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Teacher as Toolmaker: Developing AI-Assisted Oral Assessment in Mathematics

Sri Rahmadhanningsih
Bosowa University

Ahmad Swandi
Bosowa University

Nurhayati Nurhayati
College of Teacher Training and Education-Singkawang

Asdar Asdar
Bosowa University

Hamsiah Hamsiah
Bosowa University

Burhan Burhan
Bosowa University

Luís Miguel Oliveira de Barros Cardoso
Polytechnic Institute of Portalegre

Abstract: This study examines the phenomenon of *teacher as toolmaker* through the development of an AI-assisted oral assessment platform in mathematics education within a post-pandemic context. Addressing the misalignment between educational technologies and classroom realities, the study adopts a qualitative instrumental case study approach using development artefacts, AI interaction logs, and classroom implementation notes. The findings identify three key dimensions. First, pedagogical primacy ensures that instructional goals drive technological design. Second, a symbiotic human–AI collaboration emerges, where AI supports technical development while the teacher retains pedagogical authority. Third, the platform enables ecological integration by combining task delivery, response capture, recording, and analysis into a unified system, enhancing both efficiency and insight into students' reasoning. The study demonstrates that teacher-led innovation can produce contextually responsive digital tools. It concludes that AI should function as a pedagogically grounded support system that extends, rather than replaces, teacher capacity, with implications for teacher development and educational technology design.

Keywords: Artificial intelligence in education, Mathematics education, Oral assessment, Teacher–AI collaboration, Teacher as toolmaker

Introduction

The rapid advancement of educational technology in the post-pandemic era has significantly transformed teaching and assessment practices. The widespread adoption of digital tools has enabled new forms of interaction, evaluation, and content delivery in classrooms. However, despite this expansion, a growing body of

research highlights a persistent misalignment between technological solutions and the contextual realities of pedagogical practice (Tripathi et al., 2025; Vorobyeva et al., 2025). Many educational technologies are designed with an emphasis on scalability and standardization, often overlooking the nuanced and situated nature of classroom teaching.

This misalignment is particularly evident in assessment practices, especially in mathematics education. Oral assessment plays a crucial role in uncovering students' conceptual understanding, reasoning processes, and problem-solving strategies through direct interaction. Compared to written assessments, oral approaches allow teachers to dynamically adjust questions and provide immediate, contextualized feedback. However, the implementation of such rich assessment practices remains challenging due to constraints such as limited time, difficulties in documentation, and issues related to consistency and reliability (Terrazas-Arellanes et al., 2025).

Recent developments in artificial intelligence (AI), particularly generative AI, offer new possibilities to address these challenges. AI technologies have demonstrated potential in supporting personalized learning, generating adaptive content, and facilitating various forms of assessment (Cardona et al., 2023; Mamta Kumari & Anoj Raj, 2025). Moreover, AI's capability to process and generate natural language enables its integration into practices that were previously difficult to digitize, including performance-based and interactive assessments. However, existing discourse often positions AI as a tool for automation, which may risk diminishing teacher agency and reinforcing top-down technological approaches (Dao et al., 2025; Holmes & Tuomi, 2022).

In response, there is a growing need to reconceptualize the role of teachers within educational technology ecosystems. Rather than being passive users of technology, teachers can act as active designers and developers of learning tools that reflect their specific pedagogical contexts. Research increasingly emphasizes the importance of teacher agency and the need to position educators as partners in AI integration rather than mere recipients of technological solutions (Tripathi et al., 2025).

Method

Research Design and Context

This study adopts a qualitative approach using an instrumental case study design to explore the phenomenon of a teacher acting as a toolmaker in the development of an AI-assisted oral assessment platform. This design was selected because it enables an in-depth exploration of a complex phenomenon within its real-life context, particularly the interaction between pedagogical practices, technological development, and teacher-led innovation (Creswell J. W, 2013). An instrumental case study also allows a specific case to be used to illuminate broader issues, including how artificial intelligence is integrated into classroom practice and how pedagogical decisions are negotiated during iterative design processes. Furthermore, this approach supports the investigation of dynamic and context-sensitive processes that cannot be reduced to isolated variables.

The study is situated in a post-pandemic educational context, where the use of digital technologies has significantly expanded across teaching and learning environments. Despite this expansion, prior research highlights a persistent misalignment between available technological solutions and the pedagogical realities faced by teachers in practice (Bond et al., 2018; Selwyn, 2024). In addition, the rapid development of artificial intelligence in education introduces both opportunities and challenges, particularly in relation to redefining the role of teachers and ensuring meaningful integration of technology (Holmes & Tuomi, 2022; UNESCO, 2021). These conditions provide relevant context for examining how teacher-led innovation can respond to emerging educational needs.

The focus of this study is the development of an oral assessment platform in mathematics education, which is specifically designed to capture students' thinking processes. Traditional written assessments often fail to reveal how students' reason is through mathematical problems, limiting teachers' ability to diagnose conceptual understanding. By contrast, oral assessment offers opportunities to explore students' reasoning in real time, supported by AI-assisted prompts and feedback. Therefore, this study investigates how such a platform is designed, refined, and implemented in authentic classroom settings.

Participant and Research Position

The participant in this study is a mathematics educator who also serves as the primary developer of the AI-assisted oral assessment platform. The participant was selected purposively because of his direct and sustained involvement in all stages of the development process, from identifying pedagogical needs to implementing the platform in classroom practice. This dual role provides unique access to the internal processes of design, including decision-making, experimentation, and iterative refinement. As a result, the study is able to capture insights that would be difficult to obtain through external observation alone.

In addition, the researcher assumes the role of a practitioner-researcher, which allows for a deeper engagement with the research context. This position enables access to rich and detailed data, particularly regarding interactions with the AI system and the rationale behind design choices. However, it also introduces potential biases due to the researcher's close involvement in the process. To address this, reflexivity was continuously practiced throughout the study, ensuring that interpretations remained critically examined and grounded in the data (Creswell J. W, 2013).

Data Sources and Collection

Data were collected from three primary sources to provide a comprehensive understanding of the platform's development and implementation. The first source consists of development artefacts, including platform designs, assessment structures, and iterative modifications made throughout the development process. These artefacts document how pedagogical ideas are translated into technological features and how they evolve over time. As such, they provide important insights into the design logic underpinning the platform.

The second source includes AI interaction logs, which capture the collaborative processes between the developer and the AI system. These logs provide detailed records of how prompts were generated, refined, and evaluated, offering a unique perspective on human–AI co-design processes. The third source consists of classroom implementation notes, documenting how the platform was used in authentic learning contexts and how students responded to the oral assessment tasks. Together, these data sources enable triangulation, enhancing the credibility and depth of the analysis.

In addition, the use of system-generated data aligns with approaches in learning analytics, which focus on understanding learning processes through digital trace data. Such approaches enable the examination of patterns in interaction and decision-making that may not be visible through traditional qualitative data alone (Ifenthaler & Yau, 2020). By combining multiple data sources, this study ensures a more comprehensive and nuanced understanding of the phenomenon under investigation.

Data Analysis

Data were analyzed using an inductive and iterative thematic analysis approach following the framework proposed by Braun & Clarke (2006). This approach was selected because it allows patterns of meaning to emerge from the data rather than being imposed by predefined categories. It is particularly suitable for complex, design-oriented studies where multiple data sources interact dynamically. Moreover, thematic analysis provides flexibility in capturing both explicit and implicit dimensions of meaning across the dataset.

The analysis process involved several stages, beginning with familiarization through repeated reading of all data sources. This was followed by initial coding, where meaningful segments of data were identified and labeled inductively. Subsequently, codes were grouped into preliminary themes, which were then reviewed and refined to ensure coherence and distinctiveness. Finally, themes were defined and clearly articulated to represent key patterns in the data.

To ensure the rigor and trustworthiness of the analysis, the process followed established qualitative research standards, including transparency, consistency, and systematic documentation of analytical decisions. Particular attention was given to maintaining an audit trail and ensuring that interpretations were grounded in the data. These practices align with recommendations by Nowell et al. (2017), which emphasize the importance of methodological rigor in thematic analysis. Through this approach, the study provides a credible and well-substantiated account of the development and implementation of the AI-assisted oral assessment platform.

Results and Discussion

Findings

Pedagogical Primacy in Design Decisions

The findings indicate that the development of the oral assessment platform was not driven by available technical possibilities, but rather by pedagogical needs emerging from classroom practice. From the initial stage, the system was designed to address the limitations of conventional assessments in capturing students' thinking processes, particularly in mathematics, which requires deep reasoning and structured representation. This orientation reflects a deliberate shift from technology-centered design to pedagogy-driven development, ensuring that each feature aligns with instructional goals. As a result, the system prioritizes meaningful assessment over mere technical functionality.

As the development progressed, multiple revisions were implemented in response to real classroom demands. One of the primary considerations was ensuring that the application could function offline, allowing it to be used in contexts with unstable or limited internet connectivity. This decision reflects the realities of classroom implementation, where reliance on internet access can disrupt assessment practices. Consequently, the system was designed to remain functional regardless of external technological constraints.

This is reflected in the platform interface (see Figure 1), where teachers select class and student data from a structured list, and the system automatically generates student information to support efficient assessment setup. The interface integrates class lists, student identities, and assessment packages into a single system, reducing administrative workload during assessment sessions. By simplifying data management, the system allows teachers to focus more on observing and evaluating student responses. For the purpose of publication, the interface displayed in Figure 1 has been translated into English; however, in actual classroom use, the platform is presented in the local language to ensure accessibility and ease of understanding for students.

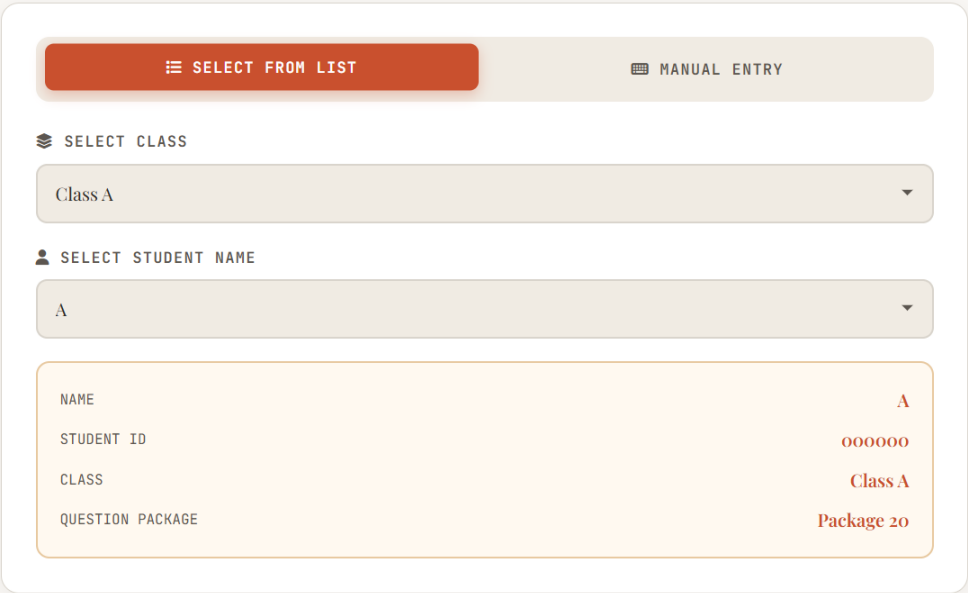

Figure 1. Interface of the AI-assisted oral assessment platform showing structured student selection and automatically generated student information. All data are anonymized for ethical purposes

In addition, the need to manage assessment time effectively led to the development of an automatic timer feature that regulates the duration of student responses. This feature addresses practical challenges encountered during oral assessments, where maintaining consistent timing across students can be difficult. The timer operates as an embedded control mechanism that ensures fairness and standardization, thereby improving the reliability of the assessment process. The assessment duration was standardized to five minutes for each session, and the system automatically terminates the process when the time limit is reached.

This integration is clearly visible in the system interface (see Figure 2), where the timer operates simultaneously with screen and audio recording while students engage with assessment tasks. This dual recording mechanism ensures that both verbal responses and on-screen activities are captured in real time. By automating these processes, the system minimizes the need for manual intervention and reduces the risk of data loss. The timer shown in Figure 2 represents the fixed five-minute duration, after which the system automatically ends the

recording session. Similar to Figure 1, the interface shown in Figure 2 is presented in English for clarity in publication, while the operational version used in classrooms remains in the local language.

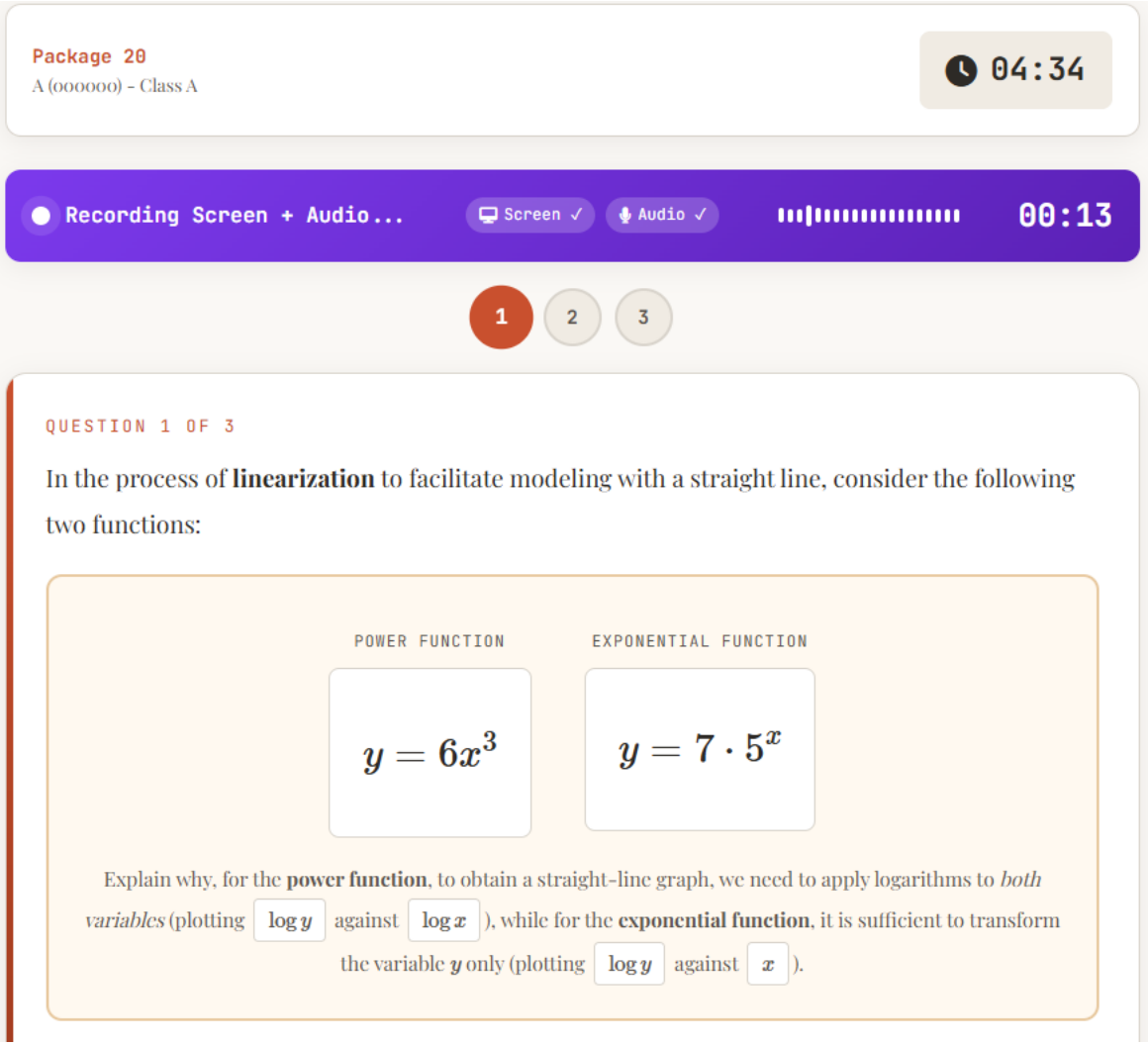

Figure 2. Integrated timer and dual recording system (screen and audio) during oral assessment, with a fixed five-minute duration that automatically terminates the session

Documentation also became a central consideration in system design, particularly in capturing students' thinking processes. The platform records not only spoken responses but also visual interactions through screen recording, allowing teachers to analyze how students approach problem-solving tasks. This enables a shift from product-oriented assessment to process-oriented evaluation. As a result, teachers gain deeper insights into students' reasoning and conceptual understanding.

Furthermore, the system incorporates structured student data and iterative refinement of assessment content. Question prompts were revised multiple times to eliminate ambiguity and improve clarity, ensuring that students can interpret tasks accurately. This iterative refinement reflects continuous pedagogical reflection throughout the development process. Overall, these findings demonstrate that the evolution of the platform is guided by pedagogical priorities rather than technological constraints.

Symbiotic Human–AI Collaboration

The second finding reveals that the development process occurred through an intensive and iterative collaboration between the teacher and artificial intelligence. In this process, AI functioned as a technical interpreter that translated pedagogical ideas into executable system structures. However, the teacher remained the primary decision-maker, evaluating and refining each output produced by the AI. This dynamic highlights a symbiotic relationship in which human expertise and artificial intelligence complement each other.

The interaction began with the need to develop an oral assessment application with specific features, including audio recording, structured question packages, and time constraints. The AI generated an initial version of the system, which was then subjected to multiple cycles of revision. Each iteration involved critical evaluation of the system's alignment with pedagogical objectives. This process ensured that the resulting platform was not only technically functional but also educationally meaningful.

The outcomes of this human–AI collaboration are observable in the task interface (see Figure 3), where mathematical representations and interactive elements are integrated to support conceptual understanding and student exploration. The interface reflects multiple layers of refinement, particularly in improving clarity, usability, and conceptual representation. Mathematical expressions were adjusted to ensure accuracy, while visual elements were enhanced to support student comprehension. As shown in Figure 3, the interface is presented in English for publication clarity, while the operational version used in classroom practice remains in the local language to preserve contextual relevance.

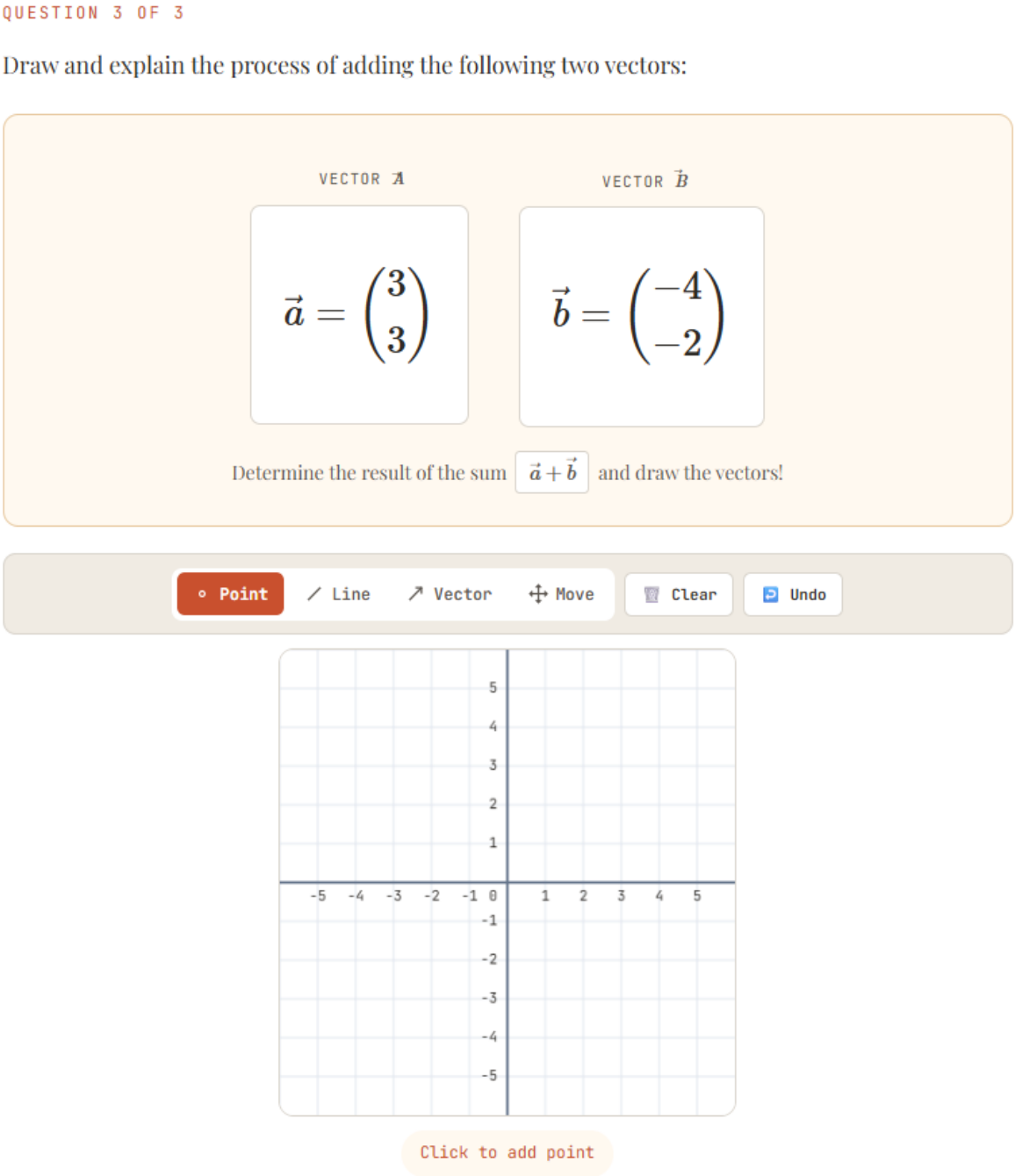

Figure 3. Example of AI-generated mathematical tasks combining structured representations and interactive elements to support student reasoning and exploration

The collaborative process also addressed various technical challenges encountered during development. For example, delays in recording storage were resolved through system optimization to match the time-sensitive nature of oral assessment. Similarly, improvements were made to the rendering of mathematical expressions to enhance readability and conceptual clarity. Interactive components were also refined to encourage student engagement and exploration. These adjustments illustrate how iterative collaboration leads to continuous system improvement.

These findings demonstrate that AI does not replace the role of the teacher but instead expands the teacher's capacity to design technological solutions. The teacher actively interprets, evaluates, and modifies AI-generated outputs to ensure alignment with instructional goals. This reinforces the importance of teacher agency in technology integration. To further illustrate this iterative process, a summary is presented in Table 1.

Table 1. Summary of iterative development process and teacher–AI prompt interactions

Development Stage	Focus of Revision	Teacher Instruction / Prompt	AI Response	Pedagogical Adjustment
Initial	System structure	Develop an oral assessment application with audio recording and question packages	Generated initial system framework	Establishing assessment based on students' reasoning
Iteration 1	Offline system	The system must operate without internet access	Adapted local storage functionality	Ensuring assessment usability in limited connectivity contexts
Iteration 2	Time management	Add an automatic timer feature	Implemented countdown timer	Controlling response duration consistently
Iteration 3	Recording	Record both audio and screen activity	Implemented audio and screen recording	Documenting students' thinking processes
Iteration 4	Student data	Integrate class-based student list	Implemented structured input system	Improving efficiency of assessment administration
Iteration 5	Question content	Revise question wording for clarity	Reformulated question prompts	Reducing ambiguity in student understanding
Iteration 6	System flow	Ensure process ends and saves automatically	Improved saving mechanism	Preventing data loss during assessment

Ecological Integration of Assessment Components

The third finding shows that the development of the platform resulted in the integration of multiple assessment components into a unified system. In conventional practice, task delivery, response collection, recording, and evaluation are often conducted separately, leading to inefficiencies and fragmented data. This fragmentation limits the teacher's ability to capture the full scope of student learning processes. As a result, assessment practices often emphasize final answers rather than the reasoning behind them. Through the developed platform, these components are integrated into a single, coherent workflow. Students can access questions, provide oral responses, and have their interactions automatically recorded within one environment. This integration reduces reliance on multiple tools and simplifies the assessment process. Consequently, teachers can focus more on interpreting student understanding rather than managing technical procedures.

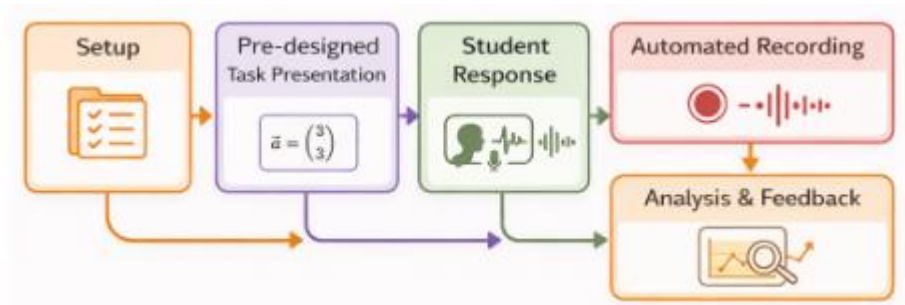

Figure 4. Workflow of the AI-assisted oral assessment system illustrating the sequence from assessment setup, pre-designed task presentation, student response, automated recording, to analysis and feedback

This integrated workflow is illustrated in the system design (see Figure 4), where task presentation, response capture, and data storage are seamlessly connected. The figure demonstrates how different components interact within a unified structure, reducing fragmentation and improving efficiency. As with previous figures, the interface shown has been adapted into English for publication clarity, while the actual classroom implementation remains in the local language to support student comprehension. This distinction highlights the balance between research communication and contextual authenticity.

The addition of screen recording further extends the function of assessment by enabling detailed analysis of students' problem-solving processes. Teachers can review how students approach tasks, identify misconceptions, and evaluate reasoning strategies. This provides a richer and more comprehensive understanding of student learning. As a result, assessment becomes both evaluative and diagnostic in nature.

In addition to improving the quality of assessment data, the integrated system reduces the cognitive and logistical burden on teachers. Automated features such as recording, timing, and data storage streamline the implementation of oral assessments. This allows teachers to allocate more attention to pedagogical interpretation and feedback. Overall, the platform demonstrates how technology can enhance both efficiency and depth in assessment practices when guided by pedagogical priorities.

Across these findings, the platform functions not merely as a technological tool, but as a pedagogically driven system in which design decisions are continuously shaped by classroom realities. This reinforces the importance of aligning technological development with contextual needs. It also highlights the role of teachers as active designers in educational innovation. Ultimately, the findings contribute to a deeper understanding of how AI can support, rather than replace, pedagogical practice.

Discussion

The findings of this study contribute to the growing discourse on artificial intelligence in education by repositioning teachers as active designers, rather than passive users of technology. This perspective aligns with prior research emphasizing the importance of teacher involvement in the co-design of AI-supported learning environments, where educators actively shape both pedagogical and technological dimensions of instruction (Lin & Brummelen, 2021; Tripathi et al., 2025). In contrast to dominant narratives that position technology as the primary driver of educational transformation, this study reinforces the argument that meaningful innovation in education must originate from pedagogical needs rather than technological affordances. Existing literature has consistently highlighted a persistent misalignment between rapidly advancing educational technologies and the complex realities of classroom practice (Ouyang & Jiao, 2021; Zawacki-Richter et al., 2019).

First, the finding on pedagogical primacy underscores that effective educational technology design should be grounded in pedagogical intentions. The system developed in this study demonstrates how features such as offline functionality, structured student input, and controlled assessment timing emerged from contextual classroom needs rather than technical convenience. This supports the broader argument that technology integration must be guided by teachers' professional knowledge and contextual awareness (Ouyang & Jiao, 2021). Without such grounding, AI-driven systems risk promoting superficial or procedural learning, a concern widely discussed in the literature on AI in education (Zawacki-Richter et al., 2019). Furthermore, the findings reinforce the idea that teachers should retain pedagogical control, ensuring that AI serves as a tool that adapts to instructional goals rather than dictating them.

Second, the findings on human–AI collaboration highlight a complementary relationship in which AI extends, rather than replaces, teacher capacity. This aligns with the concept of "human-in-the-loop" systems, where AI supports decision-making while teachers remain the final authority in pedagogical judgments (Chaudhry & Kazim, 2022). In this study, AI functioned as a technical mediator that translated pedagogical intentions into system features, while the teacher critically evaluated and refined the outputs. This reflects the paradigm shift toward AI-supported and AI-empowered learning, where humans and AI collaborate in iterative processes rather than operate in isolation (Ouyang & Jiao, 2021). Importantly, the use of pre-designed and standardized assessment tasks ensures consistency and fairness, addressing concerns about validity and reliability in AI-supported assessment systems.

Moreover, the findings extend the concept of teacher agency beyond technology use to include active participation in system development. This supports emerging research emphasizing that teachers should not be positioned as end-users, but as partners in the design and implementation of AI technologies (Tripathi et al.,

2025). The iterative development process observed in this study illustrates how continuous evaluation and refinement are essential for aligning AI systems with pedagogical objectives. This also highlights the growing importance of new competencies among educators, including the ability to critically interpret AI-generated outputs and adapt them to specific instructional contexts. Such competencies are increasingly recognized as essential components of AI literacy and professional development in the digital era (Chaudhry & Kazim, 2022).

In addition, the findings implicitly address key ethical considerations in AI-supported education, particularly in relation to fairness, transparency, and accountability. The structured design of assessment tasks and the teacher's central role in validating AI outputs contribute to more trustworthy and explainable systems. This aligns with the growing emphasis on explainable AI (XAI) in education, which advocates for transparency in how AI systems generate recommendations and decisions (Khosravi et al., 2022). Without such transparency, there is a risk that AI systems may introduce bias, reinforce misconceptions, or reduce learner autonomy.

Finally, this study contributes to a broader reconceptualization of AI in education, shifting from automation-driven models toward human-centered, pedagogically grounded systems. While early developments in AI in education often focused on efficiency, automation, and scalability, recent research suggests a growing need to prioritize human agency, contextual relevance, and ethical responsibility (Holmes & Tuomi, 2022; Zawacki-Richter et al., 2019). The findings of this study provide empirical support for this shift, demonstrating that teacher-led, context-sensitive design can produce more meaningful and sustainable educational innovations. Therefore, future research should further explore collaborative design models, particularly in diverse and resource-constrained contexts, to better understand how AI can be effectively integrated into real-world educational settings.

Conclusion

This study examines the phenomenon of teacher as toolmaker through the development of an AI-assisted oral assessment platform in a post-pandemic context. The findings demonstrate that teacher-led innovation can produce assessment solutions that are closely aligned with pedagogical needs and classroom realities. This is particularly evident in mathematics education, where understanding students' reasoning processes requires more than conventional written assessment approaches. By situating technology within authentic classroom practice, the study highlights how pedagogical concerns can effectively guide technological development.

Three key findings underpin this contribution. First, pedagogical considerations consistently guided the design process, ensuring that all technological features directly addressed practical classroom challenges. Second, the collaboration between teacher and AI was iterative and symbiotic, with AI supporting technical processes while the teacher retained full pedagogical control. Third, the platform enabled the integration of multiple assessment components into a unified system, improving both efficiency and the depth of insight into student learning processes.

These findings highlight the importance of positioning teachers as active designers rather than passive users of technology. From a practical perspective, this implies the need to support teachers in developing design-oriented and AI-related competencies. From a research perspective, further studies are needed to explore how teacher–AI co-design can be implemented across diverse educational contexts. Overall, this study suggests that AI should function as a pedagogically responsive tool shaped by teachers to support meaningful and context-sensitive assessment practices.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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Author(s) Information

Sri Rahmadhanningsih
Bosowa University (Universitas Bosowa), Jl. Urip Sumoharjo Km 4, Makassar, Indonesia
ORCID iD: https://orcid.org/0000-0002-9423-729X
*Contact e-mail: sri.rahma@universitasbosowa.ac.id

Nurhayati Nurhayati
College of Teacher Training and Education-Singkawang (Institut Sains dan Bisnis Internasional Singkawang)
Jl. STKIP, Naram, Singkawang Utara, Indonesia
ORCID iD: https://orcid.org/0000-0003-0644-6700

Hamsiah Hamsiah
Bosowa University (Universitas Bosowa)
Jl. Urip Sumoharjo Km 4, Makassar, Indonesia
ORCID iD: https://orcid.org/0000-0002-1877-2602

Luís Miguel Oliveira de Barros Cardoso
Polytechnic Institute of Portalegre, Portugal
Praça do Município 11, 7300-110 Portalegre, Portugal
ORCID iD: https://orcid.org/0000-0003-3748-5593

Ahmad Swandi
Bosowa University (Universitas Bosowa), Jl. Urip Sumoharjo Km 4, Makassar, Indonesia
ORCID iD: https://orcid.org/0000-0003-4884-4416

Asdar Asdar
Bosowa University (Universitas Bosowa)
Jl. Urip Sumoharjo Km 4, Makassar, Indonesia
ORCID iD: https://orcid.org/0000-0002-3277-0283

Burhan Burhan
Bosowa University (Universitas Bosowa)
Jl. Urip Sumoharjo Km 4, Makassar, Indonesia
ORCID iD: https://orcid.org/0009-0007-3293-8692

*Corresponding author(s) contact email

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