EDUKASIA: Jurnal Pendidikan dan Pembelajaran
Vol. 7, 1 (January-June, 2026), pp. 187-202
ISSN: 2721-1150; EISSN: 2721-1169; DOI: 10.62775/edukasia.v7i1.1808

Innovation in Blended Learning: A Solution to the Shortage of Computer Laboratories in Information, Communication, and Technology Courses

Sagiman[1], Laras Shesa[1], Muhammad Istan[1], Ruly Morganna[1]

[1] Institut Agama Islam Negeri Curup, Indonesia

ARTICLE INFO

Keywords:

instructional innovation;
blended learning;
learning model

Article history:

Received 2025-11-06
Revised 2025-01-13
Accepted 2026-02-15

ABSTRACT

Advances in digital technology have created substantial opportunities for instructional innovation, particularly in higher education institutions facing limitations in physical facilities such as computer laboratories. This study aims to develop and evaluate the effectiveness of a blended learning model supported by Google Classroom as a solution to the shortage of computer laboratories in the Information and Communication Technology course. The research method employed was research and development with an instructional design approach based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Data were collected through observations, interviews, questionnaires, and analysis of student performance within the blended learning environment. The findings revealed that the blended learning model not only enhanced students' learning independence but also improved teaching effectiveness by optimizing digital resources. Moreover, the implementation of Google Classroom provided flexibility in accessing materials, facilitated more dynamic interaction, and reduced the operational burden on computer laboratories. The novelty of this research lies in the integration of digital instructional strategies with the specific needs of faith-based higher education institutions, which remain underexplored in the higher education literature. Accordingly, this study contributes to the development of adaptive instructional models that can be applied in other educational institutions facing similar infrastructural constraints.

Corresponding Author:
Sagiman
Institut Agama Islam Negeri Curup, Indonesia; sagiman@iaincurup.ac.id

1. INTRODUCTION

The rapid development of information and communication technology (ICT) has reshaped educational systems worldwide, compelling universities to integrate digital tools to enhance learning quality and strengthen graduates' competitiveness in the digital era (Arikarani & Amirudin, 2021). Alongside these global demands, higher education institutions are expected to prepare students with adequate digital literacy and practical technological skills to remain relevant in an increasingly interconnected and innovation-driven world (Farias-Gaytan et al., 2023).

Despite these expectations, many universities still face significant infrastructure limitations that hinder effective ICT-based learning (Rasimin et al., 2024). At IAIN Curup, for instance, the availability of computer laboratories is far below the actual learning needs. The existing laboratories can accommodate only about 20% of the total student demand, resulting in long queues, restricted access to essential practice sessions, and unequal learning opportunities between students who rely solely on campus facilities and those who have personal devices. Such constraints directly affect the achievement of learning outcomes, particularly those requiring hands-on digital skills (Ulfah & Saeful Anwar, 2024).

To address these challenges, higher education institutions must adopt learning strategies that reduce dependence on limited physical facilities without compromising instructional quality (Abekiri et al., 2024). Blended learning has emerged as a promising alternative that combines face-to-face and online instruction to provide flexible, accessible, and interactive learning experiences (Ilham et al., 2023). Digital platforms such as Google Classroom support the distribution of materials, discussions, assessments, and feedback (Stokes, 2022), enabling students to continue learning beyond classroom hours while maintaining structured guidance from lecturers.

A considerable body of research demonstrates the effectiveness of blended learning in improving learning quality. Müller and Wulf (2020) emphasize that blending online and face-to-face instruction enhances flexibility and interaction, whereas Anthony et al. (2022) highlight pedagogical richness, access to knowledge, social interaction, cost effectiveness, ease of revision, and flexibility as key advantages of the approach. Kang and Kim (2021) further show that students engaged in blended learning tend to achieve better academic outcomes than those in traditional settings due to increased autonomy and active participation.

In faith-based higher education, however, blended learning implementation requires contextual adaptation. Fakhri et al. (2023) argue that technology integration must be aligned with value-based instructional practices, while Mahfiroh et al. (2025) report that students in such institutions often encounter challenges in digital readiness and infrastructure availability. Additional studies, such as Kumar et al. (2020), show that Google Classroom can enhance engagement and feedback, though it requires lecturer training and continuous evaluation. Moreover, Shohel et al. (2022) and Xu (2024) reveal that blended learning effectively addresses limitations in physical laboratories and expands access to learning resources.

Although prior studies highlight the potential of blended learning across various contexts (Kayi, 2024; Mizza et al., 2025; Radovan et al., 2024; Sala et al., 2024), research remains limited on how blended learning can be systematically designed to address infrastructure shortages, particularly within faith-based institutions where instructional characteristics and value-oriented learning hold distinct importance. This gap is evident in ICT-related courses at IAIN Curup, where inadequate computer laboratories and diverse levels of student digital readiness pose significant instructional challenges. Previous research (e.g., McCarthy & Palmer, 2023) has not yet offered a contextualized blended learning model tailored to these dual constraints: infrastructure limitations and value-based academic environments.

Therefore, this study explicitly aims to develop a Google Classroom-assisted blended learning model as a contextual solution to overcome computer laboratory shortages in ICT courses at IAIN Curup. Specifically, the study seeks to (1) design a pedagogical framework that strategically combines essential face-to-face practical sessions with structured online learning; (2) ensure equitable access to digital materials, simulations, and continuous feedback; (3) support independent learning beyond classroom hours; and (4) enhance teaching efficiency through digital management of learning activities. This model is expected to provide a measurable and contextually appropriate strategy to maintain the quality of practical ICT instruction despite infrastructural constraints.

2. METHODS

2.1. Design

This study adopted a research and development (R&D) design with a quasi-experimental pretest-posttest control group approach to develop and test a blended learning model assisted by Google Classroom. The design was chosen to address the shortage of computer laboratories in the Computer Applications course (also referred to as the Information and Communication Technology course) at IAIN Curup. The R&D framework followed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) to systematically create, implement, and evaluate the instructional model. A quasi-experimental component was integrated to compare the model's effectiveness against conventional teaching methods, using pretest and posttest scores to measure improvements in student learning outcomes and independence.

2.2. Participants and Locus

The study was conducted at Institut Agama Islam Negeri Curup (IAIN Curup), specifically within the Faculty of Tarbiyah. Participants were undergraduate students enrolled in the Computer Applications course from the Islamic education department in the 4th semester. Convenience sampling was employed to select participants, as the groups were based on existing class assignments to minimize disruption to the academic schedule. For the limited preliminary trial, 32 students from one class participated. For the large-scale trial, 100 students were divided into two groups: an experimental group (n=50) that received the blended learning intervention and a control group (n=50) that followed conventional face-to-face methods. Lecturers teaching the course were also involved in interviews and observations.

2.3. Procedure of Development (ADDIE)

The development procedure was implemented empirically through the ADDIE stages, focusing on practical application in the context of limited laboratory access.

In the Analysis stage, needs were identified through direct classroom observations of 10 sessions, semi-structured interviews with 5 lecturers and 20 students, and questionnaires distributed to 100 students. These revealed that computer laboratories accommodated only 20% of demand, with key barriers including student digital readiness (average self-reported proficiency score of 3.2/5) and inconsistent internet access. This data informed the model's focus on Google Classroom for off-campus practice.

The Design stage involved creating a blueprint for the blended model, integrating online (Google Classroom for material distribution, discussions, and assignments) and face-to-face sessions (laboratory-based collaboration and consultation). The structure balanced theory (online readings and modeling) with practice (in-lab projects), drawing from constructivist, behaviorist, cognitivist, and connectivist theories. Specific features included phased learning sequences (e.g., knowledge construction online, application in-lab) and assessment rubrics for quizzes and projects.

During Development, the design was translated into materials: 14 digital modules, video tutorials, and worksheets uploaded to Google Classroom, aligned with the undergraduate curriculum. A limited preliminary trial was conducted over three meetings with 32 students to test feasibility, resulting in iterative revisions such as adding mobile-friendly formats based on feedback.

Implementation occurred over 14 meetings (one online and one face-to-face per topic) in the Computer Applications course. Students in the experimental group accessed materials via Google Classroom, completed individual and group tasks, and received feedback, while the control group used traditional lectures. Monitoring included weekly logs of student engagement (e.g., 85% completion rate in experimental group).

The Evaluation stage used formative (ongoing feedback via questionnaires after each cycle) and summative approaches (pre/posttests, final interviews). Adjustments were made based on data, such as enhancing video clarity after the first cycle.

2.4. Instruments

There were three main instruments utilized in this study. The first referred to learning outcome tests (pretest/posttest) with 40 multiple-choice and practical items. The tests assessed cognitive, affective, and psychomotor domains (Cronbach's alpha = 0.87; content validity index, CVI = 0.92). The tests' indicators encompassed cognitive knowledge recall (e.g., understanding key concepts in computer applications), affective attitudes toward technology integration (e.g., motivation and interest in ICT tasks), and psychomotor skills application (e.g., proficiency in software usage and problem-solving in digital environments). The tests were adapted from multidimensional assessment frameworks in blended learning contexts (Jeong & González-Gómez, 2022).

The second was the student independence questionnaire (20 Likert-scale items, alpha = 0.82; construct validity confirmed via confirmatory factor analysis, CFA fit indices: CFI = 0.95, RMSEA = 0.06). This instrument measured self-directed learning, with indicators including self-management (e.g., planning and organizing learning activities), desire for learning (e.g., initiative in seeking resources), and self-control (e.g., monitoring progress and adjusting strategies). This instrument was drawn from validated scales correlating self-directed learning with academic performance in higher education (Dehghani & Ghaffarifar, 2024).

The third was the perception questionnaire (15 items, alpha = 0.85; content validity ratio, CVR = 0.88) on model usability, featuring indicators such as ease of use (e.g., navigation and accessibility of Google Classroom), content quality (e.g., relevance and clarity of materials), and interaction effectiveness (e.g., feedback and collaboration features). This instrument was based on the Blended Learning Usability Evaluation Questionnaire (BLUE-Q) validation studies (Arora et al., 2024).

The fourth was the semi-structured interview guidance for 10 students and 5 lecturers exploring experiences, with indicators probing benefits (e.g., flexibility in learning), challenges (e.g., technical barriers), and overall satisfaction (e.g., impact on engagement and outcomes). This instrument was informed by qualitative guides for blended learning implementations (Batista-Toledo & Gavilan, 2025).

The fifth was the classroom observation checklist tracking engagement and interactions during 8 sessions (inter-rater reliability kappa = 0.85; face validity established through expert review), including indicators for behavioral engagement (e.g., participation in tasks), emotional engagement (e.g., enthusiasm and persistence), and cognitive engagement (e.g., critical thinking and collaboration). This instrument was derived from observation protocols for blended environments (National Education Association, 2021).

2.5. Data Collection Techniques

Data were collected through mixed methods. Quantitative data came from pre/posttests administered before and after implementation, and questionnaires distributed online via Google Forms to all participants post-intervention. Qualitative data were gathered via interviews (recorded and transcribed, lasting 20-30 minutes each) and observations (noted during face-to-face sessions). All data collection occurred from February to September 2025, with ethical approval from IAIN Curup's research committee, ensuring informed consent and anonymity.

2.6. Data Analysis Techniques

Quantitative data were analyzed using SPSS v.25. Paired-sample t-tests examined within-group differences (pre/posttest) for the limited trial and experimental group, while independent-sample t-tests compared posttest scores between experimental and control groups (assuming normality via Shapiro-Wilk tests, $p > 0.05$). Effect sizes were calculated using Cohen's d. Qualitative data from interviews and observations underwent thematic analysis. Transcripts were coded inductively (e.g., themes like "increased autonomy" and "infrastructure barriers"), with inter-coder reliability (kappa = 0.81) verified by two researchers. Triangulation integrated quantitative and qualitative findings for a comprehensive evaluation of the model's effectiveness in addressing laboratory shortages.

3. FINDINGS AND DISCUSSION

3.1. Findings

Through the flow of ADDIE model, this study's blended-learning model was developed through a couple of steps, namely analysis, design, development, implementation, and evaluation. The analysis phase laid the groundwork for the developed blended-learning model in the Computer Applications course by specifying intended outcomes, structuring instruction, and situating delivery within learner and environmental realities. Drawing from course competencies, the study set outcomes spanning cognitive, affective, and psychomotor domains: students should articulate the roles of computer applications in personal and professional contexts; proficiently use productivity suites; employ creative software for graphics, photo editing, and animation; apply design principles to produce purposeful digital artefacts; and diagnose authentic problems to select and justify suitable technological solutions. Instructional analysis indicated needs for stronger digital literacy, analytical and creative thinking, problem-solving, time management, collaboration, and communication. The model's architecture combined constructivist, behaviorist, cognitivist, and connectivist perspectives to sequence online and face-to-face work, with each phase serving a distinct instructional function. Learner and context profiling showed heterogeneous preparation and digital readiness, alongside adequate institutional infrastructure (laboratories and a learning platform) but variable connectivity; these constraints were addressed through scaffolds, flexible pacing, and multimodal resources. The synthesis aligned objectives, strategies, and performance standards with learner characteristics and setting, positioning subsequent design and development for coherent implementation and evaluation.

The design phase translated the analysis into a coherent framework for the developed blended-learning model in the Computer Applications course. It specified the instructional flow, clarified instructor and student responsibilities, set measurable performance objectives, and defined assessment procedures. The course integrated online and face-to-face sessions informed by complementary learning theories; the instructional flow is summarized in Table 1.

Table 1. Instructional phases of the developed model

Phase	Mode	Theoretical Basis	Main Activities
Knowledge Construction	Online	Constructivism	Students engage with readings and prior experiences, supported by online discussions.
Modeling	Online	Behaviorism	Learners study cases and examples, followed by practice and discussion.
Collaborative Learning and Practice	Face-to-face	Constructivism & Connectivism	Small groups apply concepts, share perspectives, and complete projects.
Individual Learning and Application	Face-to-face	Cognitivism	Students work independently on tasks that involve problem analysis and decision making.
Consultation with Instructor	Face-to-face	Constructivism & Cognitivism	Instructor provides feedback, clarification, and mentoring through discussion.
Learning Evaluation	Online & Face-to-face	Behaviorism	Progress is measured through quizzes, projects, and summative assessments with feedback.

This sequencing linked theory to practice and balanced digital preparation with in-lab application. In practice, instructors curated resources, guided interaction, moderated activities, and provided timely feedback, while students engaged actively in discussions, collaborated on projects, completed individual tasks, and reflected during consultation. Performance objectives required students to communicate the role of computer applications in professional and everyday contexts, demonstrate proficiency with productivity tools, produce creative digital outputs using specialized software, apply design principles to their work, and analyze authentic problems to select appropriate technological solutions. Assessment captured both process and outcomes through quizzes, online interaction, ongoing feedback, project/product evaluation, and final examinations, supported by explicit rubrics to ensure fairness and reliability.

The development stage translated the design into deployable materials, assessment tools, and a working prototype of the developed blended-learning model. Digital modules, readings, case tasks, and practice worksheets were produced and uploaded to Google Classroom to support both online preparation and in-lab application; group projects and individual assignments were aligned to ensure continuity, supplemented by visual aids, project briefs, and interactive media. The model was consolidated into a handbook that sets out its conceptual basis, phased syntax, roles, performance benchmarks, and assessment procedures. The overview of the developed blended learning model in this study can be seen in Table 2.

Table 2. Overview of the developed blended-learning model

Component	Sub-Component	Description
Goals	Learning Independence	Enhance students' capacity for self-directed learning.
	Academic Achievement	Improve overall learning performance in the Computer Applications course.
Context	Course	Computer Applications (undergraduate level).
Target Learners	Students	Undergraduate (Bachelor's degree).
Learning Materials	Meeting 1 & 2	Introduction to computer applications and word-processing software (delivered in online and offline sessions).
	Meeting 3 & 4	Data processing applications and presentation tools (online and offline).
	Meeting 5 & 6	Project management applications and photo-editing tools (online and offline).
	Meeting 7 & 8	Basic and advanced graphic design (online and offline).
	Meeting 9 & 10	Basic and advanced animation (online and offline).
	Meeting 11 & 12	Design principles and their application in creative digital products (online and offline).
	Meeting 13 & 14	Case studies: selecting appropriate applications to solve problems in business contexts (online and offline).
Learning Structure	Phase 1 – Knowledge Construction	Online mode; Constructivist basis; delivered via Google Classroom and supported by ICT media. Students construct knowledge through readings, reflection, and online discussion.
	Phase 2 – Modeling	Online mode; Behaviorist basis; implemented through Google Classroom and ICT media. Students learn from case examples and practice tasks.
	Phase 3 – Collaborative Learning	Face-to-face mode; Constructivist and Connectivist basis; conducted in the computer laboratory using ICT media. Students work in groups to complete tasks and projects.
	Phase 4 – Independent Learning	Face-to-face mode; Cognitivist basis; conducted in the computer laboratory with ICT media. Students complete individual assignments involving analysis and decision making.
	Phase 5 – Consultation	Face-to-face mode; Constructivist, Connectivist, and Cognitivist basis; learning consultation with the instructor in the computer laboratory. Students clarify concepts, receive feedback, and refine understanding.
	Phase 6 – Evaluation	Online and face-to-face mode; Behaviorist basis; assessment conducted through formative and summative methods. Evaluation includes quizzes, projects, and final examinations with continuous feedback.

To measure learning across cognitive, affective, and psychomotor domains, the team constructed knowledge tests, product rubrics, collaboration checklists, and structured feedback forms, then sought expert review and conducted pilot trials to establish validity and reliability. Findings from expert appraisal and pilots informed iterative revisions to materials, sequencing, and evaluation criteria, ensuring that the developed model was feasible, pedagogically robust, and responsive to learner needs.

The implementation stage applied the developed blended-learning model in the Computer Applications course through a structured sequence of 14 meetings, each topic delivered in two sessions, namely one online via Google Classroom and one face-to-face in the computer laboratory, to balance conceptual preparation with hands-on practice. Online sessions emphasized knowledge construction and modeling through readings, tutorials, case demonstrations, and guided discussion; offline sessions focused on collaborative work, individual application, and consultation with the instructor. The sequence progressed from introduction to computer applications and word processing (Meetings 1–2), to data processing and presentation tools (3–4), project management and photo editing (5–6), basic and advanced graphic design (7–8), basic and advanced animation (9–10), design principles and their application (11–12), and business-oriented case studies requiring tool selection and solution design (13–14). Throughout, instructors curated resources, moderated interaction, supervised lab activities, and provided timely feedback; students engaged actively online, collaborated on projects, completed individual tasks, and refined outputs during consultation. Formative feedback was integrated continuously, and summative assessments concluded the cycle. The staged delivery effectively linked theory to practice, supported both individual mastery and group performance, and demonstrated the model's feasibility and potential to strengthen learner independence and achievement.

The subsequent evaluation phase was conducted to measure the effectiveness of the developed blended learning model. Based on the evaluation results, the following quantitative data support the effectiveness of the blended learning model assisted by Google Classroom in enhancing student independence and academic achievement in the Information and Communication Technology course at IAIN Curup. A limited trial was carried out over three meetings using pretest and posttest methods to measure the improvement in students' learning independence. The trial results are presented in the following table:

Table 3. Results of the limited trial

Meeting	Mean Pretest	Mean Posttest	Difference	t-value	Sig. (p-value)
1	52.09	61.47	-9.376	-12.399	0.000
2	60.62	70.63	-10.000	-13.565	0.000
3	63.13	73.76	-10.626	-15.318	0.000

From the table above, the results of the t-test indicate that the Sig. (p-value) is smaller than 0.05 ($p = 0.000$), which means that students' learning independence increased significantly after participating in the blended learning model. The higher mean posttest scores demonstrate that this model supported students in better understanding the material.

A large-scale trial was then conducted using a pretest–posttest control group design involving two groups of students, namely the experimental group (which used blended learning) and the control group (which used conventional learning methods). The mean posttest results of the two groups are presented in the following table:

Table 4. Results of the large-scale trial

Group	N (Number of Students)	Mean Posttest Score
Experimental	50	80.64
Control	50	67.42

These results indicate that students who learned through the blended learning model obtained higher mean scores compared with the control group that used conventional teaching methods. To further examine the effectiveness of the model, an independent sample t-test was conducted. The results are presented in the following table:

Table 5. Independent sample t-test results

t-value	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval
7.017	98	0.000	13.327	9.558 – 17.096

The t-test results show that the p-value = 0.000 < 0.05, which indicates a significant difference between the experimental and control groups. This finding demonstrates that the blended learning model supported by *Google Classroom* is significantly more effective in improving students' learning outcomes compared with conventional methods. Based on the questionnaire administered to students after the implementation of the blended learning model, the results are as follows:

Table 6. Student questionnaire results after the implementation of blended learning

Response Category	Percentage of Students (%)
Very interesting and enjoyable	51.66%
Interesting and easy to follow	44.00%
Fairly interesting	4.33%
Less interesting	0.00%

The majority of students (51.66%) reported that the model was very interesting and enjoyable, while 44% stated that learning through the blended learning model was interesting and easy to understand. Only 4.33% of students considered the model to be fairly interesting, and none of the students indicated that the method was less interesting. The following figure illustrates a comparison of the mean posttest scores between the experimental group and the control group:

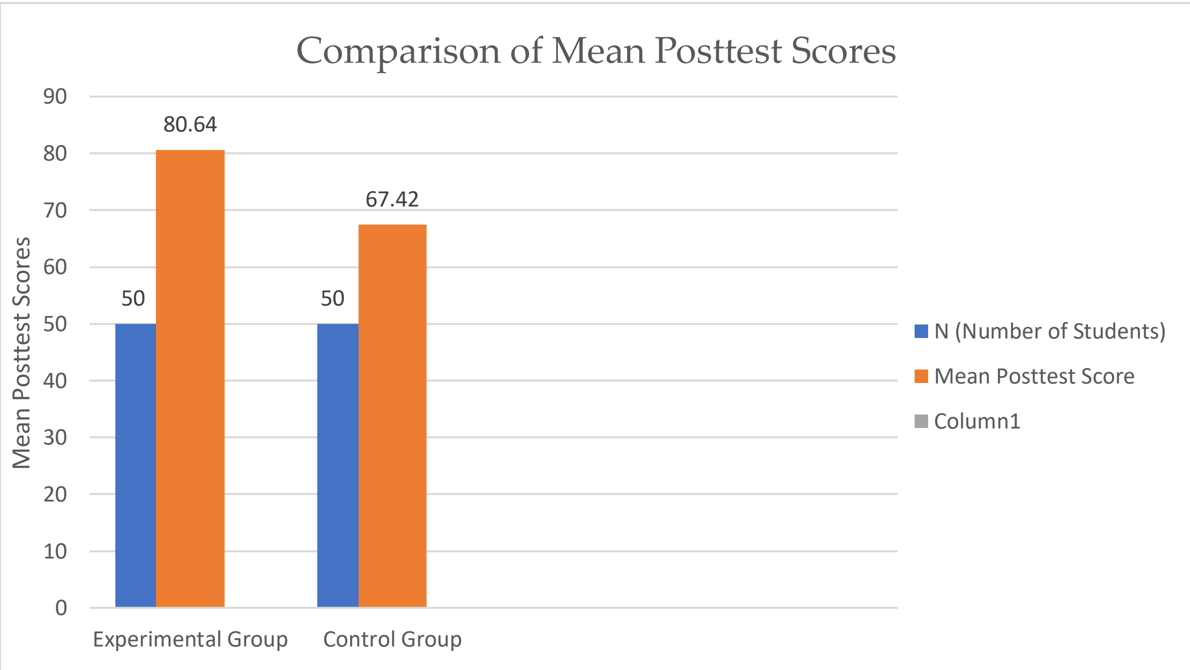

Figure 1. Comparison of mean posttest scores

From the diagram above, it is evident that the mean score of the experimental group was higher than that of the control group, confirming that the blended learning method enhanced students' learning outcomes. Based on the quantitative data obtained, it can be concluded that the blended learning model supported by Google Classroom proved effective in improving both student independence and learning achievement. Statistical tests demonstrated significant differences between students who learned through this model and those who continued with conventional teaching methods. In addition, student responses to this model were overwhelmingly positive, with the majority reporting that the method was more engaging and facilitated their understanding of the material. Therefore, the blended learning model can serve as an innovative solution to overcome the shortage of computer laboratories at the Faculty of Tarbiyah, IAIN Curup.

Building on these quantitative findings, classroom observations corroborated a clear shift in learning behaviors. Students demonstrated greater autonomy, participated more actively in asking questions and engaging in discussion, and managed their study time more efficiently. Face to face sessions consequently pivoted toward problem solving and conceptual deepening, while foundational content delivery was accommodated in the online space. Lecturers were thereby able to devote more time to academic mentoring and individualized guidance, since baseline explanations had already been addressed through the digital materials.

Interview data further reinforced these patterns. Both students and lecturers reported that the model improved conceptual understanding and expedited feedback cycles, which in turn sustained momentum between sessions. At the same time, participants highlighted several practical constraints that tempered implementation, notably the stability of internet access, uneven availability of personal devices, and the continuing need for training in platform use and in the design of high-quality digital materials.

Questionnaire evidence aligned with the observational and interview results and indicated strong acceptance of the model. A majority of students evaluated the learning experience as very interesting and enjoyable at 51.66 percent, while 44.00 percent rated it interesting and easy to understand. Only 4.33 percent considered it fairly interesting, and none rated it less interesting. Taken together, these qualitative and survey-based findings provide convergent evidence that the blended learning approach supported by Google Classroom fostered higher engagement and more effective learning processes, while also identifying concrete infrastructural and capacity building priorities for sustained adoption.

3.1. Discussion

The blended learning model was developed that integrates face-to-face sessions with online learning through Google Classroom, addressing the shortage of computer laboratories in ICT courses at IAIN Curup. This model demonstrated higher achievement relative to conventional instruction, evidenced by a significant posttest mean difference of 13.33 points ($t = 7.02$, $df = 98$, $p < 0.001$), with a 95% confidence interval from 9.56 to 17.10, indicating not just flexibility but measurable learning gains through timely feedback and iterative practice. In limited trials, pretest–posttest gains of nine to eleven points per session were consistently significant ($p = 0.000$), supporting enhanced conceptual understanding and autonomy. The instructional structure balanced theory and practice by shifting face-to-face time to higher-order activities like problem-solving, while offloading foundational content online, aligning with observed increases in participation and time management. Google Classroom served as an enabling infrastructure for rapid feedback, structured interaction, and multi-device accessibility, shortening response times and driving efficiency in technology-supported instruction (Gupta & Pathania, 2021; Hussein et al., 2022; Perrotta et al., 2021). Digital resources, including e-books, articles, and interactive exercises, afforded spaced review and self-paced repetition, which interviewees linked to improved outcomes and triangulated with posttest advantages. The digital evaluation system enhanced transparency, allowing immediate results and longitudinal monitoring, explaining faster task completion and self-regulation (Cao et al., 2025; Cosa & Torelli, 2024; Vancoillie et al., 2025). Synthesizing evidence, the model's theory of change, flexible access, rapid feedback, and structured interaction, explains improvements in outcomes, task efficiency, and motivation, positioning it as a viable solution for infrastructural constraints.

The results of this study align with and extend prior research on blended learning, particularly in the context of ICT courses in higher education. For instance, several similar studies underscore the effectiveness of blended approaches in enhancing student outcomes through technology integration. Chen et al. (2024) reported increased participation and problem-solving skills in blended ICT courses at Chinese universities, mirroring our findings as both emphasize balancing online preparation with lab-based application to boost cognitive and psychomotor domains. Godsk and Møller (2025) demonstrated that educational technologies in blended formats raised motivation and pass rates in European higher education, akin to our results through interconnected behavioral and affective engagement via platforms like Google Classroom. Ndibalema (2025) highlighted digital literacy enhancements in sub-Saharan African HEIs via blended methods, paralleling our independence gains as both address infrastructural gaps with multimodal resources. Mei et al. (2025) showed ARCS-motivated blended designs improved self-efficacy in STEM courses, consistent with our feedback cycles fostering self-regulation. Alam and Ogawa (2024) noted ICT readiness boosts in South African graduates through blended training, similar in promoting employability skills amid connectivity challenges. Attridge and O'Mahony (2025) reported LMS integration in apprenticeships enhanced collaboration, echoing our collaborative phases in lab sessions. Egara and Mosimege (2024) found blended simulations improved analytical thinking in business ICT, comparable to our project-based tasks translating theory to practice. Finally, Chaves-Yuste and de-la-Peña (2025) evidenced cost-effective flexibility in Asian HEIs' blended models, reinforcing our equity-oriented rationale for lab shortages. These similarities arise from a common focus on hybrid modalities in higher education to leverage digital tools for better access and interaction, teaching us that contextual scaffolding, like our ADDIE-based design, amplifies gains in diverse settings by mitigating reliance on physical infrastructure.

In contrast, five differing studies reveal challenges or suboptimal outcomes in blended learning implementations, highlighting variances in context or execution. Fisher et al. (2025) showed delayed feedback in Australian accounting hybrids reduced motivation beyond 10 days, contrasting our rapid cycles as it lacked platform automation, emphasizing timely tech integration to sustain engagement. Simon et al. (2025) reported subjectivity and bias in participation assessment during Philippine online-offline shifts, unlike our rubric-supported evaluations, revealing that clear criteria prevent demotivation in large classes. Fabian et al. (2024) noted disconnection and rushed pacing in Belgian hybrid lectures, diverging from our balanced sequencing due to poor modality alignment, teaching the value of phased designs for social cohesion. Lastly, Godsk and Møller (2025) highlighted informal learning disruptions from tech in UK universities, differing as our model preserved face-to-face depth, illustrating that over-digitization risks affective isolation without hybrid complementarity. These differences stem from inadequate infrastructural support or rushed adoptions in non-ICT-focused or under-resourced contexts, from which we learn that proactive fidelity checks and adaptive training can transform potential pitfalls into strengths, ensuring broader applicability.

As implications, the blended learning model significantly enhanced student learning independence and motivation through three core mechanisms: on-demand access to materials, rapid feedback cycles, and structured collaborative spaces that normalized question-asking and active discussion. Quantitative results from limited and large-scale trials, combined with qualitative evidence from interviews and observations, showed that students developed stronger self-regulation, better time management, and higher autonomy, as they shifted from passive recipients to self-directed learners capable of revisiting content and refining work independently. Survey data revealed overwhelmingly positive perceptions, with 51.66% rating the experience as very interesting and enjoyable and 44.00% as interesting and easy to understand, triangulating with increased participation and aligning with expectancy-value theory, where perceived control and task value sustain engagement. For lecturers, the model reallocated effort from content delivery to high-value facilitation and individualized mentoring, supported by Google Classroom's automation features (assignment scheduling, instant grading, and activity logs), allowing deeper focus on problem-solving during face-to-face sessions. Overall, the model not only raised academic performance but also fostered lasting motivational and self-regulatory gains, offering a scalable pathway for resource-constrained institutions to cultivate 21st-century learning competencies while preserving meaningful instructor–student interaction.

This study contributes a novel Google Classroom-supported blended learning model, developed through the ADDIE framework, specifically tailored for ICT courses in faith-based higher education institutions facing acute computer laboratory shortages. It delivers robust quasi-experimental evidence (posttest mean difference 13.33 points, $t(98) = 7.02$, $p < .001$) that the six-phase design (knowledge construction, modeling, collaborative and independent practice, consultation, and evaluation) significantly outperforms conventional teaching while markedly enhancing student independence and engagement. By contextualizing digital pedagogy within the value-oriented environment of IAIN Curup, the research fills a critical gap in the literature and provides a replicable, equity-focused blueprint readily adaptable by other resource-constrained universities, especially Islamic higher education institutions across Indonesia and similar developing contexts.

As limitations, despite positive outcomes, the study faced constraints in device ownership and internet stability, which created unequal access to online components, interrupted feedback cycles, and potentially threatened internal validity and equity of impact. Conducted at a single faith-based institution (N = 100) with a specific ICT course focus, results may not fully generalize to secular or better-resourced settings. Future implementations should therefore incorporate device-lending programs, expanded campus Wi-Fi, data subsidies, and systematic lecturer training while larger, multi-site studies are needed to establish minimum connectivity thresholds and strengthen external validity.

4. CONCLUSION

The innovation of blended learning supported by Google Classroom represents a strategic solution to the shortage of computer laboratories, which has long been a barrier to technology-based instruction. This model integrates face-to-face and online learning, enabling students to access materials, complete assignments, and interact with lecturers flexibly without relying on the availability of computer laboratories. Through blended learning, students are able to use their personal devices to study essential concepts, while face-to-face sessions are more focused on discussion, problem-solving, and in-depth academic guidance. In addition, the use of Google Classroom facilitates the distribution of materials, assignment submission, and evaluation of learning outcomes in an efficient manner. The implementation of this model has been shown to improve students' learning independence, strengthen the effectiveness of lecturers' teaching, and optimize the use of available resources in higher education. Although challenges remain in its implementation, such as the readiness of students and lecturers to adopt technology, the findings indicate that with appropriate training and adaptation, blended learning can serve as an innovative, effective, and sustainable instructional method to enhance the quality of higher education.

Based on the findings of this study, several recommendations can be made for policymakers to enhance the effectiveness of technology-based learning. First, training programs should be provided for both lecturers and students in the use of educational technologies. Such training should include the use of Google Classroom, the development of digital instructional materials, and interactive technology-based teaching strategies. With this training, both lecturers and students will be better prepared to optimize the use of blended learning as an integral part of their academic activities. Second, improving digital infrastructure in higher education institutions is essential to ensure the sustainability of this model. Universities may provide additional computer laboratories that students can access outside of regular class hours and strengthen campus internet networks to guarantee more stable access to online learning. In addition, universities can collaborate with internet service providers to offer special data packages for students participating in online courses. Third, the curriculum must be further developed to support the implementation of blended learning. Curricula should be designed to enable an effective combination of online and face-to-face instruction. Technology-related courses in particular need to be developed with more innovative approaches so that students can gain learning experiences that are more relevant to current advancements. Fourth, continuous evaluation of the blended learning model should be conducted regularly to identify strengths as well as challenges that still need to be addressed. Higher education institutions can administer surveys and interviews with both students and lecturers to assess the effectiveness of this model and adapt teaching methods based on the feedback received. Through regular evaluations, the blended learning model can continue to evolve and be adjusted to meet the changing academic needs.

By implementing these recommendations, the blended learning model supported by Google Classroom is expected to serve as a long-term solution for improving instructional quality. Although challenges remain, with proper institutional support and the readiness of all stakeholders, this model holds significant potential to become a sustainable teaching method that is highly relevant to the demands of education in the digital era.

REFERENCES

Abekiri, N., Ajaamoum, M., Rachdy, A., Nassiri, B., & Benydir, M. (2024). Towards hybrid technical learning: Transforming traditional Laboratories for distance learning. *Computer Applications in Engineering Education*, *32*(5), e22771. https://doi.org/10.1002/cae.22771

Alam, M. J., & Ogawa, K. (2024). Future-readiness and employable ICT skills of university graduates in Bangladesh: An analysis during the post-covid era. *Cogent Social Sciences*, *10*(1), 2359014. https://doi.org/10.1080/23311886.2024.2359014

Anthony, B., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. A. L. E., Abdullah, A., & Ming, G. L. (2022). Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review. *Technology, Knowledge and Learning*, *27*(2), 531–578. https://doi.org/10.1007/s10758-020-09477-z

Arikarani, Y., & Amirudin, M. F. (2021). Pemanfaatan Media dan Teknologi Digital Dalam Mengatasi Masalah Pembelajaran Dimasa Pandemi. *Ej*, *4*(1), 93–116. https://doi.org/10.37092/ej.v4i1.296

Arora, A. K., Rodriguez, C., Carver, T., Zhang, H., & Schuster, T. (2024). Validation of the Blended Learning Usability Evaluation–Questionnaire (BLUE-Q) through an innovative Bayesian questionnaire validation approach. *Journal of Educational Evaluation for Health Professions*, *21*, 1–7. https://doi.org/10.3352/jeehp.2024.21.31

Attridge, E., & O'Mahony, T. (2025). 'I could replicate the situation exactly the same as I do in class': Apprentice lecturers use of a learning management system at an Irish university during and after COVID-19. *Journal of Vocational Education & Training*, *0*(0), 1–18. https://doi.org/10.1080/13636820.2025.2507582

Batista-Toledo, S., & Gavilan, D. (2025). A Blended Learning Future: COVID-19 Lessons for "Phygital" Higher Education. *The International Review of Research in Open and Distributed Learning*, *26*(2), 1–22. https://doi.org/10.19173/irrodl.v26i2.8259

Cao, Y., Yan, Z., Yang, L., Panadero, E., & Chen, C. (2025). Technology-mediated self-assessment in higher education: A critical review. *Contemporary Educational Technology*, *17*(3), ep588. https://doi.org/10.30935/cedtech/16739

Chaves-Yuste, B., & de-la-Peña, C. (2025). Impact of Digital Resources on ESP Academic Performance. *TESOL Journal*, *16*(2), e70037. https://doi.org/10.1002/tesj.70037

Chen, M., Wang, Z., Liang, L., Ma, Z., & Liu, Y. (2024). Typical Practical Cases in Blended Learning. In M. Li, X. Han, & J. Cheng (Eds.), *Handbook of Educational Reform Through Blended Learning* (pp. 231–378). Springer Nature. https://doi.org/10.1007/978-981-99-6269-3_6

Cosa, M., & Torelli, R. (2024). Digital Transformation and Flexible Performance Management: A Systematic Literature Review of the Evolution of Performance Measurement Systems. *Global Journal of Flexible Systems Management*, *25*(3), 445–466. https://doi.org/10.1007/s40171-024-00409-9

Dehghani, G., & Ghaffarifar, S. (2024). Readiness for self-directed learning among basic sciences medical students. *Journal of Education and Health Promotion*, *13*(1), 243. https://doi.org/10.4103/jehp.jehp_1849_23

Egara, F. O., & Mosimege, M. (2024). Effect of blended learning approach on secondary school learners' mathematics achievement and retention. *Education and Information Technologies*, *29*(15), 19863–19888. https://doi.org/10.1007/s10639-024-12651-w

Fabian, K., Smith, S., & Taylor-Smith, E. (2024). Being in Two Places at the Same Time: A Future for Hybrid Learning Based on Student Preferences. *TechTrends*, *68*(4), 693–704. https://doi.org/10.1007/s11528-024-00974-x

Fakhri, J., Sada, H. J., Saputra, M. I., Jamil, S., & Mursyidah, D. (2023). Performing Hybrid Learning at Islamic Higher Education Institusions for Mitigating Learning Loss. *Jurnal Pendidikan Islam*, *9*(2), 223–240.

Farias-Gaytan, S., Aguaded, I., & Ramirez-Montoya, M.-S. (2023). Digital transformation and digital literacy in the context of complexity within higher education institutions: A systematic literature review. *Humanities and Social Sciences Communications*, *10*(1), 386. https://doi.org/10.1057/s41599-023-01875-9

Fisher, D. P., Brotto, G., Lim, I., & Southam, C. (2025). The Impact of Timely Formative Feedback on University Student Motivation. *Assessment & Evaluation in Higher Education*, *50*(4), 622–631. https://doi.org/10.1080/02602938.2025.2449891

Godsk, M., & Møller, K. L. (2025). Engaging students in higher education with educational technology. *Education and Information Technologies*, *30*(3), 2941–2976. https://doi.org/10.1007/s10639-024-12901-x

Gupta, A., & Pathania, P. (2021). To study the impact of Google Classroom as a platform of learning and collaboration at the teacher education level. *Education and Information Technologies*, *26*(1), 843–857.

Hussein, M. H., Ow, S. H., Al-Azawei, A., & Ibrahim, I. (2022). What drives students' successful reuse of online learning in higher education? A case of Google Classroom. *Australasian Journal of Educational Technology*, *38*(3), 1–21. https://doi.org/10.14742/ajet.7335

Ilham, M., Mujiyati, S., & Saefudin, A. (2023). Efektivitas Blended Learning pada Pembelajaran Teknologi Pendidikan Mahasiswa Semester 4 Prodi PAI. *Ideguru: Jurnal Karya Ilmiah Guru*, *9*(1), 16–23. https://doi.org/10.51169/ideguru.v9i1.692

Jeong, J. S., & González-Gómez, D. (2022). Editorial: Cognitive, Affective, Behavioral, and Multidimensional Domain Research in STEM Education: Active Approaches and Methods Towards Sustainable Development Goals (SDGs). *Frontiers in Psychology*, *13*, 1–4. https://doi.org/10.3389/fpsyg.2022.881153

Kang, H. Y., & Kim, H. R. (2021). Impact of blended learning on learning outcomes in the public healthcare education course: A review of flipped classroom with team-based learning. *BMC Medical Education*, *21*(1), 78. https://doi.org/10.1186/s12909-021-02508-y

Kayi, E. A. (2024). Transitioning to blended learning during COVID-19: Exploring instructors and adult learners’ experiences in three Ghanaian universities. *British Journal of Educational Technology*, *55*(6), 2760–2786. https://doi.org/10.1111/bjet.13475

Kumar, J. A., Bervell, B., & Osman, S. (2020). Google classroom: Insights from Malaysian higher education students’ and instructors’ experiences. *Education and Information Technologies*, *25*(5), 4175–4195. https://doi.org/10.1007/s10639-020-10163-x

Mahfiroh, S., Mustika, L. R. A., Rojaenah, S., & Sulianto, J. (2025). Analysis of School Readiness in Developing School Digitalization at MA Al Hikmah Kajen. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *10*(1), 465–484.

McCarthy, S., & Palmer, E. (2023). Defining an effective approach to blended learning in higher education: A systematic review. *Australasian Journal of Educational Technology*, *39*(2), 98–114. https://doi.org/10.14742/ajet.8489

Mei, Q., Chan, N. N., Gill, R. S., Subramaniam, N., Motevalli, S., & Ang, C.-S. (2025). Impact of attention, relevance, confidence, satisfaction (ARCS) model on teaching effectiveness in higher education: A systematic review. *Discover Education*, *4*(1), 252. https://doi.org/10.1007/s44217-025-00674-5

Mizza, D., Reese, M., & Malouche, D. (2025). Flipped classroom evaluation and blended learning potential: A case study of engagement and inclusion in quantitative education. *Smart Learning Environments*, *12*(1), 56. https://doi.org/10.1186/s40561-025-00412-2

Müller, F. A., & Wulf, T. (2020). Technology-supported management education: A systematic review of antecedents of learning effectiveness. *International Journal of Educational Technology in Higher Education*, *17*(1), 47. https://doi.org/10.1186/s41239-020-00226-x

National Education Association. (2021). *Checklist for Blended Learning*. https://www.nea.org/professional-excellence/student-engagement/tools-tips/checklist-blended-learning

Ndibalema, P. (2025). Digital literacy gaps in promoting 21st century skills among students in higher education institutions in Sub-Saharan Africa: A systematic review. *Cogent Education*, *12*(1), 2452085. https://doi.org/10.1080/2331186X.2025.2452085

Perrotta, C., Gulson, K. N., Williamson, B., & Witzenberger, K. (2021). Automation, APIs and the distributed labour of platform pedagogies in Google Classroom. *Critical Studies in Education*, *62*(1), 97–113. https://doi.org/10.1080/17508487.2020.1855597

Radovan, M., Radovan, D. M., Radovan, M., & Radovan, D. M. (2024). Harmonizing Pedagogy and Technology: Insights into Teaching Approaches That Foster Sustainable Motivation and Efficiency in Blended Learning. *Sustainability*, *16*(7). https://doi.org/10.3390/su16072704

Rasimin, Semma, A. B., Zakiyuddin, Ali, M., & Helmy, M. I. (2024). Multi-dimensional challenges in the Indonesian social science information technology-based learning: A systematic literature review. *Heliyon*, *10*(7). https://doi.org/10.1016/j.heliyon.2024.e28706

Sala, R., Maffei, A., Pirola, F., Enoksson, F., Ljubić, S., Skoki, A., Zammit, J. P., Bonello, A., Podržaj, P., Žužek, T., Priarone, P. C., Antonelli, D., & Pezzotta, G. (2024). Blended learning in the engineering field: A systematic literature review. *Computer Applications in Engineering Education*, *32*(3), e22712. https://doi.org/10.1002/cae.22712

Shohel, M. M. C., Ashrafuzzaman, M., Azim, F., Naomee, I., Rahman, M. S., & Siddik, M. A. B. (2022). Blended learning space for primary and secondary education: Challenges and opportunities in resource-constrained contexts. *Designing Effective Distance and Blended Learning Environments in K-12*, 187–222.

Simon, P. D., Jiang, J., & Fryer, L. K. (2025). Assessment of class participation in online and offline learning environments: A qualitative investigation of teachers’ best practices and challenges. *Higher Education Research & Development*, *44*(5), 1191–1208. https://doi.org/10.1080/07294360.2025.2462024

Stokes, J. A. (2022). Using Google Tools to Increase Student Learning, Engagement, and Collaboration in Remote, Hybrid, and In-person Courses. *The FASEB Journal*, *36*(S1). https://doi.org/10.1096/fasebj.2022.36.S1.R2523

Ulfah, U., & Saeful Anwar. (2024). Inovasi Digital dalam Pendidikan Islam: Meningkatkan Kualitas Pembelajaran dan Keterlibatan Mahasiswa. *Ulul Albab: Jurnal Pendidikan Agama Islam*, *2*(1), 58–76. https://doi.org/10.30999/ululalbab.v2i1.3354

Vancoillie, L., Fryling, M., & Samei, E. (2025). Relevance and application of digital project management in academic research: A case study in a Medical Physics lab and practice. *Journal of Applied Clinical Medical Physics*, *26*(9), e70242. https://doi.org/10.1002/acm2.70242

Xu, B. (2024). Technology integration into Chinese as a foreign language learning in higher education: An integrated bibliometric analysis and systematic review (2000–2024). *Language Teaching Research*, 13621688241277911. https://doi.org/10.1177/13621688241277911