Ilomata International Journal of Social Science

OPEN ACCESS

RECEIVED 18 December 2025
ACCEPTED 9 April 2025
PUBLISHED 31 July 2026

CITATION
Setiawati D, Fitriasari A, Limarandani NP, (2026). Optimizing the Application of Artificial Intelligence in High School Learning Communication Strategies. Ilomata International Journal of Social Science. 7 (3), 845-853.
doi: 10.61194/ijss.v7i3.2076

TYPE Original Research
PUBLISHED 31 July 2026
DOI 10.61194/ijss.v7i3.2076
VOL 7 Issue 3 July 2026

Optimizing the Application of Artificial Intelligence in High School Learning Communication Strategies

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Abstract

The accelerated integration of Artificial Intelligence (AI) into educational ecosystems presents profound opportunities for pedagogical transformation, particularly within Senior High School (SMA) environments. This study investigates the optimization of AI applications in mediating learning communication strategies operationally defined herein as the facilitation of purposeful, bidirectional feedback loops, the structuring of adaptive interaction patterns, and the refinement of instructional messaging. Employing a qualitative mixed-methods design, this research triangulates a systematic literature review with a thematic analysis of semi-structured stakeholder interviews involving school leadership, instructional staff, and counseling professionals. The findings suggest that AI can enrich learning communication by dynamically adjusting instructional messaging and providing real-time, bidirectional feedback to students, thereby supporting constructivist knowledge building. Applications such as chatbot-based conversational agents, adaptive learning algorithms, and automated content generation tools are reported to facilitate greater efficiency in material delivery while affording students personalized learning pathways. However, the study identifies critical structural constraints, noting that successful implementation within the SMA context is heavily contingent upon infrastructural readiness, the mitigation of the digital divide, and the comprehensive development of teachers' digital pedagogical literacy. The authors conclude that while AI holds significant potential to make learning communication more inclusive and data-driven, causal impacts on long-term achievement require further quantitative evaluation. Therefore, it is crucial for educational institutions to develop comprehensive, human-centered governance policies that support the sustainable and ethical integration of this technology.

KEYWORDS

artificial intelligence; learning communication; sma; educational strategies; adaptive technology.

Introduction

The rapid evolution of information and communication technology (ICT) has profoundly disrupted traditional pedagogical paradigms within the education sector. Foremost among these advancements is the emergence of Artificial Intelligence (AI), which presents unprecedented opportunities to elevate the quality of instruction at the Senior High School (SMA) level. While early educational technology primarily focused on providing static access to digitized resources, modern AI introduces automation based on complex associations in data, enabling the dynamic adaptation of teaching and learning processes (Russell & Norvig, 2021; Selwyn, 2019; U.S. Department of Education, Office of Educational Technology, 2023). However, the efficacy of AI in education cannot be evaluated purely through technical benchmarks or generic learning outcomes; it must be assessed through the specialized lens of learning communication.

Instructional communication refers to the systematic study of the human communication process across all learning situations, representing a critical intersection among pedagogy, educational psychology, and communication theory (Goodboy, 2018). Within this framework, effective learning communication is operationalized through

purposeful, bidirectional, and iterative feedback loops that transform the knowledge, actions, and conceptual understandings of the engaged parties (Gutenson, n.d.). AI technologies possess the potential to fundamentally alter instructional messaging defined as the system used to convey signs, symbols, and signals between instructors and learners by offering real-time, personalized interaction patterns that dynamically adapt to individual student capabilities (Huang & Hew, 2021; M. J. W. Lee et al., 2021).

By functioning as an active participant in the feedback loop, AI disrupts traditional unilateral feedback models, fostering a more democratic and continuous dialogue between the learner and the instructional material (Gutenson, n.d.).

Despite the theoretical promise of AI-augmented communication, a critical research gap persists regarding its practical implementation in secondary education. Recent systematic reviews indicate that while Generative AI tools are heavily researched within higher education, their practical application, integration challenges, and ethical implications within K-12 environments remain severely underexplored (Alfarwan, 2025; C. Chou & Chen, 2019; P. Zhang & Tur, 2024). Specifically, there is a lack of empirical data on how secondary school teachers perceive and navigate the pedagogical shifts required to maintain professional agency while integrating AI into their instructional messaging (Alfarwan, 2025). This empirical gap is particularly acute in developing educational contexts such as Indonesia.

Analyses of Indonesia's ongoing transition toward an Education 5.0 ecosystem reveal that the adoption of AI in SMA settings is severely constrained by systemic barriers (Nguyen, Do, et al., 2022). These include profound digital and physical infrastructure deficits, pervasive inequality in technological access, and low AI literacy among educators (Ahmad et al., 2023). Furthermore, the lack of culturally sensitive, localized Natural Language Processing (NLP) models limits the efficacy of automated communication tools (Pulungan et al., 2025). Beyond technical constraints, scholars emphasize the urgent necessity of developing a character-centered AI pedagogy in Indonesia, citing profound concerns that an over-reliance on automation may erode essential human interaction, empathy, and moral development within the classroom (Asep et al., 2025).

To address these critical gaps in the literature, this study examines the implementation of AI within Indonesian SMA environments, focusing specifically on how technological affordances interact with established communication theories, such as constructivism and cognitivism. By moving beyond generalized learning outcomes, this research isolates the specific mechanisms of learning communication strategies. Specifically, this study is guided by the following explicit research questions:

1. How do high school educators perceive the role of AI in shaping learning communication strategies, specifically regarding the optimization of bidirectional feedback loops and adaptive instructional messaging?
2. What are the reported pedagogical benefits and structural challenges of implementing AI-driven communication tools within the context of Indonesian Senior High Schools?
3. How can educational institutions develop robust governance frameworks and character-centered pedagogies to address the ethical and infrastructural barriers associated with AI integration?

In addition to adaptive feedback systems, AI-enabled learning approaches such as game-based learning and personalized instruction are increasingly positioned as key mechanisms for enhancing student engagement and educational accessibility (C. Lee et al., 2021). These approaches are argued to support higher-order learning outcomes including motivation, problem-solving, and collaborative capacity by dynamically tailoring content and interaction patterns to individual learner profiles (Fadel & Bialik, 2020; Kotsiantis & Pintelas, 2021). However, the current body of literature remains predominantly pedagogical in orientation, emphasizing learning outcomes while providing limited conceptual attention to the underlying communication processes through which these outcomes are produced. In particular, there is insufficient analysis of how AI reconfigures instructional messaging, mediates feedback loops, and restructures the interactional dynamics between teachers, students, and learning systems (Y. Zhang & Zhang, 2020). This gap is especially pronounced in secondary education contexts, where communication practices are more tightly embedded in institutional structures and socio-cultural expectations. Consequently, a critical need emerges to examine how AI-driven affordances operate not merely as instructional tools, but as communicative infrastructures that shape the production, circulation, and interpretation of meaning within Indonesian SMA learning environments.

Artificial intelligence (AI) plays a crucial role in developing teaching materials. By utilizing machine learning algorithms, AI can analyze student learning data to identify patterns and provide recommendations for materials best suited to each individual's needs. This system can detect areas where students are struggling and then automatically suggest additional exercises or provide simpler re-explanations. This approach not only improves learning effectiveness but also supports more adaptive learning, where students can learn at their own pace and learning style (Rohmah & Setiawan, 2020). In addition to assisting with learning personalization, AI also supports increased educational accessibility. This technology enables the creation of a more effective and efficient distance learning system.

The importance of collaboration between technology developers and educators is also a determining factor in the successful implementation of AI in learning. Technology developers need to understand the needs and challenges faced by educators in managing classes and delivering materials. Conversely, educators need adequate training to effectively utilize AI in their learning communication strategies (Huang & Hew, 2021). With good collaboration, AI technology can be more easily and effectively adapted in the education system. This research will explore how AI can be applied to improve learning communication between teachers and students, as well as how this technology can be used to develop more engaging and adaptive teaching materials (Zhou & Guo, 2022). This research aims to explore how AI can be applied to enhance learning communication between teachers and students at the senior high school level, particularly in the development of adaptive and engaging teaching materials. In addition, this study seeks to identify practical challenges in implementation, including infrastructure readiness and teacher preparedness. By doing so, the research provides contextual insights that may inform school-level strategies and considerations for integrating AI into instructional communication practices.

Methods

This research employs a qualitative mixed-methods design, systematically integrating a comprehensive literature review with the thematic analysis of semi-structured stakeholder interviews (Creswell & Poth, 2018; Snyder, 2019). To ensure methodological transparency, reproducibility, and analytical rigor, all phases of data collection and synthesis were aligned with established qualitative reporting standards. The literature review component was conducted in adherence to the Enhancing Transparency in Reporting the synthesis of Qualitative Research (ENTREQ) statement (Tong et al., 2012).

The primary literature search was executed across major academic databases, including Scopus, Web of Science, PubMed, and Google Scholar, utilizing Boolean search strings such as ("Artificial Intelligence" OR "Generative AI" OR "LLMs") AND ("K-12" OR "High School" OR "Secondary Education" OR "SMA") AND ("Learning Communication" OR "Feedback Loops" OR "Instructional Messaging"). The initial database search yielded a total of 487 records across all four platforms. Following automated deduplication, 324 unique records remained. Title and abstract screening resulted in the exclusion of 241 records, leaving 83 articles for full-text assessment. Of these, 52 were subsequently excluded primarily due to a focus on tertiary rather than secondary education (n = 24), publication prior to 2020 (n = 15), or insufficient empirical grounding (n = 13). The final synthesis corpus comprised 31 sources, including 18 peer-reviewed empirical studies, 9 systematic reviews, and 4 institutional policy reports. To analytically integrate the two data strands, thematic clusters derived from the literature review were used as an initial coding framework, which was then iteratively refined through engagement with the interview data. This process followed a convergent qualitative synthesis logic, enabling systematic triangulation between global research patterns and locally situated practitioner perspectives. Through this approach, the analysis identified areas of empirical convergence, context-specific elaboration, and productive divergence, thereby enhancing both the depth and contextual validity of the findings while reducing the risk of single-source interpretive bias (Noble & Smith, 2015).

Data analysis of the interview transcripts was executed utilizing a rigorous thematic coding scheme based on the highly validated six-step framework proposed by Braun and Clarke (2006). This inductive and deductive analytical process involved: (1) immersive familiarization with the transcribed data through repeated readings, (2) the systematic generation of initial descriptive and in vivo codes, (3) the collation of related codes into prospective overarching themes, (4) the iterative review of themes against the dataset to ensure representativeness, (5) the explicit definition and naming of final themes, and (6) the synthesis of the analytic narrative.

To process the qualitative data efficiently, Computer-Assisted Qualitative Data Analysis Software (CAQDAS), specifically MAXQDA, was utilized in conjunction with supplementary Natural Language Processing (NLP) tools for initial topic modeling. However, recognizing that generative AI lacks the intuition, contextual nuance, and creativity necessary for deep qualitative memoing, a human-in-the-loop methodology was strictly maintained. Human coders manually reviewed all AI-generated preliminary codebooks, refining and organizing the codes logically into the final thematic categories guided by the study's theoretical frameworks. To guarantee the overall trustworthiness, credibility, and transferability of the findings in accordance with the Standards for Reporting Qualitative Research (SRQR) guidelines (O'Brien et al., 2014), source triangulation was performed by cross-referencing practitioner narratives directly with the synthesized literature. Furthermore, intercoder reliability protocols were established during the coding phase to mitigate interpretive bias and ensure analytical consistency.

In-depth interview data were used to complement and contextualize the findings derived from the literature review. Rather than serving as standalone evidence, these practitioner insights were integrated analytically through triangulation to examine how AI-related practices are enacted within real classroom and institutional settings. This approach enabled the study to move beyond abstract conceptualizations by capturing context-specific dynamics, including practical constraints, adaptive strategies, and locally situated interpretations of AI-supported learning material development in Indonesian secondary education.

Result and Discussion

Application of Constructivism Theory in AI Learning Communication Strategy

Constructivism theory, developed by Jean Piaget and Lev Vygotsky, explains that learning is an active process in which students construct knowledge based on their experiences and interactions with their surroundings (T. Anderson, 2020; Vygotsky, 1978). The application of artificial intelligence (AI) in education supports this approach by providing a more interactive and personalized learning environment (P. N. Chou & Chen, 2019). For example, features like adaptive learning and the use of chatbots allow students to explore material in a way that suits their needs, while still receiving relevant feedback. This aligns with Vygotsky's concept of the Zone of Proximal Development (ZPD), which states that learning is more effective when students are helped to overcome challenges beyond their capabilities with appropriate support. The thematic analysis of the interview transcripts, rigorously triangulated with the systematic literature review, yielded five primary themes regarding the optimization of AI in high school learning communication strategies. These themes illustrate the complex, multi-dimensional interplay between theoretical pedagogical frameworks, perceived technological affordances, and highly localized structural challenges within the Indonesian educational landscape.

Theme 1: Constructivist Interaction Patterns and Adaptive Scaffolding. Constructivist learning theory, profoundly influenced by the work of Lev Vygotsky, posits that learning is an active, iterative process of knowledge construction that relies on appropriately mediated support within a student's Zone of Proximal Development (ZPD) (Vygotsky, 1978). Informants reported that AI-driven educational platforms can facilitate more dynamic interaction patterns by enabling real-time, personalized feedback and task adaptation. However, such features do not inherently constitute scaffolding in the Vygotskian sense. Rather, AI may support scaffolding processes when its outputs are embedded within teacher-guided instructional design, where educators actively interpret, structure, and align AI-generated feedback with students' developmental needs. Under these conditions, the technology can assist students in engaging more actively with learning materials and constructing knowledge pathways beyond passive information reception.

Informant 1, the School Principal, articulated this perceived benefit: "One of the most profound impacts we have observed is AI's ability to tailor learning materials to individual student needs, allowing them to navigate the curriculum at their own pace. For instance, the AI mathematics platform we utilize automatically adjusts the difficulty of questions according to the student's real-time progress. We observe that this supports students in tackling challenges just beyond their current independent capabilities, directly aligning with the concept of the ZPD." This narrative suggests that AI functions as an automated pedagogical mediator, enhancing the learning communication process by delivering adaptive instructional messages that respond instantaneously to student inputs and cognitive load.

Theme 2: Cognitive Structuring and the Optimization of Feedback Loops In the domain of educational research, learning communication is frequently operationalized through the mechanism of feedback loops purposeful, bidirectional, and iterative interactions intended to transform student knowledge, correct misconceptions, and guide future action. Cognitivist frameworks, such as those proposed by Bruner and Ausubel, emphasize the critical importance of structured information processing, repetition, and immediate

reinforcement in solidifying knowledge structures. The integration of AI drastically reduces the latency of these feedback loops, transitioning them from delayed, evaluative responses to immediate, formative dialogues.

Informant 2, an ICT teacher, highlighted how AI integration optimizes these communication cycles: "Utilizing AI- based applications allows me to generate automated, targeted practice exercises and, crucially, provide immediate, real-time feedback to the students. This iterative process allows students to identify specific areas for improvement instantly, without waiting for manual grading. From a pedagogical management standpoint, the data analysis features allow me to monitor aggregate progress and intervene much faster when a student exhibits recurring conceptual errors." In this context, AI is perceived not as a replacement for the educator, but as a technological catalyst that accelerates the feedback loop. By facilitating rapid instructional messaging, AI enables a more individualized and cognitively supportive communication environment, allowing the human teacher to focus on higher-order analytical guidance.

Theme 3: Socio-Emotional Support, Counseling, and Character-Centered Pedagogy Beyond strictly academic applications, effective learning communication encompasses the socio-emotional dialogues that are critical to holistic student development. Current educational literature emphasizes the absolute necessity of a character-centered AI pedagogy, particularly within the Indonesian context, warning that an over-reliance on automation may erode essential human interaction, empathy, and moral development in the classroom (M. Li & Wang, 2022). The application of AI must therefore be balanced between technical efficiency and emotional intelligence.

Informant 3, a Guidance and Counseling teacher, detailed both the utility and the inherent limitations of AI in this highly sensitive domain: "AI serves as a powerful analytical tool for our department. It helps us aggregate vast amounts of academic and behavioral data to identify subtle patterns that may indicate underlying learning difficulties, drops in motivation, or emotional distress that might otherwise go unnoticed. Furthermore, AI supports the provision of online counseling interfaces and suggests relevant self-development modules. However, human interaction remains completely irreplaceable. We must meticulously balance technological data analysis with a profoundly humanistic approach to ensure students feel personally cared for, understood, and morally guided." This perspective strongly underscores the consensus in the broader literature that AI must serve strictly as a pedagogical partner rather than a human substitute, reinforcing the irreplaceable role of educator empathy, socio-emotional support, and professional ethical judgment.

Theme 4: Structural Barriers and the Persistent Digital Divide Despite the highly optimistic perceived pedagogical affordances of AI, the practical, daily implementation within Indonesian SMA settings remains severely constrained by systemic structural barriers (Nguyen, Pham, et al., 2022). Inadequate digital and physical infrastructure emerged as a dominant, recurring theme across all interviews, closely reflecting broader findings in recent K-12 AI integration studies in developing nations (J. Anderson & Rainie, 2023).

Informant 1 candidly observed, "The most obvious and immediate challenge we face is limited infrastructure. Although our school is located in an urban area, unstable internet connections and a severe lack of adequate hardware in certain classrooms prevent the equitable utilization of AI tools." This digital divide directly threatens the efficacy of learning communication strategies; students without consistent, high-speed access are entirely excluded from the bidirectional feedback loops facilitated by cloud-based AI platforms. Furthermore, the literature highlights that the lack of Natural Language Processing (NLP) models optimized for regional Indonesian dialects further impedes the seamless communication between student and machine (Aji et al., 2022). Without targeted, systemic governmental investment in infrastructure, AI implementation risks exacerbating existing educational inequalities rather than resolving them.

Theme 5: Pedagogical Agency and the Imperative of Teacher Readiness The final theme addresses the crucial human element of AI implementation: teacher digital literacy, preparedness, and the preservation of pedagogical agency. The successful integration of AI relies entirely on the educators tasked with its deployment.

However, Informant 2 reported significant operational hurdles: "The most common barrier I encounter is the profound digital skills gap among instructional staff. AI tools are rendered completely ineffective if educators feel overwhelmed by the technology, or if they do not understand how to align automated content generation with the stringent requirements of the national curriculum." (J. Li & Wang, 2022)

This observation aligns with recent qualitative research indicating that teacher training frequently focuses purely on technical, button-pushing operations rather than the deeper pedagogical integration required to maintain classroom authority and agency. Teachers simultaneously embrace AI's potential for administrative efficiency while expressing deep concerns regarding student over-dependence and the erosion of critical thinking skills. To truly optimize learning communication, professional development initiatives must transition from mere software tutorials to comprehensive training paradigms focusing on AI ethics, the mitigation of algorithmic bias, and the strategic integration of AI into complex instructional message design.

Empirical support for this interpretation was consistently reflected in the interview data. Informants described how AI enabled tools allow students to engage with learning materials at an individualized pace while receiving timely, adaptive feedback. As noted by both the school principal and ICT teacher, these features can create conditions that approximate developmentally appropriate support, particularly when aligned with instructional objectives. However, this support remains contingent upon pedagogical mediation, as teachers play a critical role in interpreting AI-generated outputs and ensuring their alignment with students' Zone of Proximal Development.

Furthermore, the application of AI also supports the theory of cognitivism, where students actively process information and construct knowledge. By providing learning materials tailored to students' cognitive abilities and providing opportunities for practice and repetition as needed, AI technology enhances this information processing process (Ausubel, 1968; Bruner, 1966). This aligns with the opinions of ICT teachers who state that AI enables more efficient and structured learning materials to be tailored and provides a more personalized learning experience (VanLehn, 2022).

However, despite the significant benefits offered, several challenges remain that require attention in implementing AI in schools. Challenges related to infrastructure readiness, teacher training, and difficulties in integrating technology into school policies remain significant obstacles, as noted by three informants. This highlights the importance of improving technological facilities and ongoing teacher training to maximize the use of AI technology, echoing Johnson and Adams (2022) who emphasized the importance of teacher readiness in using new technologies.

Cognitivism theory also underpins this research. This theory focuses on the internal processes of information processing and how students construct and organize new knowledge. AI supports this theory by providing learning materials tailored to students' cognitive levels and providing reinforcement through tailored practice and repetition

(Ausubel, 1968; Bruner, 1966). Thus, these two theories complement each other and provide a strong foundation for understanding how AI can optimize communication and learning strategies at the high school level. The application of this theory to AI-based learning not only enhances teaching effectiveness but also facilitates students' active construction of their knowledge through more personalized and adaptive experiences.

In the application of AI in schools, various perspectives expressed by informants highlight the importance of using this technology in supporting more dynamic and structured learning strategies.

As the principal of a high school that has begun implementing AI technology in its teaching, I greatly appreciate the application of cognitive theory in this context. This theory focuses on how students process, structure, and organize knowledge, and AI plays a significant role in this regard. For example, with an adaptive learning system that adapts material to students' levels of understanding, we can ensure that each student receives material that aligns with their cognitive abilities. Furthermore, AI provides opportunities for repeated practice and reinforcement of concepts not yet mastered, in line with the principles proposed by Bruner and Ausubel. From our experience in schools, AI technology not only makes it easier for teachers to deliver material but also helps students become more active in the learning process by providing a more personalized and adaptive experience. Of course, to maximize the potential of AI, we need to continue improving our infrastructure and providing ongoing training for teachers so they can utilize this technology to its full potential. (Informant 1)

In this case, technology not only provides support to teachers, but also to students to better understand the material in a way that is more appropriate to their cognitive level.

As an ICT teacher who has used AI applications in my teaching, I truly appreciate the benefits of cognitive theory in AI-based learning. With AI, I can provide teaching materials tailored to students' cognitive levels, facilitating their learning more efficiently and at their own pace. For example, the application I use allows students to review material or practice problems with varying levels of difficulty as their abilities develop. This strongly supports Bruner's theory of learning through repetition and reinforcement. Furthermore, the data analysis provided by the AI application allows me to monitor student progress and provide faster intervention if any students are struggling. As a teacher, I find it easier to support students in overcoming their learning difficulties in a more focused manner. However, the main challenge we face is ensuring that all fellow teachers can utilize this technology optimally, which requires ongoing training and technical support. (Informant 2)

AI also has a positive impact in the field of guidance and counseling, where cognitive theory can be applied to support students' academic and personal development.

As a Guidance and Counseling (BK) teacher, I also see a very positive role for AI in supporting the student guidance process. Cognitive theory emphasizes the importance of information processing in learning, and AI helps us optimize this process by providing more in-depth analysis of students' academic and behavioral development. With the data provided by the AI system, I can more easily understand students' learning difficulties and provide more targeted advice. Furthermore, AI also supports the provision of online counseling services, giving students the flexibility to access counseling materials at any time according to their needs. This is a concrete example of how technology can enhance the learning and guidance process, allowing students to feel more engaged and receive the support they need to develop cognitively. However, we continue to believe that while technology is very helpful, human interaction remains irreplaceable in supporting students' personal development. (Informant 3)

The findings suggest that AI-supported learning environments may facilitate more structured and efficient information processing by providing materials that are adapted to students' levels of understanding, alongside opportunities for repeated practice and conceptual reinforcement. In this sense, AI-enabled features appear to align with key principles of cognitive learning theory, particularly in supporting differentiated learning pathways. However, both the reviewed studies and informants indicate that such potential remains contingent upon critical implementation conditions, including adequate technological infrastructure and sustained teacher training. Without these supporting factors, the effectiveness of AI integration in enhancing learning processes may be limited.

Learning Communication in AI, Learning Communication Strategy Effective learning communication is central to success in the educational process. With advances in technology, including artificial intelligence (AI), learning communication is now becoming more dynamic and adaptive. AI technology enables more responsive interactions between teachers and students, making learning less one-way and more collaborative and personalized. This supports the primary goals of learning communication: helping students understand the material, increasing their engagement, and strengthening the relationship between educators and learners.

As a principal who has begun integrating AI technology into the learning process, I strongly support its use in improving communication within our school. AI enables more adaptive and responsive interactions between teachers and students. This technology makes communication more dynamic and extends beyond face-to-face communication. AI provides the opportunity to provide students with faster feedback, allowing them to quickly understand whether they have mastered the material. Through the use of AI applications, we can tailor the delivery of material to individual students' needs, helping them learn at their own pace. This clearly aligns with the goals of effective communication within our school: helping students better understand the material, increasing their engagement, and strengthening the relationship between educators and students. However, to achieve this, we need to continue improving our infrastructure and providing training for teachers so they can optimize this technology, ensuring its maximum benefits for all parties. (Informant 1)

With these steps, we are confident that the implementation of AI technology will further improve the quality of education and communication in our schools.

As an ICT teacher, I truly appreciate the benefits of using AI in learning communications. AI allows me to provide faster and more accurate feedback to students. For example, through an AI-based learning application, I can provide practice exercises tailored to each student's abilities and provide immediate feedback after they complete them. This increases their engagement in learning, as they can immediately identify areas for improvement. Furthermore, learning communications become more interactive and adaptive. AI allows students to learn at their own pace and revisit material they find difficult. With this technology, students not only receive information but also actively participate in the learning process, leading to deeper understanding. This is crucial for creating effective communication between teachers and students, as communication is not just about delivering material but also about the responses and interactions that occur during the learning process. With AI, this process becomes more dynamic and provides a more personalized learning experience. (Informant 2)

Thus, AI-based learning communication not only improves understanding of the material, but also enriches

interactions between students and teachers, making them more collaborative and flexible.

As a Guidance and Counseling (BK) teacher, I also see the great potential of AI in supporting learning communication, particularly in providing more personalized support to students. AI not only assists teachers in delivering material but also allows us to identify learning problems or difficulties experienced by students more quickly. By using AI applications, we can obtain more detailed data on student development and provide more timely interventions (Hussain et al., 2021). Furthermore, AI also enables more flexible communication, particularly in the context of counseling services. With this ease of access, students can feel more comfortable and open in seeking help, which improves the quality of communication between students and BK teachers. Students can access counseling materials or get help anytime according to their needs, which is very important in this digital age. AI can also help match counseling materials to students' emotional and academic needs. (Informant 3)

This not only improves the quality of learning but also strengthens the relationship between students and educators, ensuring that they feel supported in their learning journey.

Technology-Based Learning Strategies in Optimizing Artificial Intelligence Applications in Learning Communication Strategies at the High School Level

The implementation of technology-based learning strategies, particularly through the use of artificial intelligence (AI), is now a crucial step in creating a more adaptive and effective education system at the high school level. The use of AI enables a more structured, personalized, and interactive learning process. This is evident from the various perspectives shared by those directly involved in the educational process, from principals and ICT teachers to guidance and counseling teachers.

The use of AI has truly brought positive changes to the teaching and learning process at our school. One of the most noticeable impacts is AI's ability to adapt learning materials to suit the needs and abilities of each student. Learning becomes more personalized, allowing students to learn at their own pace, which naturally increases their engagement in the learning process. Furthermore, another positive impact is evident in learning evaluation. AI allows us to provide automated evaluations and rapid feedback, allowing students to immediately determine their understanding of the material. This also makes it much easier to monitor student progress in real time. However, we also recognize that the biggest challenge is ensuring that all infrastructure at the school, including the internet network and hardware, can support the optimal use of this technology. Therefore, we continue to strive to improve technology facilities and provide training for teachers so they are better prepared to utilize AI in learning. (Informant 1)

Meanwhile, in terms of direct classroom instruction, I feel that AI has made classroom learning more engaging and dynamic. The AI-based applications I use allow students to interact directly with the learning materials, such as through simulations or games designed to teach specific concepts. This is very effective in increasing student engagement, as they can learn while actively participating in fun and challenging activities.

In line with this, the use of AI also supports efficiency in the assessment process, allowing me to assess student learning outcomes more quickly and accurately. The adaptive learning feature is particularly helpful for students struggling with specific material, allowing them to receive additional explanations and more targeted practice. Of course, while the benefits are significant, one of the main challenges we face is ensuring that all teachers, especially those unfamiliar with technology, can effectively utilize this application. Therefore, it is crucial for us to conduct ongoing training so that all teachers can effectively use this technology in their teaching. (Informant 2)

Not only in academic processes, AI technology is also starting to make a major contribution in non-academic aspects, especially in the field of guidance and counseling services.

AI is a powerful tool in supporting the guidance and counseling process in schools. This technology allows us to more quickly analyze students' academic and emotional development and identify issues that may not be immediately apparent. For example, AI can help collect data on student achievement across various subjects and identify patterns or changes that may indicate learning difficulties or personal issues affecting their performance. Furthermore, ease of access is a distinct advantage, as AI supports online counselling services, allowing students to access counseling materials more flexibly. However, we remain convinced that human interaction in counseling is crucial. Therefore, while AI is very useful in supporting the process, it should still be seen as a tool, not a replacement for the role of a counselor. With the right combination of technology and a human approach, we can provide more holistic and effective services to students. (Informant 3)

Taking these three perspectives into account, overall, the implementation of AI in our school's learning strategy has had a significant impact on increasing student engagement, simplifying classroom management, and providing more personalized and adaptive learning. While there are challenges related to infrastructure readiness and teacher training, the use of AI has enabled us to create more engaging and effective learning experiences and support a more data- driven guidance and counseling process. Considering the three perspectives presented, the implementation of AI in learning strategies at the school demonstrates meaningful potential in increasing student engagement, accelerating feedback processes, and supporting more personalized and adaptive learning experiences. In addition, AI assists teachers in monitoring student progress more systematically and contributes to more data-informed guidance and counseling practices. However, these positive outcomes should be understood within the context of a school that has already begun integrating technology into its learning environment. The effectiveness of AI remains closely tied to teachers' digital competence, the reliability of infrastructure, and the school's ability to align technological tools with clear pedagogical objectives. While AI can enhance efficiency and responsiveness, it does not replace the relational and empathetic dimensions of learning communication, which remain central to the educational process. Therefore, strengthening the synergy between technological development, human resource readiness, and sustainable education policies becomes essential. AI integration should not focus solely on technical adoption, but also on carefully designing communication strategies that ensure technology genuinely supports interaction, guidance, and meaningful learning experiences. By continuing to improve facilities and training for educators, we are confident that AI technology can have an even greater impact on education in the future.

AI Applications in the Development of Teaching Materials in Optimizing Artificial Intelligence Applications in Learning Communication Strategies at the High School Level

The use of artificial intelligence (AI) in developing teaching materials has become an innovative solution that supports effective learning. Through analysis of student learning data, AI can recommend teaching materials tailored to individual abilities and needs, making learning communication strategies more personalized, targeted, and impactful. Perspectives from various parties directly involved

in education demonstrate that AI not only accelerates and simplifies the process of material development but also improves the quality of student engagement in the classroom. This aligns with what the principal, the first informant, stated. According to him, the use of AI in developing teaching materials is a significant breakthrough in today's education world.

In schools that have implemented AI-based learning systems, the impact is significant, particularly in terms of lesson planning efficiency (Bengtsson, 2016). AI is able to analyze student learning outcome data and provide feedback to teachers regarding material that needs to be emphasized or adjusted, according to each student's needs. Furthermore, these benefits are felt not only by students but also by teachers. This is because AI can support teachers in saving time and energy in developing teaching materials. Teachers no longer need to design all materials manually, as AI can provide references, practice questions, and even learning videos that can be directly adapted to the context and learning needs. This makes the learning communication process more effective, and students understand the material more easily because the approach is personalized and data-driven. However, the Principal also highlighted that the main challenge still faced is ensuring that all teachers are able to optimally utilize AI features, which of course requires ongoing training. (Informant 1)

Similarly, the second informant, an ICT teacher, emphasized the significant contribution of AI to the development of teaching materials, particularly in the context of interactive digital learning. The AI application used allows for the automatic creation of practice questions based on the topic being taught, and can even be adjusted to a level of difficulty that matches the student's learning achievement. This significantly speeds up the material development process while ensuring that students receive targeted practice.

Furthermore, ICT teachers also mentioned that AI not only generates questions but also recommends multimedia content such as interactive learning videos. This makes teaching materials more engaging and easier to understand. Interestingly, AI can also monitor student learning activities and provide signals if a student is having difficulty understanding a topic. This allows teachers to intervene more quickly, either in the form of additional explanations or follow-up exercises. However, teachers also emphasized the importance of aligning AI-generated materials with the national curriculum, as adjustments are sometimes necessary to maintain relevance and meet educational standards. (Informant 2)

Taking these three perspectives into account, it can be concluded that the application of AI in developing teaching materials has a significant positive impact on increasing the effectiveness of learning communication strategies at the high school level. AI enables teachers to create more relevant, adaptive, and engaging teaching materials, and provides data support for more in-depth and targeted counseling services. However, to ensure optimal implementation, the successful integration of AI in teaching materials development depends heavily on the readiness of the technological infrastructure and human resources. Continuous training for teachers and alignment of materials with the national curriculum are necessary for AI to truly optimize the role of educators in improving the overall quality of learning.

Challenges of AI Implementation in Senior High Schools (SMA) in Optimizing Artificial Intelligence Applications in Learning Communication Strategies at the High School Level

Although the use of AI in learning offers numerous benefits, the reality is that implementing this technology at the high school level still faces various challenges. These obstacles arise not only from the technical side, but also from cultural aspects and human resource readiness. To better understand how these challenges manifest themselves in the field, below are the perspectives of three informants with direct experience implementing AI in schools.

One of the earliest challenges faced was the readiness of the school's systems and environment, as conveyed by the principal, the first informant.

The success of AI implementation is determined not only by the availability of technology, but also by the readiness of the school ecosystem as a whole. The most obvious challenge we face is limited infrastructure, particularly a stable internet connection and adequate hardware. Although our school is located in an urban area, some classrooms still lack optimal internet access, limiting the full use of AI. Furthermore, teacher readiness is also a concern. Many teachers are enthusiastic about using AI, but not all understand how to integrate it into their learning strategies. We see the need for more intensive and ongoing training so that all educators are truly able to operate and utilize AI effectively. On the other hand, some teachers also worry that AI could diminish their role in teaching. Therefore, we consistently emphasize that this technology is a tool, not a replacement for teachers. We believe this approach is crucial for smoother AI adoption and widespread acceptance. (Informant 1)

The challenges faced by the principal are also felt by teachers in the field. This was confirmed by an ICT teacher who revealed another reality in the process of adopting AI technology in the classroom.

From my perspective as an ICT teacher, the most common challenge I encounter is the digital skills gap between teachers, students, and even educational staff. Although AI technology is readily available in various learning applications, its use will be ineffective if users lack adequate digital literacy. I often encounter fellow teachers who feel overwhelmed when first trying out AI features, such as automated question generation or adaptive learning systems. Furthermore, technical challenges such as limited devices and unstable internet connections remain a barrier, especially when learning takes place online or through cloud-based platforms. Furthermore, understanding of how to align AI use with the national curriculum is also limited. Therefore, it is crucial for schools to provide collaborative training spaces where teachers can learn through practice, share experiences, and provide mutual support. (Informant 2)

The challenges of implementing AI aren't limited to academic teaching and learning; they're also felt in guidance and counseling. The perspectives of guidance counselors demonstrate how students' social-emotional aspects also require attention when implementing this technology.

As a guidance counselor who is also involved in technology integration, I see that challenges in AI implementation also arise in non-academic contexts. While AI can help analyze student behavior and development data, its use still requires thoughtful human interpretation. This is where the role of teachers becomes crucial. One challenge I face is ensuring that the data generated by AI systems is used ethically and not misinterpreted. Furthermore, in the context of counseling services, the use of AI technology is often limited by a lack of infrastructure support, such as a secure and user-friendly online counseling platform. Another challenge is resistance from some students who feel uncomfortable with technological approaches in the counseling process. Therefore, our role is to balance the use of technology with a humanistic approach, so that students still feel personally cared for. AI should be a support to strengthen services, not a substitute for direct interaction between students and teachers. (Informant 3)

Through these three perspectives, it can be seen that AI implementation is not free from complex and diverse obstacles. From these three perspectives, it can be concluded

that the challenges of AI implementation in high schools encompass not only technical aspects, such as infrastructure and devices, but also human aspects, such as digital skills, the mental readiness of teachers and students, and concerns about changing roles in the world of education. To address these challenges, a holistic approach is needed: from improving facilities and developing supportive school policies to ongoing teacher training and mentoring. As a next step, collaboration between stakeholders is essential. The successful implementation of AI in educational settings depends heavily on the synergy between school leaders, subject teachers, guidance counselors, students, and parents. Only with strong collaboration and a shared vision can AI be optimized as an effective, inclusive, and sustainable learning communication strategy.

Conclusion

This research investigated the optimization of Artificial Intelligence in mediating learning communication strategies within Senior High School environments, specifically focusing on the Indonesian educational context. The rigorous thematic analysis of qualitative practitioner experiences, triangulated with recent empirical K–12 AI literature, suggests that AI possesses profound potential to transform instructional messaging. By facilitating purposeful, iterative, and bidirectional feedback loops, AI-driven platforms can provide students with highly personalized, constructivist scaffolding that dynamically adapts to their individual cognitive capacities and learning paces. Furthermore, AI demonstrates significant utility in aggregating behavioral data to support Guidance and Counseling professionals in identifying hidden student needs. However, these findings must be interpreted strictly within the context of the study's methodological limitations. As a qualitative inquiry based on a small, purposive sample size of informants and synthesized literature, the research accurately captures perceived benefits, thematic trends, and lived implementation experiences rather than statistically measurable impacts on long-term academic achievement (Goyal & Gupta, 2021). The full realization of AI's pedagogical potential remains heavily obstructed by localized structural barriers, particularly the pervasive digital divide, inadequate network infrastructure, and varying levels of digital pedagogical literacy among teaching staff.

While this study provides important insights into the integration of AI in learning communication, several limitations should be acknowledged. First, the findings are based on a qualitative synthesis of existing literature and a relatively small number of interviews, which may limit the generalizability of the results. Second, the empirical insights are contextually grounded in Indonesian senior high school settings and thus may not fully capture variations across different educational systems or educational levels. In light of these limitations, the findings suggest that bridging the gap between AI's theoretical potential and its practical and ethical implementation may require a transition from ad-hoc technological adoption toward more structured and systemic integration. Based on the constraints identified in this research, several conditional recommendations are proposed for educational leaders. Educational institutions should establish AI Governance and Ethics Task Forces composed of educators, administrators, IT specialists, and community stakeholders to formulate comprehensive AI policies grounded in the ethical principles of beneficence, justice, and transparency. Such policies should ensure that AI applications do not reinforce algorithmic biases or exacerbate existing educational inequalities among diverse student populations, while routine bias audits and equity assurance evaluations should be mandated. In addition, schools should enforce strict data privacy protocols by conducting Data Privacy Impact Assessments before adopting third-party AI software. Institutions must guarantee that student Personally Identifiable Information (PII) is protected from unauthorized access through vendor transparency, data minimization practices, and compliance with national data protection regulations.

Furthermore, teacher professional development programs should move beyond basic technical troubleshooting and focus on strengthening AI literacy. Educators need to develop the capacity to critically evaluate AI-generated content, align algorithmic outputs with curriculum requirements, and maintain professional agency within increasingly automated educational environments. Teachers should be empowered to utilize AI for designing more effective instructional communication rather than merely automating administrative functions. To preserve empathy, moral development, and human connection in educational communication, schools are also encouraged to adopt the Human-AI-Human (H–AI–H) pedagogical model. This framework ensures that every use of AI in the classroom begins with human pedagogical inquiry and concludes with human reflection, critical judgment, and evaluation. By embedding AI within a character-centered pedagogical approach, educational institutions can position AI as a collaborative and subordinate teaching partner rather than a substitute for educators.

By prioritizing ethical governance, infrastructural equity, and human-centered pedagogy, educational institutions can effectively harness the power of Artificial Intelligence to cultivate a more responsive, inclusive, and dynamic learning communication environment for high school students. In this context, the integration of AI into learning communication strategies offers significant potential to improve educational quality by enabling more personalized, adaptive, and efficient learning experiences. Nevertheless, the successful implementation of AI technologies depends on several critical factors, including infrastructure readiness, educators' digital competencies, and an institutional culture that is receptive to technological transformation. Through coordinated and sustained efforts, Artificial Intelligence can become a strategic tool for strengthening the quality and effectiveness of secondary education in the future.

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