Contemporary Educational Technology, 2023, **15**(4), ep449
ISSN: 1309-517X (Online)

OPEN ACCESS

Review Article

A review of empirical studies examining the effects of e-learning on university students' academic achievement

Lyudmila S. Chikileva [1]
0000-0002-4737-9041

Alexey A. Chistyakov [2*]
0000-0003-4266-2515

Maryana V. Busygina [3]
0000-0003-0804-7981

Alexey I. Prokopyev [4]
0000-0002-6583-2727

Elena V. Grib [5]
0000-0001-7191-1715

Dmitry N. Tsvetkov [6]
0000-0002-9460-7289

[1] Financial University Under the Government of the Russian Federation, Moscow, RUSSIA
[2] Peoples' Friendship University of Russia, Moscow, RUSSIA
[3] Volgograd State Socio-Pedagogical University, Volgograd, RUSSIA
[4] Plekhanov Russian University of Economics, Moscow, RUSSIA
[5] Moscow Aviation Institute (National Research University), Moscow, RUSSIA
[6] I.M. Sechenov First Moscow State Medical University, Moscow, RUSSIA
[*] Corresponding author: sauber60@yandex.ru

Citation: Chikileva, L. S., Chistyakov, A. A., Busygina, M. V., Prokopyev, A. I., Grib, E. V., & Tsvetkov, D. N. (2023). A review of empirical studies examining the effects of e-learning on university students' academic achievement. *Contemporary Educational Technology, 15*(4), ep449. https://doi.org/10.30935/cedtech/13418

ARTICLE INFO

Received: 1 Apr 2023
Accepted: 17 May 2023

ABSTRACT

The purpose of this research is to review peer-reviewed articles on the effects of e-learning on the academic performance of university students. The SCOPUS database was searched for peer-reviewed articles. The data obtained were analyzed using the content analysis method. Twenty-seven articles were found in journals indexed in the SCOPUS database and considered suitable for this study. Two researchers used the content analysis method to determine the effects of the articles reviewed. The results showed that studies in this area have increased in intensity in recent years. These studies were generally conducted over five years. It was found that quantitative methods were predominantly chosen. Researchers published most articles in 2021 and 2022. Most of the studies reviewed used a quantitative design, and only seven articles chose an experimental research design. Most studies were conducted in Pakistan, Saudi Arabia, Spain, India, Iran, and Turkey. The results show that different measurement instruments or tools were used to measure students' academic achievement. The impact of the peer-reviewed articles on the impact of e-learning on college students' academic achievement was examined in four categories. These categories are detailed in the results. Finally, pedagogical conclusions are drawn in light of the results obtained.

Keywords: e-learning, university students, academic achievement, review

INTRODUCTION

With the rapid development and growth of technological advancement, researchers have begun using new teaching methods and techniques in education. The numerous benefits of technology have encouraged instructors and teachers to adapt and use the new advances in education to deliver course content to students at every level (Niyazova et al., 2022). With this aspect, many colleges and universities worldwide have adopted e-learning systems and face-to-face classes to support them in increasing the level of education presented to students (Bossman & Agyei, 2022). In the last three years, e-learning has been widely adopted at all levels of education, especially in higher education, because of the emergence of the COVID-19 pandemic in the world (Alqahtani & Nadeem, 2021; Platonova et al., 2022). Therefore, most universities have been compelled to adopt learning management and e-learning systems to supplement traditional classroom instruction (Bossman & Agyei, 2022; Liu & Yu, 2022). Specifically, the outbreak of COVID-19 has accelerated the use of e-learning in higher education (Xiberta et al., 2022).

In the literature, e-learning can be conceptualized by researchers in different ways. E-learning can be defined simply as using computers and networks in education. Through e-learning, the content of courses is delivered electronically to students when they need it to follow and learn from the courses at any level. Researchers also define e-learning as web-based, online, computer-assisted/based, and internet-based learning (Santos et al., 2016). The advent of computer and internet technologies and the use of smartphones and tablets in recent years have greatly facilitated the adoption of e-learning. To parallel with these developments, researchers and educators have begun to use e-learning as a teaching tool, and the importance of e-learning has been recognized by all educational stakeholders during the pandemic (Zalat et al., 2021).

Through e-learning, educators and instructors who teach at universities can present course content visually in a digital learning environment and allow their students to participate in an online environment. This type of learning and teaching through e-learning offers faculty and students many advantages, such as learning independently without depending on time and place and implementing teaching activities without a physical classroom (Masalimova et al., 2022; Zedan, 2021). From this point of view, e-learning can potentially bring about a paradigm shift in learning and teaching since the advent of the pandemic. To this date, e-learning has been increasingly used by researchers to support traditional teaching and learning methods in various fields (Alanazi & Alshaalan, 2020). In addition, teaching through e-learning can pose some difficulties regarding how best to use it in learning and teaching. Therefore, educational researchers need more information about the impact of e-learning on student achievement.

The present study focused on university students because they had the opportunity to experience a new learning environment and take courses related to e-learning. In particular, the widespread use of e-learning during the COVID-19 pandemic led to distance teaching through e-learning and forced instructors and universities to deliver their courses to students online. Because of this need, researchers and universities have recognized the importance of e-learning. To get more information about the impact of e-learning courses and activities in higher education, it is important to study the effects of e-learning on students' academic achievement. In particular, how e-learning affects students' academic performance has become important since the COVID-19 pandemic and recent technological developments in education. Therefore, this study aims to analyze the effects of e-learning on university students' academic achievement.

A literature review will contribute to understanding e-learning trends related to teaching and learning in higher education. However, review research to understand the influences of e-learning on students' academic performance has received very little attention in the research literature. Although e-learning offers many possibilities as a teaching tool or learning environment, the number of studies examining the impact of e-learning on student academic achievement is very few. In a previous study, Rodrigues et al. (2019) solely analyzed 99 academic articles from 2010 to 2018 according to the keywords, including education and e-learning. They conducted a text analysis using qualitative software to extract meaning from many articles. The results revealed four dominant themes, namely education systems and learning topics, which drive student behavior and the use of online learning tools. Research has agreed that e-learning has great potential as a teaching tool and learning environment inside and outside the classroom. In this case, its effects on student academic achievement must be understood. Hence, a review of research findings in the literature is

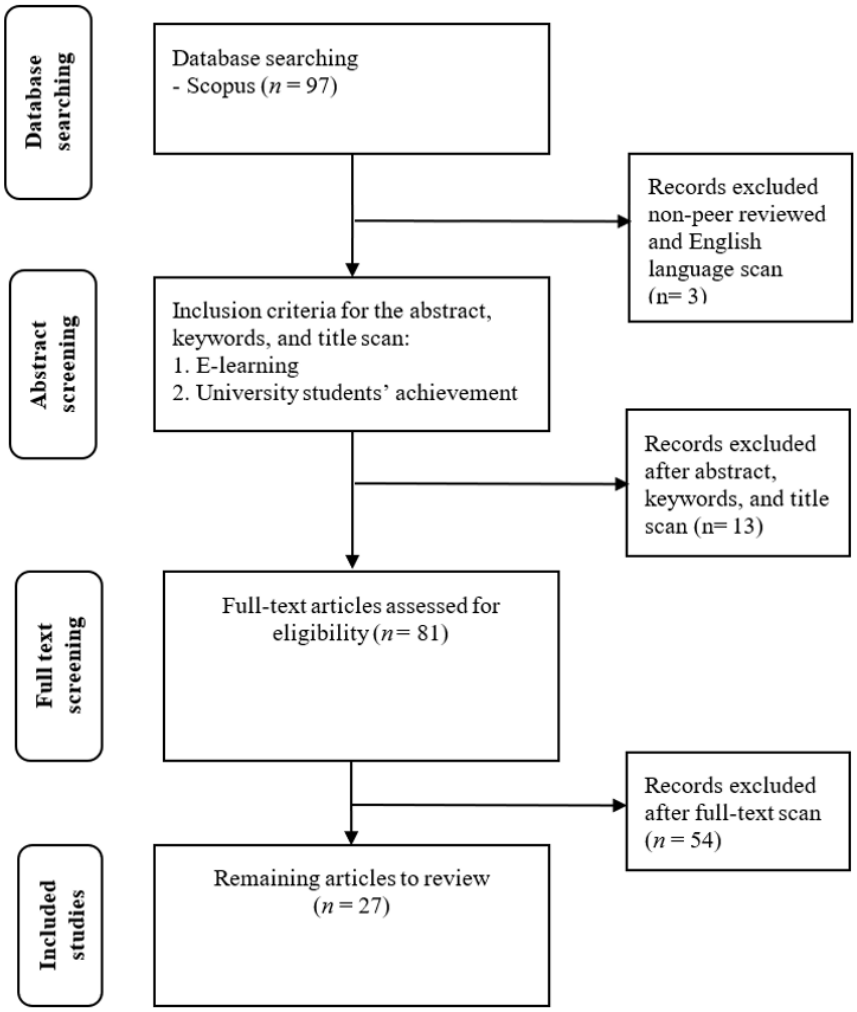

Figure 1. PRISMA flow chart (Source: Authors)

wanted to shed light on the influences of e-learning on university students' academic performance. Therefore, this study conducted a review of empirical studies on the effects of e-learning on university students' academic achievement.

METHOD

This literature review was conducted based on the reporting elements for systematic reviews, named PRISMA, proposed by Moher et al. (2009). **Figure 1** shows the PRISMA method used for data collection and analysis. The database SCOPUS was selected for an initial data search to identify relevant studies. In this database, the combinations of the keywords "e-learning," "achievement", and "performance" in the abstracts, titles, and keywords were used to search for relevant studies. The PRISMA flowchart and its instructions were followed in this study to systematically present the number of articles identified, included, and excluded and the reasons for the exclusions. No year restriction was used to limit the search results when searching the database. After the initial search, we narrowed the search using the options "social sciences," "articles," and "English." The articles searched were limited to the "English" option. The initial search for journal articles yielded 97 results. After removing non-related articles about search keywords, 27 were involved in the analysis (See **Appendix**). The PRISMA flowchart is given in **Figure 1**.

Later, the retrieved papers were further screened based on the following criteria by reading the abstract, title, and keywords. The criteria to involve the articles in the present study are (i) the article should be in English, (ii) it should be a peer-reviewed publication, and (iii) the study should be empirical and investigate the effects of e-learning on student performance. Of these 97 studies, 13 were excluded because they were not empirical, and 54 were excluded because they were irrelevant to integrated e-learning, achievement, or

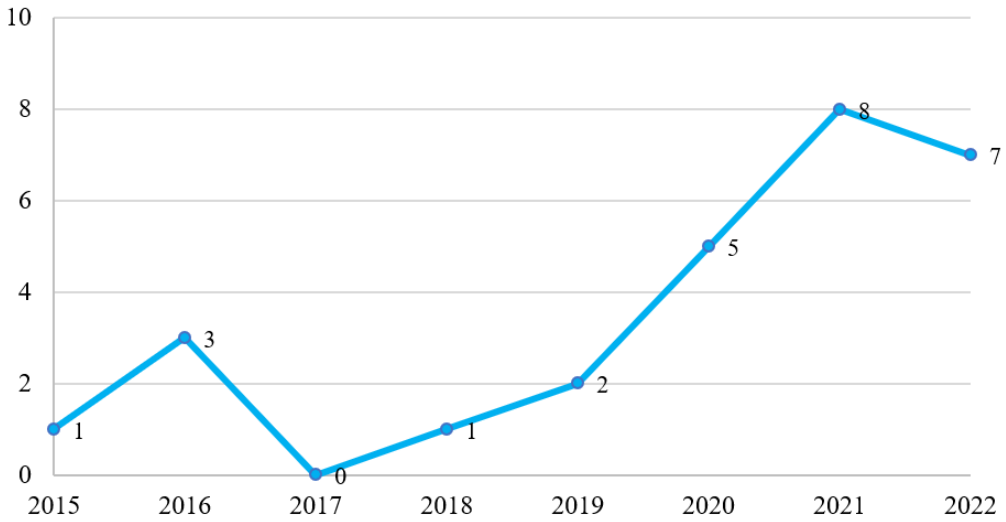

Figure 2. The number of published articles (Source: Authors)

performance. In total, 27 papers were found suitable for a final eligibility assessment. The last search was conducted on March 23, 2023. The researchers read the full texts collaboratively to obtain more information about the articles and reflect their content according to the established search criteria. The articles eligible for analysis were determined. Finally, 70 articles were excluded, and 27 were retained for further analysis based on the initial database search.

An examination of the years in which each of these 27 articles was published in peer-reviewed journals revealed that the earliest study was published in 2015. Since that date, 27 articles have been published. To analyze the eligible articles after the initial search, the authors created a coding sheet in the Excel program and used this sheet to explore the articles. For this purpose, the authors read all the articles in detail and created a set of codes, such as elearning, e-learning, student performance, student achievement, and learning outcomes. Later, these initial codes were used to create broader categories, such as the impacts of learning activities, positive affects on achievement, and negative effects on performance.

As a result of this process, four common themes emerged from the analysis. While reading and analyzing the articles, the coding process did not end. The researchers met regularly to analyze the articles. To determine the broader categories, the researchers discussed them among themselves. They held several meetings to analyze all the articles according to the analysis criteria before beginning the data analysis.

RESULTS

After the researchers analyzed all 27 articles, they categorized them by the year they were published. **Figure 2** shows that the number of articles published between 2015 and 2022 gradually increased. This result indicates that research on the impact of e-learning on university students' academic outcomes was rare in the SCOPUS database before 2015. Most articles were published by researchers in 2021 (n=8) and 2022 (n=7). After these years, many articles were published in 2020 (n=5). In the years before 2020, articles were published in 2019 (n=2), 2018 (n=1), 2016 (n=3), and 2015 (n=1). In 2016, no article was published on e-learning and university students' academic outcomes.

The results of the descriptive statistics provide information about the research design and the author's countries. Of the 27 papers reviewed, the majority (n=20) chose a quantitative design, and only seven articles chose an experimental research design. Studies were conducted in Pakistan (n = 3), Saudi Arabia (n = 3), Spain (n = 3), India (n = 2), Iran (n = 2), Turkey (n = 2), and one study in each of the following countries: Brazil, Egypt, Jordan, Indonesia, Iraq, Mauritius, Palestine, the Republic of Korea, South Africa, Thailand, the United Arab Emirates, and more than one country.

Measurements of Achievement

In the articles examined in this study, academic achievement or performance was mainly assessed using various measurement instruments or tools. These measurement tools are achievement tests (Bana et al., 2021; Rashid, 2020; Zare et al., 2016), final grades or exams (de Araujo Guerra Grangeia et al., 2016; Kokoç & Altun, 2019; Ramdani et al., 2021; Sánchez-Cabrero et al., 2021; Yavuzalp & Bahcivan, 2021) and theoretical exam (de Araujo Guerra Grangeia et al. 2016), GPA scores (Fernandez et al., 2022; Innab et al., 2022; Jawad & Shalash, 2020; Kim et al., 2019; Nácher et al., 2021), learning activities (Rajabalee et al., 2020), mid-term grades, scientific test (Rezaee et al., 2022), social network analysis & network metrics (de-Marcos et al., 2016), students' self- reporting (Prakasha et al., 2022; Sobaih et al., 2022), survey questionnaire (Abdullatif & Gameil, 2021). These results show that most studies reviewed did not use actual GPA values from student records or the registrar. The results show that the researchers conceptualized the concept of "achievement" in different ways. This result shows that there is no standard for the definition of achievement in the minds of the researchers. One reason for these results may be that it is difficult to collect real GPA data from university database is difficult. In this case, the contradictory results in the published articles may highlight the differences in the measurement of the constructs.

E-learning as a Teaching Method

E-learning is one of the teaching approaches that have emerged in the last two decades depending on technological developments in education. Therefore, it is important to investigate how researchers have addressed e-learning teaching methods. Five studies were found that examined the impact of e-learning activities or teaching methods on university students' learning outcomes (see Table 1). In general, the studies in this category used experimental research design and studies with control and experimental groups. For example, Zare et al. (2016) investigated the effects of e-learning on chemistry students' creativity and content knowledge at a university in Iran. The study used a pretest and posttest experimental design with a control group. The participants, 100 chemistry students, were attending two separate classes. Forty students were selected from this group and divided into the experimental and control groups. A specially designed test on the introduction to chemistry course and the Abedi Inventory to assess creativity was used to collect the data. The results showed that the experimental group scored statistically significantly higher on the measured variables, knowledge, and creativity. Therefore, it can be concluded that e-learning is effective for acquiring knowledge and creativity in chemistry students and that more e-learning opportunities should be offered to a wider audience.

Nácher et al. (2021) evaluated the efficacy of the e-learning platform GoKoan in enhancing academic performance. To this end, an experiment was conducted on 171 university students enrolled in a psychology program and randomly assigned to one of two conditions. The experimental group engaged in traditional learning and e-learning using the GoKoan platform, whereas the control group only engaged in traditional learning. The results demonstrated that using GoKoan improved the academic performance of students. The results demonstrate the significance of blended learning for enhancing student performance. Rashid (2020) desired to determine the impact of e-learning on the academic performance of physiology students at a medical university. Twenty students were divided into two groups, one experimental and one control, with one of the experimental groups studying the e-learning method and the control group studying the lecture method. On the post-test in physiology, there were no statistically significant differences between the mean scores of the experimental group taught via e-learning and the mean scores of the control group taught via lecture. Bana et al. (2021) examined the academic performance of e-learning and didactic teaching strategies among dental students in their third year. They examined two groups: an experimental group using e-learning and a control group using traditional instruction. Each group contained 25 individuals. Both groups were instructed with similar learning objectives and course content. Videos, a literature review, and clinical scenarios were among the course materials emailed (asynchronously) to the e-learning group participants. In the didactic learning group, the material was presented over two lectures. Using 15 MCQs, academic performance was evaluated at the beginning of the course, after its completion, and after five weeks. Five weeks later, the results demonstrated a statistically significant difference between the mean academic scores of all three performances in the e-learning and didactic learning groups. After completing the courses, however, academic performance was not statistically significant.

Rezaee et al. (2022) investigated the effect of case-based e-learning (CBEL) on nursing students' academic performance and problem-solving skills. In this pretest and posttest study, 128 nursing students who had taken nutrition courses between 2015 and 2017 were selected (blindly) via census sampling for the pre-and post-tests. Before and after the educational intervention, students completed a problem-solving inventory that measured problem-solving confidence (PSC), approach-avoidance style (AA), personal control (PC), and academic functioning using a scientific test. Before and after the intervention, they analyzed continuous variables and categorical variables. After the intervention, mean PSC, AA, and PC scores decreased, according to the findings. After the intervention, students' average science grades improved. The findings demonstrated that the CBEL method positively impacted students' ability to solve learning problems and academic performance.

Summarizing the studies discussed above, a rough picture of the research on the results of experimental studies can be presented as follows.

- The studies that used e-learning as a teaching method reported statistically significant effects on academic achievement and performance (Nácher et al., 2021; Rezaee et al., 2022; Zare et al., 2016).
- Although the study of Bana et al. (2021), a significant effect was found in part of the outcomes on academic performance, and insignificant statistical differences were also found between the control and experimental groups. Rashid (2020) also found no statistically significant differences between the mean score of the experimental group taught using the e-learning method and the mean score of the control group taught using the lecture method on posttest physiology.

E-learning as a Learning Environment

Five articles considered and studied e-learning as a learning environment in their research. In general, these studies in this category used experimental research design and studies with control and experimental groups.

For instance, de-Marcos et al. (2016) analyzed the social network structure produced by a gamified undergraduate social curriculum and the effect of student position on learning achievement. During a semester-long experiment, students were given access to a social networking website that provided gamified activities and enabled social interaction and collaboration. A network graph was constructed using social network analysis, and four measures for the overall network and nine measures for each participant were calculated. The individual measures were then evaluated using correlation, principal component analysis, and multiple linear regressions as predictors of student performance. With 167 actors and 2,505 links, the resulting social network can be described as a small world. The analyses revealed the structural metrics' potential as predictors of learning performance, but the measures deemed significantly varied. Most centrality measures had a moderate correlation with learning achievement.

Kokoc and Altun (2019) examined learners' interaction with learning dashboards as a predictor of the outcome of an online learning experience and the extent to which this interaction data can be used to predict and guide their academic performance. As a learning analytics tool, they developed a prescriptive learning dashboard integrated with an e-learning environment. Students enrolled in a twelve-week computer network and communications course were the participants. Students' academic performance and transcript data were analyzed using data mining techniques. Learners were divided into four groups based on their behavior patterns, as determined by cluster analysis of their interactions with the prescriptive learning dashboard. When the respective clusters are profiled based on academic performance, a similar pattern emerges. The study revealed that interaction with the prescriptive learning dashboard significantly affected students' academic performance. The artificial neural network algorithm provided the most accurate academic performance predictions. The findings indicated that prescriptive learning dashboards could be utilized in online courses to enhance learner performance and learning design in e-learning environments. By analyzing student learning activities, Rajabalee et al. (2020) sought to understand the relationship between student engagement in an online module and their overall performance. Using an activity-based learning design strategy, they implemented a general education module (for first-year students) on the Moodle eLearning platform using an online format. The correlation between student engagement in the online module and their performance on the last learning activity was weakly significant but statistically significant. The study of Jawad

and Shalash (2020) investigated the impact of e-learning on the academic performance of university students in Palestine. The study showed that implementing an e-learning strategy positively and statistically significantly affected students' grade point average (GPA). Sánchez-Cabrero et al. (2021) focused on comparing academic performance in the three courses of the secondary education master's program in the last on-site evaluation. They also found that performance in the latter cohort improved significantly, increasing average grades by more than 10%.

Summarizing the studies discussed above, a rough picture of the research has indicated the positive influences of e-learning on university students' academic achievement.

The Positive Influence of E-learning

Fifteen studies examined the relationships between e-learning and academic achievement and have reported positive influences of e-learning on academic achievement. For example, Altaany (2015) investigated the use of WhatsApp by students from their perspective and the impact of WhatsApp (text, image, video, audio, and call) on students' academic performance.

The researcher created a questionnaire to assess students' academic performance based on previous research. The questionnaire was administered to 364 undergraduates at a Jordanian university. The results indicated a statistically significant correlation between WhatsApp text, images, and videos and the academic performance of Irbid University students. The correlation between (audio and call) and academic performance was not statistically significant, according to the findings of this study. During this emergency transition to e-learning, Kerzi et al. (2021) highlighted the factors that influence how students perceive their academic performance. During the first wave of the pandemic, an online survey was used to conduct an empirical analysis on a sample of 10,092 college students from 10 countries and four continents. A structural equation model revealed that the primary determinants of e-learning quality were service quality, the active role of the online educator instructor, and overall system quality. In contrast, digital literacy and online interactions between students and teachers were deemed less important. The relationship between the quality of e-learning and student performance was substantially mediated by student satisfaction with e-learning. The model produced consistent results across this study's countries, genders, academic fields, and educational levels. Suresh et al. (2018) investigated the effect of e-learning on students' academic performance. The results of a questionnaire created and distributed to students were analyzed. Their findings indicated that e-learning positively affected the academic performance of students. The study by de Araujo Guerra Grangeia et al. (2016) examined the relationship between sixth-year medical students' participation and acceptance in a new e-learning environment and their academic performance. Their analyses demonstrated positive correlations between platform time and final medical grades.

Rasheed et al. (2020) investigated the association between service quality dimensions (tangibility, responsiveness, assurance, reliability, empathy, and e-learning) and student academic performance through student motivation and satisfaction. They gathered information from 384 participants enrolled in Pakistani higher education institutions. Through student motivation and satisfaction, all service quality dimensions (tangibility, responsiveness, assurance, reliability, empathy, and e-learning) were positively associated with student academic performance.

In another investigation, Ramdani et al. (2021) examined the correlations between self-efficacy, creativity perception, productive disposition, and students' academic performance when e-learning was implemented. Their findings revealed a direct correlation between self-efficacy and academic achievement. In addition, there was no correlation between creativity perception and academic performance. They discovered a direct correlation between productive disposition and academic achievement. Yavuzalp and Bahcivan (2021) examined the relationship between e-learning readiness and self-regulation skills, satisfaction, and academic performance among college students taking on-campus classes via distance learning. The research revealed that university students' readiness for e-learning influences their self-regulation skills, level of satisfaction, and academic performance. Al-Abdullatif and Gameil (2021) intended to develop a model to investigate how integrating digital technologies into project-based learning (PBL) increased students' academic achievement in higher education. They utilized the technology acceptance model (TAM) to investigate the digital technology environment in terms of perceived usefulness, perceived ease of use, attitudes toward digital technology integration, and the influence of these factors on learning engagement and academic achievement PBL

among graduate students. As the primary data collection method, a questionnaire was designed to collect pertinent information regarding adopting digital technologies, PBL, learning ownership, and academic performance among students. The participants were 185 graduates enrolled in a course in which PBL was implemented. Analyzing the data using structural equation modeling (SEM) required a proactive research approach. When digital technology was integrated into a PBL environment, the results indicated that TAM-related factors and students' learning engagement positively impacted their academic achievement.

Bossman and Agyei (2022) investigated the impact of perceived e-learning satisfaction on the relationships between e-learning satisfaction drivers and perceived learner performance. In 2021, they collected responses to a nationwide online survey. Their findings revealed that technology anxiety, instructor factors, course quality, technology quality, and ease of use are significant determinants of e-learning student satisfaction and performance in distance education. Results indicated that perceived learner satisfaction mediates the relationships between satisfaction-influencing factors and learning outcomes of Ghanaian distance learners. Alam et al. (2021) developed a framework for using e-learning services and their contribution to academic achievement and learning. Five major factors (learner quality, instructor quality, information quality, system quality, and institutional quality) determined the performance of e-learning services, accounting for 48.7% of the variance in the perceived usefulness of ELS and 71.2% of the variance in e-learning system use, according to their findings. Together, the researchers found that the perceived usefulness of ELS and the use of ELS explained 70.6% of student learning and academic performance. During the COVID-19 pandemic, Younas et al. (2022) investigated the online influencing factors for learning among college students in Pakistan. The results correlated e-learning satisfaction with academic achievement, and Pakistani students who utilized e-learning during the pandemic reported greater academic satisfaction and achievement. Prakasha et al. (2022) conducted a study to determine whether university students have favorable attitudes toward e-learning and whether this affects their academic performance. Their findings indicate a weakly positive correlation between attitudes toward e-learning and academic performance among graduate students, but not among undergraduates. In their study, females outperformed males and had more favorable attitudes toward e-learning. In addition, they discovered that socioeconomic status (SES) had no effect on students' attitudes toward e-learning but did affect their academic performance. Sobaih et al. (2022) investigated the impact of social network applications on academic performance in e-learning during COVID-19. Their analyses revealed that social network applications as e-learning platforms positively and statistically significantly affected students' academic performance. Fernandez et al. (2022) studied the relationship between the e-learning environment, e-learning adoption, digital readiness, and student attitudes toward e-learning and academic achievement. According to their findings, student academic achievement is significantly influenced by the e-learning environment, digital readiness, academic engagement, and student and faculty attitudes toward e-learning. Innab et al. (2022) investigated the impact of students' sense of community and satisfaction during e-learning on academic achievement. According to their findings, academic achievement was strongly and positively correlated with satisfaction with teaching, assessment, overall skills and learning experiences, and overall satisfaction with e-learning. Students who collaborated with their peers and were more engaged in learning were more satisfied with e-learning and had greater academic success. Female participants reported a stronger sense of community, greater satisfaction with e-learning, and higher academic achievement than their male counterparts.

The Negative Influence of E-learning

Two studies examined the relationships between e-learning and academic achievement and have reported negative influences of e-learning on academic achievement. For example, Kim et al. (2019) investigated the perceptions of e-learning among college students and the mediating role of academic engagement and digital readiness in the university context on academic achievement. According to the findings, two factors, including e-learning adoption and attitudes toward e-learning, did not directly predict academic achievement. In another study, Na et al. (2020) examined the relationship between motivation and academic achievement among Thai university students participating in e-learning. They discovered that e-learning student motivation was in the upper to middle range. They determined a weak positive correlation between academic achievement and motivation, but this correlation was not statistically significant.

DISCUSSION

This study investigated the effects of e-learning on the academic performance of university students. In this review, 27 articles that met the inclusion criteria were examined. Researchers published most articles in 2021 (n=8) and 2022 (n=7). Most reviewed studies (n=20) used a quantitative design, and only seven articles chose an experimental research design. Most studies were conducted in Pakistan (n = 3), Saudi Arabia (n = 3), Spain (n = 3), India (n = 2), Iran (n = 2), and Turkey (n = 2), respectively. In general, the results showed that most studies examined the relationships between e-learning, other variables related to e-learning, and academic achievement. In this systematic review, most studies found positive and significant improvements in the effect of e-learning on university students' achievement. These studies yielded remarkably different results. Therefore, we can conclude that previous researchers in this field have not yet reached a consensus because they pursued different objectives and characteristics.

Researchers have used different variables and measurements to examine the relationship between e-learning and achievement and to investigate the impact of e-learning on achievement. The results revealed that various measurement instruments or tools were used to measure students' academic achievement or performance. These measurement tools are achievement tests (Bana et al., 2021; Rashid, 2020; Zare et al., 2016), final grades or exams (de Araujo Guerra Grangeia et al., 2016; Kokoç & Altun, 2019; Ramdani et al., 2021; Sánchez-Cabrero et al., 2021; Usak et al., 20222; Yavuzalp & Bahcivan, 2021) and theoretical exam (de Araujo Guerra Grangeia et al. 2016), GPA scores (Fernandez et al. 2022; Kim et al., 2019; Innab et al., 2022; Jawad & Shalash, 2020; Nácher et al., 2021), learning activities (Rajabalee et al., 2020), mid-term grades, scientific test (Rezaee et al., 2022), social network analysis & network metrics (de-Marcos et al., 2016), students' self- reporting (Prakasha et al., 2022); Sobaih et al., 2022), survey questionnaire (Abdullatif & Gameil, 2021). Based on these results, we can conclude that most studies reviewed did not use actual GPA values from student records or the registrar. This result may be because researchers conceptualized the term "achievement" differently. This result suggests that there is no standard for the definition of performance in the minds of the researchers. This result has led to researchers using many variables to evaluate the impact of e-learning on student performance.

Similar to other previous research findings examined in this study (e.g., Ramdani et al., 2021; Rashid, 2020), the results of this study suggest that e-learning can be valuable in improving students' academic performance. We think the reason is possible if e-learning activities or modules are well planned and adapted to the unique educational needs of university students. For example, many researchers (e.g., Nácher et al., 2021; Rezaee et al., 2022; Zare et al., 2016) indicated that e-learning improves students' academic achievement. Of the studies reviewed in this research, only two (Kim et al., 2019; Na et al., 2020) reported negative effects of e-learning on academic achievement. However, these studies did not explain the lack of a relationship between e-learning and achievement.

In general, the studies reviewed reported that e-learning is comparable, and in many cases, to face-to-face classroom instruction. Research has also reported that e-learning has positive and significant effects on achievement. This finding is largely consistent with previous studies that reported that students who used e-learning compared to traditional learning had higher achievement than face-to-face learning.

This systematic review study suggests that teaching using e-learning can improve student performance compared to traditional teaching. Although e-learning teaching modules and activities take more time and are time-consuming, they can be easily introduced and implemented to improve student performance if they are well-designed and prepared. Similarly, Mhishi et al. (2023) found that lack of teacher training and support and inadequate infrastructural facilities were the major barriers to teacher readiness to implement e-learning in schools.

CONCLUSION

This review examined the studies on e-learning and university students' academic achievement and performance. The studies generally reported the positive effects of e-learning on students' academic performance. Although some studies have explored many variables that could contribute to the proposed relationship, most studies insufficiently studied the effects of moderators and mediators on students'

achievement to clarify the effects of certain variables on achievement. The researchers believe that the results of this study contribute to the existing literature by filling in the gaps and highlighting the importance of the influence of e-learning and students' academic achievement.

RECOMMENDATIONS

In general, research has confirmed that e-learning positively impacts students' achievement. It is then necessary to consider in what context and for what purposes e-learning teaching courses or modules should be used. Universities must equip their instructors with technical skills, pedagogical principles, and teaching strategies to develop effective e-learning environments. Preparing e-learning modules takes more time and is more complex than preparing traditional lectures (Cela et al., 2015). The lack of knowledge and skills to create courses according to the principles of e-learning course preparation is one of the biggest challenges for lecturers when implementing e-learning. Hence, future research should focus on the challenges of lecturers when implementing e-learning at universities.

LIMITATIONS

There are some limitations to this study. First, only articles from the SCOPUS database were analyzed in this study. The articles in the other databases were not considered in this study. Second, the definitions of "e-learning" in some studies were unclear, i.e., ambiguities in the definition and use of the term "e-learning" in the studies examined. Due to these limitations, some studies on "e-learning" and performance were not searched in the database. Some authors did not define their study as "e-learning." Third, the study's limited selection criteria included only peer-reviewed journal articles to verify the representativeness of the study results. Other publications may need to focus on expanding the study to get a broader view of e-learning and university students' achievement. Therefore, the researchers suggest that readers be aware of an important point related to the present work that emphasizes the comprehensive nature of the present study before summarizing difficult perspectives from the review.

Author contributions: All authors were involved in the concept, design, data collection, interpretation, writing, and critically revising the article. All authors approved the final version of the article.

Funding: The authors received no financial support for this article's research and/or authorship.

Ethics declaration: The authors declared that the study did not require an ethics committee approval since it was based on existing literature.

Declaration of interest: Authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

Alam, M. M., Ahmad, N., Naveed, Q.N., Patel, A., Abohashrh, M., & Khaleel, M.A. (2021). E-learning services to achieve sustainable learning and academic performance: An empirical study. *Sustainability*, *13*, 2653. https://doi.org/10.3390/su13052653

Al-Abdullatif, A. M., & Gameil, A. A. (2021). The effect of digital technology integration on students' academic performance through project-based learning in an e-learning environment. *International Journal of Emerging Technologies in Learning*, *16*(11), 189-210. https://doi.org/10.3991/ijet.v16i11.19421

Alanazi, A. A., & Alshaalan, Z. M. (2020). Views of faculty members on the use of e-learning in Saudi medical and health colleges during COVID-19 pandemic. *Journal of Nature and Science of Medicine*, *3*(4), 308-317. https://doi.org/10.4103/JNSM.JNSM_82_20

Alqahtani, N., & Nadeem, F. (2021). Improving the effectiveness of e-learning processes through dynamic programming: A survey. *International Journal of Advanced Computer Science and Applications, 12*(5), 818-825.

Bana, K. F. M. A., Ilyas, F., Sadia, H., Hakeem, S., & Kadri, W. B. (2021). Effects of e-learning on academic performance: Quasi experimental study. *Rawal Medical Journal*, *46*(4), 967-969.

Cela, K. L., Sicilia, M. Á., & Sánchez, S. (2015). Social network analysis in e-learning environments: A preliminary systematic review. *Educational Psychology Review*, *27*, 219-246. https://doi.org/10.1007/s10648-014-9276-0

de Araujo Guerra Grangeia, T., de Jorge, B., Franci, D., Martins Santos, T., Vellutini Setubal, M. S., Schweller, M., & de Carvalho-Filho, M. A. (2016). Cognitive load and self-determination theories applied to e-learning: impact on students' participation and academic performance. *PLoS ONE, 11*(3), e0152462. https://doi.org/10.1371/journal.pone.0152462

de-Marcos, L., García-López, E., García-Cabot, A., Medina-Merodio, J.-A., Domínguez, A., Martínez-Herráiz, J.-J., & Diez-Folledo, T. (2016). Social network analysis of a gamified e-learning course: Small-world phenomenon and network metrics as predictors of academic performance. *Computers in Human Behavior, 60, 312-321.* https://doi.org/10.1016/j.chb.2016.02.052

Fernandez A. I., Al Radaideh, A., Sisodia, G. S., Mathew, A., & del Rio, J. A. J. (2022). Managing university e-learning environments and academic achievement in the United Arab Emirates: An instructor and student perspective. *PLoS ONE, 17*(5), e0268338. https://doi.org/10.1371/journal. pone.0268338

Innab, A., Albloushi, M., Alruwaili, M., Alqahtani, N., Alenazi, L., & Alkathiri, A. (2022). The influence of sense of community and satisfaction with e-learning and their impact on nursing students' academic achievement. *International Review of Research in Open and Distributed Learning, 23*(4), 19-34.

Jawad, Y. A. L. A., & Shalash, B. (2020). The impact of e-learning strategy on students' academic achievement case study: Al-Quds Open University. *International Journal of Higher Education, 9*(6), 44-53.

Kerzič, D., Alex, J. K., Alvarado, R. P. B., Bezerra, D. S., Cheraghi, M., Dobrowolska, B., Fagbamigbe, A. F., Faris, M. E., França, T., González-Fernández, B., Gonzalez-Robledo, L. M., Inasius, F., Kar, S. K., Lazányi, K., Lazăr, F., Machin-Mastromatteo, J. D., Marôco, J., Marques, B. P., Mejía-Rodríguez, O., … Aristovnik, A. (2021). Academic student satisfaction and perceived performance in the e- learning environment during the COVID-19 pandemic: Evidence across ten countries. *PLoS ONE 16*(10), e0258807. https://doi.org/10.1371/journal.pone.0258807

Kim, H. J., Hong, A. J., & Song, H. D. (2019). The roles of academic engagement and digital readiness in students' achievements in university e-learning environments. *International Journal of Educational Technology in Higher Education, 16*(1), 1-18.

Kokoç, M., & Altun, A. (2019): Effects of learner interaction with learning dashboards on academic performance in an e-learning environment, *Behaviour & Information Technology, 40*(2), 161-175, https://doi.org/10.1080/0144929X.2019.1680731

Liu, M., Yu, D. (2022). Towards intelligent e-learning systems. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-11479-6

Masalimova, A. R., Erdyneeva, K. G., Kislyakov, A. S., Sizova, Z. M., Kalashnikova, E., & Khairullina, E. R. (2022). Validation of the scale on pre-service teachers' digital competence to assist students with functional diversity. *Contemporary Educational Technology, 14*(4), ep382. https://doi.org/10.30935/cedtech/12301

Mhishi, M., Chimbwanda, V. M., & Gwizangwe, I. (2023). Embracing the new normal: Geography teachers' preparedness and the use of e-learning methodologies. *Pedagogical Research, 8*(1), em0147. https://doi.org/10.29333/pr/12665

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, *6*(7), e1000097. https://doi.org/doi:10.1371/journal.pmed1000097

Na, K. S., Petsangsri, S., & Tasir, Z. (2020). The relationship between academic performance and motivation level in e-learning among Thailand university students. *International Journal of Information and Education Technology*, *10*(3), 184.

Nácher, M. J., Badenes-Ribera, L., Torrijos, C., Ballesteros, M. A., & Cebadera, E. (2021). *The effectiveness of the GoKoan e-learning platform in improving university students' academic performance. Studies in Educational Evaluation, 70*, 101026. https://doi.org/10.1016/j.stueduc.2021.101026

Niyazova, G. B., Utemov, V. V., Savina, T. N., Karavanova, L. Z., Karnaukh, I. S., Zakharova, V. L., & Galimova, E. G. (2022). Classification of open mathematical problems and their role in academic achievement and motivation of students. *Eurasia Journal of Mathematics, Science and Technology Education, 18*(8), em2143. https://doi.org/10.29333/EJMSTE/12265

Platonova, R. I., Khuziakhmetov, A. N., Prokopyev, A. I., Rastorgueva, N. E., Rushina, M. A., & Chistyakov, A. A. (2022). Knowledge in digital environments: A systematic review of literature. *Frontiers in Education, 7,* 1060455. https://doi.org/10.3389/feduc.2022.1060455

Ramdani, Y., Mohamed, W. H. S. W., & Syam, N. K. (2021). E-learning and academic performance during COVID-19: The case of teaching integral calculus. *International Journal of Education and Practice*, *9*(2), 424-439. https://doi.org/10.18488/journal.61.2021.92.424.439

Prakasha, G. S., Sangeetha, R., Almeida, S. M., & Chellasamy, A. (2022). Examining university students' attitude towards e-learning and their academic achievement during COVID-19. *International Journal of Information and Education Technology*, *12*(10), 1056-1064. https://doi.org/10.18178/ijiet.2022.12.10.1720

Rajabalee, B. Y., Santally, M. I., & Rennie, F. (2020). A study of the relationship between students' engagement and their academic performances in an eLearning environment. *E-Learning and Digital Media*, *17*(1), 1-20. https://doi.org/10.1177/2042753019882567

Rasheed, H. M. W., He, Y., Khalid, J., Khizar, H. M. U., & Sharif, S. (2020). The relationship between e-learning and academic performance of students. *Journal of Public Affairs, 22*(3), e2492. https://doi.org/10.1002/pa.2492

Rashid, M. N. (2020). The effect of the use of e-learning teaching physiology in the academic achievement of students of the technical medical institute. *Indian Journal of Forensic Medicine & Toxicology*, *14*(3), 1367-1373.

Rezaee, R., Haveshki, F., Barati-Boldaji, R., & Mehrabi, M. (2022). The effect of case-based e-learning on academic performance and problem-solving ability in nursing students: A pre-and post-test study. *Journal of Education and Health Promotion*, *11*(1), 302. https://doi.org/10.4103/jehp.jehp_1613_21

Rodrigues, H., Almeida, F., Figueiredo, V., & Lopes, S. L. (2019). Tracking e-learning through published papers: A systematic review. *Computers & Education*, *136*, 87-98. https://doi.org/10.1016/j.compedu.2019.03.007

Sánchez-Cabrero, R., Casado-Pérez, J., Arigita-García, A., Zubiaurre-Ibáñez, E., Gil-Pareja, D., & Sánchez-Rico, A. (2021). E-Assessment in e-learning degrees: Comparison vs. face-to-face assessment through perceived stress and academic performance in a longitudinal study. *Applied Sciences*, *11*, 7664. https://doi.org/10.3390/app11167664

Santos GN, Leite AF, Figueiredo PT, Pimentel NM, Flores-Mir C, de Melo NS, Guerra EN, De Luca Canto G. (2016). Effectiveness of e-learning in oral radiology education: A systematic review. *Journal of Dental Education, 80*(9), 1126-39. https://doi.org/10.1002/j.0022-0337.2016.80.9.tb06195.x

Sobaih, A. E. E., Hasanein, A., & Elshaer, I. A. (2022). Higher Education in and after COVID-19: The impact of using social network applications for e-learning on students' academic performance. *Sustainability*, *14*, 5195. https://doi.org/10.3390/su14095195

Sarikhani, R., Salari, M., & Mansouri, V. (2016). The impact of e-learning on university students' academic achievement and creativity. *Journal of Technical Education and Training*, *8*(1), 25-33.

Suresh, M., Vishnu Priya, V., & Gayathri, R. (2018). Effect of e-learning on academic performance of undergraduate students. *Drug Invention Today*, *10*(9), 1797-1800.

Usak, M., Uygun, H., & Duran, M. (2022). The effects of science teachers' pedagogical content knowledge on students' attitudes toward science and their achievement. *Journal of Baltic Science Education, 21*(4), 694-705. https://doi.org/10.33225/jbse/22.21.694

Xiberta, P., Thió-Henestrosa, S., Fontàs, J., & Boada, I. (2022). The experience of using a new e-learning tool in architectural studies. *IEEE Access*, *10*, 87008-87021. https://doi.org/10.1109/ACCESS.2022.3198977

Yavuzalp, N., & Bahcivan, E. A. (2021). Structural equation modeling analysis of relationships among university students' readiness for e-learning, self-regulation skills, satisfaction, and academic achievement. *Research and Practice in Technology Enhanced Learning*, 16, 15. https://doi.org/10.1186/s41039-021-00162-y

Younas, M., Noor, U, Zhou, X., Menhas, R., & Qingyu, X. (2022). COVID-19, students satisfaction about e-learning and academic achievement: Mediating analysis of online influencing factors. *Frontiers in Psychology, 13*, 948061. https://doi.org/10.3389/fpsyg.2022.948061

Zalat, M. M., Hamed, M. S., & Bolbol, S. A. (2021). The experiences, challenges, and acceptance of elearning as a tool for teaching during the COVID-19 pandemic among university medical staff. *PLoS ONE, 16*(3), e0248758. https://doi.org/10.1371/journal.pone.0248758

Zedan, R. (2021). Student feedback as a predictor of learning motivation, academic achievement and classroom climate. *Education and Self Development, 16*(2), 27-46. https://doi.org/10.26907/esd.16.2.03

APPENDIX

Table A1. Variables of the selected articles

	Study	Country	Participants	Measures of achievement
1	Al-Abdullatif and Gameil (2021)	Saudi Arabia	185 undergraduate students	Survey questionnaire
2	Alam et al. (2021)	Saudi Arabia	384 participants	Questionnaire items
3	Altaany (2015)	Jordan	364 undergraduates	Questionnaire
4	Bana et al (2021)	Pakistan	50 third-year dental students	Pre and post test
5	Bossman & Agyei (2022)	South Africa	388 undergraduates	Survey questionnaire
6	de Araujo Guerra Grangeia et al. (2016)	Brazil	263 sixth-year undergraduate medical students	1) the final grade in the Clinical Emergency Discipline, 2) the theoretical exam, 3) the OSCE, 4) the CARE scores, and 5) the AAB assessment.
7	de-Marcos et al. (2016)	Spain	161 first and second-year undergraduate	Social network analysis & network metrics
8	Fernandez et al. (2022)	United Arab Emirates	200 undergraduate students	Grade point average (GPA)
9	Innab et al. (2022)	Saudi Arabia	103 nursing undergraduate students	Grade point average (GPA)
10	Jawad and Shalash (2020)	Palestine	382 students	Grade point average (GPA)
11	Kerzič et al. (2021)	10 countries	10,092 higher education students from	Survey questionnaire
12	Kim et al. (2019)	Republic of Korea	614 undergraduates	Grade point average (GPA)
13	Kokoç and Altun (2019)	Turkey	126 higher education students	Mid-term grades (%40) and final grades
14	Na et al. (2020)	Thailand	115 social science students	NA
15	Nácher et al (2021)	Spain	171 university students	Grade point average (GPA)
16	Prakasha et al. (2022)	India	840 university students	Self report in the questionnaire
17	Rasheed et al. (2020)	Pakistan	384 university students	Survey questionnaire
18	Rashid (2020)	Iraq	Undergraduate students	Achievement test
19	Rezaee et al. (2022)	Iran	128 nursing students	Problem-solving confidence (PSC), approach-avoidance style (AA), and personal control (PC) and achievement measure: a scientific test for evaluating academic function
20	Rajabalee et al. (2020)	Mauritius	1105 registered first-year full-time students	Eight learning activities
21	Ramdani et al. (2021)	Indonesia	108 undergraduate students	Grade scores for a topic
22	Sánchez-Cabrero et al. (2021)	Spain	919 graduate students	Final exam for the three mandatory courses
23	Sobaih et al. (2022)	Egypt	600 undergraduate students	Students' self- reporting
24	Suresh et al. (2018)	India	Undergraduate students	Questionnaire
25	Yavuzalp and Bahcivan (2021)	Turkey	749 university students	Average final grades
26	Younas et al. (2022)	Pakistan	1,200 university students	Questionnaire
27	Zare et al. (2016)	Iran	40 chemistry undergraduate	Achievement test