Volume 4 Number 1 (2026)
January – June 2026
Page: 593-600

EDUJAVARE: International Journal of Educational Research
ISSN: 3031-2884
https://edujavare.com/index.php/edujavare
DOI: 10.70610/edujavare.v4i01.1371

Development of a Digital Leadership-Based Supervision Instrument to Improve the Pedagogical Competence of School Teachers

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Article history Submitted: 2026/03/18; Revised: 2026/04/07; Accepted: 2026/06/09

Abstract

This study aims to develop a digital leadership-based supervision instrument to improve the pedagogical competence of teachers at SD Negeri 2 Kwadungan. The study employed a Research and Development (R&D) approach using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. Data were collected through observation, interviews, questionnaires, and documentation involving the school principal, teachers, and expert validators. The results of the needs analysis revealed that the existing supervision practices were still conventional, administrative, and had not fully accommodated the demands of digital pedagogy and teachers' professional development in the digital learning era. Based on these findings, a supervision instrument was designed by integrating dimensions of digital leadership with indicators of pedagogical competence, including lesson planning, classroom implementation, use of digital media, assessment, reflection, and follow-up improvement. The validation results showed that the instrument was feasible in terms of content, construct, and practical use. Furthermore, the implementation of the instrument demonstrated that it made the supervision process more systematic, transparent, and evidence-based, while also contributing to the improvement of teachers' pedagogical competence, particularly in instructional planning, classroom management, digital media integration, and learning evaluation. The study concludes that a digital leadership-based supervision instrument can function as an innovative and practical tool to strengthen academic supervision and support teacher pedagogical development in elementary schools facing the challenges of digital educational transformation.

Keywords Digital leadership, supervision instrument development, academic supervision, pedagogical competence, elementary school teachers

INTRODUCTION

Education in the digital era requires schools to transform not only their instructional practices but also their leadership and supervision systems. The rapid integration of information and communication technology into educational processes has changed how teachers plan lessons, deliver instruction, assess learning outcomes, and interact with students. In this context, school principals are no longer expected to function merely as administrative managers; they must also become digital leaders who are capable of guiding teachers through pedagogical adaptation in technology-rich learning environments. Digital leadership emphasizes a principal's ability to promote innovation, utilize data and digital platforms for school improvement, and support teachers in integrating technology meaningfully into teaching and learning. In elementary schools, where the quality of classroom interaction strongly influences students' foundational learning, the role of principal leadership becomes particularly important in ensuring that teachers possess adequate pedagogical competence to design relevant, engaging, and student-centered instruction in the digital age (Ansori et al., 2021; Hikmah & Sutapa, 2025).

Pedagogical competence remains one of the most essential competencies teachers must master because it directly influences the quality of learning implementation. This competence includes understanding student characteristics, designing learning plans, implementing effective teaching strategies, using learning media, conducting assessment, and reflecting on learning outcomes for continuous improvement. However, in many schools, teachers' pedagogical competence is still uneven, especially when faced with the demands of digital learning transformation. Some teachers may be able to use digital devices or platforms, yet still struggle to connect them with pedagogically sound teaching practices. This challenge indicates that pedagogical competence in the current era should not be viewed only as traditional classroom management skill, but also as the ability to integrate digital resources, interactive learning models, and data-informed instruction into meaningful learning experiences. Therefore, schools need systematic efforts to strengthen teacher competence through structured guidance, monitoring, and professional support led by the principal (Rasdiana et al., 2024; Yulin & Danso, 2025).

One strategic effort to improve teachers' pedagogical competence is academic supervision. Academic supervision is a professional assistance process carried out by school principals to help teachers improve the planning, implementation, and evaluation of learning. Effective supervision is not merely evaluative, but developmental, collaborative, and continuous. Recent studies have shown that principal supervision contributes positively to the enhancement of pedagogical competence, especially when supervision includes classroom observation, reflective feedback, follow-up coaching, and the use of valid instruments. Nevertheless, supervision practices in many elementary schools still face several limitations, such as inconsistent implementation, lack of systematic documentation, time constraints, and the use of conventional instruments that do not fully capture the realities of digital learning. As a result, supervision often becomes administrative rather than transformative. This condition highlights the need for supervision instruments that are more adaptive, practical, and aligned with current

educational demands, particularly those related to digital teaching and school leadership transformation (Siahaan, 2024; Budi et al., 2025).

The concept of digital leadership offers an important framework for redesigning academic supervision in schools. Digital leadership refers to a leader's capacity to influence school improvement through strategic use of technology, digital communication, innovation culture, and evidence-based decision-making. In relation to supervision, digital leadership can be reflected in the principal's ability to use digital platforms for observation records, feedback delivery, teacher performance mapping, follow-up planning, and collaborative professional learning. Supervision supported by digital leadership enables more efficient documentation, faster communication, better monitoring of teacher progress, and more responsive professional development interventions. Research has also indicated that digital supervision and technology-supported instructional leadership can strengthen teachers' confidence, reflective practice, and professional digital competence. Thus, integrating digital leadership principles into a supervision instrument is a relevant innovation for elementary schools that are seeking to improve teacher quality in a more structured and sustainable way (Agustina et al., 2020; Rasdiana et al., 2024; Prayogo et al., 2025).

At SD Negeri 2 Kwadungan, the development of a digital leadership-based supervision instrument becomes highly relevant as part of efforts to improve teacher pedagogical competence in response to contemporary educational challenges. The school, like many others, faces the need to ensure that teachers are not only pedagogically competent in conventional terms but are also prepared to manage learning in digitally enriched environments. A supervision instrument that is specifically designed based on digital leadership principles can help the principal conduct supervision more systematically, objectively, and efficiently, while also providing teachers with clearer indicators for pedagogical improvement. Such an instrument is expected to bridge the gap between supervision practices and the actual professional needs of teachers by integrating pedagogical standards, digital learning dimensions, and school leadership functions into one practical tool. Therefore, this study on the development of a digital leadership-based supervision instrument is important both theoretically and practically, because it contributes to the strengthening of supervision innovation and offers a contextual model for improving teachers' pedagogical competence at the elementary school level, especially at SD Negeri 2 Kwadungan (Irmawanti et al., 2025; Fadhilah & Wasliman, 2025; Silaban et al., 2025).

METHODS

This study employed a Research and Development (R&D) approach aimed at developing a digital leadership-based supervision instrument to improve the pedagogical competence of teachers at SD Negeri 2 Kwadungan. The development procedure adopted the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The analysis stage was conducted to identify the supervision needs of the principal and the pedagogical competence needs of teachers in the context of digital learning. The design stage

involved formulating instrument indicators based on dimensions of digital leadership and teacher pedagogical competence, followed by preparing the instrument blueprint and scoring rubric. In the development stage, the supervision instrument was drafted and validated by experts in educational management, supervision, and instructional media to assess its content validity, construct relevance, and practicality. The implementation stage was carried out on teachers at SD Negeri 2 Kwadungan to examine the usability of the instrument in the supervision process, while the evaluation stage was conducted to analyze the effectiveness of the instrument in supporting the improvement of teachers' pedagogical competence. Data were collected through observation, interviews, questionnaires, and documentation. The data analysis technique used descriptive qualitative analysis for need assessment and expert suggestions, as well as descriptive quantitative analysis to determine the validity, practicality, and effectiveness of the developed instrument.

FINDINGS AND DISCUSSION

Needs Analysis for the Development of a Digital Leadership-Based Supervision Instrument

The results of the needs analysis at SD Negeri 2 Kwadungan indicate that the existing academic supervision practices have not fully supported the systematic improvement of teachers' pedagogical competence in the digital learning era. Supervision activities were still predominantly conducted through conventional classroom observation and administrative checking of lesson plans, with limited use of structured indicators related to digital pedagogy, technology integration, or reflective follow-up. Interviews with the principal and teachers revealed that supervision was often implemented as a routine administrative obligation rather than a developmental process aimed at improving instructional quality. Teachers stated that the feedback they received tended to focus on lesson completeness and classroom discipline, while aspects such as student-centered digital learning design, interactive media use, and digital assessment strategies were not explicitly addressed. This condition shows that the supervision process had not yet been aligned with the current demands of pedagogical competence, which require teachers to combine pedagogical knowledge with digital learning skills. From a theoretical perspective, this finding confirms that supervision instruments must evolve from traditional compliance-oriented tools into adaptive instruments that can assess and guide teaching practices in digitally mediated learning contexts (Timan et al., 2022; Yulin & Danso, 2025).

The needs analysis also showed that the principal required a more practical and comprehensive supervision instrument to carry out instructional leadership in a digital environment. The principal reported difficulties in monitoring teacher development consistently because the available supervision format did not provide measurable indicators for digital teaching competence, documentation of follow-up actions, or integrated records of teacher progress over time. In addition, supervision data were still managed manually, making it difficult to compare results across observation periods or identify patterns of

pedagogical strengths and weaknesses among teachers. This finding is important because digital leadership is not limited to the use of technology tools, but also includes the leader's capacity to manage school improvement through digital systems, data-based decisions, and innovation-oriented professional support. In this regard, a digital leadership-based supervision instrument is needed not only as an assessment form, but as a management tool that enables principals to plan supervision, record evidence, provide feedback, and evaluate pedagogical development more efficiently. This supports the view that digital leadership strengthens school leaders' ability to transform supervision into a strategic process for continuous teacher development rather than a fragmented administrative activity (Joni et al., 2025; Stana et al., 2024).

From the teachers' perspective, the needs analysis identified a strong expectation for supervision that is more constructive, transparent, and relevant to the realities of classroom teaching in the digital era. Teachers expressed the need for clearer supervision indicators that explain what aspects of pedagogical competence are being assessed, particularly in lesson planning, classroom implementation, use of digital media, assessment, and reflection. Several teachers also indicated that they needed more specific guidance on how to design active and technology-supported learning experiences, rather than simply being informed whether their teaching was "good" or "less good." This finding suggests that teachers do not only need supervision as an evaluation mechanism, but as a professional learning process that helps them improve instructional practice. In theoretical terms, such expectations are consistent with the contemporary understanding of academic supervision as collegial, formative, and feedback-oriented. When supervision is supported by a well-designed instrument, teachers can better understand performance expectations, engage in reflective practice, and use feedback for pedagogical improvement. Therefore, the development of a digital leadership-based supervision instrument at SD Negeri 2 Kwadungan responds to both organizational needs and teacher professional needs by creating a clearer bridge between supervision, feedback, and pedagogical growth (Juhariah et al., 2025; Susanti et al., 2026).

Overall, the needs analysis confirms that the development of a digital leadership-based supervision instrument is highly relevant for SD Negeri 2 Kwadungan because there is a clear gap between existing supervision practices and the pedagogical demands of contemporary schooling. The school requires an instrument that is capable of integrating supervision indicators with dimensions of digital leadership, such as data use, digital communication, innovation support, and technology-enabled monitoring, while also focusing on core pedagogical competencies of teachers. Theoretically, this reinforces the idea that educational quality improvement in the digital era cannot rely solely on teacher competence development or principal leadership as separate domains; rather, both must be connected through a supervision mechanism that is systematic, evidence-based, and development-oriented. The instrument to be developed in this study is therefore positioned as an intervention tool that addresses practical school needs while also operationalizing the relationship between digital leadership and pedagogical competence improvement in a concrete elementary school context

(Irmawanti et al., 2025; Joni et al., 2025; Timan et al., 2022).

Design and Validation of the Digital Leadership-Based Supervision Instrument

The results of this study show that the design of the digital leadership-based supervision instrument was carried out systematically by integrating two core dimensions, namely digital leadership and teachers' pedagogical competence. At the design stage, the instrument was structured to capture not only the traditional supervision components such as lesson planning, classroom implementation, and assessment, but also digital dimensions including the use of digital learning platforms, technology-supported instructional strategies, digital communication between principal and teachers, documentation of supervision data, and follow-up based on digital evidence. The initial draft of the instrument was developed from the findings of the needs analysis, which revealed that the existing supervision format at SD Negeri 2 Kwadungan had not yet accommodated digital teaching practices and did not provide clear indicators for measuring pedagogical competence in technology-enriched learning. Therefore, the new instrument was organized into several supervision components such as pre-observation preparation, classroom observation, post-observation feedback, reflective evaluation, and follow-up planning, each of which was linked to observable indicators of pedagogical competence and digital instructional practice. This design reflects the view that an effective supervision instrument in the digital era should function not merely as an administrative checklist, but as a structured professional support system that connects instructional supervision with leadership, technology integration, and teacher development (Nisa et al., 2023; Prayogo et al., 2025).

In the process of formulating the instrument indicators, the study identified that the most relevant indicators of digital leadership in supervision include the principal's ability to plan supervision using digital systems, provide timely and evidence-based feedback, encourage teachers to integrate technology into learning, use digital records to monitor pedagogical growth, and facilitate follow-up coaching based on supervision findings. These dimensions were then combined with indicators of pedagogical competence, such as understanding learner characteristics, designing student-centered lesson plans, selecting learning methods, utilizing digital media, conducting authentic assessment, and reflecting on learning outcomes. The theoretical significance of this integration lies in the recognition that pedagogical competence improvement in the digital era cannot be separated from the leadership environment in which teachers work. When principals exercise digital leadership, supervision becomes more responsive to the actual instructional challenges teachers face, especially those related to technology use, digital assessment, and differentiated learning. In this sense, the instrument was designed not only to measure teacher performance, but also to operationalize how digital leadership can guide and strengthen pedagogical practices. This aligns with contemporary views that school leaders' professional digital competence should encompass both managerial and pedagogical dimensions, because leadership in digital schools requires the ability to influence teaching quality through data, systems, and instructional support (Tømte, 2024; Kardoyo et al., 2025).

The validation results indicate that the developed instrument has strong feasibility in terms of content, construct, and practical relevance. Expert validation involved specialists in educational supervision, school leadership, and digital learning who assessed the suitability of the instrument indicators with the objectives of academic supervision and pedagogical competence development. The experts generally considered the instrument appropriate because its items were not limited to observing teacher behavior in class, but also addressed planning quality, technology-supported pedagogy, reflection, and follow-up improvement. Several revisions were suggested, particularly in clarifying the wording of indicators, reducing overlapping statements, and ensuring that each item was measurable in the real supervision process. The revised instrument subsequently demonstrated stronger coherence between the supervision stages and the dimensions being measured. From a theoretical standpoint, this validation process is essential because an instrument can only function effectively if it represents the conceptual framework on which it is built. In development research, validity is not simply a statistical requirement; it is evidence that the instrument meaningfully translates abstract constructs such as digital leadership and pedagogical competence into observable supervision indicators. Thus, the validation findings confirm that the instrument has conceptual adequacy to be used as a tool for instructional improvement in elementary schools (Rif'an & Widjanarko, 2024; Nisa et al., 2023).

Another important result of the design and validation stage is that the instrument was found to be practical and contextually relevant for implementation at SD Negeri 2 Kwadungan. The structure of the instrument allows principals to record supervision findings more systematically, while teachers can more easily understand the standards being used to assess and improve their pedagogical competence. This practicality is important because one of the recurring weaknesses of supervision in schools is the gap between well-formulated standards and the actual usability of instruments in daily school practice. The digital leadership-based instrument developed in this study addresses that issue by combining structured supervision indicators with a flexible format that can be adapted to digital documentation and monitoring systems. Theoretically, this supports the argument that educational innovation is effective when it is both valid and usable. A supervision instrument that is theoretically sound but impractical will have limited impact on teacher development, whereas an instrument that is practical but conceptually weak may fail to guide meaningful pedagogical improvement. Therefore, the results of the design and validation stage demonstrate that the developed instrument serves as both a technically feasible product and a theoretically grounded innovation for strengthening pedagogical competence through digitally oriented school supervision (Bentri et al., 2022; Rasdiana et al., 2024).

Implementation of the Supervision Instrument and Its Contribution to Improving Teachers' Pedagogical Competence

The implementation results at SD Negeri 2 Kwadungan show that the digital leadership-based supervision instrument made the supervision process more systematic, transparent, and focused on instructional improvement. During the trial stage, the principal used the

instrument in three integrated phases: pre-observation, classroom observation, and post-observation reflection. In the pre-observation phase, teachers were asked to submit lesson plans, learning media, and assessment designs, allowing the principal to review not only administrative completeness but also the alignment of learning objectives, strategies, digital resources, and student needs. During classroom observation, the instrument enabled the principal to record evidence related to classroom interaction, student engagement, the use of digital media, questioning strategies, and formative assessment practices. In the post-observation phase, the instrument guided feedback discussions by linking observation findings to specific pedagogical indicators and follow-up recommendations. As a result, supervision was no longer perceived as a one-time evaluation activity, but as a structured developmental process that provided teachers with concrete input for improving teaching practice. This finding supports the argument that technology-oriented supervision becomes more effective when it is supported by clear instruments that transform supervision from administrative control into instructional coaching and continuous professional assistance (Mahmudi, 2024; Sermal et al., 2025).

The findings further indicate that the implementation of the instrument contributed to improvement in several dimensions of teachers' pedagogical competence, particularly in lesson planning, classroom management, use of digital media, and learning evaluation. Teachers who previously prepared lesson plans primarily to fulfill administrative obligations began to show better alignment between learning objectives, teaching methods, digital resources, and student assessment strategies. Classroom observations also showed a shift toward more student-centered instruction, where teachers increasingly used interactive learning media, visual presentations, and digital platforms to support participation and concept understanding. In terms of assessment, teachers became more aware of the importance of formative feedback and began to use varied assessment techniques rather than relying solely on written tasks. These improvements suggest that a well-structured supervision instrument can function as both a monitoring device and a pedagogical guide, because it helps teachers understand what quality teaching looks like in practice. Theoretically, this aligns with the view that pedagogical competence in the digital era includes not only mastery of content delivery, but also the ability to design interactive, technology-supported, and reflective learning experiences that respond to diverse student needs (Ahyar & Herlambang, 2025; Awam et al., 2023).

Another important result is that the instrument strengthened the quality of feedback and follow-up actions provided by the principal. Before the instrument was developed, feedback was often general and centered on classroom order or lesson implementation in a broad sense. After implementation, feedback became more specific because the principal could refer directly to indicators in the instrument, such as the suitability of learning objectives with methods, the use of digital learning media, the facilitation of active student participation, and the use of assessment results for instructional improvement. Teachers reported that such feedback was easier to understand and more useful because it clearly identified both strengths

and areas for improvement. In addition, the digital orientation of the instrument enabled better documentation of supervision results, making it possible to compare teacher progress across supervision cycles and design more targeted follow-up coaching. This is theoretically significant because effective supervision depends not only on observation itself, but on the quality of feedback, reflection, and sustained professional dialogue that follows it. When supervision feedback is evidence-based and connected to measurable pedagogical indicators, it is more likely to influence teacher learning and classroom change (Sapwan et al., 2025; Daniati et al., 2026).

The implementation also revealed that the instrument contributed to the principal's role as a digital instructional leader rather than merely a school administrator. By using a supervision tool grounded in digital leadership, the principal was better positioned to map teachers' pedagogical needs, identify recurring instructional problems, and plan school-based professional development more strategically. For example, supervision results showed common teacher needs in the areas of digital media integration, differentiated instruction, and assessment variation. These findings then became the basis for follow-up discussions, peer sharing, and recommendations for training. In this sense, the instrument served not only as a supervision checklist but also as a decision-support tool for school improvement. Theoretically, this confirms that digital leadership becomes meaningful when it is translated into concrete leadership practices that directly affect teaching quality. Leadership in the digital era is not simply about adopting technology, but about using technology and supervision data to build a professional learning culture in which teachers continuously improve their pedagogical competence (Setiawan, 2026; Sutisman et al., 2026).

Overall, the implementation results demonstrate that the digital leadership-based supervision instrument had a positive contribution to improving teachers' pedagogical competence at SD Negeri 2 Kwadungan. Its contribution can be seen in the increased clarity of supervision standards, the stronger connection between observation and pedagogical feedback, the improved use of digital resources in teaching, and the more systematic follow-up of teacher development. Theoretically, these findings reinforce the relationship between supervision, digital leadership, and pedagogical competence by showing that teacher improvement is more likely to occur when school leadership is supported by a valid and practical supervision instrument. The instrument does not work merely as a technical form for observation, but as a mediating mechanism that connects leadership practice with classroom pedagogy through evidence, reflection, and professional support. Therefore, the implementation stage confirms that the developed instrument is not only feasible to use, but also pedagogically meaningful as an innovation for strengthening teacher competence in elementary schools facing the demands of digital educational transformation (Hasanudin et al., 2025; Mahmudi, 2024; Sapwan et al., 2025).

CONCLUSION

This study concludes that the development of a digital leadership-based supervision instrument at SD Negeri 2 Kwadungan is both relevant and effective in improving teachers' pedagogical competence in the context of digital-era learning. The results of the needs analysis revealed that the existing supervision practices were still conventional, administrative, and had not fully accommodated digital pedagogy or the professional development needs of teachers. In response to these conditions, the instrument was designed by integrating dimensions of digital leadership with core indicators of pedagogical competence, including lesson planning, classroom implementation, use of digital media, assessment, reflection, and follow-up improvement. The validation results confirmed that the instrument was feasible in terms of content, construct, and practical use, while its implementation demonstrated positive contributions to the supervision process by making it more systematic, transparent, evidence-based, and oriented toward instructional improvement. In addition, the instrument strengthened the principal's role as a digital instructional leader and helped teachers improve the quality of lesson design, classroom interaction, digital learning integration, and learning evaluation. Therefore, this study affirms that a digital leadership-based supervision instrument can serve as an innovative and practical tool for connecting school leadership, academic supervision, and teacher pedagogical development in elementary schools, particularly in responding to the demands of educational transformation in the digital age..

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