


## Validity of SIPENA: An AI-Integrated Web-Based Application for Mathematics Teachers Learning Administration

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### ABSTRACT

The rapid advancement of digital technology requires mathematics teachers to have strong pedagogical competence in designing and managing learning materials effectively. However, many teachers still face challenges in preparing comprehensive learning documents, such as Annual Programs (Prota), Semester Programs (Promes), teaching modules integrated with student worksheets (LKPD), assessment instruments, reflections, document covers, and class administration records. This study aimed to develop and assess the validity of SIPENA (Sistem Perangkat Pembelajaran/Learning Administration System), an AI-integrated web-based application that automatically generates complete learning documents for mathematics teachers. The development followed the 4D model (Define, Design, Develop, and Disseminate), limited to the first three stages. Expert validation was conducted by a media expert and a content expert using Likert-scale instruments. The results showed a media validity 86.36% and content validity of 96.84%, both were categorized as Very Valid. Usability was awarded the highest score by media experts (96.00%), while content experts confirmed that their product matched Merdeka Curriculum perfectly (100.00%). This study finally provides a valuable contribution to the field of AI-based educational technology in mathematics education context in Indonesia by showing that SIPENA can serve as both a valid and feasible platform to use for supporting mathematics teachers pedagogical competences in the digital era. This study was intentionally limited to evaluating the validity aspect of SIPENA development, while its effectiveness and effect size will be explored in a subsequent publication.

**Keywords:** Artificial Intelligence, Learning Administration System, Mathematics Teacher, Pedagogical Competence, SIPENA.

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### Introduction

The rapid advancement of digital technology has significantly transformed the educational landscape, especially in the way teachers design, manage, and implement learning practices. Through the lens of math education, math teachers have to not only know the content but also be both competent and proficient in developing thorough and well-structured learning documents. Good mathematics learning according to the Merdeka Curriculum is based on these documents consisting of Annual Programs (Prota), Semester Programs (Promes), Teaching Modules, Student Worksheets (LKPD) assessment instruments, and class administration records (Kemendikbudristek, 2022).

Despite its critical importance in preparing learning documents, it is one of the big challenges that mathematics teachers still face. Some Elementary Maths teachers have a difficult time adjusting to these new mandates, specifically the aspects of creating differentiated instruction and authentic assessment tools (Mukhibin & Nafidhoh, 2023). It is a lengthy and cumbersome process that leads to formatting issues and discrepancies with curriculum standards (Rahayu et al., 2022). The circumstances are aggravated with the constant change in curriculum in Indonesia, which requires teachers to continuously refactor learning documents (Hadi & Retnawati, 2025). Based on the latest data from PISA 2022, Indonesia's mathematics literacy scores ranked only 71st out of the world's 80 countries (OECD, 2023), indicating an urgent need to enhance overall mathematics learning quality, which includes the quality of teachers' learning materials in addition to instructional documents..

Artificial Intelligence (AI) integration in education is an emerging solution to administrative issues. AI-Powered Educational Tools: These tools have proven successful in automating routine work and overall educational process efficiency (Holmes, 2021; Luan, 2020). Previous studies have demonstrated that generative AI effectively supports multimodal learning processes and can provide responsive feedback (Baidoo-Anu & Ansah, 2023; Chiu, 2023; Christoforou & Ioannou, 2024). Specifically, Google's Phil earned himself a 'cult following' following the report's release and tools like Google Gemini could support next-gen AI educational tools that allow teachers to quickly generate learning materials and assessments and provide personalize feedback on both student work. (Imran & Almusharraf, 2024). Later research backed up, indeed, that AI is a key part of the 21st-century learning experience (Akgun & Greenhow, 2022; Crompton & Burke, 2023). Similarly, (Seo, 2021) showed that AI-assisted tools significantly reduced teachers administrative workload while improving document quality and consistency.

Several studies have explored the development of web-based platforms and digital media to support teachers' pedagogical work. Previous research showed that AI-based digital media achieved a media validity score of 91.1% and a content validity score of 86.4% in the context of mathematics learning for visual-spatial intelligence (Wahyuni, 2023). Research on digital technology in mathematics education has further demonstrated that well-designed digital-based learning media significantly improves students' mathematical ability (Cirneanu & Moldoveanu, 2024). Similarly, (Muflikhah & Kamal, 2024) demonstrated that web-based media can effectively support mathematical assessment in elementary schools, further affirming the potential of

digital tools in enhancing mathematics learning practices. Beyond media development, the design of mathematics learning tools based on realistic mathematics education approaches has also been shown to support meaningful and contextual learning for junior high school students (Fausiah et al., 2023). Subsequent research backed this finding, confirming that AI acted as an efficient scaffold (a term often used in education) by designing personalized and adaptive systems to support students at any point along the continuum of expertise (Hwang & Tu, 2021). Previous research stressed the need for validity criteria in evaluating technology-enhanced learning tools; thus, it provides the educational technology development based on clear landmarks (Van Haastrecht et al., 2024).

These new requirements for preparing learning documents in the Indonesian context as a result of implementing the Merdeka Curriculum prepare instructional plans that are more flexible and student-centered (Kemendikbudristek, 2022). Furthermore (Mukhibin & Nafidhoh, 2023) showed that many mathematics teachers struggle to adapt to these new requirements, particularly in designing differentiated instruction and authentic assessment instruments. Most prior studies on education technology for instructors have been largely restricted to Learning Management Systems (LMS) and digital content system, with limited consideration of AI-based document generation systems specifically designed for mathematics teachers (Furqon et al., 2023). Some commercial tools do provide AI-assisted document creation but are usually not designed with the particular needs of the Indonesian curriculum and the mathematics education context in consideration.

Which brings us to the gap for a locally developed context-sensitive solution. The existing studies have, in particular, failed to address the development of AI systems that automatically output complete documents (to be used as lesson plans) generated for classroom use and aligned with the core elements of curriculum relevant to the secondary education administrative burden faced by Indonesian mathematics teachers under Merdeka Curriculum . While prior studies have explored digital media and LMS platforms, no validated tool has been reported that integrates AI-based document generation within a single, locally developed platform. This gap is particularly evident in the context of Indonesian mathematics teachers, who require a comprehensive system that covers the full range of Merdeka Curriculum administrative components, from annual programs and teaching modules to assessment instruments and class management records.

This study addresses the gap by developing SIPENA (Sistem Perangkat Pembelajaran), an AI-integrated web-based learning administration system specifically designed for mathematics teachers. SIPENA enables teachers to input key learning parameters and automatically generates complete learning documents, including Prota, Promes, Teaching Modules integrating LKPD, assessment, and reflection, document covers, as well as class attendance and grading management systems, all in standardized formats aligned with the Merdeka Curriculum. The primary objective of this study is therefore to develop and rigorously evaluate the content and media validity of SIPENA as a learning administration system for mathematics teachers in the digital era. Validity assessment constitutes a critical and non-negotiable first phase of educational technology development, as it establishes the foundational quality of a product before any field implementation can be meaningfully evaluated (Plomp, 2023; Yaniawati et al., 2021). Accordingly, this study deliberately focuses on this foundational phase, with the understanding that evaluations of practicality and effectiveness will be carried out in subsequent stages of research.

## Methods

### Research Design

This study employed a Research and Development (R&D) approach using the 4D model (Define, Design, Develop, and Disseminate) developed by (Yaniawati et al., 2021). The 4D model was selected for its systematic and structured framework for developing educational technology products (Wijaya et al., 2022; Yaniawati et al., 2021). For the purposes of this study, the research was limited to the first three stages Define, Design, and Develop as the Disseminate stage will be implemented through a community service program (PKM) involving mathematics teachers in Tasikmalaya. This approach is consistent with previous educational technology development research that successfully applied a partial 4D model for media validation purposes (Plomp, 2023).

### Participants or Data Sources

The participants in this study consisted of two expert validators selected through purposive sampling based on their relevant expertise. The first validator was a media expert, Tepy Oktari, S.I.Kom., M.A.P., a lecturer in public administration and a vocational teacher specializing in Multimedia, as well as a professional producer, director, and writer, with academic backgrounds in Communication Science and Public Administration. The second was a content expert, Belda Nurmultiefa Lesmana, M.Pd., a Mathematics Education lecturer at Universitas Islam Darussalam Ciamis.

Both validators were selected based on their competence in evaluating web-based educational media and mathematics learning content, respectively. This study does not involve human subjects in a clinical or sensitive research context; however, it would be best to avoid using basic re-analysis techniques such as this with any type of PII. However, all participants gave informed consent before taking part and the data were collected and reported in accordance with relevant standards for research ethics.

### **Research Instruments**

The primary instruments used in this study were validation questionnaires designed for two expert validators: a media expert and a content expert. The media validation instrument assessed four aspects of SIPENA: display (5 items), usability (5 items), functionality (8 items), and technical performance (4 items). Hence, the content validation instrument was used to evaluate four criteria: curriculum alignment (5 items), mathematics content quality (5 items), component completeness of the document (5 items) and support for pedagogical competence (4 items). These instruments followed a five-point Likert scale from 1 (Not Feasible) to 5 (Very Feasible).

### **Research Procedures**

The Define stage involved a comprehensive needs analysis through direct observation and unstructured interviews with mathematics teachers at the research school to identify key challenges in preparing learning documents and to map the difficulties encountered in implementing the Merdeka Curriculum (Fitriani et al., 2023). An analysis of Merdeka Curriculum requirements was also conducted to establish the standard components needed for each type of learning document. The Design stage involved developing the system architecture, user interface design, and AI integration framework. The SIPENA platform was designed as a web-based application with six main features: (1) an Annual Program (Prota) generator, (2) a Semester Program (Promes) generator, (3) a Teaching Module generator integrating LKPD, assessment, and reflection, (4) a document cover generator, (5) an attendance management system, and (6) a student grade management system. All document generation features are AI-powered, requiring teachers to only input key parameters such as subject, grade level, and learning objectives. The Develop stage involved the actual construction of the SIPENA web application, followed by expert validation. The developed platform was then presented to the previously selected media and content experts for validation. Both experts evaluated SIPENA using the validation instruments described above.

### Data Collection Techniques

Data were collected using two primary techniques. First, expert validation data were obtained through structured validation questionnaires distributed directly to the two expert validators during the Develop stage. Each validator independently assessed SIPENA using the respective validation instrument. The media validation questionnaire (22 items across four aspects) and the content validation questionnaire (19 items across four aspects) both employing a five-point Likert scale. Validators were also given direct access to the SIPENA platform to facilitate hands-on evaluation before completing the questionnaire. Second, needs analysis data were collected at the Define stage through direct observation of mathematics teachers' learning document preparation practices and unstructured interviews conducted at the research school in Tasikmalaya. These interviews explored the key challenges teachers face in preparing learning documents aligned with the Merdeka Curriculum and informed the design requirements of SIPENA.

### Data Analysis Techniques

Data from the validation instruments were analyzed using a percentage formula to determine the validity level of SIPENA. The validity percentage was calculated as follows:  $\text{Validity (\%)} = (\text{Total Score Obtained} / \text{Maximum Total Score}) \times 100\%$ . The validity percentages were then interpreted using the criteria adapted from (Plomp, 2023) as presented in Table 1.

**Table 1.** Validity Criteria

Validity (%)	Category	Decision
85.01% – 100%	Very Valid	No revision needed
70.01% – 85%	Valid	Minor revision
50.01% – 70%	Fairly Valid	Major revision
01% – 50%	Not Valid	Cannot be used

Adapted from (Wijaya et al., 2022)

## Result and Discussions

### Define Stage

During the Define stage it was determined via needs analysis that mathematics teachers encountered major challenges preparing comprehensive and coherent curriculum documents. A recent study revealed that teachers were spending hours a week preparing documents for their classes. The major challenges that you found are:

the difficulty of preparing learning documents according to the latest school format in accordance with the Merdeka Curriculum; there are differences between teachers in writing formats; and understanding about what is needed as a whole for each type of learning document. According to the researchers, these findings echo previous research pointing to the administrative burden on teachers in Indonesian schools (Rahayu et al., 2022).

### Design Stage

Based on the needs analysis, SIPENA was designed as a comprehensive web-based learning administration system with six integrated features. System architecture created with AI Integration seamless flow- Teachers provide few parameters and complete learning documents get generated automatically. Simplicity and ease of use were important factors during the design phase, so that teachers could use the system regardless of their familiarity with digital systems. This framework of integrated AI was created to generate documents that conform to Merdeka Curriculum standards and components. Figure 1 lays out the general form of SIPENA dashboard by Design stage, including main menu navigation; document formulas; and class management panel only enabled for teachers after they are logged in.

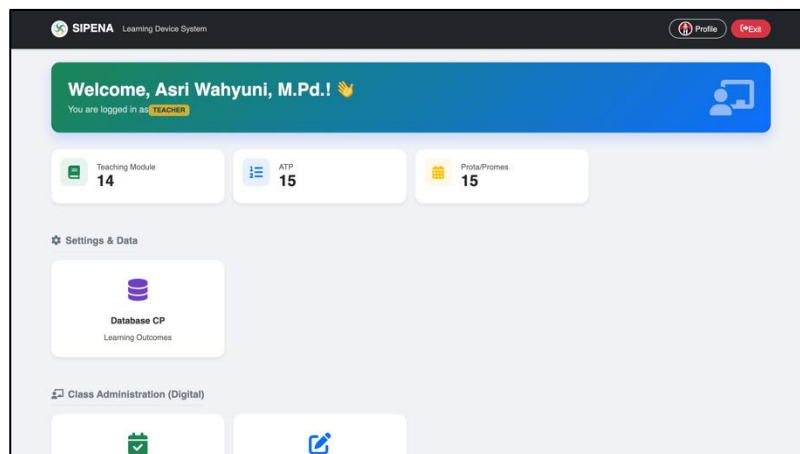
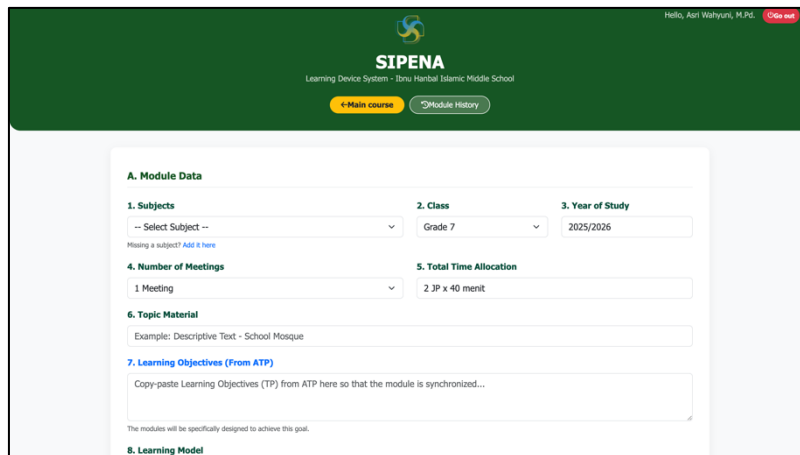


Figure 1. SIPENA Dashboard View at Design Stage

### Develop Stage

The Develop stage produced a fully functional SIPENA web platform. The six main features of SIPENA operate as follows: (1) the Prota Generator produces a complete Annual Program based on the subject, grade level, and academic year entered by the teacher; (2) the Promes Generator produces a complete Semester Program with a weekly distribution of learning topics; (3) the Teaching Module Generator produces a comprehensive module integrating LKPD, assessment instruments, and reflection

components according to the specified learning objectives; (4) the Cover Generator produces professional document covers for all learning documents; (5) the Attendance Management System enables teachers to digitally record and manage student attendance; and (6) the Grade Management System enables teachers to input, calculate, and manage student grades efficiently. [Figure 2](#) shows the input interface of the Teaching Module Generator feature, where teachers enter key parameters, including subject, grade level and academic year when designing a Module along with number of meetings per week and learning objectives.



**Figure 2.** Display of the SIPENA Teaching Module Generator Feature at the Development Stage

Media expert validation assessed SIPENA across four aspects: display, usability, functionality, and technical performance. The validation results are presented in [Table 2](#).

**Table 2.** Media Expert Validation Results

No.	Assessment Aspect	Score Obtained	Max Score	%
1	Display	21	25	84.00
2	Usability	24	25	96.00
3	Functionality	34	40	85.00
4	Technical Performance	16	20	80.00
	Total	95	110	86.36
	Category	Very Valid		

The media validity test obtained a total of 86.36 % that SIPENA was valid with his very valid category. Usability obtained the highest score (96.00%) which means that SIPENA interface is intuitive and can be used without specific training. The result indicates that SIPENA is capable of helping teachers handle their administrative responsibilities. In addition, the use of AI in this app also coincides with a global trend towards technology-assisted administration in schools. In the context of mathematics education specifically, (Wijaya et al., 2024) Stated that AI-based administration systems are critical in digital transformation allowing teachers to govern learning processes more systematically and quickly. The media expert specifically noted the need to improve the Teaching Module generator feature due to errors in the Assessment and Reflection components. The expert also recommended strengthening data security by restricting data access permissions for each teacher according to their respective subject areas. These findings are consistent with (Wahyuni, 2023), who obtained a media validity score of 91.1% for AI-based digital media in mathematics learning, and with (Wijaya et al., 2022), who confirmed that well-designed technology-based media achieves high validity levels.

Content expert validation assessed SIPENA across four aspects: curriculum alignment, mathematics content quality, document component completeness, and pedagogical competence support. The validation results are presented in [Table 3](#).

**Table 3.** Content Expert Validation Results

No.	Assessment Aspect	Score Obtained	Max Score	%
1	Curriculum Alignment	25	25	100.00
2	Mathematics Content Quality	23	25	92.00
3	Document Component Completeness	24	25	96.00
4	Pedagogical Competence Support	20	20	100.00
	Total	92	95	96.84
	Category	Very Valid		

Content validation results showed that SIPENA achieved a total validity percentage of 96.84%, which was categorized as Very Valid. The content expert noted that the documents generated by SIPENA were aligned with the requirements of the Merdeka Curriculum, and that the LKPD, assessment, and reflection components integrated into the Teaching Module were comprehensive and appropriate for mathematics learning. The curriculum alignment and pedagogical competence support aspects

received perfect scores (100.00%), demonstrating that SIPENA is fully aligned with the demands of the Merdeka Curriculum. The content expert recommended improvements in two areas: (1) the assessment rubric in the LKPD should be clarified by adding assessment criteria and scoring weights to make the evaluation process more objective and measurable; and (2) the learning reflection section should be written more explicitly, both for student and teacher reflections, to strengthen the overall learning evaluation process. These findings are consistent with (Wahyuni, 2023) who obtained a content validity score of 86.4% for AI-based media in mathematics, and with (Van Haastrecht et al., 2024), who emphasized the importance of curriculum alignment in learning device validity assessment.

It is acknowledged that test results and effect size are important indicators of product effectiveness. However, as this study was intentionally limited to the validity dimension of SIPENA development, such measures fall outside the scope of the present investigation. A subsequent study examining the practicality and effectiveness of SIPENA through field implementation, including the measurement of effect size, will be addressed in a subsequent publication. It is important to clarify the intentional scope of the present study in relation to the broader evaluation framework of educational technology products. Following the quality criteria for educational technology products established in the R&D literature which distinguish validity, practicality, and effectiveness as separate and sequential dimensions of product quality (Plomp, 2023; Yaniawati et al., 2021). This study was purposefully designed to focus on validity as the foundational phase of SIPENA's development. Establishing validity is a prerequisite before field-based evaluation can be meaningfully conducted; a product that has not been validated by domain experts cannot be responsibly deployed for practicality or effectiveness testing. In this respect, the present study fulfills a critical and complete research objective within the phased development trajectory of SIPENA. This phased approach is consistent with established practices in educational R&D research in Indonesia (Plomp, 2023; Yaniawati et al., 2021) and ensures that each dimension of product quality receives rigorous and focused attention.

From both Experts validation results prove that SIPENA is a valid and feasible platform to facilitate the administrative and pedagogical work of mathematics teachers. Document generation powered by AI is a huge step up from the well-trodden path of manual document preparation, since it really cuts down on the workload and aligns with curriculum whilst remaining consistent. These findings are supported by

(Holmes, 2021), who translated it to the educational field and showed that AI solutions can automate repetitive tasks and help us become efficient in our work. Additionally, SIPENA's web-based nature brings it closer to accessibility on various devices and locations, an even more relevant issue in the post-pandemic world of education (Zawacki-Richter, 2021). At the school level, the utilization of AI in educational administration has been shown to enhance overall school performance, particularly in supporting teachers' operational and managerial responsibilities (Hutami, 2024).

This study extends prior work conducted by Wahyuni and colleagues (Wahyuni, 2023; Wahyuni, 2025) which demonstrated the effectiveness of AI and visual media in student learning contexts, by showing that AI integration can also be effectively applied in teacher administrative systems. While those studies focused on student-facing media including SAC-assisted comic media for visual-spatial intelligence and generative AI as multimodal scaffolding. The present study demonstrates that AI can also transform the administrative dimension of teachers' work. The perfect curriculum alignment scores (100%) obtained in this study further align with (Van Haastrecht et al., 2024), who emphasized that curriculum coherence is a non-negotiable criterion in evaluating the validity of educational tools developed in the Indonesian context.

The recommendations provided by both validators including addressing errors in the Assessment and Reflection components of the Teaching Module generator, improving data security through role-based access control, clarifying assessment rubrics, and making reflection components more explicit—provide a clear roadmap for the refinement of SIPENA. These findings are consistent with (Seo, 2021), who observed that building inclusive AI-supported educational tools requires an iterative process based on expert input. The high usability score (96.00%) also suggests that SIPENA had potentially overcome the issue of low digital literacy among teachers as documented in previous studies (Fitriani et al., 2023) About barriers for implementing educational technology in Indonesian schools. In direct response to these recommendations, the developer identified three priority improvements for the next iteration of SIPENA: (1) correcting errors in the Teaching Module generator's Assessment and Reflection outputs by refining the AI prompt structure to ensure that all required components are generated completely and accurately; (2) implementing a role-based access control system to restrict each teacher's data access to their respective subject area, thereby strengthening data privacy and security; and (3) revising the assessment rubric within the LKPD template to include explicit criteria descriptors and scoring weights, while restructuring the reflection section to separately accommodate

both student and teacher reflection components. These proposed upgrades are in line with the iterative development strategy championed by (Seo, 2021) And show that the developer is really serious about building not just a technically valid platform but one that's also practical for real-world classroom use. Complementing this, (Nemani, 2025) found that AI-driven administrative tools are pushing teachers into higher-octane work environments, so they need better systems to respond faster and more efficiently – streams auto-minimize the manual labor of administration while allowing them more time to focus on the quality of instruction.

Overall, these findings establish SIPENA as a theoretically-based, expert-endorsed platform in readiness for the next stage of its evolutionary path. The transition from the Develop stage to the Disseminate stage represents a natural progression in the 4D model framework, and the validity scores obtained in this study provide the necessary foundation for that progression with confidence.

## **Conclusion**

This study successfully developed SIPENA (Sistem Perangkat Pembelajaran), an AI-integrated web-based learning administration system for mathematics teachers, through the Define, Design, and Develop stages of the 4D model. Expert validation confirmed that SIPENA achieved Very Valid ratings in both media validity (86.36%) and content validity (96.84%), establishing it as a valid and feasible platform for supporting mathematics teachers in preparing comprehensive learning documents aligned with the Merdeka Curriculum. Future research will examine the practicality and effectiveness of SIPENA through broader field implementation.

Some limitations of the current study suggest avenues for future research. As the first and foremost aspect, a tuberculosis study of SIPENA practical aspects and effectiveness needs to be conducted with wider scale mathematics teachers from different levels and areas in Indonesia. Such a study should employ pre- and post-measures of teachers' administrative workload, document quality, and pedagogical competence to quantify the platform's impact. The Disseminate stage of SIPENA's development, involving field implementation through a community service program (PKM) with mathematics teachers in Tasikmalaya Regency, will be discussed in a subsequent publication. Second, future studies need to widen the validator panel with further experts, like practitioners of mathematics education from schools who have intensive classroom experiences to strengthen the credibility and comprehensiveness in measuring validity.

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