

## Development of Abacus Training Management in the Artificial Intelligence Era

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**ABSTRACT.** The growing reliance on AI-driven technologies has raised critical concerns about the decline in students' abilities in critical thinking, logical reasoning, and motor skills. In response, this study investigates the potential of abacus learning a traditional method that stimulates both hemispheres of the brain by engaging both hands simultaneously to mitigate these challenges. The primary objective is to develop and evaluate an abacus training management model that strengthens the instructional competence of Madrasah Ibtidaiyah teachers, enabling them to implement abacus-based learning effectively within the context of modern educational demands. The research was conducted at Madrasah Ibtidaiyah Negeri Bandar Lampung using the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation stages. Data were collected through surveys, interviews, and documentation to support the design, development, and validation of the training model. Expert assessments demonstrated high feasibility: material experts rated the model at 88.75%, and media experts at 92.5%. Additionally, teachers who participated in the training assessed its effectiveness at 85%, indicating strong usability. Quantitative analysis using a t-test revealed a t-observed value of 44.737, significantly exceeding the t-critical value of 2.069 at a 0.05 significance level. This confirms that the model is statistically effective in improving teachers' abacus teaching skills. These findings reaffirm the continued relevance of traditional tools like the abacus in an era dominated by artificial intelligence. The study concludes that integrating such manual learning strategies can complement digital advancements. Future research is recommended to explore this model's application across varied educational settings and learner demographics.

**Keywords:** *Development, Abacus training management, Artificial Intelligence, Teacher skills*

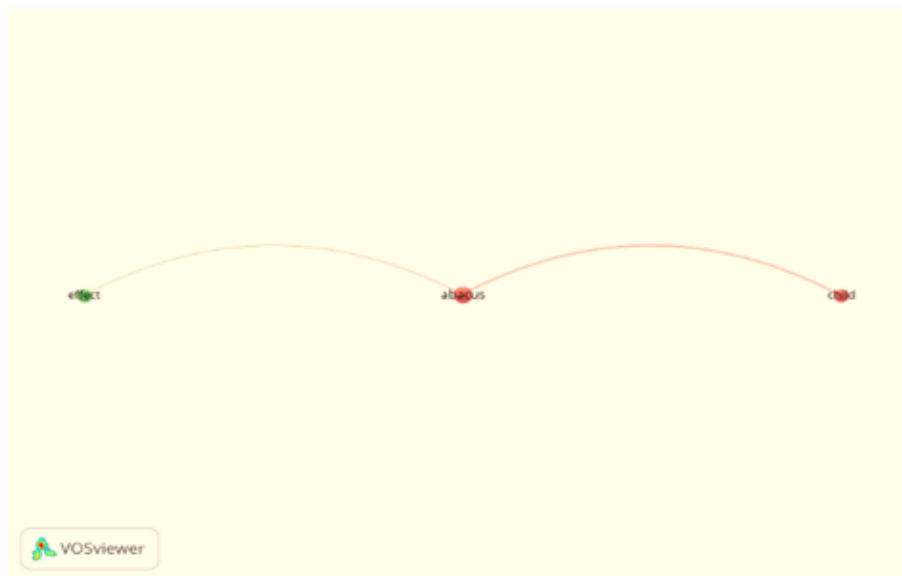
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## INTRODUCTION

The rapid integration of Artificial Intelligence (AI) in education has transformed how students learn by enabling personalized and efficient instruction. However, this advancement raises critical concerns. Many researchers have highlighted that the overreliance on AI tools may reduce students' critical thinking, logical reasoning, and motor skills, especially at early education levels (Tedre et al., 2021; Wu, 2023; Zhai et al., 2021); (Cope et al., 2021; Dahlan et al., 2022; Viberg et al., 2023); (Chen et al., 2023; Fyfe, 2023; Marzuki et al., 2023); (Kurniawan et al., 2024; Limna et al., 2022; Sain et al., 2025; Seo et al., 2021). In underprivileged areas, the digital divide worsens the problem, as students lack equal access to technology (Lembani et al., 2020; Mathrani

et al., 2022); (Jamil, 2021; Nhedzi, 2021; Saha et al., 2021). (In this context, traditional tools like the abacus offer a cost-effective, inclusive alternative that supports both cognitive and motor development as a figure below.



**Figure 1.** Abacus Training Analysis from VosViewer

This figure highlights a literature gap where abacus is discussed, it is narrowly focused mainly on connection with children or mathematical outcomes. There is no strong cluster or diverse linkage, which visually confirms that research on abacus training models for teachers or institutional implementation is lacking. Despite its historical use across civilizations and its proven benefits in East Asia, the abacus is underutilized in many Islamic primary schools, such as Madrasah Ibtidaiyah. Previous studies have mostly emphasized the positive outcomes of abacus use on students such as improved numeracy, memory, and discipline patience (Neveu et al., 2023; Stigler, 1984; C. Wang, 2020); (Lima-Silva et al., 2021; Lu et al., 2023); (Caux, 2009; Lu et al., 2023; Patriarca, 2024); (Demattè & Furinghetti, 2022; Phil, 2023). However, few have explored how to empower teachers through structured training programs. A bibliometric analysis using Publish or Perish and VosViewer on 200 Scopus-indexed articles from 2015–2024 with the keyword “abacus training” found only five direct link strengths related to teacher development, revealing a significant gap in the literature.

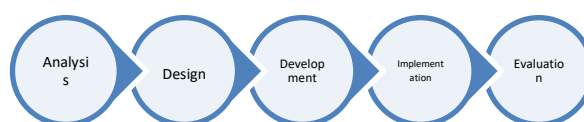
This research addresses that gap by shifting the focus from students to teachers—specifically their lack of access to effective training. Pre-research at Madrasah Ibtidaiyah in Bandar Lampung found that only 4.25% of teachers were proficient in using the abacus, though 95.75% expressed interest in learning. Barriers included a lack of training centers and feelings of embarrassment when learning alongside students. This study argues that any effort to revive abacus learning in the classroom must begin with enhancing teacher capacity, not merely promoting student tools.

The purpose of this study is to develop and validate a comprehensive abacus training management model based on a planning–implementation evaluation framework (Edison et al., 2017); (Artha et al., 2021; Darmawan et al., 2021). Unlike previous research that focuses on abacus learning outcomes in students or discusses AI trends broadly, this study provides a practical and replicable solution for institutionalizing abacus training at the teacher level. It directly complements the existing body of literature by filling the gap in professional development models tailored to Islamic elementary education.

This study proposes a testable hypothesis: that a structured and teacher-focused abacus training model can significantly enhance instructional competence and support balanced cognitive, motor, and character development among students. By integrating traditional learning tools like the abacus in the AI era, the model aims to bridge educational gaps and promote sustainable teaching strategies in diverse school contexts. The findings are expected to offer empirical evidence and practical frameworks for policymakers, curriculum developers, and education practitioners.

## METHOD

This study was carried out at the State Madrasah Ibtidaiyah in Bandar Lampung, Indonesia, with the goal of developing an abacus training management model for teachers in the age of artificial intelligence. This research approach involves research and development (R&D) using the ADDIE model, which stands for analysis, design, development, implementation, and evaluation (Creswell, 2014; Hua, 2016; Koderi et al., 2023), followed by a group pretest-posttest design to assess the effectiveness of using abacus training modules in learning. The ADDIE development model was chosen because the development steps are straightforward and easy to assess (Papavlasopoulou & Giannakos, 2020; Schott & Seel, 2015), including in the context of abacus training. Figure 1 depicts the development stages:



**Figure 2.** The Steps of the ADDIE Development Model (Hua, 2016).

During the analysis stage, the researcher collected data on teacher needs for abacus learning skills. Needs analysis data was collected through surveys and interviews. Interviews were conducted with 47 Madrasah Ibtidaiyah teachers to determine the skills required to effectively teach abacus. During the design stage, the abacus training module was structured to include materials on abacus use, teaching techniques, and strategies for linking social-emotional values in the learning process (Caux, 2009; Lu et al., 2023; Patriarca, 2024; C. Wang, 2020).

The development stage involved creating training materials based on the design, which were then tested on a small-scale trial to gather feedback from teachers at Madrasah Ibtidaiyah Negeri Bandar Lampung. This feedback was used to improve the module before it was more widely deployed. Furthermore, experts in education and abacus were involved in module validation. This validation includes several criteria, such as (Anugrahana, 2019; Barker, 2006; León et al., 2021):

**Table 1.** Abacus Training Module Validation Criteria

No	Material Validation Criteria	Media Validation Criteria
1	Suitability of the material	Media suitability to the needs
2	Completeness and clarity of material	Display
3	Ease of understanding	Attractiveness
4	Flexibility of use in various situations	Ease of media operation

The feasibility criteria of the developed module were evaluated based on the percentage interpretation as presented in the following Table, and the analysis of the results was formulated in (1).

**Table 2.** The Likert Scale Evaluation Criteria (Berlian et al., 2021; Kusuma et al., 2022)

Score	The Likert Scale Evaluation Criteria
1	The validator strongly disagrees with the evaluation statement or indicator
2	The validator disagrees with the evaluation statement or indicator
3	The validators agree with the evaluation statement or indicator
4	The validators strongly agree with the evaluation statement or indicator

Table 3. Feasibility Criteria for the Developed Module (Prabowo et al., 2024)

Percentage	Interpretation
0%-20%	Not feasible
21%-40%	Less feasible
41%-60%	Quite feasible
61%-80%	Feasible
81%-100%	Very feasible

$$P = \frac{\sum x}{\sum xi} \times 100\% \tag{1}$$

Description:

P = Percent value sought/expected

$\sum x$  = Total score

$\sum xi$  = Maximum score

100 = Fixed number (Young et al., 2019)

In this formula, P is the percentage score,  $\sum x$  is the total number of user scores in one question item, and  $\sum xi$  is the maximum score for one question item. The training module is tested and declared usable if the interpretation of the results exceeds 60% (Young et al., 2019).

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Furthermore, during the implementation stage, the abacus training module was tested on teachers at the State Madrasah Ibtidaiyah of Bandar Lampung to determine its effectiveness in improving teacher skills in teaching abacus. The module effectiveness design included a pretest-post test of 47 abacus training management trainee teachers. The data was gathered using a Likert scale survey instrument. The pretest and posttest results were compared using a paired sample t-test to see if there was a significant difference between before and after training (Hijriyah et al., 2022; Koderi et al., 2023; Zahro et al., 2022).

## RESULT AND DISCUSSION

### Result

The ADDIE model was used to develop abacus training management in the AI era for Madrasah Ibtidaiyah teachers in Bandar Lampung City. This model ensures that each stage of development is evaluated in a systematic manner, resulting in an effective and efficient training module. The following are the outcomes of research using the ADDIE model.

### Analysis

In the age of artificial intelligence (AI)-based learning technologies, students are increasingly reliant on technology to solve mathematics problems, reducing their ability to think critically and analytically. While AI simplifies the teaching process, it frequently overlooks a thorough understanding of fundamental mathematics concepts. As a result, the abacus as a

traditional counting tool remains relevant because it can train both the right and left brains at the same time, thereby improving students' motor skills, concentration, and memory. Despite the significant benefits, most teachers at the State Madrasah Ibtidaiyah in Bandar Lampung City lack the necessary skills to teach abacus, but 95.75% expressed a desire to attend training. As a result, comprehensive abacus skills training is required through the development of a training management model, allowing teachers to effectively teach this tool while also assisting students in understanding math concepts more deeply and interactively.

**Design**

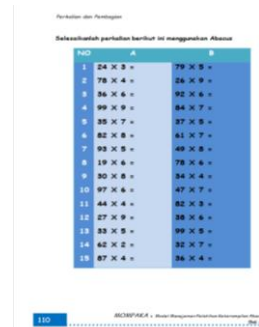
This abacus training management model product was specifically designed for teachers who plan to teach abacus skills to students. The module provides a comprehensive guide from the fundamentals of the abacus to advanced calculation techniques such as addition, subtraction, multiplication, and division. Each chapter in the module is structured so that teachers can gradually learn how to use an abacus and apply it in classroom teaching and learning activities. The primary goal of this module is to provide teachers with the practical and theoretical skills required to improve the quality of mathematics education in Madrasahs.



**Figure 3.** Cover



**Figure 4.** Material



**Figure 5.** Exercises

In addition to the learning materials, this module includes a barcode that directs users to the video tutorial. The tutorial video shows teachers how to use the abacus in a step-by-step visual demonstration, making each concept and technique more understandable. Participants can access the video directly from their mobile devices by scanning the module's barcode. This feature will assist teachers who are accustomed to learning visually in mastering abacus skills more quickly and effectively. Each chapter includes practice questions to help students hone their skills with the material they have learned. It is intended to help teachers master the abacus before using it in the classroom with students. This module not only helps teachers improve their skills, but it also prepares them to teach abacus using effective and engaging methods for students.

**Development**

The abacus skills training module was designed using a computer/laptop with document processing and design applications, such as Microsoft Word 365 and Canva, to create its visual layout. Each module material includes a visual guide to using the abacus and video tutorials. The video tutorials were created using the smartphone's built-in recorder app and edited with video editing software like Kinemaster and CapCut. Each video tutorial lasts 3-5 minutes and includes simple and easy-to-follow demonstrations of practical abacus use.

Material and media experts validated the module and video tutorials after the development. Material experts evaluated the module based on its suitability, completeness and clarity, ease of understanding, and usability in a variety of situations. The following are the results of the assessment by the material experts:

**Table 4.** Material Expert Validation Result

Validator	Score		Percentage
	Maximum	Result	
I	40	36	90 %

II	40	35	87,5 %
Total	80	71	88,75 %

According to Table 4, the material expert validation results show that the abacus skills training module received a total score of 71 out of a possible 80 points, with an average percentage of 88.75%. These findings indicate that the module is considered highly valid and appropriate for training. The material presented in the module is appropriate for the training's needs and objectives. Still, revisions and improvements were required to ensure that the module was perfect before it was widely used.

Media experts evaluated the modules and videos based on their relevance to the needs, appearance, attractiveness, and ease of use. The experts suggested ways to improve several aspects, such as incorporating interactive evaluations into the module and adjusting the length of video tutorials to better suit learning needs. The following are the results of the assessment by media experts:

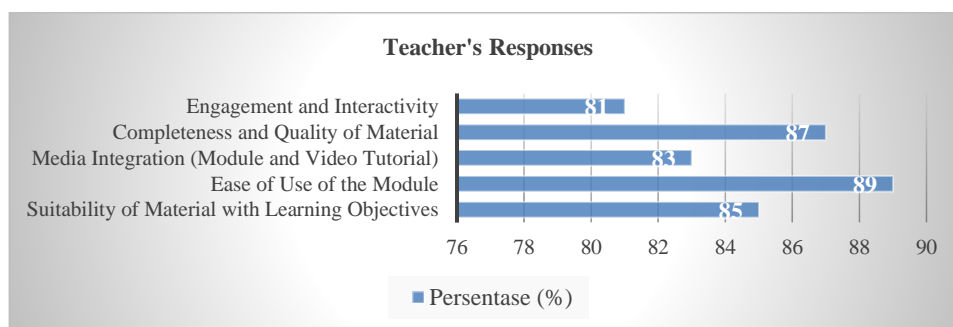
**Table 5.** Media expert validation result

Validator	Score		Percentage
	Maximum	Result	
I	40	38	95 %
II	40	36	90 %
Total	80	71	92,5 %

Table 5 displays the results of media expert validation. The abacus skills training module received a total score of 71 out of a possible 80, with an average percentage of 92.5%. These findings indicate that the training module was considered very valid and suitable for use in terms of media. The high score indicated that the module's appearance, attractiveness, and usability were excellent. Nonetheless, minor improvements were required to perfect the learning media, allowing the module to be more effective in assisting teachers in teaching abacus.

**Implementation**

The implementation phase involved 47 teachers from State Madrasah Ibtidaiyah in Bandar Lampung City. The abacus training module is available in both printed and digital formats, with access via a laptop or Android device. Teachers can also scan the module's barcode to access video tutorials that support the training. After the training, teachers were asked to complete a questionnaire to assess the module's usefulness. The following figure displays the results of the teachers' responses:



**Figure 6.** Teacher's Responses

**Table 6.** The Results of Respondents' Assessment of the Product

Indicators	Respondents	Maximum Score	Final Score	Percentage
Suitability of Material with Learning Objectives	47	235	200	85%
Ease of Use of the Module	47	235	210	89%

Media Integration (Module and Video Tutorial)	47	235	195	83%
Completeness and Quality of Material	47	235	205	87%
Engagement and Interactivity	47	235	190	81%
Total	47	1175	1000	85%

Table 6 displays the assessment results of 47 respondents. The abacus training management module received a total score of 1000 out of a maximum score of 1175, with an average percentage of 85%. The module's ease of use indicator received the highest score of 89%, indicating that teachers found this module to be extremely user-friendly. The material's completeness and quality were also rated highly, with 87%, indicating that the information presented was quite complete and of high quality. Furthermore, the material's suitability to the learning objectives received 85%, indicating that the module material was highly relevant to the learning needs. However, the score for the media integration indicator (module and video tutorial) was only 83%, indicating that there is still room for improvement in aligning the module material with the video tutorial. The indicators with the lowest scores are engagement and interactivity, which only received 81%, indicating that the module's interactivity needs to be improved to provide a more dynamic and engaging learning experience to participants.

### Evaluation

The effectiveness of the abacus skills training management model is measured during the evaluation stage using a variety of methods, including material and media expert assessments, as well as direct testing via teacher questionnaires. The training model is considered successful if it can improve the character of State Madrasah Ibtidaiyah teachers in Bandar Lampung City, such as achievement motivation, self-confidence, creativity, and perseverance. According to the results of a questionnaire administered to 20 respondents with 35 question items, teacher character increased significantly, with the character of patience reaching 77% and not easily giving up 75%, with achievement motivation scoring the lowest at 61%. This character improvement demonstrates the success of the implementation of the abacus skills training.

Furthermore, the effectiveness of the training model was assessed using a paired sample t-test to compare success rates before and after model development.

**Table 7.** The result of the Paired Sample t-test

Paired Samples Test	Pair 1 After - Before
Mean	43.72
Std. Deviation	4.886
Std. Error Mean	0.977
Lower	41.703
Upper	45.737
t	44.737
df	45
Sig. (2-tailed)	0

According to Table 7, the calculated t-test value is 44.737, which is greater than the t-table value of 2.069 with df 45 and a significance level of 0.05. This indicates a significant difference in training success prior to and after model implementation. Thus, the development of the abacus skills training management model was effective in improving training implementation success and teacher character at the State Madrasah Ibtidaiyah in Bandar Lampung City.

## **Discussion**

According to the findings, the development of the abacus skills training management model was highly effective in improving the abilities of teachers at the State Madrasah Ibtidaiyah in Bandar Lampung City. The ADDIE model provided systematic evaluation at each stage, facilitating the development of an effective training module. This statement is consistent with Yujie Lu and Lima-Silva et al.'s findings, which emphasized that abacus training can improve students' cognitive skills, such as numeracy, spatial processing, and mathematical self-efficacy (Lima-Silva et al., 2021; Lu et al., 2023).

With the rise of artificial intelligence (AI) technology, the abacus has resurfaced as a teaching tool capable of balancing the right and left brain and improving students' fine motor skills. While some studies, such as Abdullah Abonamah's, argue that technology has replaced the role of the abacus in learning, others advocate for the use of the abacus as an in-depth teaching medium (Abonamah et al., 2021). Wang Yunqi et al. conducted research that supports the relevance of the abacus, particularly in improving students' basic math skills and cognitive abilities more interactively than using modern technology-based tools (Y. Wang et al., 2013).

Based on the results of 47 teachers' effectiveness questionnaires, this abacus training module received an average score of 85% in various indicators, with the module's ease of use receiving the highest score of 89%. However, the engagement and interactivity indicator, which received the lowest score (81%), indicates that this aspect still requires improvement, particularly in terms of incorporating more dynamic interactivity into learning. Despite some difficulties in increasing participant engagement, this study generally supports the use of an abacus in the modern educational system. This study also emphasizes the importance of preserving the abacus as an educational, cultural heritage (Kempner & Pullan, 2012; Maričić & Lazić, 2020), which is consistent with Cong Mou et al.'s findings that the abacus can shape students' characteristics, such as perseverance and discipline (Mou et al., 2022).

The development of an abacus training model with a holistic approach offers significant benefits to teachers in a variety of ways, including improved pedagogical and professional skills (Gueudet & Poisard, 2019; León et al., 2021). Abacus training improves structured management, allowing teachers to design more effective learning experiences. Teachers are developing a better understanding of the abacus, viewing it as a tool for teaching students logical thinking and motor skills (Maričić & Lazić, 2020; Murti et al., 2022). Teachers perform better with interactive modules that allow them to learn independently (Arianto et al., 2024; Arif et al., 2025; Gueudet & Poisard, 2019; Liu et al., 2022). Furthermore, teachers can use more effective learning strategies that meet the needs of their students, enriching their instruction with a focus on student character development (Hatano, 2016; Mou et al., 2022; Zhou, 2024). The holistic approach to abacus learning improves mental rotation ability, arithmetic calculation performance, perseverance, self-control, achievement motivation, and mathematical self-efficacy (Akın, 2022; Mou et al., 2022; Zhou, 2024). Teachers who participate in this training are better prepared to apply abacus skills to modern educational challenges, as well as develop competencies for future change agents.

Training modules with interactive video tutorials make it easier for teachers to access the material, improve their understanding of it, accelerate the implementation of new methods, and motivate them to be more confident in their teaching (Santagata & Guarino, 2011; Tomczyk et al., 2023). Video tutorials aid teachers' comprehension of new methods by presenting steps visually and sequentially, making it easier for teachers to follow and master new concepts (Ahmet et al., 2018; Noetel et al., 2021). Video tutorials also allow teachers to learn at their own pace, repeating parts that are unclear more flexibly (Fidan & Debbag, 2023; Krumm et al., 2022; Lapitan et al., 2021; Nabayra, 2020). It demonstrates the significance of technology integration in learning for improving accessibility (Ais Isti'ana, 2024; Akram et al., 2021; Bereczki & Kárpáti,

2021; Liu et al., 2022; Maričić & Lazić, 2020). With an 85% usefulness score from teachers, this module was effective in facilitating abacus teaching, consistent with Watanabe et al.'s findings that video tutorials improve teachers' understanding of new methods (Watanabe, 2021).

The development of abacus training management also provides numerous benefits for teachers in dealing with the challenge of students' reliance on artificial intelligence (AI) technology by encouraging mastery of the abacus, which stimulates critical and analytical thinking skills (León et al., 2021; Maričić & Lazić, 2020). Abacus provides an important balance in learning, ensuring that students do not rely solely on AI but can also fully comprehend concepts (Neveu et al., 2023; Stigler, 1984; C. Wang, 2020). Furthermore, it contributes to the preservation of traditional educational methods that benefit students' cognitive development over time (Kempner & Pullan, 2012; Maričić & Lazić, 2020). Furthermore, it empowers teachers to shape students' character, particularly patience and perseverance (Mou et al., 2022). It also enables teachers to create holistic learning that focuses not only on cognitive skills but also on students' emotional and social skills, such as self-confidence and perseverance, making it an effective solution to the needs of education in the 21<sup>st</sup> Century (Caux, 2009; Lu et al., 2023; Patriarca, 2024; C. Wang, 2020).

The results of the development of the abacus skills training management model show that it is effective in improving the ability of the State Madrasah Ibtidaiyah teachers in Bandar Lampung City. This is in line with previous research that supports the importance of the abacus as a learning tool capable of improving cognitive skills, developing student character, and preserving the cultural heritage of education in the modern era.

## **CONCLUSION**

This study uncovered a surprising finding that was only identified through research, namely that teachers at the Madrasah Ibtidaiyah level, despite their low initial proficiency in using the abacus (only 4.25%), showed significant skill improvement after participating in a structured, multimedia-based abacus training management program. This finding has important implications as it challenges the prevailing assumption that traditional tools like the abacus are obsolete in the age of artificial intelligence. The success of printed and electronic modules, complemented by video tutorials, demonstrates that traditional mathematical tools can be effectively revitalized and integrated into modern teacher training strategies.

The scientific contribution of this research lies in confirming previous studies that emphasized the abacus's role in enhancing cognitive development, perseverance, and character building, while also providing new evidence supporting its continued relevance in the digital era. It introduces a training management model as a new method to systematically improve teachers' skills through a self-directed and media-enriched approach. This study also contributes to the discourse by bridging the gap between traditional learning tools and digital innovation, enriching perspectives on how cultural heritage tools can coexist with AI-based education.

However, the study has several limitations. The sample size was relatively small and focused solely on Madrasah Ibtidaiyah teachers in Bandar Lampung, which limits the generalizability of the findings. The demographic coverage was also narrow, lacking variation in terms of age, gender, and school typology. Additionally, while the t-test results ( $t\text{-observed} = 44.737 < t\text{-critical} = 2.069$  at  $\alpha = 0.05$ ) show effectiveness.

Future research should expand to include larger, more diverse samples across different regions, school types, and teacher demographics. It is also recommended that future studies explore digital-based abacus training that combines traditional tools with AI or interactive platforms to create a balanced, hybrid learning approach. Such investigations would provide a more holistic understanding and inform the development of scalable policies for integrating cultural pedagogical tools into modern educational systems.

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