fisher & Baird, 2020; Kruk, 2021; Winkelman et al., 2020) have adopted mixed-methods and quantitative research. Lastly, studies on the Second Life experience (Sancar-Tokmak & Dogusoy, 2020; Yurieva et al., 2021) have adopted both qualitative research design and mixed-method design.

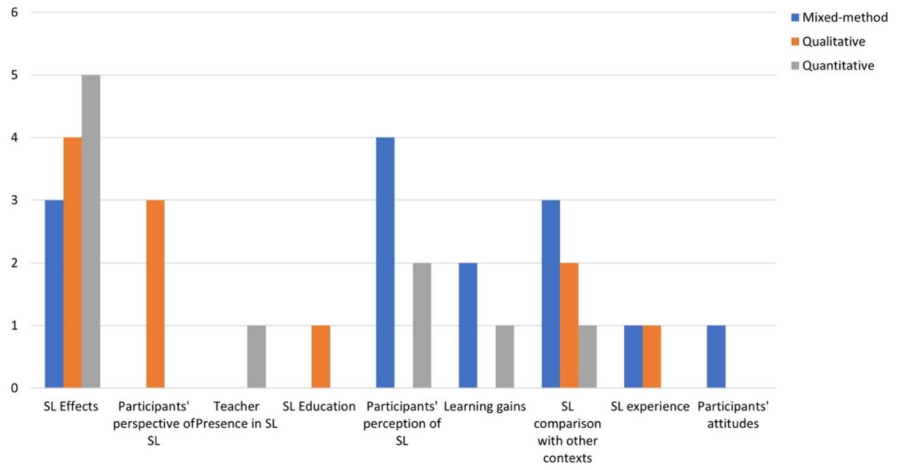

Fig. 6 Methodological approaches adopted and research aim of the 24 empirical articles analyzed. (Some studies have more than one aim)

Participants, countries, and research areas

The studies included in the systematic review in this research are at higher education, university, college, postsecondary, undergraduate, or graduate levels. Information about the study participants, the countries where the studies were conducted, and the research areas are given in Table 6 to answer the third research question.

The methodological approaches used in the empirical studies were examined to determine if there are differences in the methods used in the studies of the different disciplines. All of the studies included in this study are related to education. However, the studies are broken down into further research areas. As shown in Table 6, the fields of studies are indicated for each article, and some studies may have more than one research area. These studies are categorized under seven titles medicine (includes radiology education and nursing), art & design, foreign language, learning styles (includes authentic learning, collaborative learning, problem-based learning, inquiry-based learning, game-based learning), learning environments (includes virtual learning environment, avatar-mediated environments, multiuser virtual environments), digital technologies (includes emerging digital technologies, virtual laboratory, three-dimensional virtual worlds) and others (including user acceptance and teacher presence). Figure 7 displays the distribution of articles across these seven categories of research areas and the types of research methodologies. The results show that studies on digital technologies, learning environments, learning styles, and the medicine field have adopted all three methodological approaches, qualitative (n = 10), quantitative (n = 8), and mixed-methods (n = 11). One research area about language has exclusively adopted a mixed method (n = 4), while another on art and design has adopted qualitative methods (n = 2). Lastly, empirical studies in the other disciplinary areas have adopted both quantitative research design (n = 2) and qualitative research design (n = 1).

Table 6 Sources corresponding to publication year, participants, countries, and research areas

Sources	Year	Participants	Country	Research areas
Ceylan Dadakoglu & Özsoy, 2020	2020	16 students	Turkey	Art and Design Education
Ghanbarzadeh & Ghapanchi, 2020	2020	135 students	Australia	Three-Dimensional Virtual Worlds, User Acceptance
Han & Resta, 2020	2020	12 students	USA	Authentic Learning, Collaborative Learning
Kuznetcova & Glassman, 2020	2020	30 students	USA	Multiuser Virtual Environments
Lorenzo-Alvarez et al., 2020	2020	90 students	Spain	Radiology Education, Game-based Learning
Winkelmann et al., 2020	2020	279 students	USA	Virtual laboratory
Yu et al., 2020	2020	17 students	USA-Taiwan	Foreign Language, Three-Dimensional Virtual Worlds
Fisher & Baird, 2020	2020	478 faculty members	Norway	Emerging Digital Technologies
Sancar-Tokmak & Dogusoy, 2020	2020	21 students	Turkey	Problem-based Learning
Kuznetcova et al., 2021	2021	57 students	USA	Multiuser Virtual Environments, Teacher Presence
Glassmanet et al., 2021	2021	117 students	USA	Multiuser Virtual Environments, Epistemic identity
Kruk, 2021	2021	A student	Poland	Foreign Language, Informal Learning
Morsinket et al., 2021	2021	8 students	Netherlands	Inquiry-based learning, Biomedical Education, Virtual laboratory
Rudolphi-Solero et al., 2021	2021	52 students	Spain	Radiology Education, Game-based learning
Wang et al., 2021	2021	28 students	Australia	Chinese as a Foreign Language, Three-Dimensional Virtual Worlds
Wijeysingha et al., 2021	2021	13 students	Singapore	Radiology Education, Virtual learning environment
Yurieva et al., 2021	2021	132 students	Ukraine	Foreign Language
Alblehai, 2022	2022	112 students	Saudi Arabia	Avatar-mediated environments
Aydogan & Aras, 2022	2022	22 students	Turkey	Virtual laboratory
Ceylan Dadakoglu, 2022	2022	17 students	Turkey	Art and Design Education
Irwin et al., 2022	2022	24 students	Australia	Nursing, Avatar-mediated environments
Rudolphi-Solero et al., 2022	2022	463 students	Spain	Radiology Education, Multiuser Virtual Environments, Game-based Learning
Valencia et al., 2022	2022	150 students	Spain-El Salvador	Virtual learning environment

Table 6 (continued)

Sources	Year	Participants	Country	Research areas
Dai et al., 2023	2023	18 lecturers	Australia, Peoples R China	Virtual learning environment

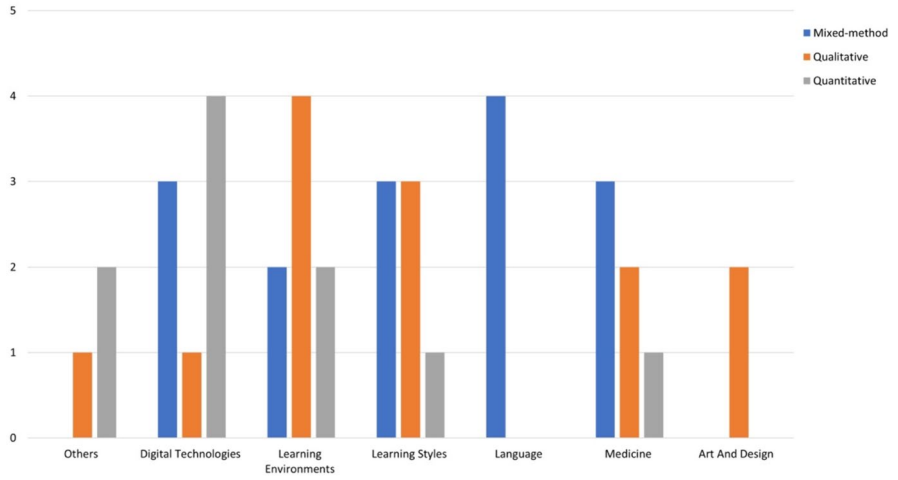

Fig. 7 Methodological approaches adopted by empirical studies in the different disciplinary areas. (Some studies may have more than one focus)

Publication years and countries

Studies evaluated in this systematic review included studies from after COVID-19 to the date of this study (November 2019—May 2023). The 24 articles included in this study were published in 13 different countries. Considering the publication year and countries of these studies, they can be interpreted in Fig. 8 as follows: In 2020, there were three publications from the USA, two publications from Turkey, one publication from Spain, one publication from Australia, one publication from the USA-Taiwan pair. In 2021, there were two publications from the USA, one from Poland, one from the Netherlands, one from Spain, one from Australia, one from Ukraine, one from Singapore, and one from Norway. In 2022, there was one publication from Saudi Arabia, two from Turkey, one from Spain, one from Australia, and one from the Spain-El Salvador pair. In 2023, one publication from the Australia-People's Republic of China pair was published.

Geographic distribution

The reviewed studies were conducted in 13 countries worldwide: the USA, Poland, Netherlands, Saudi Arabia, Turkey, Spain, Australia, Ukraine, Taiwan, Singapore, El Salvador, Peoples R China, and Norway. Figure 9 shows that the majority of the studies are conducted in the USA (21%) and Turkey (17%).

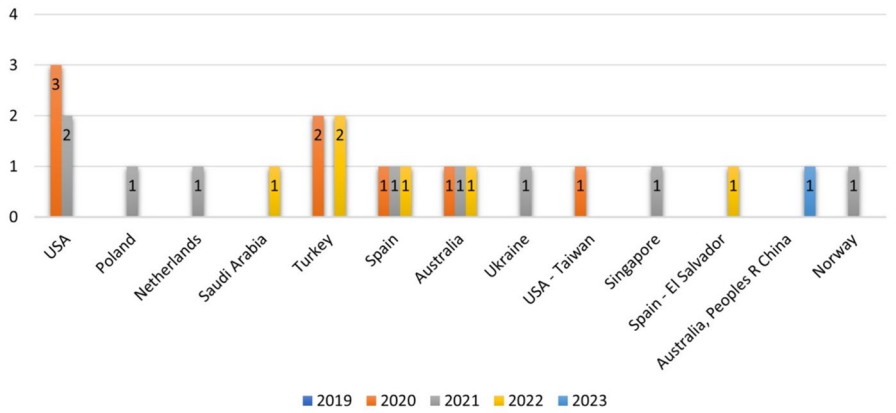

Fig. 8 Publication year with countries

Research population

The research population of the studies reviewed includes students and instructors in higher education, e.g., students, faculty, and instructors. The results presented in Fig. 3 show that studies involving students were the most common, followed by studies involving other faculty and teaching staff. Within the scope of this research, participants in 22 of 24 studies (Alblehai, 2022; Aydogan & Aras, 2022; Ceylan Dadakoglu, 2022; Ceylan Dadakoglu & Özsoy, 2020; Ghanbarzadeh & Ghapanchi, 2020; Glassmanet et al., 2021; Han & Resta, 2020; Irwin et al., 2022; Kruk, 2021; Kuznetcova & Glassman, 2020; Kuznetcova et al., 2021; Lorenzo-Alvarez et al., 2020; Morsinket et al., 2021; Rudolphi-Solero et al., 2021, 2022; Sancar-Tokmak & Dogusoy, 2020; Valencia et al., 2022; Wang et al., 2021; Wijeysingha et al., 2021; Winkelmann et al., 2020; Yu et al., 2020; Yurieva et al., 2021) consisted of students, and in two of them (Dai et al., 2023; Fisher & Baird, 2020) lecturers.

Results of the studies

Information on the results of the research studies is given in Table 7, which helps to explain the first research question. This table provides a list of authors and their research results related to using Second Life (SL) learning environments in various educational contexts.

As can be seen in Table 7, the studies discussed in this study have produced different results. According to the results obtained, the studies can be classified and summarized as follows:

Enhancement of Skills and Creativity:

- Including Second Life (SL) in art and design education enhances students' 21st-century skills, imagination, and creativity (Ceylan Dadakoglu & Özsoy, 2020).

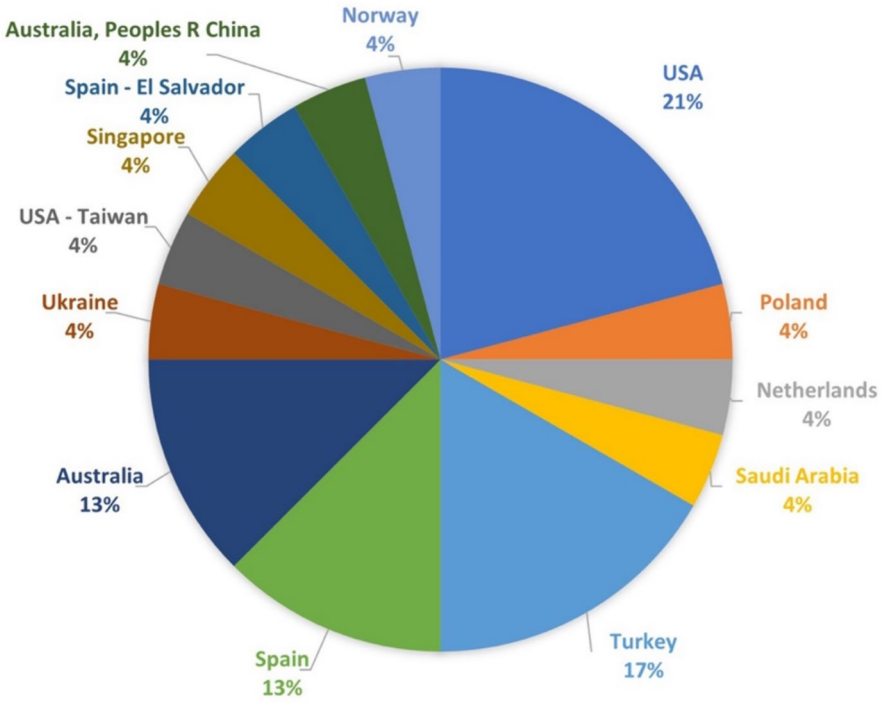

Fig. 9 Geographic distribution of published articles

- SL application has a positive effect on improvement in application skills, 3D thinking skills, design skills, and creativity in art and design education (Ceylan Dadakoglu, 2022).
- SL can create independent learning communities that foster transformative learning and multiple perspectives (Kuznetcova & Glassman, 2020).
- Diminished teacher presence encourages students to become independent learners (Kuznetcova et al., 2021).

Positive impact on learning and engagement:

- Use of 3D virtual worlds (3DVWs) in learning environments positively affects user acceptance, student satisfaction, learning outcomes, retention, course engagement, and graduate outcomes. Computer self-efficacy of higher education students does not significantly impact the acceptance of 3DVWs (Ghanbarzadeh & Ghapanchi, 2020).
- Authentic learning is facilitated through social constructivism and online collaborative learning in virtual worlds (Han & Resta, 2020).
- Virtual Labstore positively impacts students' perceptions of learning experimental design and enhances student–teacher interaction (Morsinket et al., 2021).
- Virtual worlds can provide a safe space for students to develop their epistemic learning identity (Glassmanet et al., 2021).

Table 7 Sources corresponding to research results

Authors	Research results
Ceylan Dadakoglu & Özsoy, 2020	The inclusion of SL in the art and design education curriculum will contribute to 21st-century skills and develop the imagination and creativity of students
Ghanbarzadeh & Ghapanchi, 2020	The effectiveness of ease of use, usefulness, enjoyment, and visual attractiveness of a 3DVW-based learning environment on user acceptance of the technology. Findings also suggest that the application of 3DVWs has a significant impact on student satisfaction, learning outcome, retention, course engagement, and students' graduate outcomes. The study confirms that the computer self-efficacy of higher education students does not have a positive impact on the acceptance of 3DVWs
Han & Resta, 2020	Participants' construction of new knowledge resulted in authentic learning from the standpoints of social constructivism and online collaborative learning theory and further discuss the factors that enabled the participants' authentic learning experience
Kuznetcova & Glassman, 2020	Second Life can be used to create independent learning communities that have possibilities for transformative learning, creating contexts in which students move beyond simple understanding and engage multiple perspectives in their meaning-making processes
Lorenzo-Alvarez et al., 2020	Competitive game-based learning within Second Life is an effective and well-accepted means of teaching core radiological anatomy and radiological signs content to medical students. The higher medium-term outcomes obtained by participants may indicate effective learning with the game. Additionally, valuable positive perceptions about the game, the educational contents, and the potential benefit for their education were discovered among non-participants
Winkelmann et al., 2020	Students performing chemistry experiments in the virtual world of Second Life demonstrated equivalent or greater learning gains on lab reports and quizzes compared to students completing analogous experiments in a real-world lab setting. Their experience in SecondLife was sufficient for the students to perform equally well on a lab practicum also. The students performing the SL experiments expressed positive opinions about their virtual lab experience. Neither group of students showed any change in their attitudes about chemistry during the semester
Yu et al., 2020	The participants maintained their anxiety levels due to the partial anonymity presented in the Second Life context
Fisher & Baird, 2020	In the findings of the survey, respondents identified several instructional technologies such as augmented reality (AR), virtual reality (VR), mixed reality (MR), and artificial intelligence (AI) as being on the cusp of changing learner engagement options and could soon become standard tools for the online course environment
Sancar-Tokmak & Dogusoy, 2020	The novice instructional designers stated that the problem-solving process in the Second Life promoted their motivation and engagement related to the real-world problem. To solve the real-world problem, five groups proposed Analysis-Design-Development-Implementation-Evaluation model, while one group proposed an Attention-Relevance-Confidence-Satisfaction model. Although the participants were aware of the potential of the Second Life as a Problem-based Learning environment, they stated that they preferred alternative technologies due to access and usability issues

Table 7 (continued)

Authors	Research results
Kuznetcova et al., 2021	Diminished teacher presence can encourage students to become active and independent learning agents
Glassmanet et al., 2021	The MUVE was used as a safe space to develop students' epistemic learning identity through micro identity-crises manifested through micro-rebellions
Kruk, 2021	The participant's FLA was subject to some changes both during her visits to SL and from one session to the next. These ups and downs in FLA levels were affected by a host of negative (e.g. conversations with strangers, the lack of sufficient language, negative experience) and positive (e.g. conversations with familiar interlocutors, interesting topics, language progress) factors
Morsinket et al., 2021	Virtual Labstore positively affected students' perceptions on learning about experimental design and increased student–teacher interaction flexibility
Rudolphi-Solero et al., 2021	A multiuser game adapted to team competition to learn radiology in Second Life was very positively perceived by third-year medical students, who highly valued its content, organisation, and usefulness for their training. Most of the participants agreed that they had collaborated as a team and that playing in competitive environments helps them learn better. The best post-exposure and academic results compared to non-participating students indicate the potential impact of the game on learning
Wang et al., 2021	Students welcomed the experiential learning opportunity to explore Chinese culture and language outside the classroom afforded by CI. Anecdotal evidence suggested that students became more aware of the complicated pragmatic issues in real life communication
Wijeysingha et al., 2021	Overall learning achievement outcomes and knowledge retention scores between Second Life® and non- Second Life® student participants were closely similar and statistically insignificant. Thematic analysis of the confidence survey questionnaires revealed that the students in general desired more clinical hands-on practice
Yurieva et al., 2021	Students are rather active in their English language use and demonstrate a positive attitude while engaging with different online tools. Moreover, the use of such informal learning technologies may well help them transition from language learners regarding foreign language as an end in itself into language users able to apply their knowledge of the language in actual performance
Alblehai, 2022	Individual experience was positively associated with students' engagement; (2) social, physical, and task attraction was found to positively mediate the link between experience and engagement. The outcomes from this study provide valuable implications for promoting online learners' engagement in avatar-mediated environments

Table 7 (continued)

Authors	Research results
Aydogan & Aras, 2022	In this study, a new basic programmable logic controllers laboratory was designed, simulated and virtually implemented on Second Life, a 3D virtual world with powerful features such as object construction and programming language. Then, this virtual programmable logic controllers laboratory was introduced to the students of Electricity and Energy Department of Usak University who had previously taken the programmable logic controllers course theoretically, and a survey about this laboratory was administered. One-hundred percent of the students who participated in the survey found this lab to be helpful, and 95.45% found it to be useful
Ceylan Dadakoglu, 2022	The participants' application skills, 3D thinking skills, design skills and creativity during the practise of the SL application improved. Despite some technical difficulties in understanding SL, it is thought that SL is a suitable environment for art and design education. Also, due to the COVID-19 pandemic, most of the education activities are conducted on virtual environments. Therefore, it is thought that SL will contribute to distance education by online learning
Irwin et al., 2022	Second Life was shown to mimic real-world, experiential learning. All participants agreed that Second Life could be utilised to rehearse and refine nursing skills in readiness for practice. Registered Nurses recognised that learning via this virtual platform could assist to close the theory practice gap
Rudolphi-Solero et al., 2022	Competitive learning games within virtual worlds like Second Life have great learning potential in radiology, but the mean score in the game decreased, acceptance of virtual world technology was lower, and opinion about the game was worse with a compulsory participation, and even worse when dropouts were not allowed. Under the conditions in which this study was conducted, learning games in three-dimensional virtual environments should be voluntary to maintain adequate motivation and engagement of medical students
Valencia et al., 2022	Students perceive specific advantages linked to the design of VR activities in virtual reality
Dai et al., 2023	Changing from traditional to virtual teaching context is a complex process, which (re)shaped the lecturers' various senses of identity and agency towards different instructional approaches resulting in the sense of in-betweenness with multiple digital competencies. These changes indicated that they taught in an "in-between' mode mapped by different teaching mediations

- Anonymity in the Second Life context maintains participants' anxiety levels (Yu et al., 2020).
- In avatar-mediated environments, the association between individual experience, engagement, and mediating factors (social, physical, and task attraction) is positive (Alblehai, 2022).
- Augmented reality, virtual reality, mixed reality, and artificial intelligence are identified as emerging instructional technologies with the potential to enhance learner engagement in online courses (Fisher & Baird, 2020).

- There were no significant differences in overall learning achievement outcomes and knowledge retention scores between students who participated in Second Life and those who did not. Additionally, students expressed a general desire for more hands-on clinical practice (Wijeysingha et al., 2021).

Subject-Specific Learning:

- Competitive game-based learning in Second Life effectively teaches radiological anatomy to medical students (Lorenzo-Alvarez et al., 2020).
- Students performing chemistry experiments in Second Life show equivalent or more significant learning gains compared to real-world lab settings (Winkelmann et al., 2020).
- A multiuser game for radiology learning in Second Life is highly valued, promotes team collaboration, and shows better post-exposure and academic results than non-participating students (Rudolphi-Solero et al., 2021).
- Second Life provides experiential learning opportunities for exploring Chinese culture and language (Wang et al., 2021).
- Second Life can be utilized for real-world experiential learning in nursing, closing the theory–practice gap (Irwin et al., 2022).
- Students have a positive perception and usefulness of a virtual programmable logic controller laboratory in Second Life (Aydogan & Aras, 2022).

Impact on Language Learning:

- Students actively use English and have a positive attitude when using online tools. These tools can help them transition from seeing the foreign language as an academic pursuit to becoming language users who can apply their knowledge effectively (Yurieva et al., 2021).
- Participants' Foreign Language Anxiety (FLA) fluctuates based on positive and negative factors experienced in Second Life (Kruk, 2021).

Perceived Advantages of Virtual Reality and Transition to Virtual Teaching:

- Transitioning from traditional to virtual teaching reshapes lecturers' identities and instructional approaches, resulting in an "in-between" teaching mode with multiple digital competencies (Dai et al., 2023).
- Novice instructional designers find problem-solving in Second Life motivating but prefer alternative technologies due to access and usability issues (Sancar-Tokmak & Dogusoy, 2020).
- Students perceive specific advantages in the design of virtual reality (VR) activities (Valencia et al., 2022).

Discussion

This study aims to identify and summarize the current literature on the impact and strategies of Second Life as an educational tool in different educational settings in higher education. The first research question aims to determine the potential impacts of using Second Life as an educational tool in various educational settings in higher education. The results of 24 studies covered in this research were analyzed to answer this research question. According to the data obtained, using Second Life as an educational tool in different educational settings in higher education has impacts on the enhancement of skills and creativity (Ceylan Dadakoglu, 2022; Ceylan Dadakoglu & Özsoy, 2020; Kuznetcova & Glassman, 2020; Kuznetcova et al., 2021). Moreover, it has a positive effect on learning and engagement (Alblehai, 2022; Fisher & Baird, 2020; Ghanbarzadeh & Ghapanchi, 2020; Glassmanet et al., 2021; Han & Resta, 2020; Morsinket et al., 2021; Wijeysingha et al., 2021; Yu et al., 2020). Apart from these, results have been achieved in subject-specific learning (Aydogan & Aras, 2022; Irwin et al., 2022; Lorenzo-Alvarez et al., 2020; Rudolphi-Solero et al., 2021; Wang et al., 2021; Winkelmann et al., 2020) and these results can be summarized as follows: Second Life effectively supports subject-specific learning by teaching radiological anatomy, enhancing chemistry experiment outcomes, promoting radiology team collaboration, exploring Chinese culture and language, bridging the nursing theory–practice gap, and positively impacting perceptions of virtual programmable logic controller laboratories. Moreover, results have been achieved in language learning (Kruk, 2021; Yurieva et al., 2021) and these results can be summarized as follows: Online tools in Second Life help students actively use English and develop a positive attitude towards the language, transitioning to practical language users, while their Foreign Language Anxiety varies with their experiences in the virtual environment. Lastly, conclusions have been drawn about the perceived advantages of virtual reality and the transition to virtual teaching (Dai et al., 2023; Sancar-Tokmak & Dogusoy, 2020; Valencia et al., 2022) and according to these conclusions, transitioning to virtual teaching reshapes lecturers' identities and instructional approaches, requiring multiple digital competencies, while novice instructional designers find problem-solving in Second Life motivating but challenging due to access and usability issues, and students perceive specific advantages in VR activity design.

The second research question is about using Second Life as a tool for teaching and learning in higher education. Full-text analysis of 24 empirical studies showed that the theme of the Second Life research varied from the Second Life effects, participants' perspective of Second Life, participants' perception of Second Life, participants' attitudes of Second Life education/experience, teacher presence in Second Life, learning gains, and Second Life comparison with other contexts. Figure 6 depicts the distribution of articles based on their research aims and the methodologies employed. The findings reveal that the primary research focus centered on measuring the effects of the Second Life environment, followed by exploring participants' perceptions of Second Life and Second Life

comparison with other contexts. Interpreting these research aims at the methodological approach shows these results: A study on teacher presence (Kuznetcova et al., 2021) employed a quantitative method. In contrast, three studies on participants' perspectives (Ceylan Dadakoglu, 2022; Han & Resta, 2020; Morsinket et al., 2021) and a study on Second Life education (Kuznetcova & Glassman, 2020) used qualitative methods. One study on participants' attitudes toward Second Life (Winkelman et al., 2020) utilized a mixed-method design. Studies comparing Second Life with other contexts and investigating its effects (Dai et al., 2023; Glassman et al., 2021; Rudolphi-Solero et al., 2021; Valencia et al., 2022; Wijeysingha et al., 2021; Winkelman et al., 2020) employed qualitative, quantitative, and mixed-method research designs. Studies on participants' perceptions of Second Life (Lorenzo-Alvarez et al., 2020; Rudolphi-Solero et al., 2021, 2022; Valencia et al., 2022; Wang et al., 2021; Yurieva et al., 2021) and learning gains (Fisher & Baird, 2020; Kruk, 2021; Winkelman et al., 2020), utilized mixed methods and quantitative approaches. Lastly, studies on the Second Life experience (Sancar-Tokmak & Dogusoy, 2020; Yurieva et al., 2021) employed both quantitative and mixed-method designs.

As shown in Fig. 6, studies evaluated against objectives fall into qualitative, quantitative, and mixed methods. Studies included in this review utilized a range of methodologies, such as thematic analysis for qualitative data and meta-analysis techniques for quantitative data. Considering the totality of studies evaluated using these research methods, the studies primarily targeted SL effects (n = 12). Participants' perception of SL (n = 6) and SL comparison with other contexts (n = 6) have the same number of studies. The number of studies aiming at participants' perspectives of SL (n = 3) and learning gains (n = 3) is the same. While two studies pursued SL experience goals, the fewest (n = 1) studies examined goals of teacher presence, SL education, and participant attitudes. It should be noted that some of these studies have multiple purposes.

The third research question seeks to answer the current research status on using Second Life as an educational tool in higher education. In this context, the profiles of the people who participated in these studies, the countries where the studies were carried out, the research designs, the publication year, and the research areas were comprehensively analyzed. This systematic review includes the studies carried out in higher education. Studies have two different populations: students and teaching staff. According to the results obtained, most of the studies were carried out with students because they are easier to access for researchers. On the other hand, only two of the studies (Dai et al., 2023; Fisher & Baird, 2020) were conducted with the participation of faculty and lecturers. The geographic distribution of the reviewed papers supported the claim that many countries are aware of Second Life as an educational tool. However, there were relatively more publications in the USA (21%) and Turkey (17%). The distribution of publications by year and country, which is shown in Fig. 8, can be summarized as follows: In 2020, there were three publications from the USA, two from Turkey, one from Spain, one from Australia, and one from the US-Taiwan pair. In 2021, there were two publications from the USA, one from Poland, one from the Netherlands, one from Spain, one from Australia, one from Ukraine, one from Singapore, and one from Norway. In 2022,

there was one publication from Saudi Arabia, two from Turkey, one from Spain, one from Australia, and one from the Spain-El Salvador pair. In 2023, one was from the combination of Australia and the People's Republic of China. This distribution provides insight into the geographic diversity of published research and highlights the involvement of multiple countries in research on the use of Second Life as an educational tool. Studies included in this research include all research design types: qualitative, quantitative, and mixed-methods. Categorizing the studies into these three categories, it is found that the three research methods covered approximately the same number of studies. As shown in Table 5, of the 24 studies, nine were qualitative, seven were quantitative, and eight were mixed-method. The methodological approaches used in the empirical studies were reviewed to determine whether there were methodological differences between studies in different fields. Although all studies included in this research are related to education, these studies were categorized under seven titles: medicine, art and design, foreign language, learning styles, learning environments, digital technologies, and other disciplinary areas. Interpreting these categories using the methodological approach shown in Fig. 7 leads to the following conclusions: Studies on digital technologies, learning environments, learning styles, and the medical field have adopted all three methodological approaches, qualitative (n = 10), quantitative (n = 8), and mixed-methods (n = 11). One research area about language has exclusively adopted a mixed method (n = 4), while another on art and design has adopted qualitative methods (n = 2). Lastly, empirical studies in the other disciplinary areas have adopted both quantitative research design (n = 2) and qualitative research design (n = 1).

A more detailed analysis reveals that the research findings varied significantly based on the methodologies employed and the specific learning outcomes measured. Qualitative studies frequently concentrated on the subjective experiences of students and instructors, such as the impact of Second Life on creativity in art and design education (Ceylan Dadakoglu & Özsoy, 2020) and the value of authentic learning experiences (Han & Resta, 2020). Quantitative studies typically involved the administration of surveys and the administration of tests to measure specific learning outcomes. For example, Ghanbarzadeh and Ghapanchi (2020) investigated the impact of 3D virtual worlds on student satisfaction and learning outcomes, while Winkelmann et al. (2020) compared learning gains in virtual chemistry experiments versus real-world laboratory settings. Mixed methods studies, which combine both qualitative and quantitative approaches, provide a comprehensive understanding of the impacts of Second Life. One example is the evaluation of the effectiveness of game-based learning in radiology education (Lorenzo-Alvarez et al., 2020). The learning outcomes also varied, with several studies reporting significant enhancements in various skills, including 3D thinking, design skills, and creativity (Ceylan Dadakoglu, 2022), as well as notable learning gains in subject-specific areas like chemistry and radiology (Winkelmann et al., 2020). Furthermore, increased student engagement and motivation were highlighted, with virtual environments positively impacting students' perceptions of experimental design and enhancing student–teacher interaction (Morsinket et al., 2021). In the field of language acquisition, the utilisation of online tools in Second Life has been demonstrated to facilitate active utilisation of the English language and the development of a positive attitude towards

the language, thereby reducing foreign language anxiety (Kruk, 2021; Yurieva et al., 2021).

The findings on Second Life indicate that similar metaverse platforms have the potential to enhance learning outcomes across various disciplines by providing immersive and interactive environments. However, they may similarly face challenges related to anxiety, technical difficulties, and usability issues, which need to be addressed to maximize their educational potential. Future research should concentrate on these difficulties. Furthermore, direct comparisons of these platforms should be conducted with a focus on user engagement, learning outcomes, and the ease of integration into educational curricula. Such comparisons can assist educators in making informed decisions regarding the optimal virtual environment to meet their needs.

Limitations, recommendations and future research

This systematic review included 24 empirical studies on the use of Second Life in education and evaluated them in the light of three research questions: effectiveness, purpose, and current status. The findings and recommendations are based on the data from this research, and they are as follows:

This research comprises articles on education-related study areas that can be methodically explored and studies about higher education. In this context, it is advised to explore Second Life's capabilities outside of the classroom to confirm its efficacy in disciplines like architecture, design, and business simulation and to evaluate the transferability of learning outcomes to different industries. Examining Second Life's usability and accessibility for various user groups is necessary when conducting participant-centered evaluations. According to the reviewed research, students make up 91.7% of the participants. The majority of surveys, 21%, are conducted in the United States, while 17% are conducted in Turkey, according to the geographic distribution. It is recommended that researchers conduct studies in a variety of cultural and national contexts in order to ascertain the global applicability and effectiveness of Second Life. Such studies can help to ensure inclusivity and usability across different populations. The 24 publications that were the focus of the study were published between the years 2020 and 2023, with nine appearing in 2020, 8 in 2021, 6 in 2022, and 1 in 2023. The number of studies has decreased over the last two years. Hence, it is advised that this year's studies be increased.

This study has several limitations. The first limitation is that this review was conducted using only three databases: Scopus, Web of Science (WoS), and ERIC. Incorporating articles from additional databases could produce various outcomes; therefore, further studies can investigate the same subjects by including more articles from various databases. Although the selected databases provide extensive coverage, they still have certain limitations. WoS and Scopus predominantly cover peer-reviewed international journals and have extensive coverage in science and technology fields, but they might not adequately represent studies from less prominent regions or disciplines not well-represented in these databases, often focusing more on North America, Europe, and the hard sciences, which may result in biased

coverage (Stahlschmidt & Stephen, 2020). Additionally, the focus on publications in English may have excluded relevant studies in other languages, potentially introducing a language bias. Lastly, this study is limited to studies conducted between November 2019 and May 2023. These limitations suggest that the findings may not fully encompass the global and interdisciplinary scope of Second Life's application in education.

In addition to these, there are specific advantages and challenges when comparing Second Life with other virtual learning environments. Other platforms could offer better accessibility and ease of use unlike Second Life, where the experience is very immersive and interactive. To identify best practices and possible areas of improvement, the future research is recommended to seek a systematic comparison between these environments. Apart from this, future research should explore several key areas. First, research should investigate the effectiveness of these platforms across different educational levels and disciplines to identify specific areas where they are most beneficial. Moreover, there is a need to examine the role of instructor training and support in the successful implementation of virtual learning environments. Finally, studies should explore the potential for virtual environments to support inclusivity and accessibility in education, ensuring that all students, regardless of their background or abilities, can benefit from these technologies.

Conclusion

In summary, the increasing advancement and accessibility of Metaverse technologies, particularly Second Life, has led to an increasing amount of research investigating its impact, especially in the field of education. The purpose of this systematic review was to summarize the existing literature on the use of Second Life as an educational tool in higher education. The review encompassed 24 academic studies that investigated the effects of Second Life on various aspects, including skills and creativity enhancement, learning and engagement, subject-specific learning, language learning, perceived advantages of virtual reality, and the transition to virtual teaching.

As a result, various research findings on these issues have emerged. Several recommendations are proposed further to expand the understanding and use of Second Life. First, it is essential to explore the possibilities of Second Life beyond education, exploring opportunities in areas such as architecture, design, etc. Furthermore, to ensure inclusiveness and usability, it is crucial to evaluate Second Life's user experience and accessibility from the perspective of different user groups. Additionally, it is recommended to conduct research in other countries and cultural settings to fully understand the applicability and effectiveness of Second Life in various educational settings. It is also worth noting that the number of studies related to Second Life has declined in recent years. This fact highlights the need to intensify research efforts to keep up with evolving virtual environment technologies. In summary, this systematic review strengthens the existing knowledge based on Second Life as an educational tool. The recommendations outlined are intended to expand its potential

applications, fill research gaps, and provide valuable insights for educators, educational institutions, and policymakers.

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Data availability The datasets generated and analyzed during the current study are presented within this study.

Declarations

Conflict of interest We have no known conflict of interest to disclose.

Ethical statement I hereby declare that this manuscript is the result of my independent creation under the reviewers' comments. Except for the quoted contents, this manuscript does not contain any research achievements that have been published or written by other individuals or groups. The authors of this manuscript are me, Esra İşgör Şimşek (corresponding author) and Şehnaz Baltacı. The legal responsibility of this statement shall be borne by us.

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