

DIGITAL LEARNING AND STUDENT ACADEMIC PERFORMANCE IN HIGHER EDUCATION

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Abstract

Digital learning is now widely integrated into higher education instruction, student assessment, and other support services. This article provides an overview of the effects of digital learning approaches on student learning outcomes in higher education, including online learning, blended and flipped learning models, learning management systems, open educational resources, learning analytics, and digital assessment tools. Evidence included in this review comes from primary and secondary research articles and meta-analyses. Actual effect sizes from published research studies are reported. Results suggest that digital learning approaches lead to learning outcomes at least as good as those achieved through more traditional approaches, though the magnitude and direction of effects vary based on course and student characteristics and other factors, including quality of student-teacher interaction, student self-management skills, teacher skill and training, and institutional support. Meta-analyses find small to large positive effect sizes for various digital learning approaches. Other studies find important differences between fully online learning during emergencies and more planned approaches to online learning. Sustained success with online higher education requires attention to a range of student, teacher, and institutional practices. Learning analytics tools are used to help understand student learning outcomes. Conclusions drawn in this article highlight the importance of considering the overall quality of support services related to technology use in learning.

Keywords: digital learning, higher education, student achievement, online learning, blended learning, educational technology.

I. Introduction

Digital learning has become a regular part of higher education through learning management systems, videoconferencing, online assessment, electronic libraries, recorded lectures, mobile applications, open educational resources, and other technology-supported services. Its effect on academic performance depends largely on how these tools are designed and integrated into teaching rather than on whether a course is simply online or face-to-face. Digital approaches can improve access to learning materials, allow repeated review of lectures, provide flexible feedback and practice opportunities, and support asynchronous interaction. At the same time, weak course structure, limited teacher–student interaction, digital distractions, unequal access to technology, and heavy dependence on student self-direction can reduce their effectiveness. Research by Dziuban et al. (2018), Bralić and Divjak (2018), and Akçayır and Akçayır (2018) shows that blended and flipped learning can support achievement when technology is combined with well-designed learning activities. Kim et al. (2019) also found that student engagement and technology readiness were associated with achievement in online courses, while Smith and Hill (2019) highlighted that blended learning outcomes differ considerably depending on course design, instructor interaction, assessment methods, and the amount of online learning involved.

Evidence from pandemic and post-pandemic research further shows that digital learning can produce positive academic outcomes when supported by appropriate instructional planning. Bond et al. (2021), Iglesias-Pradas et al. (2021), and Guo et al. (2021) reported that institutions were able to maintain or improve student performance during periods of extensive online instruction, although emergency remote teaching should not be treated as equivalent to planned online education. Meta-analytic evidence provides stronger quantitative support. Martin et al. (2022) reported a small but significant positive effect of online and distance learning compared with face-to-face instruction ($g = 0.156$), while Kozanitis and Nenciovici (2023) found that active learning improved test performance by 0.489 standard deviations. More recent analyses found positive effects for online learning during the pandemic ($g = 0.336$), blended learning ($g = 0.651$), flipped classrooms (0.75), and other technology-supported approaches, although substantial differences existed across studies and contexts (Xiong et al., 2025; Yu et al., 2025; Uzun et al., 2026; Küçük-Avcı & İstanbullu, 2026). Overall, digital learning can improve academic performance, but its

success depends on instructional design, student engagement, teacher support, assessment practices, technology access, and the specific learning context..

2. Concept and Development of Online Education at the Higher Education Level

Digital learning in higher education includes blended learning, flipped classrooms, MOOCs, virtual laboratories, digital assessment tools, learning analytics, and collaborative online spaces. Dziuban et al. (2018) noted that blended learning is widely used because it combines the advantages of face-to-face and online instruction, while Smith and Hill (2019) emphasized that blended learning includes many different models and should not be treated as a single approach. Over time, universities have moved from basic websites and digital libraries toward course management systems, online assessments, live and recorded instruction, and more interactive digital learning environments.

This development has also shifted attention from simple content delivery to more active and flexible learning. Bralić and Divjak (2018) found that MOOCs can complement traditional teaching, while Akçayır and Akçayır (2018) identified improved learning outcomes as a major benefit of flipped classrooms. Van Alten et al. (2019), in a meta-analysis of 114 studies, reported modest improvements in learning outcomes, particularly when classroom time was maintained and quizzes were included. These findings suggest that the benefits of digital learning often come from changes in learning activities, study habits, feedback, and classroom interaction rather than from technology alone.

Research has also focused on student engagement and the use of digital learning data. Martin et al. (2020) reviewed 619 articles and found that student-related issues were among the most common topics, while Bond et al. (2020) found that behavioral engagement was studied more often than emotional or cognitive engagement. This has encouraged the use of measures such as logins, clicks, attendance, and assignment completion, although these indicators may not fully reflect actual learning. Van Dorresteijn et al. (2025) identified course design, learner readiness, instructor skills, and institutional support as major factors affecting online higher education. García-García et al. (2026) further noted inconsistencies in how academic performance is defined and measured, suggesting that digital learning data should be interpreted carefully and linked directly to learning goals and academic outcomes.

Table 1. Selected Quantitative Evidence on Digital and Technology-Supported Learning in Higher Education

Study	Design / Scope	Numerical Evidence	Main Academic Result
Kim et al. (2019)	University e-learning study	Higher-education e-learning learners; model tested links among readiness, engagement and achievement	Academic engagement and digital readiness were associated with achievement in the e-learning environment.
Iglesias-Pradas et al. (2021)	Case study of a bachelor program	43 courses plus 43 course coordinators	Academic performance increased during emergency remote teaching in the studied program.
Martin et al. (2022)	Second-order meta-analysis	19 meta-analyses; 841 primary studies; 26 effect-size comparisons	Overall effect favored distance/online learning: $g = 0.156$, 95% CI [0.087, 0.224].
Kozanitis & Nenciovici (2023)	Meta-analysis	104 studies; 111 effect sizes; $N = 15,896$	Active instruction: $g = 0.489$, 95% CI [0.414, 0.564] over traditional lecturing.
Xiong et al. (2025)	Meta-analysis of pandemic online learning	35 studies; 17 countries/regions; $N = 8,079$	Online learning: $g = 0.336$, 95% CI [0.139, 0.534].
Yu et al. (2025)	Blended-learning meta-analysis	133 studies; $N = 18,464$	Blended learning effect on performance: $g = 0.651$, $p < .001$.
Uzun et al. (2026)	Second-order flipped-classroom meta-analysis	25 first-order meta-analyses	Overall effect: $ES = 0.75$, 95% CI [0.62, 0.87].
Küçük-Avcı & İstanbullu (2026)	Temporal meta-analysis	34 primary studies; 45 effect sizes	Overall $g = 0.945$; higher-education subgroup $g = 1.161$; high heterogeneity ($I^2 = 93.66\%$).

3. Digital Learning Tools and Technologies in Higher Education

Learning management systems, video-based instruction, open educational resources, learning analytics, and digital assessment tools have become central to contemporary higher education. Their contribution to academic performance, however, depends less on the technology itself and more on how it is integrated into teaching and learning activities. Learning management systems provide a structured environment for distributing course materials, communication, assessment, and record keeping. Abuhassna et al. (2020), in a study of 243 higher education students, found that prior experience, peer interaction, self-directed learning, and satisfaction with online learning were associated with stronger learning outcomes. These findings suggest that an LMS is more effective when it is used for structured weekly activities, interaction, quizzes, feedback, and clear instructional guidance rather than merely as a repository for course materials.

Video-based and flipped learning can also support academic achievement when students remain actively involved in learning. Hew et al. (2020) found that students in a fully online flipped classroom achieved outcomes comparable with those in traditional flipped settings. Meta-analytic evidence further indicates that flipped learning tends to produce better results when instructional videos are combined with quizzes, discussion, problem-solving, and meaningful classroom activities (Van Alten et al., 2019; Uzun et al., 2026). Thus, recorded lectures alone may offer limited value, whereas shorter and purposefully designed videos can provide students with greater flexibility for reviewing difficult material before participating in active learning.

Open educational resources and MOOCs expand access to learning materials and may reduce financial barriers for students. Cho and Permzadian (2024) reported that the use of open educational resources was associated with improvements in course completion and academic grades. Similarly, Wang and Li (2022) found that MOOCs had positive effects on academic achievement and motivation, although their influence on engagement and self-regulated learning was less consistent. Bralić and Divjak (2018) also showed that MOOCs can be effectively incorporated into university courses when their activities are directly connected with formal course requirements. These findings indicate that open digital resources are most useful when students receive clear guidance regarding how they should use them to achieve course learning outcomes.

Learning analytics offers another means of supporting students by using data about participation, assignments, assessment behavior, and learning progress. Dashboards and related systems can help students and instructors identify areas requiring attention. Hellings and Haelermans (2022), in a randomized controlled trial involving 556 first-year programming students, examined the use of a learning analytics dashboard combined with weekly email reminders. Although such systems can provide useful information, their educational value depends on whether the information leads to meaningful academic action. García-García et al. (2026) similarly identified inconsistencies in how learning analytics research measures academic achievement. Learning analytics therefore appears most useful when combined with interventions such as tutoring, academic advising, study guidance, and targeted feedback.

Digital assessment tools can further improve learning by increasing opportunities for feedback and revision during a course. Online quizzes, peer assessment, self-assessment, automated feedback, discussion activities, and electronic portfolios allow students to evaluate their progress before final examinations. Yan et al. (2022), analysing 626 effect sizes from 175 studies involving 19,383 participants, reported positive effects of self-assessment ($g = 0.585$), peer assessment ($g = 0.606$), and combined self- and peer-assessment ($g = 0.448$) on academic achievement. Overall, digital technologies contribute most effectively to student performance when they promote active participation, timely feedback, interaction, self-regulation, and meaningful connections between digital activities and formal learning objectives. Poorly designed digital learning, by contrast, may increase workload, encourage superficial task completion, and add technology without improving the quality of learning.

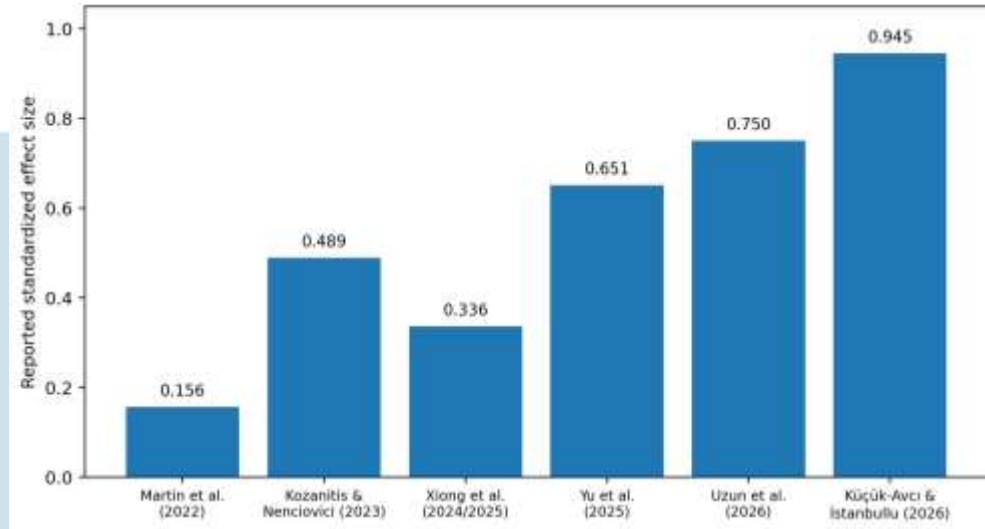


Figure 1. Selected Standardized Effect Sizes Reported in Recent Meta-Analytic Research

Source: Prepared from Martin et al. (2022), Kozanitis and Nenciovici (2023), Xiong et al. (2025), Yu et al. (2025), Uzun et al. (2026), and Küçük-Avcı and İstanbullu (2026). The studies examine different interventions and are shown for comparison, not as one combined estimate.

4. Digital Learning and Student Academic Performance

Recent research indicates that online instruction can improve student outcomes, although its effectiveness varies considerably across educational settings. Martin et al. (2022), in a second-order meta-analysis synthesizing 19 meta-analyses and 841 studies, reported a small-to-moderate overall effect ($g = 0.156$), with stronger effects in postsecondary education than in K–12 settings. These findings suggest that online learning can be beneficial at scale, but its success depends on course design, assessment methods, student motivation and preparation, faculty involvement, and the alignment between online activities and learning objectives. Similar conclusions were reported by van Dorresteijn et al. (2025), who found that effective postsecondary online learning requires coordinated attention to course, student, instructor, and institutional factors rather than reliance on technology alone.

Blended learning appears particularly promising because it combines the flexibility of online instruction with face-to-face interaction. Yu et al. (2025), in a meta-analysis of 133 studies involving 18,464 participants, reported a moderate-to-large positive effect on learning outcomes ($g = 0.651$, $p < .001$).

Outcomes differed according to instructional approach, proportion of online learning, type of online

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interaction, geographic location, and publication year. This variation indicates that there is no single ideal blended-learning model. Instead, institutions should determine which activities are best delivered online and which require direct classroom interaction. Online components may be particularly useful for discussion, practice, multimedia access, and flexible study, while face-to-face sessions may be more suitable for practical, experimental, and higher-order learning activities.

Evidence from the pandemic period also demonstrates that students can achieve positive outcomes through online learning when courses provide sufficient academic support. Xiong et al. (2025) reviewed 35 studies from 17 countries and regions involving 8,079 university students and found a moderate positive effect of online learning compared with face-to-face instruction ($g = 0.336$, 95% CI [0.139, 0.534]). Stronger effects were reported in medicine, engineering, and natural sciences, while effects were weaker in social sciences. Küçük-Avcı and İstanbullu (2026) provided a post-pandemic perspective, reporting an overall mean effect size of $g = 0.945$ across 34 studies and 45 effect sizes, although heterogeneity was very high ($I^2 = 93.66\%$). The post-pandemic effect was substantially higher ($g = 1.610$) than the pandemic-period effect ($g = 0.549$), suggesting that deliberately planned online education may perform better than emergency remote teaching.

Flipped learning provides further evidence that digital instruction is most effective when technology supports active learning. Strelan et al. (2020), reviewing 198 studies with 33,678 participants, reported a positive effect of flipped learning ($g = 0.50$). Van Alten et al. (2019) similarly found significant benefits, particularly when quizzes and structured classroom activities were included. A later second-order meta-analysis by Uzun et al. (2026) reported an overall effect size of 0.75. These findings suggest that the strength of flipped learning comes not simply from using videos but from allowing students to encounter basic material before class and devote classroom time to guided practice, discussion, and application.

Student characteristics also influence success in digital environments. Kim et al. (2019) linked digital skills and academic engagement with student success, while Jansen et al. (2019) found that self-management interventions can improve higher education outcomes. Online learning requires students to organize study time, meet deadlines, monitor progress, and seek assistance independently. Clear weekly schedules, frequent deadlines, progress-tracking tools, instructor feedback, and regular communication can therefore strengthen student performance. Academic achievement should also be assessed through

multiple indicators rather than test scores alone. Cho and Permzadian (2024) linked open educational resource use with higher grades and course completion, while Bond et al. (2020) emphasized behavioral, cognitive, and emotional engagement as important educational outcomes. García-García et al. (2026) similarly highlighted variation in how academic achievement is measured. Overall, the evidence suggests that digital learning produces the strongest academic benefits when technology is combined with purposeful pedagogy, active engagement, student self-management, effective assessment, and sustained academic support.

Table 2. Scale of Recent Review Evidence Relevant to Digital Learning in Higher Education

Source	Evidence Base	Key Numerical Detail	Relevance
Akçayır & Akçayır (2018)	Systematic review of flipped classrooms	71 research articles	Learning performance was the most frequently reported advantage; challenges often occurred in out-of-class activity.
Smith & Hill (2019)	Review of blended-learning research	97 articles from 15 journals	Found broad variation in definitions, scale and research focus.
Bond et al. (2020)	Systematic evidence map	243 higher-education studies	Behavioral engagement was identified more often than affective or cognitive engagement.
Martin et al. (2020)	Systematic review of online teaching and learning	619 articles across 12 journals	Identified 12 research themes; most studies were quantitative and many were in higher education.
Akpen et al. (2024)	Systematic review	18 peer-reviewed studies	Reported mixed effects on performance and engagement; internet quality, tools and

			motivation were recurring conditions.
van Dorresteijn et al. (2025)	Meta-review	47 reviews/meta-analyses	27 systematic reviews, 9 literature reviews, 7 meta-analyses, 2 scoping reviews and 2 combined review/meta-analysis studies.
García-García et al. (2026)	Meta-review of learning analytics and performance	19 systematic reviews	Found variation in performance definitions and limited attention to several educational-context variables.

5. Factors Influencing the Effectiveness of Digital Learning

Recent research indicates that online instruction can improve student outcomes, although its effectiveness varies considerably across educational settings. Evidence from large-scale reviews shows a small-to-moderate overall effect of online learning, with stronger outcomes in postsecondary education than in K–12 settings. The effectiveness of online instruction depends on several factors, including course design, assessment methods, student motivation and preparation, faculty involvement, and alignment between online activities and learning objectives. Effective postsecondary online learning therefore requires attention to course, student, instructor, and institutional factors rather than reliance on technology alone (Martin et al., 2022; van Dorresteijn et al., 2025).

Blended learning appears particularly promising because it combines the flexibility of online instruction with face-to-face interaction. A meta-analysis of 133 studies involving 18,464 participants reported a moderate-to-large positive effect on learning outcomes ($g = 0.651$, $p < .001$). Outcomes varied according to instructional approach, proportion of online learning, type of online interaction, geographic location, and publication year. This suggests that there is no single ideal blended-learning model. Online components may be particularly useful for discussion, practice, multimedia access, and flexible study,

while face-to-face sessions may be more suitable for practical, experimental, and higher-order learning activities (Yu et al., 2025).

Evidence from the pandemic and post-pandemic periods also shows that students can achieve positive outcomes through online learning when sufficient academic support is provided. A review of 35 studies from 17 countries and regions involving 8,079 university students found a moderate positive effect of online learning compared with face-to-face instruction ($g = 0.336$, 95% CI [0.139, 0.534]). Stronger effects were reported in medicine, engineering, and natural sciences than in social sciences. Post-pandemic evidence also reported a higher overall effect of online learning, although substantial variation existed across studies. These findings indicate that intentionally planned online education may produce stronger outcomes than emergency remote teaching (Xiong et al., 2025; Küçük-Avcı & İstanbullu, 2026).

Flipped learning provides further evidence that digital instruction is more effective when technology supports active learning rather than simply replacing classroom lectures. Meta-analytic findings show positive effects of flipped learning, particularly when pre-class materials are combined with quizzes, structured activities, guided practice, discussion, and application during class. The main benefit therefore appears to come from changes in the learning process rather than from video use alone (Van Alten et al., 2019; Strelan et al., 2020; Uzun et al., 2026).

Student characteristics also influence success in digital environments. Digital skills, academic engagement, self-management, and the ability to organize study time can affect learning outcomes. Clear weekly schedules, frequent deadlines, progress-tracking tools, instructor feedback, and regular communication can help students remain engaged and manage online learning more effectively. Academic achievement should also be assessed through multiple indicators, including grades, course completion, retention, progression, and behavioral, cognitive, and emotional engagement, rather than relying only on test scores (Kim et al., 2019; Jansen et al., 2019; Bond et al., 2020; Cho & Permzadian, 2024; García-García et al., 2026).

Overall, digital learning produces the strongest academic benefits when technology is combined with purposeful course design, active engagement, student self-management, effective assessment, and sustained academic support.

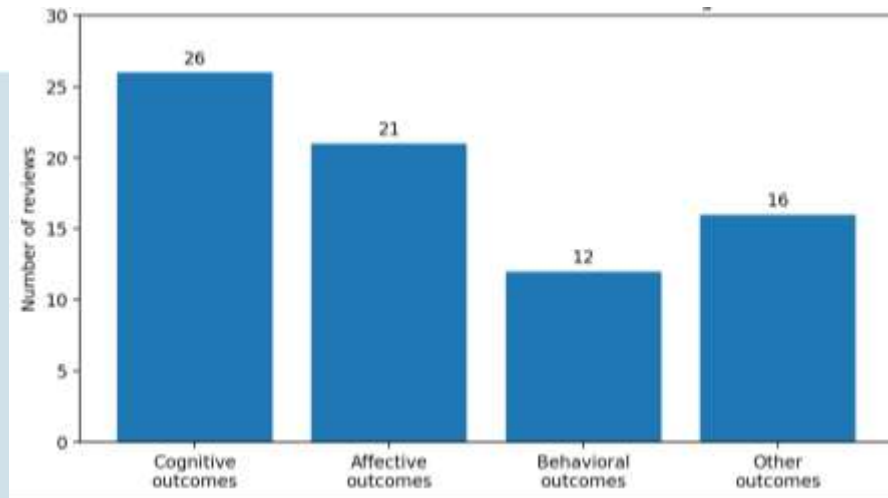


Figure 2. Outcome Domains Examined Across 47 Reviews of Online Higher Education

Source: van Dorresteijn et al. (2025). Categories are not mutually exclusive; one review could examine more than one outcome domain.

6. Benefits and Challenges of Digital Learning

One of the main advantages of digital learning is flexibility. Students can review recorded material, access readings at convenient times, and participate in learning alongside work or family responsibilities. This flexibility is especially useful in higher education, where students often have different schedules, responsibilities, and levels of preparation. Digital resources can also broaden access to materials that may not be available locally. The use of MOOCs and open educational resources has been associated with improved access, course completion, and academic performance (Bralić & Divjak, 2018; Cho & Permzadian, 2024).

Digital tools also create greater opportunities for practice and feedback. Online quizzes, self-assessment, peer assessment, and repeated exercises can provide students with faster information about their progress. Evidence shows positive effects of self-assessment and peer assessment on academic achievement, with reported effect sizes of 0.585 and 0.606, respectively. Technology-supported peer assessment can further strengthen these benefits by making feedback easier to provide and receive, particularly in large classes (Yan et al., 2022).

Another benefit is the potential to make classroom time more active. In flipped learning, students review basic material before class and use classroom time for discussion, application, and guided practice. Meta-analytic findings have reported positive effects for flipped classrooms, with effect sizes ranging from about 0.50 to 0.75. These benefits appear to come less from video use itself and more from the opportunity to use face-to-face time for activities that require greater interaction and support (Strelan et al., 2020; Uzun et al., 2026).

Despite these benefits, digital learning also creates access and engagement challenges. Students may face limited access to devices, reliable internet, suitable study environments, or required software. Feelings of isolation, low motivation, and weak interaction can also reduce engagement. Research has shown that differences in digital access, motivation, and instructor interaction can influence learning outcomes, while high levels of online activity do not always indicate meaningful cognitive engagement (Bond et al., 2020; Akpen et al., 2024).

Digital overload is another concern. Using too many platforms, receiving excessive notifications, watching lengthy online lectures, and completing numerous small assignments can increase workload and reduce concentration. Consistent weekly structures, fewer unnecessary technologies, clear deadlines, and purposeful assignments can reduce these problems. Academic integrity is also more difficult to manage online, particularly with open-book assessments and generative AI tools. Applied tasks, case-based assignments, oral presentations, multiple drafts, and problem-solving activities can provide stronger evidence of student understanding than assessments based mainly on memorization.

Learning analytics can help identify students who may require support, but such systems should be used cautiously. Risk indicators may not capture factors such as previous academic preparation, disability, work responsibilities, assessment design, or access difficulties. Research has also found inconsistent definitions of academic performance in learning analytics studies. These tools are therefore most useful when they support, rather than replace, academic judgment and when students are clearly informed about how their data are being used (García-García et al., 2026).

Table 3. Recent Numerical Findings Relevant to Benefits and Risks of Digital Learning

Area	Study	Reported Number	Interpretation for Higher Education
Flipped learning	Akçayır & Akçayır (2018)	71 studies reviewed	Learning performance was the most commonly reported advantage, but out-of-class activity created frequent challenges.
Online-learning research	Martin et al. (2020)	619 articles; 12 journals; 12 themes	The field is broad and heavily represented in higher education; learner and engagement topics dominate.
Digital engagement	Bond et al. (2020)	243 studies	Behavioral engagement was reported more often than affective or cognitive engagement.
Online academic achievement	Xiong et al. (2025)	35 studies; N = 8,079; $g = 0.336$	Average academic effect was positive but varied across subjects and contexts.
Effective online HE conditions	van Dorresteijn et al. (2025)	47 reviews; 26 examined cognitive outcomes, 21 affective, 12 behavioral	Effectiveness depends on multiple outcome domains and conditions at several levels.
Post-pandemic online learning	Küçük-Avcı & İstanbullu (2026)	34 studies; 45 effects; $I^2 = 93.66\%$	Average effects were positive, but very high heterogeneity warns against one-size-fits-all conclusions.

7. Strategies for Improving Academic Outcomes through Digital Learning

1. Align digital tools with learning outcomes by selecting technologies that directly support instruction, practice, feedback, interaction, and assessment.
2. Combine flexibility with clear structure through weekly schedules, centralized deadlines, regular feedback, and support for student self-regulation.
3. Promote meaningful teacher and peer interaction through discussions, collaborative activities, group problem-solving, and timely feedback.
4. Use blended and flipped learning strategically by combining online preparation with face-to-face discussion, application, and practical activities.
5. Strengthen digital assessment through quizzes, projects, oral assessments, self-assessment, and peer assessment focused on higher-order learning.
6. Provide institutional and faculty support through academic advising, teacher training, accessibility services, learning analytics, and responsible use of digital tools

8. Conclusion

Digital learning can improve academic outcomes, but its benefits are not automatic. Research on online, blended, flipped, and technology-enhanced learning generally reports positive effects, while also showing considerable variation across students, disciplines, institutions, and course designs (Martin et al., 2022; Kozanitis & Nenciovici, 2023; Xiong et al., 2025; Yu et al., 2025; Uzun et al., 2026; Küçük-Avcı & İstanbullu, 2026). The strongest conclusion is that digital learning works best when it is intentionally designed, clearly organized, interactive, and supported by appropriate assessment. Students require academic guidance and opportunities to develop self-management and digital skills, while faculty require training and institutional support. Technology should therefore be treated as a means of improving access, practice, feedback, interaction, and learning quality rather than as an educational goal in itself. The central aim should be to use digital learning in ways that improve academic performance while reducing barriers and maintaining equitable access for students.

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