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Technology-Based Mathematics Learning Management and Its Role in Enhancing Elementary Students' Learning Motivation: A Descriptive Study

Ani Nurbaini
Universitas Islam Nusantara Bandung, Indonesia
aninurbaini@uninus.ac.id

Nana Herdiana Abdurrahman
Universitas Islam Nusantara Bandung, Indonesia
nanaherdiana@uninus.ac.id

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Abstract:

This study aims to describe and analyze technology-based mathematics learning management and its contribution to enhancing students' motivation to learn at SDN Palasari and SDN Cibalagung. Employing a qualitative descriptive approach with a comparative case study design, the research involved teachers, principals, and students in grades IV–VI through interviews, observations, and document analysis. The results indicate that all stages of learning management—based on the POAC framework—functioned relatively effectively. Planning involved aligning objectives, content, and digital media (e.g., GeoGebra, video tutorials, interactive quizzes), resulting in structured learning activities focused on conceptual understanding and student motivation. Organizing was demonstrated through adaptive strategies tailored to school conditions, including role allocation, device rotation, BYOD (Bring Your Own Device) utilization, and offline access to materials. Implementation via flipped classroom and blended learning models successfully increased student participation, engagement, and learning autonomy. Evaluation utilized digital features for formative assessment, learning analytics, and rapid feedback, serving as a basis for reflection and instructional improvement. Follow-up actions included adaptive remediation, enrichment, and teacher-student reflection, which were shown to strengthen students' self-efficacy and intrinsic motivation. Despite challenges regarding infrastructure readiness, varying levels of digital literacy, and teacher workload, the integration of technology provided an engaging, interactive learning experience that fostered student independence. This study contributes to the development of a technology-based learning management model that is adaptive, contextual, and aligned with the "Kurikulum Merdeka" (Independent Curriculum), while also recommending enhancements to teachers' digital competence, infrastructure strengthening, and institutional support to ensure the sustainability of these practices.

Keywords: educational technology; elementary school; instructional management; learning motivation; mathematics.

INTRODUCTION

Education in the digital era demands substantial innovation in the learning process, particularly in mathematics, which students often perceive as abstract and uninteresting. This situation requires teachers to implement effective pedagogical and managerial strategies to increase student motivation, engagement, and overall understanding. The use of educational technology, such as interactive applications, video tutorials, and learning management platforms, can be a means of delivering a more contextual and participatory learning experience. Furthermore, structured learning management, encompassing planning, organization, implementation, evaluation, and follow-up, plays a crucial role in ensuring each stage of learning is effective (Hertina et al., 2024). The planning stage allows for the formulation of clear objectives and the selection of appropriate media, while the organization stage supports collaboration and the optimal distribution of learning resources. Implementing technology-based learning encourages active student engagement, while formative evaluation provides specific, real-time feedback. Adaptive follow-up, including remedial and collaborative reflection, ensures evaluation data is translated into continuous learning improvements. Thus, pedagogical and managerial innovations integrated with technology not only make mathematics more engaging, but also build a culture of active learning, increase student motivation, and prepare them to face the demands of 21st-century education (Kemdikbud, 2022).

Empirical evidence over the past decade confirms that technology integration in mathematics learning has the potential to improve student engagement and learning outcomes. However, its effectiveness is heavily influenced by instructional design, implementation quality, and the specific context of each school. Recent reviews and meta-analyses indicate that technology interventions generally have a positive impact on students' mathematical understanding and motivation, although the degree of effectiveness varies. This difference arises from factors such as teachers' digital competence, infrastructure availability, institutional support, and the methods used to integrate technology into the learning process. Furthermore, studies show that technology cannot be a stand-alone solution; learning success depends heavily on how teachers design interactive, relevant, and structured learning experiences. Formative evaluations based on digital data, such as learning analytics and interactive quizzes, have been shown to provide rapid and specific feedback, enabling real-time adjustments to learning strategies (Sirait & Dewi, 2024). Therefore, effective technology implementation requires a balance between pedagogical innovation, adaptive classroom management, and strategic use of digital tools. These findings emphasize the need for a holistic approach to implementing technology-based mathematics learning to consistently boost student motivation, engagement, and achievement.

The application of gamification approaches and interactive visual media has been proven to increase student motivation and participation when pedagogically integrated into the learning process. Gamification, through mechanisms such as challenges, points, and rewards, creates a more engaging and competitive learning environment, thereby encouraging active student engagement. Meanwhile, interactive visual media, such as animations, simulations, and interactive whiteboards, help simplify abstract mathematical concepts, make the material more concrete, and facilitate deeper understanding (Pramesti et al., 2025). The effectiveness of this strategy depends heavily on how teachers design learning experiences that align with learning objectives and student characteristics. Successful integration positions technology as a pedagogical support, not simply an additional tool, thus encouraging active student interaction, collaboration, and reflection. Empirical studies show that the combination of gamification and interactive visual media can significantly increase students' intrinsic motivation, class participation, and problem-solving abilities. Thus, approaches that combine elements of games and interactive visualizations not only make learning more engaging, but also play a role in building cognitive and affective skills, strengthening student engagement, and supporting optimal achievement of learning objectives in the context of 21st-century education (Khoshnoodifar et al., 2023), while the development of learning analytics opens up the potential for real-time formative feedback that supports instructional differentiation, but its adoption at the elementary level is still limited.

At the policy level, the Independent Curriculum emphasizes the importance of pedagogical freedom for teachers and the use of digital learning resources to create more contextual and innovative learning. This policy opens opportunities for teachers to design teaching strategies tailored to student characteristics, utilize digital media, and develop methods that encourage active engagement and creativity. Thus, the Independent Curriculum has the potential to strengthen the integration of technology into the learning process and support the achievement of 21st-century competencies. However, implementation in the field shows disparities in readiness between schools, which impact the effectiveness of technology utilization. Factors such as infrastructure availability, teacher digital competence, and school management support are key determinants of the policy's successful implementation (Nasrullah et al., 2024). Schools with adequate facilities and trained teachers can maximize the potential of technology, while schools with limited resources tend to face challenges in realizing pedagogical innovation. These findings confirm that the Independent Curriculum policy, while providing space for creativity and flexibility, needs to be balanced with efforts to improve school and teacher capacity. A strategy of mentoring, training, and the provision of equitable digital resources is key to optimally realizing the potential of technology, enabling effective and inclusive learning across all schools.

Operationally, this article aims to describe the POAC (Planning, Organizing, Implementing, Evaluation, and Follow-up) management practices in technology-based mathematics learning in both schools. Furthermore, this study seeks to identify supporting and inhibiting factors that influence student motivation and learning engagement. With a deep understanding of these practices, this study also aims to formulate a technology-based adaptive management model that is contextual and realistically applicable in elementary schools (Wahyudi et al., 2025). The expected outcomes of this study include policy recommendations and professional development strategies for teachers, designed to improve the quality of mathematics learning in the Merdeka Curriculum era. The proposed adaptive management model emphasizes the integration of POAC functions, the use of data-based formative evaluation, and the strengthening of teachers' digital literacy, thus making the learning process more effective, innovative, and sustainable. Thus, this article not only presents a description of practices but also makes a practical contribution to teacher and institutional capacity development, thereby maximizing the potential of technology in mathematics learning. This approach is expected to strengthen student motivation, increase learning engagement, and support the achievement of 21st-century competencies in elementary schools (Darling-Hammond et al., 2017; Kemdikbud, 2022; Khoshnoodifar et al., 2023; Redecker, 2017; UNESCO, 2023; Zhang et al., 2023).

METHOD

This study employed a qualitative descriptive design with a comparative case study approach to deeply understand the technology-based mathematics learning management practices and their influence on student learning motivation in two different elementary schools, namely SDN Palasari and SDN Cibalagung. The qualitative approach was chosen because the primary objective of the study was not to test quantitative hypotheses, but rather to gain a rich understanding of the process, meaning, and dynamics of the managerial implementation of POAC (Planning, Organizing, Implementing, Evaluation/Follow-up) in a natural context (Wicks, 2017). With a comparative case study, this study enabled cross-case analysis to highlight similarities and differences in learning management practices, while also understanding the factors that influence the effectiveness of technology integration in mathematics learning. Focusing on how and why each stage of POAC is implemented helps explore the interactions between teachers, students, technology, and the school context. This approach supports in-depth and contextual interpretation of learning practices, enabling researchers to identify patterns, adaptive strategies, and emerging challenges. The research results are expected to provide practical and conceptual insights regarding technology-based learning management in elementary schools, as well as serve as a basis for developing an adaptive managerial model that can increase student motivation, engagement, and learning achievement in the Independent Curriculum era (Creswell, 2018; Miles, 1994).

The research subjects included mathematics teachers, principals, and fourth- to sixth-grade students at two study sites: Palasari Elementary School and Cibalagung Elementary School. Key informants were selected purposively, encompassing all active mathematics teachers, principals, and IT coordinators, if available. This approach ensured the participation of those central to technology-based learning management. Student samples were selected using a maximum-variation sampling strategy to capture variations based on gender, academic ability, and level of technology engagement. The estimated number of students involved was approximately 8–12 per school, resulting in a total of 11 to 15 informants per school. This number was deemed sufficient to achieve depth of analysis and ensure thematic saturation in the comparative case study. This purposive and maximum-variation approach enabled researchers to obtain diverse yet relevant perspectives, allowing the research results to comprehensively describe POAC management practices and the influence of technology integration on student motivation and learning engagement. This informant selection strategy also supports the internal validity of the study, because each participant has experience and information that is directly related to the learning process being studied (Miles, 1994; Patton, 2002).

Data collection was conducted using a combination of primary qualitative techniques. In-depth semi-structured interviews with teachers, principals, coordinators, and school committee representatives were conducted, audio-recorded and supplemented with field notes, with an average duration of 45–70 minutes per session. Classroom observations were conducted in both participatory and non-participatory ways using a standardized checklist that assessed indicators of POAC function and student engagement during the learning process. Furthermore, analysis of learning documents was an essential part of data collection, including lesson plans (RPP/RKH), syllabi adapted for digital media, electronic teaching materials, and student evaluation and assessment records. This approach enabled researchers to verify and deepen their understanding of learning management practices and technology integration. To strengthen data triangulation, this study also recommends the use of a short Likert-scale motivation survey for all fourth–sixth grade students (Amemasor et al., 2025). This survey serves as additional descriptive data that can enrich the qualitative findings, provide a quantitative picture of student motivation, and support the interpretation of the interview, observation, and document analysis results. This combination of techniques ensures a comprehensive understanding of POAC practices, the influence of technology, and factors that influence student engagement and motivation.

Data analysis followed the reduction, presentation, and conclusion cycle developed by Miles and Huberman. The process included verbatim transcription and cleaning of fieldnotes, open coding to identify units of meaning, axial coding of categories, and selective coding of core themes. This was complemented by cross-case synthesis to highlight similarities and differences in POAC practices across schools. The analysis was presented using a case-theme matrix, concept maps, and rich illustrative quotations (thick descriptions) to strengthen theoretical inferences (Miles, 1994; Miles et al., 2014).

The expected analytical outputs of this study include several forms of data representation that support an understanding of technology-based learning management practices. First, a cross-case matrix was constructed to map the implementation of POAC against student motivation indicators, thus facilitating the identification of patterns of relationships between managerial strategies and student learning responses. Second, the study produced a catalog of supporting and inhibiting factors that influence the success of technology integration, from the perspectives of teachers, students, and the school institution. A technology-based adaptive learning management model diagram was developed as a practical tool that can be contextualized at the elementary school level. This model emphasizes the integration of POAC functions, the use of formative evaluation, and the strengthening of teachers' digital literacy, thus supporting effective, innovative, and sustainable learning. This research is expected to provide policy recommendations and professional development program designs for teachers. These recommendations are aimed at closing the gaps in pedagogical and digital competencies and addressing infrastructure limitations, so that technology implementation in mathematics learning can proceed optimally. Overall, these analytical outputs provide not only theoretical understanding but also practical guidance for schools and policymakers to improve the quality of learning and student motivation in the Independent Curriculum era.

RESULTS AND DISCUSSION

Research findings indicate that technology-based mathematics learning planning at SDN Palasari and SDN Cibalagung is conducted more systematically than the initial practices commonly reported in previous studies. Teachers consistently strive to align learning objectives with the selection of technology and materials, so that the Lesson Implementation Plan (RPP) functions not merely as an administrative document but as a pedagogical framework that integrates digital activities as a key part of the learning process. Document analysis and interviews revealed that teachers formulate explicit objectives, including conceptual mastery, process skill development, and increased student motivation. To achieve these objectives, teachers select appropriate learning media, such as GeoGebra for visualizing abstract concepts and video tutorials for scaffolded learning, thus facilitating gradual understanding and active student engagement. This approach aligns with the goal-oriented planning principle widely described in educational management literature, where learning success depends heavily on the alignment between objectives, strategies, and the media used. Thus, careful and structured planning not only increases the effectiveness of technology use, but also supports the achievement of students' cognitive and affective competencies holistically (Terry & Rue, 2010) and planning practices that emphasize coherence between objectives, activities, and assessments.

The approach applied in this technology-based mathematics learning demonstrates the application of the principle of constructive alignment, where each digital activity is designed to support the achievement of predetermined learning outcomes. With clear alignment between objectives, learning strategies, and the media used, students can be actively engaged in a meaningful learning process. Digital activities, such as interactive simulations, video tutorials, and mathematical visualization software, are not merely additional tools but are positioned as integral components that facilitate in-depth conceptual understanding. Furthermore, constructive alignment allows teachers to design assessments that align with the learning objectives and the activities being implemented. Thus, evaluation becomes an instrument that supports the learning process, provides relevant

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feedback, and encourages student reflection on their own understanding. This approach also strengthens student engagement because they understand the relationship between the activities undertaken and the objectives to be achieved, making the learning experience more meaningful and contextual. The application of the principle of constructive alignment in technology integration helps create a structured, cohesive, and effective learning environment. This not only enhances understanding of mathematical concepts but also facilitates students' motivation, active participation, and the development of critical thinking skills in the context of 21st-century learning (Hattie & Timperley, 2007).

Empirically, the integration of interactive media into lesson plans (RPPs) has been shown to influence task design, making it more exploratory and focused on developing higher-order skills, such as mathematical modeling and reasoning. Observational data shows that teachers actively utilize GeoGebra to visualize the dynamics of mathematical functions and transformations, thereby making abstract concepts more concrete and understandable to students (Cheung & Slavin, 2013; Li & Ma, 2010).. These activities are then linked to collaborative tasks that encourage discussion, interaction between students, and concrete problem-solving. This approach not only increases student engagement but also stimulates critical thinking and deeper analytical skills. Previous meta-analyses have shown that the use of interactive media in mathematics learning has the potential to improve learning outcomes, especially when accompanied by appropriate pedagogical implementation and clear learning objectives. Thus, the integration of interactive media is not simply a technological addition, but an integral part of a learning strategy that supports constructive alignment. This enables classroom tasks and activities to align with learning objectives, strengthen cognitive skills, and facilitate meaningful learning experiences.

Observed learning practices emphasize the importance of thoughtful instructional design and strategic use of technology to enhance student motivation, engagement, and mathematics learning outcomes. Field findings indicate that successful technology integration is not solely determined by the availability of resources, but is highly dependent on teachers' ability to design pedagogically sound activities aligned with learning objectives. Some lesson plans still display a tendency to position technology as an add-on, rather than as a transformational medium that truly transforms students' learning experiences. This situation indicates a gap between the availability of technological tools and the quality of pedagogical design, which can impact learning effectiveness. The results of this study align with international reports highlighting the heterogeneity of EdTech's effectiveness; technology only provides a consistently positive impact when accompanied by appropriate instructional planning, the integration of relevant activities, and evaluation strategies that support meaningful learning. Thus, these findings underscore the need to strengthen teacher competencies in designing and implementing technology-based learning pedagogically. A structured and reflective approach allows technology to function as a transformational tool, rather than simply an add-on, significantly improving the quality of the learning process, student engagement, and mathematics learning outcomes (Bank, 2020; UNESCO, 2023).

From a policy and capability perspective, effective planning is facilitated by schools providing structural support, time for collaborative planning, access to devices, and technology policies that enable teachers to test and adapt evidence-based lesson plans. Interviews indicate that in locations with stronger policy support, teachers are more willing to experiment with digital activities and develop formative measures to monitor student motivation and understanding. This reinforces the argument that good planning must be linked to ongoing professional development strategies and institutional policies; this aligns with recommendations from the digital educator competency framework (DigCompEdu) and professional development literature that emphasizes ongoing coaching and support (Darling-Hammond et al., 2017; Redecker, 2017).

Conceptually, these findings confirm that planning in POAC is not a static stage but rather a cycle that must be responsive to learning data. Good lesson plans contain feedback mechanisms (e.g., digital formative assessments, application usage logs) that can be used to revise objectives and subsequent activities—a practice supported by research on the value of learning analytics and formative feedback in improving the effectiveness of technology-based learning (Mandinach & Gummer, 2016; Shute, 2008). However, the implementation of this planning-evaluation cycle is hampered by teachers' capacity to read and respond to digital data and by the limitations of software that presents data that is easily interpreted; therefore, strengthening teacher data literacy is one of the practical recommendations that directly emerges from the findings.

Organizing Learning

Organizing learning in a technology-based mathematics context emerges as a crucial aspect that bridges pedagogical planning with real-world classroom practice. Theoretically, the organizing function requires systematic arrangement of human resources, technological devices, and operational routines so that learning plans can be implemented consistently and sustainably. This stage ensures that all elements involved—teachers, students, and technological resources—function synergistically to support the achievement of learning objectives (Schoenherr et al., 2024). Observation and interview data indicate that effective organization includes clear role allocation, digital device management, study group arrangements, and activity scheduling that takes into account student capacity and resource availability. In some schools, adaptive strategies such as device rotation, BYOD (Bring Your Own Device), and offline materials are used to address infrastructure limitations, confirming that organizational effectiveness is determined not only by the number of resources but also by the creativity and managerial competence of teachers. With good organization, technology-based learning activities can run smoothly, support student engagement, and facilitate optimal use of digital media. This shows that organizing is not just logistics, but is a strategic component in learning management that determines the quality of pedagogical implementation and the success of technology integration in the classroom (Terry & Rue, 2010).

Fieldwork findings demonstrate how teachers and school management designed learning structures that enabled the optimization of digital media despite differing infrastructure conditions across locations: at SDN Palasari, which had relatively better devices and connectivity, the school implemented a clear division of tasks (e.g., technology coordinator, subject teachers, and student-tutors) and a device rotation schedule so that all classes had access in turns; while at SDN Cibalagung, with limited devices, adaptive organizational strategies such as small study groups, the use of BYOD (bring-your-own-device) when possible, and the use of digital materials accessible offline helped maintain continuity of learning. Both approaches demonstrate the principle that organization is not simply the distribution of goods, but rather the design of processes that take into account resource availability, teacher capacity, and student characteristics—a perspective that aligns with educational management literature and POAC managerial practices (Mulyasa, 2004; Terry & Rue, 2010).

Pedagogically, effective learning organization plays a crucial role in fostering technology-based collaborative activities. For example, students engage in group work utilizing GeoGebra for mathematical modeling, take team quizzes through a Learning Management System (LMS), or work on short video projects. These activities not only enhance teacher-student interaction but also facilitate communication and collaboration among students, ultimately fostering greater motivation and engagement in learning. Observations and interviews indicate that successful collaboration relies on clearly defining the roles, responsibilities, and workflow of each participant. A systematic organizational approach ensures that each student can participate actively and productively, effectively achieving learning objectives. This finding aligns with the literature on cooperative and collaborative learning, which emphasizes that structured and pedagogically guided collaboration has a positive impact on student engagement and learning outcomes. In other words, technology integration in collaborative contexts must be supported by thoughtful organization to ensure meaningful interaction and collaboration, strengthen students' intrinsic motivation, and enhance the effectiveness of the learning process (Kyndt et al., 2013). Classroom observations showed that when roles were assigned (e.g. moderator, note-taker, presenter) and technical tasks were assigned (who operates the device/account), academic discussions became more structured and student participation increased, highlighting the importance of task design and role assignment as part of organizing.

From a conceptual perspective, organizing technology-based learning is best understood as a sociotechnical system, where the integration of hardware and software must be balanced with organizational structures, individual roles, norms, and policies that support learning implementation. This study identifies best practices that can improve organizational effectiveness. First, establishing clear technical roles, such as technology coordinators or responsible teachers, helps ensure consistent device responsibilities and maintenance. Second, implementing transparent device rotation schedules and loan policies allows for equitable and optimal access for all students. Third, designing collaborative activities that emphasize each student's role ensures active participation and maximizes technology utilization in the learning process. Fourth, providing regular collaborative time for teachers for reflection and re-planning supports the ongoing evaluation and improvement of technology-based learning strategies. These steps not only optimize device use but also foster a positive culture of technology utilization. This has the potential to increase student motivation, support the sustainability of learning innovation, and strengthen schools' ability to manage digital learning

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systematically and adaptively, thereby more effectively achieving 21st-century educational goals (Redecker, 2017; UNESCO, 2023).

The findings' implications for practice and policy emphasize that technology investment must be accompanied by strengthening of school organizational structures. Budgeting efforts should not only focus on equipment procurement but also on establishing specific roles such as technology coordinators, providing professional development time for teachers, establishing device maintenance procedures, and providing ongoing managerial and technical training (Sianturi et al., 2024). These steps will enhance institutional capacity to systematically design, manage, and evaluate digital learning. Operationally, this study recommends implementing a blended-rotation model that combines synchronous and asynchronous activities to meet student needs, developing offline learning modules for schools facing connectivity challenges, and using a collaboration rubric to assess individual contributions within groups (Lincoln & Guba, 1985). This approach serves to reduce facility gaps, maintain the quality of academic interactions, and foster learning motivation through adaptive and inclusive learning structures. With adequate organizational support, digital innovation can be implemented more equitably and sustainably across various school contexts (Bank, 2020; Kyndt et al., 2013).

Learning Implementation

Learning implementation in both schools demonstrates that technology, when combined with appropriate pedagogical strategies, can drive higher levels of student participation and motivation. At SDN Palasari, teachers implemented a flipped classroom model: students received materials and short video tutorials before face-to-face sessions, allowing class time to be used for in-depth discussions, problem-solving, and modeling activities using GeoGebra. This pattern encouraged increased active engagement because students came to class with prior understanding and opportunities to apply concepts collaboratively (Guest et al., 2012). Meta-analytic evidence suggests that flipped classroom models at the K-12 level generally have positive effects on student performance and engagement, although these effects are influenced by the quality of the pre-class design and in-class activities.

Cibalagung Elementary School implements a blended learning approach that combines in-person classroom learning with online or asynchronous activities as a solution to limited technological resources. In its implementation, teachers organize small-group learning, provide printed materials and offline content for students to study at home, and utilize digital platforms at specific times to conduct formative quizzes and collaborative assignments. This approach allows for flexible learning without relying entirely on devices or a stable internet connection. Findings from various literature reviews and recent meta-analyses also reinforce that blended learning can have a positive impact on student academic achievement and attitudes, particularly when designed with collaborative activities that encourage meaningful interactions and structured formative assessments (Ali et al., 2024). With proper management, the combination of face-to-face and online learning not only overcomes technical barriers but also improves the overall quality of students' learning experiences.

Digital interaction and collaboration have emerged as key mechanisms explaining increased student participation in technology-based mathematics learning. The use of interactive quizzes, such as game-based quizzes, short discussion forums, and app-based group assignments, encourages engagement through healthy competition, instant feedback, and opportunities for each student to contribute in turn. These activities create a more dynamic and participatory learning experience, thereby increasing intrinsic motivation and active student engagement (Raharjo et al., 2024). Empirical studies on game-based learning and gamification, including the use of platforms like Kahoot!, show that these strategies can increase motivation, participation, and, in some cases, learning outcomes, especially when pedagogically designed and used as formative tools, rather than simply for entertainment. Field findings from this study support this finding, as evidenced by increased student responses and interactions during quizzes, forums, and collaborative assignments (Rahayuningsih & Hanif, 2024). Thus, the integration of digital interaction and collaboration not only enriches the learning experience but also serves as a pedagogical strategy to foster engagement, provide rapid feedback, and strengthen collaborative skills among students. This approach emphasizes the importance of instructional design that integrates technology with collaborative principles to achieve effective and meaningful learning.

Theoretically, the increase in motivation seen in the learning process can be understood through the framework of self-determination and the principles of active learning. The use of technology provides students with greater freedom to regulate their own learning rhythm and strategies, thus fulfilling their need for autonomy through independent access to materials, additional learning resources, and flexible assignment completion. Furthermore, students' sense of competence develops when they receive prompt, specific feedback, supported by a gradual assignment structure, allowing for consistent small successes (Oktayani et al., 2025). Furthermore, collaborative features within digital platforms enable productive social interactions between students and between students and teachers, strengthening the relatedness aspect, which is crucial for the development of intrinsic motivation. These three dimensions—autonomy, competence, and relatedness—simultaneously contribute to fostering intrinsic motivation, ultimately encouraging students' active engagement in various learning activities. Thus, technology integration not only modernizes the learning process but also enriches the psychological dynamics underlying student participation and learning motivation (Ryan & Deci, 2000). Furthermore, flipped/blended strategies shift attention from passive delivery to higher-level cognitive activities in the classroom, consistent with evidence that active learning improves engagement and outcomes. However, meta-analyses also confirm that benefits are not automatic; effectiveness depends on how pre-class is structured, how teachers facilitate classroom activities, and the appropriate duration/intervention.

From a practical and methodological perspective, field observations indicate several critical conditions that determine the successful implementation of technology-based learning (Malay et al., 2024). First, the quality of pre-class materials, particularly videos, must be concise, focused, and accompanied by clear assignment instructions to provide students with a foundation before engaging in face-to-face sessions. Second, the teacher's role as a facilitator in class is crucial; teachers need to guide discussions, provide problem-solving scaffolding, and ensure that digital activities truly support conceptual understanding. Third, formative assessment through interactive quizzes and the use of simple analytics can provide rapid feedback that allows teachers to intervene in a timely manner. Fourth, time management and group organization, including device rotation and role assignments, help maintain student engagement, especially in the context of limited infrastructure. Without these elements, practices that only incorporate technology into learning tend to result in shallow or temporary increases in motivation (Patandean & Indrajit, 2021). These findings align with literature emphasizing the importance of teacher pedagogical competence, robust instructional design, and ongoing professional training for flipped or blended learning models to achieve optimal effectiveness.

Obvious challenges include teacher workload (developing pre-class materials and managing collaborative activities takes time), device and connectivity limitations across multiple learning groups, and variations in student readiness for independent learning (Sipayung et al., 2024). Furthermore, several meta-studies have found that if interventions are not accompanied by systemic pedagogical changes, academic gains can be minimal. Therefore, practical recommendations from this study emphasize integrating implementation with institutional support: planning time, pedagogical coaching, and simple infrastructure for formative assessment. The implementation of technology-based learning at SDN Palasari (flipped) and SDN Cibalagung (blended) increased student participation and motivation through pre-class mechanisms that prepare initial competencies, classroom activities focused on application and collaboration, and the use of interactive quizzes/platforms for rapid feedback. However, the sustainability and depth of impact depend on the quality of instructional design, teacher capacity, and school organizational support. Therefore, implementation strategies must include pedagogical training, planning time allocation, and easy-to-use formative assessment mechanisms (Suheri, 2025).

Learning Evaluation

Technology-based learning evaluation in both schools plays a central role as a control and feedback mechanism linking instructional practices to continuous improvement. Operationally, this evaluation is conducted through regular online quizzes and formative assessments that provide immediate and, whenever possible, personalized feedback in the form of brief teacher comments, automated scoring with error indicators, and recommendations for remedial assignments tailored to students' error profiles. The use of digital instruments allows for the measurement of student process and engagement in addition to outcomes: metrics such as quiz completion rates, time-on-task, percentage of correct answers, frequency of online discussion participation, and content navigation tracks are used as engagement indicators reported to teachers via a simple dashboard (Mandinach & Gummer, 2016).

Field findings indicate that providing immediate feedback during a learning session and providing clear actionable directions can increase students' motivation and readiness to improve their understanding. These positive responses demonstrate a pattern consistent with various research findings on the effectiveness of

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formative feedback, namely that feedback that is specific, relevant to the error, and provided in a timely manner has a significant impact on improving learning quality. When students receive direct explanations of areas that need improvement and the steps they can take, they tend to demonstrate increased focus, engagement, and a willingness to repeat the learning process until they achieve a better understanding. This not only improves learning outcomes but also strengthens students' perceptions of their own abilities, making them more confident when facing similar tasks. Overall, the practice of prompt and targeted feedback serves as an important mechanism in guiding students to self-correct and develop more effective learning strategies, making learning more adaptive and oriented towards continuous improvement (Hattie & Timperley, 2007; Shute, 2008).

From a methodological perspective, the evaluation process is designed as an integral part of the POAC cycle, where quantitative data from the LMS and digital quizzes are combined with qualitative assessments such as project rubrics, observations of student engagement, and teacher reflections. This integration of multiple data sources provides a more comprehensive picture of students' academic and motivational development. A summary of the evaluation results is then discussed in a post-lesson reflection session, allowing teachers to make immediate adjustments to the lesson plan, for example by modifying modeling tasks, adding scaffolding, or identifying more appropriate remedial activities. This process resembles small-scale action research, fostering a culture of continuous instructional improvement. Furthermore, the use of peer assessment and digital portfolios serves as complementary instruments to assess collaborative skills, thinking processes, and the quality of students' contributions to digital activities (Wuisan et al., 2024). This approach expands the evaluation space from simple right-or-wrong assessments to a more authentic assessment of the process. Thus, evaluation not only measures final outcomes but also facilitates a deeper understanding of how students learn, providing a solid foundation for teachers to implement more targeted interventions.

Although technology-based evaluation offers significant potential for improving the accuracy of learning monitoring, field practice reveals a number of challenges that need to be addressed. Raw data quality is often suboptimal due to input errors or limited access to rotating devices, necessitating a data cleansing process before analysis. Furthermore, teachers' ability to read and interpret digital dashboards varies, resulting in some data not being effectively translated into appropriate instructional steps. Other challenges arise related to ethics and privacy, particularly regarding student data storage and the need for parental consent for the use of digital platforms (Darwin et al., 2025). Based on these findings, several practical recommendations are suggested: providing action-oriented dashboards with simple and easy-to-understand indicators, data literacy training for teachers to improve their ability to translate metrics into pedagogical decisions, implementing robust data ethics and security protocols, and developing a feedback system that combines automation for speed and personalized teacher feedback to ensure the depth of student understanding. Conceptually, integratively designed digital evaluation serves not only as a measurement tool but also as a driver of pedagogical transformation. When data is systematically analyzed and acted upon, evaluation can strengthen learning motivation through learning experiences that are more adaptive, responsive, and relevant to students' needs (Hattie & Timperley, 2007; Mandinach & Gummer, 2016; Shute, 2008).

Learning Follow-up

Learning follow-up in both schools appears to be a crucial phase bridging digital evaluation with improvements in instructional practices, ensuring that technological innovation does not stop at the use of tools but continues into a continuous improvement process. Empirically, teachers leveraged online quiz results and formative data to provide immediate feedback to students, whether through personalized comments, customized remedial assignments, or self-study recommendations, while teaching teams utilized dashboard summaries to identify groups of students in need of intervention. These follow-up practices were then formalized in the form of group remedial sessions, enrichment modules, and specific follow-up assignments based on error patterns. In some cases, teachers also required students to complete self-assessments and create digital portfolios for reflection. This approach aligns with evidence that rapid, specific, and actionable formative feedback enhances learning and motivates students to improve their performance (Hattie & Timperley, 2007; Shute, 2008), as well as with the idea of learning analytics facilitating data-driven interventions (Mandinach & Gummer, 2016).

From a motivational and learning psychology perspective, consistent follow-up can strengthen students' sense of competence because they experience success through a series of step-by-step tasks and receive timely feedback. This pattern aligns with the main principles of Bandura's self-efficacy theory, which emphasizes that structured success experiences are the most powerful source of building students' confidence in their academic abilities. Furthermore, follow-up mechanisms that provide space for students to choose strategies, evaluate their progress, and actively participate in reflection support the need for autonomy as outlined in Self-Determination Theory (Hanaris, 2023). At the same time, interactions between teachers and students through personalized guidance, follow-up discussions, and dialogue that values effort and the learning process strengthens a sense of relatedness. Fulfilling these two psychological needs—autonomy and relatedness—directly contributes to the growth of intrinsic motivation, ultimately leading to students being more engaged, more persistent in facing challenges, and more enjoyment in learning mathematics. Thus, planned follow-up not only serves as a control of learning, but also as a foundation for building sustainable internal motivation (Bandura, 1977; Ryan & Deci, 2000).

Observations and interviews show that providing specific feedback, along with opportunities for students to improve their work, directly impacts increased self-directed learning initiatives and engagement in subsequent learning activities. When students understand areas for improvement and the steps to take, they demonstrate greater motivation to try again and develop more effective learning strategies. At the same time, collaborative reflection with teachers through regular meetings, peer review activities, and discussions on learning cases contributes to continuous improvement in lesson plan development and classroom organization strategies. This reflective practice creates a cyclical follow-up process, where data and field experiences are used to formulate more appropriate instructional actions for the next learning cycle (Susanto et al., 2024). This approach reflects the principle of continuous improvement and strengthens the formation of professional learning communities within the school environment, as teachers share experiences, examine evidence, and develop solutions together. Thus, follow-up not only benefits students but also enhances teachers' professional capacity and the overall quality of learning management (Darling-Hammond et al., 2017).

The effectiveness of the follow-up process does not occur automatically, as several operational constraints require serious attention. Teachers' capacity to read, interpret, and convert evaluation data into appropriate pedagogical interventions still varies, resulting in inconsistent quality of follow-up across classes and teachers. Furthermore, teachers' workload increases as they must design remedial materials, facilitate supplemental learning, and monitor student progress more intensively. Technical and ethical challenges also arise, particularly those related to student data management, information security, and adherence to privacy principles (Ulfah et al., 2025). Therefore, the findings of this study emphasize the importance of systemic institutional support to ensure the sustainability of follow-up practices. This support includes data literacy training for teachers to accurately interpret metrics, providing scheduled collaborative time to design and assess intervention effectiveness, developing actionable dashboards with clear and easily understood recommendations, and establishing robust data privacy policies. This provision is a prerequisite so that digital evaluation-based follow-up can be carried out effectively, consistently, and sustainably in improving the quality of learning (Mandinach & Gummer, 2016; Redecker, 2017).

Structured follow-up—including prompt and personalized feedback, data-driven adaptive interventions, ongoing monitoring, and collaborative reflection between teachers and students—serves as a key mechanism for strengthening self-efficacy and increasing student engagement. This combination of elements makes technology-based learning innovations not only effective in increasing motivation to learn mathematics but also potentially sustainable as consistent classroom practices. For this strategy to be optimally implemented, investment is needed beyond the procurement of devices and applications, but also in teacher capacity development through ongoing training, pedagogical mentoring, and increased data literacy (Ulum et al., 2024). Furthermore, school organizational support, such as scheduling, clear follow-up procedures, regular collaboration between teachers, and supervision focused on professional growth, is essential to ensure that technology-based follow-up becomes part of the school's work culture. With this foundation, learning innovations are more easily integrated into daily practice and can contribute to the continuous improvement of the quality of mathematics learning.

CONCLUSION

This study shows that technology-based mathematics learning management at SDN Palasari and SDN Cibalagung runs effectively through the POAC cycle (Planning, Organizing, Implementing, Evaluation, and Follow-up). Each stage of the cycle has been shown to contribute to increased student motivation, engagement, and understanding, although the context and implementation strategies differ between the two schools. In the planning stage, teachers successfully align learning objectives with technology choices, such as GeoGebra, video tutorials, and interactive platforms, so that the lesson plan functions not only as an administrative document but also as a systematic pedagogical instrument. However, the effectiveness of planning is still influenced by the quality of the instructional design and the teachers' ability to integrate learning outcome data. In the organizing stage, differences in infrastructure give rise to adaptive strategies. SDN Palasari uses device rotation and a technology coordinator, while SDN Cibalagung emphasizes small-group learning, BYOD, and offline materials. This approach demonstrates that good organization goes beyond providing resources to designing task structures, role allocation, and collaboration that support student engagement. The implementation of flipped classroom learning at Palasari Elementary School and blended learning at Cibalagung Elementary School has been shown to increase participation, interaction, and intrinsic motivation. Technology is positioned as an active medium that encourages discussion, problem-solving, and learning autonomy, not simply as an additional tool. Technology-based evaluations are conducted through digital quizzes, learning analytics dashboards, and qualitative assessments, providing rapid, specific, and formative feedback. These evaluations serve as both a control mechanism and a basis for lesson plan (RPP) improvements, ensuring a continuous cycle of learning. Learning follow-up is carried out through adaptive remediation, personalized feedback, and joint teacher-student reflection. Evaluation data is not simply reported but transformed into interventions that enhance student motivation and competency and strengthen a culture of continuous improvement in schools. Cross-case findings confirm that the success of technology-based learning depends more on the quality of management, teachers' digital competency, and institutional support than solely on the availability of devices. Thus, this technology-based adaptive management model supports the integration of POAC functions, the use of data-based formative evaluation, and the strengthening of teachers' digital literacy, in line with the spirit of the Independent Curriculum and the vision of 21st-century learning, opening up opportunities for the development of innovative, inclusive, and sustainable mathematics learning.

REFERENCES

Ali, A., Maniboey, L. C., Megawati, R., Djarwo, C. F., & Listiani, H. (2024). *Media Pembelajaran Interaktif: Teori Komprehensif dan Pengembangan Media Pembelajaran Interaktif di Sekolah Dasar [Interactive Learning Media: Comprehensive Theory and Development of Interactive Learning Media in Elementary Schools]*. PT. Sonpedia Publishing Indonesia.

Amemasor, S. K., Oppong, S. O., Ghansah, B., Benuwa, B.-B., & Essel, D. D. (2025). A Systematic Review on The Impact of Teacher Professional Development on Digital Instructional Integration and Teaching Practices. *Frontiers in Education*, *10*, 1541031. https://doi.org/10.3389/feduc.2025.1541031

Bandura, A. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bank, W. (2020). *The World development report 2020: Trading for development in the age of global value chains*. World Bank.

Cheung, A. C. K., & Slavin, R. E. (2013). The Effectiveness of Educational Technology Applications for Enhancing Mathematics Schievement in K-12 Classrooms: A Meta-Analysis. *Educational Research Review*, *9*, 88–113. https://doi.org/10.1016/j.edurev.2013.01.001

Creswell, J. W. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective Teacher Professional Development*. Learning Policy Institute.

Darwin, D., Cahyono, D., Tohir, A., Djunaedi, H., Wulandari, O., Khoiriyah, R., & Subaeki, B. (2025). *Transformasi Pembelajaran Berbasis Teknologi: Memadukan Pembelajaran Tradisional dan Digital [Technology-Based Learning Transformation: Blending Traditional and Digital Learning]*. PT. Nawala Gama Education.

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied Thematic Analysis*. Sage.

Hanaris, F. (2023). Peran Guru dalam Meningkatkan Motivasi Belajar Siswa: Strategi dan Pendekatan yang Efektif [The Role of Teachers in Improving Student Learning Motivation: Effective Strategies and Approaches]. *Jurnal Kajian Pendidikan Dan Psikologi*, *1*(1), 1–11. https://doi.org/10.61397/jkpp.v1i1.9 [In Indonesian]

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hertina, D., Nurhidaya, M., Gaspersz, V., Nainggolan, E. T. A., Rosmiati, R., Sanulita, H., Suhirman, L., Pangestu, L., Prisusanti, R. D., & Ahmad, A. (2024). *Metode Pembelajaran Inovatif Era Digital: Teori dan Penerapan [Innovative Learning Methods in the Digital Era: Theory and Application]*. PT. Green Pustaka Indonesia.

Kemdikbud. (2022). *Panduan Implementasi Kurikulum Merdeka [Guide to Implementing the Independent Curriculum]*. dan Teknologi Republik Indonesia.

Khoshnoodifar, M., Ashouri, A., & Taheri, M. (2023). Effectiveness of Gamification in Enhancing Learning and Attitudes: A Study of Statistics Education for Health School Students. *Journal of Teaching and Learning*, *15*(1). https://doi.org/10.30476/jamp.2023.98953.1817

Kyndt, E., Raes, E., Lismont, B., Timmers, F., Cascallar, E., & Dochy, F. (2013). A meta-Analysis of The Effects of Face-to-Face Cooperative Learning. Do Recent Studies Falsify or Verify Earlier Findings? *Educational Research Review*, *10*(3), 133–149. https://doi.org/10.1016/j.edurev.2013.02.002

Li, Q., & Ma, X. (2010). A Meta-Analysis of The Effects of Computer Technology on School Students' Mathematics Learning. *Educational Psychology Review*, *22*(3), 215–243. https://doi.org/10.1007/s10648-010-9125-8

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE Publications.

Malay, I., Sarah, M., Ramadhani, W., Mawardah, M., & Anggraini, R. (2024). Penerapan Teknologi Pendidikan dalam Pembelajaran Jarak Jauh: Perspektif Guru dan Siswa Melalui Pendekatan Kualitatif [Implementation of Educational Technology in Distance Learning: Teacher and Student Perspectives Through a Qualitative Approach]. *Edu Society: Jurnal Pendidikan, Ilmu Sosial Dan Pengabdian Kepada Masyarakat*, *4*(3), 1913–1921. https://doi.org/10.56832/edu.v4i3.629 [In Indonesian]

Mandinach, E. B., & Gummer, E. S. (2016). *Data Literacy for Educators: Making it Count in Teacher Preparation and Practice*. Teachers College Press.

Miles. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. Thousand Oaks.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications.

Mulyasa, E. (2004). *Manajemen Berbasis Sekolah: Konsep, Strategi, dan Implementasi [School-Based Management: Concepts, Strategies, and Implementation]*. Remaja Rosdakarya.

Nasrullah, A., Judijanto, L., & Sepriano. (2024). *Guru Penggerak: Teori dan Implementasi Guru Penggerak pada Kurikulum Merdeka Belajar [Leading Teacher: Theory and Implementation of Leading Teacher in the Independent Learning Curriculum]*. PT. Green Pustaka Indonesia.

Oktayani, E., Andriani, P., Ikhsan, M. F. Al, & Abdurrahmansyah. (2025). Analisis Motivasi Belajar Siswa di Era Kurikulum Merdeka [An Analysis of Student Learning Motivation in the Independent Curriculum Era]. *MANAJERIAL : Jurnal Inovasi Manajemen Dan Supervisi Pendidikan*, *5*(1), 28–36. https://doi.org/10.51878/manajerial.v5i1.4750 [In Indonesian]

Patandean, Y. R., & Indrajit, R. E. (2021). *Flipped Classroom: Membuat Peserta Didik Berpikir Kritis, Kreatif, Mandiri, dan Mampu Berkolaborasi dalam Pembelajaran yang Responsif [Flipped Classroom: Empowering Students to Think Critically, Creatively, Independently, and Collaborate in Responsive Lea*. Penerbit Andi.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods*. Sage.

Pramesti, S. D., Putri, A. A., & Ekasari, L. A. (2025). Manfaat dan Tantangan Asesmen Berbasis Gamifikasi dalam Pendidikan Dasar: A Systematic Literature Review [Benefits and Challenges of Gamification-Based Assessment in Elementary Education: A Systematic Literature Review]. *Elementary School*, *12*(5), 994–1005. https://doi.org/10.31316/esjurnal.v12i2.4553 [In Indonesian]

Raharjo, A. D., Putri, A. A., & Budi, H. R. (2024). The Use of Game-Based Learning to Increase Student Engagement. *Hipkin Journal of Educational Research*, *1*(3), 299–310. https://doi.org/10.64014/hipkin-jer.v1i3.30

Rahayuningsih, E., & Hanif, M. (2024). Persepsi Guru dan Siswa terhadap Implementasi Kurikulum Merdeka (Perspektif Social Learning Theory (SLT) [Teacher and Student Perceptions of the Implementation of the Independent Curriculum (Social Learning Theory (SLT) Perspective)]. *Journal of Education Research*, *5*(3), 2828–2839. https://doi.org/10.37985/jer.v5i3.1305 [In Indonesian]

Redecker, C. (2017). *European framework for the digital competence of educators: DigCompEdu*. Publications Office of the European Union.

Ryan, R. M., & Deci, E. L. (2000). Self-Determination Theory and The Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Schoenherr, J., Strohmaier, A. R., & Schukajlow, S. (2024). Learning with Visualizations Helps: A Meta-Analysis of Visualization Interventions in Mathematics Education. *Educational Research Review*, *45*, 100639. https://doi.org/10.1016/j.edurev.2024.100639

Shute, V. J. (2008). Focus on Formative Feedback. *Review of Educational Research*, *78*(1), 153–189. https://doi.org/10.3102/0034654307313795

Sianturi, H. R., Sutisna, A., Dalia, A., Kurniawan, A. C., Dewi, A. V., Mardiana, C., Danial, D. S. R., Taopik, D., & Darlianti, E. (2024). *Perencanaan dan Penganggaran Pembiayaan Pendidikan: Konsep dan Teknik [Educational Financing Planning and Budgeting: Concepts and Techniques]*. Edu Publisher.

Sipayung, R., Sitanggang, N., & Purba, S. (2024). *Model Manajemen Pelatihan Berbasis Regina Meningkatkan Kompetensi Pedagogik Guru [Regina-Based Training Management Model Improves Teachers' Pedagogical Competence]*. Penerbit P4I.

Sirait, R. A., & Dewi, E. Y. (2024). Peran Teknologi Pembelajaran pada Desain Pembelajaran [The Role of Learning Technology in Learning Design]. *Jurnal Budi Pekerti Agama Kristen Dan Katolik*, *2*(4), 232–242. https://doi.org/10.61132/jbpakk.v2i4.773 [In Indonesian]

Suheri, E. (2025). *Transformasi Kepala Sekolah: Pelatihan untuk Kepemimpinan yang Efektif dan Inovatif [Principal Transformation: Training for Effective and Innovative Leadership]*. PT. Revormasi Jangkar Philosophia.

Susanto, A. H., Sutama, & Fathoni, A. (2024). Pelaksanaan Supervisi Akademik sebagai Strategi Pengembangan Keterampilan Guru dalam Implementasi Pembelajaran Kolaboratif di Sekolah Dasar [Implementation of Academic Supervision as a Strategy for Developing Teacher Skills in the Implementation of Collab. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *9*(4), 628–647. https://doi.org/10.23969/jp.v9i4.17062 [In Indonesian]

Terry, G. R., & Rue, L. W. (2010). *Principles of Management*.

Ulfah, M., Remiswal, & Khadijah. (2025). Optimalisasi Penggunaan Hasil Assesment untuk Tindak Lanjut Pembelajaran Pendidikan Agama Islam [Optimizing the Use of Assessment Results for Follow-up in Islamic Religious Education Learning]. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, *4*(1), 128–137. https://doi.org/10.31004/jerkin.v4i1.1562 [In Indonesian]

Ulum, M., Riyanto, Y., & Setyowati, S. (2024). Self Efficacy Guru Sebagai Kunci Keberhasilan Pengajaran [Teacher Self-Efficacy as the Key to Successful Teaching]. *Jurnal Administrasi Pendidikan Islam*, *06*(02), 212–229. https://doi.org/10.15642/japi.2024.6.2.212-229 [In Indonesian]

UNESCO. (2023). *Global Education Monitoring Report 2023: Technology in Education*. UNESCO.

Wahyudi, D., Fauziati, E., & Maryadi. (2025). Peran ICT dalam Pembelajaran pada Program Digital Class [The Role of ICT in Learning in the Digital Class Program]. *Didaktika: Jurnal Kependidikan*, *14*(1), 309–328. https://doi.org/10.58230/27454312.1792 [In Indonesian]

Wicks, D. (2017). The Coding Manual for Qualitative Researchers (3rd edition). *Qualitative Research in Organizations and Management: An International Journal*, *12*(2), 169–170. https://doi.org/10.1108/QROM-08-2016-1408

Wuisan, P. I., Suparman, A., & Wibawa, B. (2024). *Sistem Penilaian Kompetensi Profesional Guru Berbasis Elektronik: Konsep dan Aplikasi [Electronic-Based Teacher Professional Competency Assessment System: Concept and Application]*. Bumi Aksara.

Zhang, K., Yılmaz, R., Ustun, A. B., & Yılmaz, F. G. K. (2023). Learning Analytics in Formative Assessment: A Systematic Literature Review. *Eğitimde ve Psikolojide Ölçme ve Değerlendirme Dergisi*, *14*(Özel Sayı), 359–381. https://doi.org/10.21031/epod.1272054

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