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SIMULATION-BASED DIGITAL PEDAGOGY AND E-LEARNING OUTCOMES: A SYSTEMATIC REVIEW

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ABSTRACT
The integration of simulation-based digital pedagogy into e-learning environments is progressively reshaping how students engage with content, offering immersive and interactive learning experiences that demonstrably improve academic outcomes. Such pedagogical approaches hold particular promise for making learning meaningful, engaging, and accessible across diverse learner populations. This systematic review investigates the application of simulation tools as a mode of digital pedagogy within formal educational contexts, with the specific aim of assessing their empirical impact on e-learning outcomes. The review addresses identified gaps in the literature concerning tool integration, research methodology, and the measurement of empirical effects. Following PRISMA guidelines, sixteen peer-reviewed empirical studies were selected from Scopus, Web of Science, and ERIC, covering the period 2014 to 2025. Findings indicate that PhET Interactive Simulations was the most widely adopted platform among educators, followed by Labster and a range of other scientific and interactive simulation environments, including live simulation formats. The predominant research designs employed across the reviewed studies were quasi-experimental designs with pre-post testing, randomised controlled trials, and mixed-methods approaches. Collectively, the evidence demonstrates significant positive effects on information retention, conceptual understanding, problem-solving ability, and learner motivation. Notwithstanding its pedagogical effectiveness and capacity to bridge the gap between theory and practice in e-learning contexts, simulation-based pedagogy continues to face challenges related to educator preparedness, equitable access to technology, and the accommodation of diverse learner needs areas that warrant sustained attention to fully realise its potential.
Keywords: *Digital pedagogy, simulation, e-learning, systematic review, learning outcomes, technology.*

Introduction

The rapid expansion of digital technology has extensively influenced various sectors, including education. In particular, the teaching and learning of many subjects have experienced substantial transformation with the integration of digital tools and platforms. These innovations have redefined how educators deliver content and engage students with complex and abstract concepts in the classroom. The transition from traditional instructional techniques to more interactive, student-centered digital pedagogies reflect a broader movement toward 21st-century learning competencies, which emphasize critical thinking, collaboration, and technological fluency (sry Wahyuni Zandri, 2025). One of the biggest paradigm leaps in contemporary e-learning is digital pedagogy through simulation, which goes beyond material delivery and provides immersive, interactive and practice-oriented learning environments. Simulation-based education is radically changing the patterns of knowledge learned, maintained and used in real world situations in secure digital environments.

Digital pedagogy goes beyond the technical act of distributing knowledge electronically; it is a deeper, more intentional consideration of the effect of technology on the relationship between teaching and learning process. The use of digital technology in education has progressed from simple computer-assisted instruction in the mid-twentieth century to sophisticated AI-driven and VR-powered learning ecosystems. Within this broader change, simulation-based learning (SBL) stands out as a cornerstone of modern pedagogy, a set of instructional strategies that imitate real-world events to help students learn, acquire skills, and solve problems. Unlike traditional classroom environments that rely on teachers' lectures and textbooks, simulation-based learning bridges the gap between theory building and practice skills by providing students with hands-on, controlled, and real experiences in classroom. In recent years, educational simulations have gained prominence in STEM education, offering dynamic and interactive environments that facilitate experiential learning. Digital simulation, including virtual laboratories, interactive models and augmented reality apps are computer- based instruments intended to immediate real-world process. These simulations allow learners to engage and are just with variables in a virtual environment, promoting experiential learning and a more profound comprehension of scientific principles. It also allows students to investigate complicated scientific phenomena, sharpen problem solving abilities and cultivate a profound comprehension of fundamental concepts in such a way that conventional approach may not support. The accomplishments of these technologies in stimulating engagement and enhancing learning outcomes have generated significant interest among educators and researchers, especially in general and special education. (Chrysovalantis Kefalis, 2025)

The pedagogical aspect of education has significantly impacted the effectiveness and quality of e-learning platforms. E-learning is an educational strategy that uses technology, such as computer-based learning systems, to provide teaching and access to learning resources to all individuals. Over the last few decades, e-learning has shown encouraging results for

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learners of all ages, especially during difficult times such as during pandemics, wars, and natural disasters. Whether students are interested in expanding their horizons or gaining degrees for future job opportunities, e-learning provides the flexibility to pursue education from anywhere and at any time. (Razieh Safarifard, 2024)

Through dynamic representations, interactive simulations, and real-time feedback, innovative digital pedagogies provide new ways to visualize, model, and modify scientific and mathematical concepts.

These pedagogies offer opportunities to improve learning accessibility, meaning, and engagement for a range of learners. Likewise, digital microscopes, augmented reality, and virtual labs have made it possible for students to investigate phenomena that would be difficult to notice in a regular classroom environment. These developments make inquiry-based learning easier by allowing students to test theories, ask doubts, and examine information in secure online settings.

The pedagogical aspect of E-learning

The pedagogical aspects of e-learning focus on the notion of instructional design that supports successful online teaching and learning, emphasizing active engagement and self-regulation. E-learning pedagogy centers on two main continuums: active learning (from teacher-centered to student-centered) and authentic learning (from low to high real-world relevance). This created four design clusters, with most approaches favoring student-led, authentic tasks based on constructivism, which encourages knowledge construction through interaction. Instructional strategies draw on theories such as social constructivism to support self-regulated learning. Brian Croxall (2013) defines digital pedagogy as *"the use of electronic elements to enhance or transform the experience of education."* He emphasizes that digital pedagogy is not merely about tools but about transforming teaching and learning practices through digital means.

Digital simulation

Digital simulation refers to computer-generated models that replicate real-world processes, systems, or environments for interactive practices and analyses. E-learning enables risk-free skill building by mimicking authentic scenarios, such as software interfaces or machinery operations. Digital simulations create virtual replicas of physical or procedural realities, allowing users to perform tasks and observe outcomes without real-world consequences. They emphasize "learning by doing," based on user choices, contrasting static e-learning, such as page-turners. It is commonly used in training for high-stakes fields such as aviation, healthcare, and software use.

This literature review aims to explore the landscape of novel digital pedagogies using simulations. It seeks to identify prominent technologies, instructional methodologies, and pedagogical models that transform e-learning outcomes, as shown in the current research. This review also inquiries into the impact of these simulation pedagogies on learning outcomes of students, their motivation, and engagement. By manually analyzing all data, this review sheds light on optimal practices and areas that require further examination. This effort advances knowledge on digital simulation-enhancing instruction as a cutting-edge pedagogical tool, impacting quality education in the future. Despite the expanding collection of research, there is still a need for thorough understanding of how simulations contribute to observable educational outcomes across a variety of diverse learners and their educational levels that enhance e-learning. This study evaluates some empirical studies about the effects of digital pedagogy through simulations on e-learning outcomes and students' involvement in the educational system, providing insights into ideal practices and procedures, indicating opportunities for future research.

Research Questions

To fill the prevailing gaps and expand upon the existing works, it seeks to address the questions that correspond to the major objective of the study:

RQ1. Which simulation tools/platforms do teachers use in the classroom for improving e-learning?

RQ2. What are the most common research designs used in studies for assessing the usefulness of simulation in education?

RQ3. What are the impacts of simulation as a digital pedagogical approach on students' e-Learning Outcomes?

Methodology

Research Design

To answer the predetermined research questions, this study required a thorough systematic literature review (SLR). An SLR is a methodical approach to data gathering that adheres to predetermined eligibility criteria and focuses on themes. This study focused on journal articles published between 2014 and 2025; previous articles were not included. The recommended reporting elements for systematic review and meta-analysis (PRISMA) framework were followed for the analysis of the collected research studies. To guarantee the quality and reproducibility of the review process, PRISMA offers a standardized, peer-reviewed methodology that incorporates guideline checklists (Moher et al., 2015). PRISMA methodology consists of four successive steps: identification, screening, eligibility, and inclusion, commencing with identification. The next

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subsections provide a more detailed explanation of these steps. This methodology was chosen because of its effectiveness in synthesizing prominent journal publications, allowing for the right identification of best practices in simulation-based digital pedagogy for improved e-learning results. Figure 1 depicts an adapted PRISMA flowchart for this study.

Data Sources and Search Strategies

This systematic review followed the PRISMA standards (Moher et al. 2015). A thorough literature search was carried out using the following databases:

- Web of Science
- Scopus
- ERIC

For the information search, three well-known databases in the context of educational sciences were employed, each with similar features for using the same search string: Web of Science (WoS), Scopus, and ERIC. Irrespective of the database, the fundamental keywords employed in our search encompassed:

('Pedagogical tools' OR 'Digital education' OR 'Simulation-based learning') AND ('Pedagogical Approach' OR 'Instructional Approach' OR 'simulation') AND ('learning outcomes' OR ' E-learning' OR 'Teaching and learning') AND ('virtual laboratories' OR 'simulation platforms) *AND* ('*E-'* OR '*online learning'* OR '*digital learning)'* AND ('*simulation'* OR '*virtual reality'* OR '*simulation-)'* AND('*digital pedagogy'* OR '*pedagogy'* OR '*instructional design') AND (* 'digital education' OR "E-learning outcomes" OR "students engagement") AND ('experimental study' OR 'case study' OR 'quasi-experimental study') AND ('Digital Pedagogy' OR 'Digital Education') AND ('virtual labs' OR 'interactive simulation')

To fulfil the research objective, an exclusive selection of articles linked to systematic literature reviews in the gamification field related to learning outcomes was selected. Inclusion and exclusion criteria were established.

Eligibility criteria

We established a set of inclusion and exclusion criteria to ensure that we found extremely pertinent articles to answer our research questions. The inclusion criteria were primarily predetermined and applied during the advanced search, whereas the exclusion criteria varied during the screening phase.

Inclusion criteria

1) Studies focusing on simulation as a digital pedagogical tool for e-learning.

2) Studies specifically involving digital simulations (e.g virtual simulations, virtual labs, interactive simulation)

3) Only peer-reviewed research articles published are included.

4) Empirical studies with a clear research design (e.g experimental, case study, quasi-experimental and mixed method)

5) Studies that present empirical e-learning outcomes.

6) Articles published in English from 2014 to 2025 were included.

Exclusion criteria

1) Studies involving pedagogies other than simulations were excluded.

2) Non-empirical studies (e.g,. theoretical and literature reviews) were excluded.

3) Studies published before or after 2014–2025 were excluded.

4) Other research articles, such as conference papers, book chapters, and editorials, were also excluded.

5) All languages except English were excluded.

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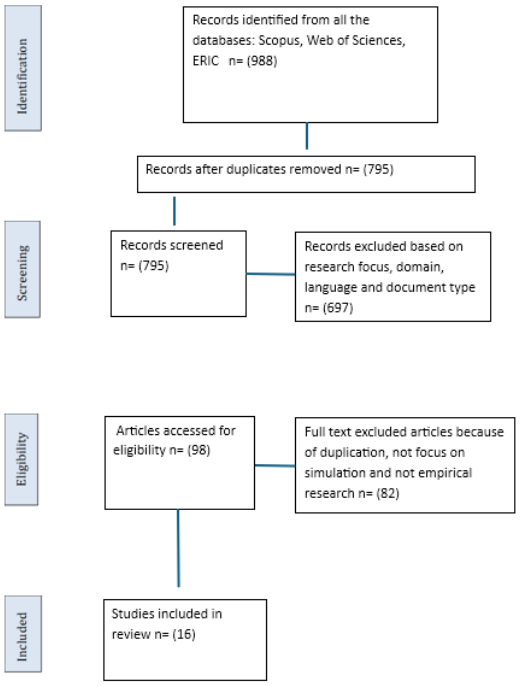

Figure 1. PRISMA Step-By-Step Diagram (source: Authors own elaboration)

These inventories were chosen because of their extensive coverage of research relevant to simulation-based learning, worldwide usability, and constant indexing standards. A complex search query was developed to find specific terms in article titles, abstracts, and keywords to increase the retrieval of possibly pertinent simulation-based research publications.

In addition, to guarantee that potentially pertinent literature was included, the references of the retrieved papers were carefully evaluated. Simulation-based digital pedagogy was the subject heading employed in the retrieval approach: A meta-analysis of E-Learning Outcome Enhancement and keyword groups. Duplicate entries were eliminated, and only English-language articles were included in the screening process.

Selection criteria and procedure

This analysis focused on peer-reviewed research articles published in simulations that contain findings about pedagogical tools, learning outcomes, digital education, e-learning, and digital pedagogy. First, empirical research was favored for inclusion because we were interested in digital pedagogical tools that are extremely relevant to teaching in the rapidly evolving digital world. In addition, papers examining school administrators and teachers' perspectives on the function and applications of simulation tools in their classrooms were chosen. The Study omitted articles from conference proceedings, book chapters, and editorials, as they are sometimes not peer reviewed. Our analysis covered investigations completed at all levels from 2014–2025. The inclusion (IC) and exclusion criteria (EC) are listed above.

Step 1. Identification

In the initial phase, the researchers search for multiple databases to identify prospective studies. According to the PRISMA diagram, a total of 988 records were discovered across all databases, including the search sources: Scopus (n = 779), Web of Science (n = 159), and ERIC (n=51).

Step 2. Screening

In the second phase, the research titles, keywords, and all abstracts of the 795 records were independently screened against the predefined eligibility criteria. At this stage, 697 records were eliminated for failing to meet the basic criteria related to focus on the research topic, population, language or document type, leaving 96 records for full-

Step 3. Eligibility

The full texts of the other 98 articles were retrieved and evaluated in detail for eligibility according to the review's inclusion criteria (study design, sample characteristics, type of intervention, and outcomes reported). After full-also eliminated for failing to meet one or more of these criteria (for example, wrong population, intervention, outcomes, or insufficient methodological quality).

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Step 4. Included

The final qualitative synthesis included 16 studies that successfully meet all the eligibility criteria. These steps and numbers are presented in the PRISMA flowchart.

RESULT

The systematic review findings are organized according to the research questions and objectives of this study. The features of the included research, such as their methodology, simulation tool they used, and intervention category are compiled in Table 1

Table 1: - Summary of studies included in this systematic review

Authors	Title	Year	Tool/Platforms	Research Design	Intervention category
Zabasta,A., Kazymyr, V., Drodz, O., Verslype, S., Espeel, L., Bruzgiene,R.	Development of a shared modelling and simulation environment for sustainable e-learning in the STEM field.	2024	SMSE platform (shared Modelling and simulation Environment) and Jupiter platform	Survey	SMSE effectively merges with Moodle's online learning capabilities with Jupiter Notebooks
Eleo, M.C. and Manguilimotan, Y.B.	Physics Education technology (PhET) interactive simulations as teaching aid in enhancing students' performance in Physics.	2024	PhET platform	Quasi-experimental research design	Interactive simulation
Srisawasdi, N. and Panjaburee, P.	Exploring the effectiveness of simulation-based inquiry learning in science with integration of formative assessment.	2015	computer simulation (PhET)	Experimental and Quasi-experimental	Simulation based inquiry and formative assessment
Keyvani,E.	Enhancing students' engagement and learning outcomes comparing interactive simulators with traditional clicker questions in introductory engineering courses.	2025	PhET platform	Quasi - experimental	Interactive simulation and i-clicker including simulation
Liu, J., et al.	Does a virtual simulation teaching platform improve surgical training for medical undergraduate.	2025	Self-developed virtual simulation teaching platform	Quasi-experimental research design	Interactive virtual simulation pedagogy, blended learning (simulation and physical practice)
Taibu,R., Mataka,L., Shekoyan,V.	Using PhET simulation to improve scientific skills and attitude of community college students.	2021	PhET inductive simulation., lab skills self-assessment, SPSA	Mixed method research design	Simulation based inquiry learning and virtual laboratory intervention
Astutik,S., Prahani,B.K.	The practicality and effectiveness of collaborative creativity learning (CCL) model by using PhET simulation to increase students' scientific creativity.	2018	Ph ET simulation	Experimental research design	Collaborative creative learning (CCL) integrated PhET simulation
Chen,S., et al.	A comparison of student's approach to inquiry, conceptual learning and attitude in simulation based and microcomputer-based Laboratories.	2015	Inquiry Based Simulation Laboratory Manual	Quasi-experimental research design	Simulation based laboratory (SBL) and microcomputer-based laboratory(MBL)
Priyakanth, R. and Krishna sai, N. M.	Impact of simulation-based teaching in the development of student's exploration and learning skills	2023	Two simulation tools:1) MATLAB (Antenna designs application) 2) Multisim live online simulator	Experimental study	Digital simulation integrated with instructional design and demonstration
Cottone, A.M., et al.	Building system capacity with the modelling-based inquiry program for 4 elementary students: A case study	2021	Star Logo Nova (Agent based game and simulation programming)	Qualitative case study	Model based enquiry learning using computational simulation
Omoy, E.Q.	Phet interactive simulation: A tool in improving academic performance of Grade 10 students in balancing chemical equation	2023	PhET platform	Quasi-experimental design	Digital simulation intervention
Alhaslaq, A.	Computer based simulated learning activities: Exploring Saudi students' attitude and experience of using simulation to facilitate unsupervised learning of science concepts	2023	PhET interactive simulation	Quantitative cross sectional survey design	Computer based virtual simulation
Cetin, A.	Effects of simulation based cooperative learning on physics achievement, Science process, attitude towards physics and usage of interactive whiteboards	2018	Computer simulation and Interactive Whiteboard	Quasi - experimental	Simulation based cooperative learning

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Chen, C.H. and Howard, B.	Effect of Live simulation on middle school students' attitude and learning towards science	2014	Live scientific simulation	Quasi-experimental	Simulation based enquiry learning
Algeria, V. Garcia	Interactive simulations in teaching linear Equations	2020	PhET simulation	Quasi-experimental	Interactive simulation and Conventional teaching
Carlos, M. Carrasco et al.	Enhancing learning: Impact of virtual reality simulations on academic performance and perception in Biological Sciences in psychological students	2025	Labster virtual laboratory platform	Quasi-Experimental	Simulation based learning, ICT and Gamification

RQ1. What simulation tools/platforms do teachers use in the classroom for improving E-learning?

Teachers employ several digital platforms and tools to integrate simulations into classroom for improving e-learning settings, enabling better student engagement, conceptual comprehension, and practical skill development in disciplines such as STEM and procedural training. Free tools such as PhET Interactive Simulations offer browser-based, research-validated interactive modules are mostly used by teachers specially in higher education, with straightforward controls to enable real-time collaboration and assessment during courses. Their unique approach enables students to experiment with the variables, test hypothesis and analyse the outcome dynamically. Similarly, virtual laboratory simulations are also used, which allow immersive, curriculum-aligned experiments in high school and college science classes, reducing practical barriers and fostering safe, guided inquiry-based learning. These tools of simulation are intuitive, and its user-friendly interface make abstract concepts more tangible, helping learners at all levels, developing a deeper understanding. Some researchers use simulation as a tool with key pedagogical benefits that enhance digital education and e-learning are shown in table given below:

Table 2: - Simulation tools used with pedagogical benefits

Researcher/Study	Simulation Tool/Platform Used	Key Pedagogical Benefits
Carlos, M. Carrasco, et al.,	Labster virtual laboratory platform	Development of deep conceptual comprehension True immersive, interactive and student centered virtual simulation experiences.
Astutik,S., Prahani, B.K.	PhET Interactive Simulations	Collaborative creative learning when combined with PhET simulation boost scientific creativity by providing collaborative, inquiry-based learning settings.
Chen, C.H. and Howard, B.	Live scientific simulation	Live simulation creates an interactive, real time, inquiry driven Learning that enhance students Scientific learning.
Taibu, R., Mataka, L., Shekoyan,V.	PhET Simulation	Enhances scientific skill by fostering inquiry based interactive learning environment.
Srisawasdi, N. and Panjaburee, P.	PhET computer simulation	Simulation based enquiry learning integrated with formative assessment enhances conceptual understanding along with continuous support and feedback.
Eleo, M.C. and Manguilimotan, Y.B.	PhET interactive Simulation	Enhance students' physics performance by promoting active visual inquiry-based learning experiences

RQ2. What are the most common research designs used in studies for assessing the usefulness of simulation in education?

This analysis comprised studies employing diverse methodological techniques, notably using quasi-experimental and case study research designs. Out of the 16 studies reviewed in this systematic literature review (SLR), 8 studies use a quasi-experimental research design that allowed for structural comparison to analyze simulation effect on e-Learning as a new digital pedagogical tool that relied on controlled pre-post test assessment to evaluate students learning gains. In addition to this, some studies used a case study method as research design. These case studies offer detailed qualitative insight into adopting simulation as one of pedagogical tool in the sphere of digital education, With a focus on specific educational setting and students' population. Other research designs preferred by researchers are survey methods and experimental methods with randomization for clear results.

Pre and posttest designs were frequently used by researchers; Studies use this method to record changes in the learning outcomes of students prior to and after following the intervention. Besides this, some of the research articles use different techniques of evaluation such as observation, Interview, assessment, questionnaire, one time test to understand more about students learning and interaction with simulation as a digital tool in classroom environment.

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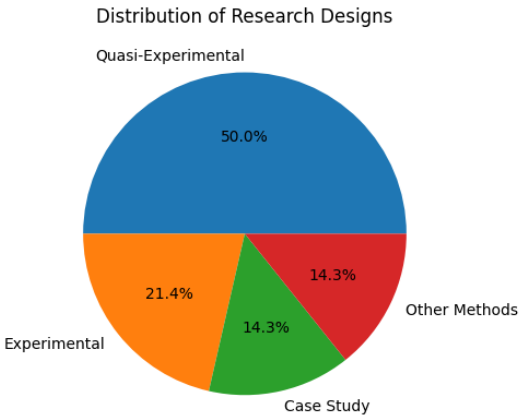

Figure 2:- pie chart showing research design used by reviewed studies

The above pie chart figure made based on above table shows favorable research designs of researchers of above-mentioned reviews, to get accurate results. It is observed that most researchers recommend quasi-experimental research design with controlled pre-posttest interventions for reliable results.

RQ3. What are the impacts of simulation as a digital pedagogical approach on students' E- learning outcomes?

Simulation as a digital pedagogy tool generally has a beneficial impact on students' e-learning outcomes, especially when it is interactive, inquiry-based and aligned with clear learning objectives. A varied range of outcome measures were examined in reviewing these studies, having a primary focus on learning outcomes, engagement of students in classrooms and development of practical skills empowering digital education. Numerous researchers evaluated learning outcomes in a variety of domains, such as theoretical comprehension, cognitive retention and practical implementation of abilities and skills. This approach reflects a shared goal among researchers to assess simulation as a digital pedagogical tool to improve both fundamental knowledge and practical abilities.

There is a great deal of interest in simulation as a technique for boosting student engagement, as seen by the numerous research that sought to understand effect of simulation on students' motivation, enthusiasm, and participation in various disciplines. Some studies examined students' views towards science and scientific inquiry changed, including how much they enjoyed science classes, Whether they were interested in STEM carrier and generally felt about scientific inquiry, it seems that simulation change the opinion of students and enrich better e-learning outcomes. (Kefalis, 2025)

Table 3: - Summary of Outcome measures of reviewed articles

SN	Authors	Year	Outcome category	Description
1.	Zabasta, A. et al.	2024	Skill based and performance-based outcome	e-Learning effectiveness, collaborative modeling skills and platform usability
2.	Eleo, M.C. & Manguilimotan, Y. B.	2024	Cognitive and behavioral outcomes	Academic performance in physics and conceptual understanding
3.	Cottone, A.M. et al.	2021	Skill based and affective outcomes	Inquiry based skills, modeling competency and students' engagement
4.	Taibu, R., Mataka, L., & Shekoyan, V.	2021	Skills and performance-based outcome	Scientific skills, lab skills and self-assessment
5.	Chen, S. et al.	2015	Cognitive and affective outcome	Conceptual understanding of student's attitude toward e-learning and successfully engage in classroom.

Findings

This review identified key trends in the efficacy and impact of simulation as a teaching tool in diverse educational settings. All the reviewed studies show that, many disciplines such as science, engineering, medicine and STEM education contexts, Simulation-based learning significantly Improves Students cognitive, effective and skill-based learning outcomes. When compared to the traditional methods, many studies found that interactive simulation platforms like PhET, labster, SMSE, starlogo Nova, MATLAB and virtual simulation teaching platforms that improve conceptual understanding, academic achievement, scientific inquiry skills, creativity and innovation and learners' engagement in classrooms.

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The increasing use of ICTs in the field of education is accomplished by the recently faced COVID-19 pandemic, that helped in the development of different tools aimed at increasing availability of information, promoting creation of variety of solutions, and improving student involvement. Among all, simulation has gained preference for its capacity to foster deeper learning outcome. (Carlos M. Carrasco, 2025). some researchers created, used and evaluated inquiry activities that engaged students in exploring physics concepts through Physics education technology (PhET) simulations. The success of PhET interactive simulation, which continuously enhanced students' performance, scientific abilities, science attitude add conceptual understanding is a significant trend in the literature (Eleo, M. C., & Manguilimotan, Y. B., 2024; Taibu, R., et al, 2021; Toma, M. J. ,2023; Omoy, E.Q.,2023). According to these Studies, accessible and visually rich simulations encourage intellectual and visual representation, quick feedback and active examination. PhET simulation software is an online collection of interactive simulations and instructional materials intended to educate and learn physics, among other subjects. It engages students with interactive exploration, game-like challenges, complex physics, mathematical models, and physically correct representations. (Melvin C. Eleo, 2024).

Several research studies shows that simulation-based instruction is more effective when it is combined with pedagogical framework such as Inquiry-based learning, formative assessment, common collaborative creativity learning, blended learning and modelling-based inquiry. (Srisawasdi and panjaburee,2015) conclude that by combining simulation-based inquiry with formative evaluation significantly improved conceptual understanding and performance of students. (Cetin, 2018) and (Astutik,S., Prahani, B.K.,2018) both stated that for enhancing science process skills, creativity and attitudes, simulations were integrated into collaborative and cooperative pedagogies.

In terms of learning outcomes, simulation-based learning gives good comprehension, understanding and longer retention as compared to earlier used methods. The blend of simulation with inquiry-based learning enhances creativity and conceptual understanding by improving reflective learning. Additionally, studies also focused on skill-based competencies other than academic outcomes. These results highlight the value of simulation not just in classroom but for the growth and development of students in real life also. (Chrysovalantis Kefalis, 2025).

The literature also shows that simulation-based learning improves affective variables such as student motivation, engagement, scientific attitude and perception of learning. Students experienced simulation environment engaging, participatory and conducive to self-directed learning (Alhaslaq,2023; Keyvani,2025)

Discussion

This review shows that simulation-based learning is producing fundamental changes not only in the tools utilized but also in the responsibilities of school administrators and teachers and instructional methodologies. The greatest change is the shift in the role and responsibilities of teachers; various studies have revealed that teacher's attitude has a significant effect on their motivation to use simulation as a pedagogical tool. Instead of using traditional method to deliver the content teachers using creative and interactive simulation to take the advantage of technology and innovation in classrooms. However, effective outcome of simulation requires systematic approaches including teacher training, institutional support and resource availability.

The overwhelming preference for interactive simulation indicates their potential to accommodate a variety of educational and various other disciplines. However, the limited utilization of other simulation types like game-based simulation OLab platform, under Ministry of Education which is accessible free to all learners and other virtual labs are interesting areas for future research. Future research might compare the performance of different simulation forms and identify challenges to implement other platforms such as virtual laboratories, in various educational settings.

This analysis reveals that there is an increasing demand for inquiry-based learning approach, which supports transcend digital education and emphasizes student centred Learning. However, the findings of the adaptability of simulation platform providing educators various innovative tools to enhance digital education and e-learning in different contexts.

The review indicates that most studies preferred quasi- experimental design over fully randomized experimental design in educational settings, reflecting the constraint of executing such test. Quasi- experimental studies use pre and post as to assess learning outcomes allowing a comprehensive valuation of simulation effectiveness. Some other commonly used methodologies in this review or case studies and mixed method, offering in depth insight of education context, which allow researchers to observe the lasting and benefiting effect of simulation as a pedagogical tool. However, a limited studies used experimental method also. This review highlighted more standardized approaches and usability of randomized experimental method to get a great diversity in research design and ensuring consistency and accuracy in result. (Chrysovalantis Kefalis, 2025)

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This study also emphasises the usability of simulation as a pedagogical tool, by revolutionizing the e-learning outcomes which benefits the diversity of learners, many studies focus on the on academic outcomes and students' engagement in the class only. However, detailed research is to be needed to guarantee fair benefits, assess outcomes for different learners, including learners with special needs and from various populations. Assess scaffolding efficacy and adaptive feedback's significance in improving outcomes such as self-efficacy and overall performance.

Conclusion

This review paper investigates the use of simulation tools in educational context to transform and revolutionize the E-learning outcomes. To achieve this goal, this review emphasizes empirical research by including 16 studies that employed simulation-based intervention and use simulation tools across various instructional methods. on the basis of analysis of various studies from 2014 to 2025, simulation has been and continues to have a significant impact on the field of digital educational context. It is used as a digital tool to enhance students' motivation, longer retention, building concepts and understanding of complex material and made laboratory work easy and feasible to all without the practical presence and risk involved.

The use of quasi-experimental designs, with pre and post-test demonstrates a methodological emphasis on examining the effect of simulation in control situations.

The examined literature demonstrates simulation-based learning as a very effective end successful instructional technique for boosting academic achievement, creativity and a positive scientific attitude among students. However, its effectiveness Is highly dependent on pedagogical integration, instructor facilitation and technological accessibility. Future study should look beyond achievement focused studies to investigate broader psychological outcomes and long-term effects, as well as address implementation challenges in a variety of educational situations.

Finally, future research should examine use of other simulation tools rather than selected ones to diverse the impact of simulation by ensuring the trained and skilled teachers are involved in teaching and with full resource availability.

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