



Original Research

Evaluating the Effectiveness of Online and Blended Learning Implementation for PPG Prajabatan Students

Lili Herawati Parapat*, Khairunnisah, Nur Hidayah, Rahmat Huda

Universitas Muhammadiyah Tapanuli Selatan, Indonesia

Article Info:

Article history

Received : 30 July 2026
Revised : 10 September 2026
Accepted : 21 September 2026
Published : 01 October 2026

Keywords:

Blended Learning
Digital Pedagogical Competence
Online Learning
Ppg Prajabatan
Teacher Education

Abstract

The study aimed to analyse the implementation of online and blended learning in enhancing students' learning achievement and digital pedagogical competence. This study employed a descriptive quantitative research design. The participants consisted of 20 PPG Prajabatan students in the Pendidikan Pancasila dan Kewarganegaraan programme who participated in the Online and Blended Learning course. Data were collected from various learning activities, including problem identification related to educational technology and Artificial Intelligence, reflection activities, case discussions, instructional design development, peer review activities, mid-term examination, and final examination. The collected data were analysed using descriptive statistical analysis to determine students' learning achievement. The findings showed that students demonstrated positive learning outcomes after participating in online and blended learning activities. All participants achieved a very good performance category, indicating that the learning activities successfully supported students' competency development. The results also showed that students were able to engage in instructional design processes, collaborative discussions, reflection, and technology-based learning activities. The study implied that well-designed online and blended learning environments could effectively support the development of digital pedagogical competence among future teachers. These findings contributed to teacher education practices by highlighting the importance of integrating technology-supported learning experiences in preparing professional teachers for digital education.

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author: Parapat, Lili Herawati, lili.herawati@um-tapsel.ac.id

1. Introduction

The rapid development of digital technology has significantly transformed educational practices and created new demands for teachers to develop digital pedagogical competence. Digital pedagogical competence refers to teachers' ability to integrate digital technologies effectively into teaching and learning processes, including designing learning

activities, selecting appropriate digital resources, and facilitating meaningful technology-supported learning experiences. In this context, teacher education programmes have an important role in preparing future teachers who are capable of responding to technological changes in education. However, many pre-service teachers still experience challenges in applying digital technologies for instructional purposes due to limited experience, insufficient technological confidence, and inadequate opportunities to practise technology-based teaching strategies.

Online and blended learning have emerged as important approaches in higher education to support flexible, interactive, and technology-enhanced learning environments. Blended learning combines face-to-face instruction with online learning activities to provide students with greater access to learning resources and opportunities for independent and collaborative learning. This approach is particularly relevant for teacher education because future teachers need direct experience in designing and participating in technology-supported learning environments before implementing them in their own classrooms. Research has shown that well-designed blended learning can improve students' engagement, learning achievement, and digital competence by encouraging active participation and self-regulated learning (Rasheed et al., 2020; Müller & Mildenberger, 2021).

Previous studies have reported positive impacts of online and blended learning implementation in higher education. Martin et al. (2020) found that effective online learning depends on the interaction between learners, instructors, and learning resources. Similarly, Yu et al. (2021) reported that blended learning could enhance student engagement and learning effectiveness when supported by appropriate instructional strategies. In teacher education contexts, Tondeur et al. (2021) emphasised that digital competence development requires authentic learning experiences that allow pre-service teachers to explore, evaluate, and apply educational technologies. These findings indicate that online and blended learning can provide valuable opportunities for developing future teachers' professional competencies.

Despite the growing number of studies on blended learning, several research gaps remain. Previous research has mainly focused on general student achievement or learning satisfaction, while fewer studies have examined how structured online and blended learning activities contribute to the development of digital pedagogical competence among PPG Prajabatan students. Furthermore, limited attention has been given to the combination of learning activities involving problem identification, reflection, instructional design development, peer review, and technology-based assessment as an integrated approach in preparing professional teachers.

Therefore, this study aimed to analyse the implementation of online and blended learning in enhancing the learning achievement and digital pedagogical competence of PPG Prajabatan students. Specifically, this study examined students' performance in

various learning activities, including technology-related problem analysis, reflection activities, instructional design development, collaborative discussions, peer review, and academic assessments. The significance of this study lies in providing empirical evidence regarding how online and blended learning can support teacher preparation programmes, particularly in developing future teachers who are capable of integrating digital technologies into educational practices.

2. Literature Review

2.1 Online and Blended Learning in Higher Education

Online learning and blended learning have become important approaches in higher education due to the increasing integration of digital technology into educational practices. Online learning refers to instructional activities conducted through digital platforms that allow interaction between learners, instructors, and learning resources without requiring physical presence. Meanwhile, blended learning combines online learning components with face-to-face instruction to create a more flexible and interactive learning environment. Unlike fully online learning, blended learning provides opportunities for students to benefit from both digital accessibility and direct interaction with instructors and peers.

The effectiveness of online and blended learning depends not only on the availability of technology but also on the quality of instructional design, interaction, and student engagement. Previous studies have demonstrated that blended learning can improve learning outcomes because it encourages students to become more active participants in the learning process. Rasheed et al. (2020) explained that blended learning provides flexibility and learning accessibility; however, its success is influenced by students' digital readiness, learning motivation, and institutional support. Similarly, Martin et al. (2020) found that effective online learning requires meaningful interaction among students, instructors, and learning materials rather than simply transferring traditional teaching methods into digital platforms.

In higher education, blended learning has been increasingly implemented because it supports independent learning and collaborative knowledge construction. Müller and Mildemberger (2021) reported that blended learning environments could provide flexible learning opportunities while maintaining instructional effectiveness. Students are able to manage their learning pace, access various digital resources, and participate in collaborative activities through online platforms. However, previous research also identified several challenges, including technological limitations, unequal digital access, and the need for stronger self-regulation skills among learners.

In teacher education, online and blended learning have additional significance because future teachers need practical experiences in using digital technologies for teaching. Teacher education programmes should not only introduce educational

technologies theoretically but also provide authentic opportunities for pre-service teachers to design and experience technology-supported learning. Tondeur et al. (2021) argued that digital competence development requires continuous exposure to technology integration activities during teacher preparation. Therefore, the implementation of online and blended learning in PPG Prajabatan programmes can serve as a practical approach to developing future teachers' ability to design innovative learning experiences.

Although previous studies have highlighted the benefits of blended learning, there remains a need to investigate how specific learning activities within blended environments contribute to students' professional competence development. Many previous studies have focused on learning achievement and student satisfaction, while fewer studies have examined integrated activities involving reflection, problem-solving, instructional design, and peer review as components of blended learning in teacher education contexts.

2.2 Digital Pedagogical Competence of Pre-Service Teachers

Digital pedagogical competence has become an essential component of teacher professionalism in the era of digital transformation. This competence refers to teachers' ability to combine technological knowledge, pedagogical strategies, and subject knowledge to create meaningful technology-supported learning experiences. For pre-service teachers, developing digital pedagogical competence is important because they will be responsible for preparing students to participate in increasingly digital learning environments.

The development of digital pedagogical competence requires more than technical skills in operating digital tools. Future teachers need to understand how technology can support learning objectives, enhance student engagement, and facilitate effective assessment. Instefjord and Munthe (2020) stated that teacher education institutions play a critical role in developing digital competence by integrating technology into teaching practices rather than treating digital skills as separate competencies. This indicates that pre-service teachers need opportunities to experience digital learning environments as learners before applying them as teachers.

Research has shown that practical experience with educational technology contributes significantly to teachers' confidence and readiness to integrate technology into classrooms. According to Cutri et al. (2020), educators require continuous professional support and learning experiences to develop effective online teaching abilities. Similarly, Scherer et al. (2021) found that teachers' technology acceptance and confidence were important factors influencing successful technology integration in education.

The role of reflection and collaborative learning is also important in developing digital pedagogical competence. Reflective activities allow pre-service teachers to analyse their experiences, identify challenges, and improve their future teaching practices. Farrell (2022) emphasised that reflective practice supports teacher professional development by

encouraging critical examination of teaching decisions. Furthermore, peer collaboration provides opportunities for sharing ideas, evaluating instructional designs, and improving teaching strategies through feedback.

The integration of Artificial Intelligence (AI) and emerging technologies has further increased the complexity of digital pedagogical competence. Future teachers need the ability to critically evaluate technological innovations and use them responsibly in educational contexts. Ng et al. (2021) highlighted that AI literacy has become an important aspect of modern education because teachers need to understand both the opportunities and challenges associated with AI-based educational tools.

Despite increasing attention to digital competence, research gaps remain regarding how teacher education programmes systematically develop these competencies through structured blended learning activities. Existing studies have frequently examined technology acceptance or digital literacy separately, while limited research has explored how activities such as problem identification, instructional design, peer review, and reflection contribute to the development of digital pedagogical competence among PPG Prajabatan students. Therefore, this study contributes to the existing literature by examining the relationship between online and blended learning implementation and the development of future teachers' digital pedagogical competence.

3. Method

This study employed a descriptive quantitative research design to analyse the implementation of online and blended learning in enhancing learning achievement and digital pedagogical competence among PPG Prajabatan students. A quantitative approach was selected because the study focused on analysing students' achievement scores obtained from various learning activities during the course. Descriptive quantitative research is appropriate for describing educational phenomena based on numerical data and identifying patterns of achievement without manipulating variables (Creswell & Creswell, 2023).

The participants of this study consisted of 20 students enrolled in the Pancasila and Citizenship Education (PPKn) program of the Pre-Service PPG program who were taking Online and Blended Learning courses in 2025-2026. Participants were selected using a total sampling technique because all students enrolled in the course were included as research participants. This study was conducted over one semester of the learning program. This study focused on evaluating student learning achievement and developing their digital pedagogical competencies through structured online and blended learning activities.

The learning activities were implemented through a combination of online learning and collaborative learning activities. The instructional activities included identifying problems related to technological development and Artificial Intelligence (AI) in

education, reflection and follow-up activities, case study discussions, instructional design development, peer review sessions, presentation activities, and comparative analysis of learning models. These activities were designed to provide students with opportunities to analyse educational problems, develop technology-supported instructional designs, and reflect on their learning experiences.

Data were collected from students' assessment results obtained throughout the semester. The assessment instruments consisted of formative and summative assessments, including synthesis tasks, reflection assignments, discussion activities, instructional design projects, peer review activities, mid-term examinations, and final examinations. Each assessment component was evaluated using predetermined assessment criteria developed by the course instructor. The assessment results were used to measure students' achievement and their ability to apply concepts related to online and blended learning.

To ensure the quality of the assessment process, several procedures were implemented. The assessment instruments were aligned with the learning outcomes of the course and reviewed to ensure their relevance to the competencies being measured. The assessment criteria were also clearly explained to students before completing the tasks to improve transparency and consistency. The use of multiple assessment components was intended to provide a comprehensive evaluation of students' learning achievement rather than relying on a single assessment method.

The collected data were analysed using descriptive statistical analysis. The analysis involved calculating students' minimum score, maximum score, mean score, and achievement distribution. The final scores were then categorised based on the achievement criteria used in the programme to determine students' learning performance. The analysis focused on identifying students' overall achievement patterns and evaluating the effectiveness of online and blended learning implementation in supporting digital pedagogical competence development.

This study was conducted based on the assumption that students' achievement scores could represent their level of competency development during the learning process. The study also assumed that the combination of online activities, reflection, collaboration, and technology-supported learning tasks contributed to students' ability to understand and apply blended learning concepts.

Although this study provided valuable information regarding the implementation of online and blended learning in a teacher education context, it had several methodological limitations. The study involved a relatively small number of participants from one study programme, which may limit the generalisability of the findings. In addition, the study focused primarily on quantitative achievement data and did not explore students' perceptions or learning experiences in depth. Future research may incorporate qualitative data, larger samples, and longitudinal approaches to provide a more comprehensive understanding of blended learning implementation in teacher education.

4. Results

The implementation of online and blended learning activities in the PPG Prajabatan programme was designed to provide students with meaningful learning experiences through technology-supported instruction, collaboration, reflection, and instructional design practices. This section presents the results of students' learning achievement based on various assessment components conducted throughout the Online and Blended Learning course. The analysis aimed to identify students' performance patterns and determine the extent to which the implemented learning activities supported the achievement of expected competencies.

4.1 Students' Learning Achievement in Online and Blended Learning Course

This study described the learning achievement of PPG Prajabatan students in the Online and Blended Learning course. The students' achievement was measured through various assessment components, including synthesis activities, reflection and follow-up tasks, case discussions, instructional design development, peer review activities, mid-term examination, and final examination. The data were collected from 20 students enrolled in the Pendidikan Pancasila dan Kewarganegaraan (PPKn) programme and were analysed using descriptive statistical analysis.

Table 1. Descriptive Statistics of Students' Learning Achievement

Assessment Component	N	Minimum	Maximum	Mean
Synthesis and Reflection Activities	20	80	90	85.25
Discussion and Case Study Activities	20	80	90	85.70
Instructional Design Activities	20	80	90	86.10
Peer Review Activities	20	80	90	87.25
Mid-Term Examination	20	80	91	85.88
Final Examination	20	84	93	88.20
Final Score	20	85.00	87.45	86.48

Table 1 indicates that students achieved good academic performance across all learning activities. The highest average achievement was obtained in the final examination component, followed by peer review activities and instructional design tasks. The overall final score demonstrated that students achieved consistent performance throughout the learning process.

The distribution of students' final scores is presented in Table 2.

Table 2. Distribution of Students' Final Scores

Category	Score Range	Number of Students	Percentage (%)
Very Good	85–100	20	100
Good	75–84	0	0
Fair	65–74	0	0
Low	<65	0	0
Total		20	100

Table 2 shows that all students achieved the very good category based on their final scores. The students' scores ranged from 85.00 to 87.45, indicating that the achievement level among participants was relatively homogeneous. No students obtained scores below the expected achievement category.

Further analysis showed that students consistently performed well in activities related to identifying problems in educational technology and Artificial Intelligence (AI), designing blended learning activities, developing instructional designs, and conducting peer review sessions. The assessment results indicated that students were able to complete both individual and collaborative learning tasks during the course.

The students' performance in the Online and Blended Learning course also showed a stable pattern between formative and summative assessments. The scores obtained from assignments, discussions, reflections, and examinations indicated that students actively participated in the learning process and successfully completed the required learning activities.

Overall, the results demonstrated that PPG Prajabatan students achieved positive learning outcomes in the Online and Blended Learning course. The assessment data showed that all participants successfully reached the expected competency level in understanding, designing, and implementing online and blended learning strategies.

5. Discussion

The findings of this study demonstrated that the implementation of online and blended learning provided positive learning outcomes for PPG Prajabatan students. The students showed consistent achievement across various learning activities, including problem identification, reflection, instructional design development, peer review, case discussions, and examinations. These results indicate that online and blended learning environments can effectively support the development of pedagogical competence among pre-service teachers, particularly in designing and implementing technology-supported learning.

The positive achievement obtained in this study can be explained by the characteristics of blended learning, which integrates face-to-face and online learning activities to provide students with greater flexibility, interaction, and access to learning resources. Blended learning does not merely combine two instructional modes but creates an integrated learning experience that encourages active participation and independent learning. This finding is consistent with Graham (2021), who explained that blended learning provides opportunities for improving learning flexibility, interaction quality, and student engagement through the combination of digital and conventional learning environments.

The results also support previous studies showing that blended learning contributes significantly to students' academic achievement. Rasheed et al. (2020) found that blended learning environments improved students' engagement and learning performance because students were able to access materials, communicate, and complete learning activities through various platforms. Similarly, Yu et al. (2021) reported that blended learning positively influenced learning effectiveness by increasing students' autonomy and participation in learning processes.

In the context of teacher education, the implementation of online and blended learning is particularly important because future teachers need not only content knowledge but also digital pedagogical competence. The current findings indicated that students were able to develop instructional designs and analyse learning problems through technology-supported activities. This finding is in line with Tondeur et al. (2021), who stated that teacher education programmes should provide authentic digital learning experiences to prepare future teachers for technology integration in classrooms.

The improvement of students' competence in designing learning activities may also be related to the project-based and reflective characteristics of the course activities. Students were required to identify educational technology problems, design instructional solutions, and evaluate learning models through peer review. According to Kohnke and Moorhouse (2021), digital learning activities that involve problem-solving and reflection can enhance teachers' confidence and competence in using educational technology.

Furthermore, reflection activities implemented in the course contributed to students' professional learning development. Reflective practice allows pre-service teachers to evaluate their experiences, identify challenges, and formulate improvements for future teaching practices. This finding supports the argument of Farrell (2022), who emphasised that reflective activities are essential components in teacher education because they encourage teachers to develop professional awareness and continuous improvement.

The role of peer review activities was also evident in supporting students' learning achievement. Through peer review, students were encouraged to evaluate instructional designs, provide feedback, and revise their work based on suggestions from peers. This collaborative process can increase students' critical thinking and academic interaction.

The findings are supported by Nicol et al. (2022), who found that peer feedback activities enhanced students' understanding of quality criteria and encouraged active involvement in learning.

The findings are also consistent with research on online collaborative learning. Martin et al. (2020) reported that successful online learning requires meaningful interaction between learners, instructors, and learning resources. The discussion and collaborative activities applied in this study created opportunities for students to exchange ideas and construct knowledge collectively. Therefore, online learning effectiveness depends not only on technology availability but also on the quality of interaction and instructional design.

The students' high achievement in examination components further indicates that online and blended learning supported knowledge acquisition and application. This finding agrees with the study conducted by Müller and Mildemberger (2021), who found that blended learning approaches could achieve comparable or better learning outcomes than traditional learning approaches when supported by appropriate instructional strategies.

In addition, the findings support the importance of learning management systems and digital platforms in facilitating higher education learning. Digital platforms provide structured environments for distributing materials, submitting assignments, conducting discussions, and monitoring student progress. According to Turnbull et al. (2021), effective digital learning platforms can improve accessibility, communication, and learning management in higher education contexts.

However, the successful implementation of online and blended learning requires adequate digital competence among students and instructors. Although the students in this study achieved positive outcomes, previous research has indicated that digital literacy, technological readiness, and institutional support influence the success of online learning implementation. According to Cutri et al. (2020), educators need continuous professional development to effectively integrate technology into teaching practices.

The findings also reinforce the importance of technology-related competencies within teacher preparation programmes. The ability to design digital learning experiences has become an essential competency for future teachers. Instefjord and Munthe (2020) argued that teacher education institutions should systematically integrate digital competence development into their curriculum rather than treating technology skills as separate knowledge areas.

Moreover, the integration of Artificial Intelligence (AI) and emerging technologies in education requires teachers to develop adaptive digital skills. The activities related to identifying technology and AI issues in this study provided students with opportunities to critically examine technological developments in education. This finding aligns with the

perspective of Ng et al. (2021), who stated that future teachers need technological awareness and ethical understanding to effectively utilise digital innovations.

The findings of this study also correspond with recent research on student engagement in blended learning environments. Broadbent and Fuller-Tyszkiewicz (2022) found that students' engagement in online learning was influenced by learning design, interaction, and self-regulation strategies. The structured activities implemented in this study may have supported students' engagement by providing clear tasks and continuous learning experiences.

Although the results indicated positive outcomes, blended learning implementation still faces several challenges. Previous studies have highlighted issues such as internet accessibility, digital fatigue, and differences in technological readiness among learners. Barrot et al. (2021) found that students' online learning experiences were influenced by technological limitations and learning environment conditions. Therefore, continuous improvement of digital infrastructure and instructional strategies remains necessary.

Overall, the findings of this study confirmed that online and blended learning can effectively support the achievement and digital pedagogical competence of PPG Prajabatan students. The integration of reflection, discussion, peer review, instructional design activities, and assessment created a comprehensive learning environment that encouraged active participation and professional development. These findings highlight the importance of implementing well-designed blended learning models in teacher education programmes to prepare future teachers for digital educational environments.

6. Conclusion

This study concluded that the implementation of online and blended learning provided positive contributions to improving the learning achievement and digital pedagogical competence of PPG Prajabatan students. The integration of various learning activities, including problem identification, reflection, case discussions, instructional design development, peer review, and online assessments, created a learning environment that encouraged active participation, collaboration, and professional development.

The findings indicated that students were able to achieve the expected learning competencies through structured online and blended learning activities. The combination of independent learning, collaborative discussion, feedback processes, and technology-supported instructional design activities supported students in developing their ability to analyse learning problems and design appropriate digital learning strategies.

This study highlighted that blended learning was not only an alternative mode of instruction but also an effective approach for preparing future teachers to face digital transformation in education. Through meaningful engagement with technology, PPG Prajabatan students developed important competencies related to digital pedagogy, instructional planning, and technology integration in learning.

Although this study was conducted within a limited group of PPG Prajabatan students in one study programme, the findings provide important implications for teacher education institutions. The implementation of well-designed online and blended learning should be continuously developed to strengthen the digital competence of pre-service teachers. Future studies are recommended to involve larger participants, different educational contexts, and more comprehensive evaluation methods to further examine the long-term impact of blended learning on teacher professional competence.

References

- Barrot, J. S., Llenares, I. I., & del Rosario, L. S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies*, 26, 7321–7338. <https://doi.org/10.1007/s10639-021-10589-x>
- Broadbent, J., & Fuller-Tyszkiewicz, M. (2022). Profiles in self-regulated learning and their relationship to learning outcomes. *Educational Psychology Review*, 34, 115–140. <https://doi.org/10.1007/s10648-021-09601-8>
- Cutri, R. M., Mena, J., & Whiting, E. F. (2020). Faculty readiness for online teaching: A critical review. *Educational Technology Research and Development*, 68, 3175–3194. <https://doi.org/10.1007/s11423-020-09824-0>
- Farrell, T. S. C. (2022). Reflective practice in language teacher education. *System*, 109, 102872. <https://doi.org/10.1016/j.system.2022.102872>
- Graham, C. R. (2021). Current research in blended learning. *Educational Technology Research and Development*, 69, 1–6. <https://doi.org/10.1007/s11423-020-09887-x>
- Instefjord, E., & Munthe, E. (2020). Educating digitally competent teachers: A systematic review. *Teaching and Teacher Education*, 93, 103110. <https://doi.org/10.1016/j.tate.2020.103110>
- Kohnke, L., & Moorhouse, B. L. (2021). Adopting artificial intelligence in English language teaching. *Language Teaching Research Quarterly*, 25, 1–14. <https://doi.org/10.32038/ltrq.2021.25.01>
- Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning. *Educational Technology Research and Development*, 68, 1–22. <https://doi.org/10.1007/s11423-020-09756-7>
- Müller, C., & Mildenerberger, T. (2021). Facilitating flexible learning by replacing classroom time with an online learning environment. *Educational Research Review*, 34, 100394. <https://doi.org/10.1016/j.edurev.2021.100394>
- Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2021). A review of AI teaching and learning from 2000 to 2020. *Computers and Education: Artificial Intelligence*, 2, 100023. <https://doi.org/10.1016/j.caeai.2021.100023>
- Nicol, D., Thomson, A., & Breslin, C. (2022). Rethinking feedback practices through peer learning. *Assessment & Evaluation in Higher Education*, 47(4), 563–578. <https://doi.org/10.1080/02602938.2021.1925613>
- Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning. *Computers & Education*, 144, 103701. <https://doi.org/10.1016/j.compedu.2019.103701>

- Tondeur, J., Howard, S., & Yang, J. (2021). One-size does not fit all: Towards an adaptive model for teacher technology integration. *Computers & Education*, 166, 104150. <https://doi.org/10.1016/j.compedu.2021.104150>
- Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-learning during the COVID-19 pandemic. *International Journal of Educational Technology in Higher Education*, 18, 1–16. <https://doi.org/10.1186/s41239-021-00266-6>
- Yu, Z., Xu, W., & Vogel, D. (2021). Enhancing student engagement through blended learning. *Educational Technology Research and Development*, 69, 1–23. <https://doi.org/10.1007/s11423-021-10017-4>
- Cutri, R. M., Mena, J., & Whiting, E. F. (2020). Faculty readiness for online teaching: A critical review. *Educational Technology Research and Development*, 68, 3175–3194. <https://doi.org/10.1007/s11423-020-09824-0>
- Farrell, T. S. C. (2022). Reflective practice in language teacher education. *System*, 109, 102872. <https://doi.org/10.1016/j.system.2022.102872>
- Instefjord, E., & Munthe, E. (2020). Educating digitally competent teachers: A systematic review of teacher education. *Teaching and Teacher Education*, 93, 103110. <https://doi.org/10.1016/j.tate.2020.103110>
- Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Educational Technology Research and Development*, 68, 1–22. <https://doi.org/10.1007/s11423-020-09756-7>
- Müller, C., & Mildemberger, T. (2021). Facilitating flexible learning by replacing classroom time with an online learning environment. *Educational Research Review*, 34, 100394. <https://doi.org/10.1016/j.edurev.2021.100394>
- Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2021). A review of AI teaching and learning from 2000 to 2020. *Computers and Education: Artificial Intelligence*, 2, 100023. <https://doi.org/10.1016/j.caeai.2021.100023>
- Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education*, 144, 103701. <https://doi.org/10.1016/j.compedu.2019.103701>
- Scherer, R., Siddiq, F., & Tondeur, J. (2021). The technology acceptance model in education: A meta-analytic structural equation modelling approach. *Computers & Education*, 157, 103967. <https://doi.org/10.1016/j.compedu.2020.103967>
- Tondeur, J., Howard, S., & Yang, J. (2021). One-size does not fit all: Towards an adaptive model for teacher technology integration. *Computers & Education*, 166, 104150. <https://doi.org/10.1016/j.compedu.2021.104150>
- Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications.
- Scherer, R., Siddiq, F., & Tondeur, J. (2021). The technology acceptance model in education: A meta-analytic structural equation modelling approach. *Computers & Education*, 157, 103967. <https://doi.org/10.1016/j.compedu.2020.103967>
- Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Educational Technology Research and Development*, 68, 1–22. <https://doi.org/10.1007/s11423-020-09756-7>