

The Implementation of Artificial Intelligence (AI)-Based Learning Media in Primary Education

Neneng Sulastr^{1*}, Dety Mulyanti², Aip Zaenal Mutaqin³, Sopa Siti Marwah⁴, Salwa Zolkafil⁵

^{1,5}Universitas Islam Nusantara Bandung, Indonesia

²Politeknik Praktisi Bandung, Indonesia

^{3,4}Universitas Garut, Indonesia

*Corresponding Author

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ABSTRACT

The rapid advancement of Artificial Intelligence (AI) holds immense potential for transforming instructional media in primary education. However, its integration faces challenges related to educators' technical readiness and students' potential cognitive dependence. This study aims to quantitatively analyze the impact of implementing AI-based learning media in primary schools across four key indicators: material preparation time efficiency, learning appeal and student engagement, operational constraints due to lack of training, and teacher apprehension regarding student dependency. A quantitative survey approach was employed. Data were collected from 50 primary school teachers (= 50) using a structured Google Forms questionnaire distributed online via WhatsApp. The survey utilized multiple-choice items grounded in ratio, percentage, ordinal frequency, and Semantic Differential formats. Data were analyzed using parametric descriptive statistics and non-parametric inferential *Chi-Square Goodness-of-Fit* tests. Findings revealed that: (1) AI significantly reduced material preparation time, with 64% of teachers saving > 6 hours/week (= 3.46 ; $D = 0.81$); (2) AI markedly enhanced learning appeal, with 68% of teachers estimating a 76%–100% increase in student engagement (= 3.52 ; $D = 0.79$); (3) Teachers experienced statistically significant operational hurdles due to a lack of formal training ($\chi^2 = 33.52$, $p < 0.0001$), with 90% frequently or always encountering technical difficulties; and (4) There was a statistically significant level of pedagogical concern ($\chi^2 = 18.32$, $p = 0.0004$), with 80% of educators worried that AI over-reliance could diminish students' critical thinking skills. The application of AI in primary education serves as a powerful accelerator for teaching efficiency and student engagement. Nevertheless, its sustainable optimization necessitates structured digital pedagogical training for teachers and clear instructional scaffolding to mitigate cognitive technology dependency among young learners.

Keywords: Artificial Intelligence, Learning Media, Primary Education, Teaching Efficiency, Student Engagement, Teacher Training, Critical Thinking

INTRODUCTION

The rapid advancement of digital technology, particularly Artificial Intelligence (AI), has driven comprehensive transformations across various sectors, most notably within education. The presence of AI extends beyond changing how information is accessed; it fundamentally transforms the paradigm of classroom instruction. Numerous studies confirm that integrating AI technology significantly enhances the quality of teaching and learning activities through the development of innovative, interactive, and highly responsive learning media tailored to modern educational needs (Luckin et al., 2016; Holmes et al., 2019).

In instructional practice, AI enables the creation of personalized and adaptive learning media by adjusting the difficulty level and content to match individual student abilities. This personalized approach mitigates

the administrative burden on teachers in manually preparing instructional materials, thereby allowing educators to focus more on improving the quality of pedagogical interactions. Academic literature indicates that the optimal utilization of AI contributes meaningfully to increasing teaching efficiency and enhancing learning outcomes (Zawacki-Richter et al., 2019; Chen et al., 2020).

Specifically, within primary school environments, the learning process demands an approach that is concrete, contextual, engaging, and aligned with the cognitive and psychological development of children aged 7–12. Primary school students, operating within the concrete operational stage, require multimodal stimulation to grasp abstract concepts more effectively. Supported by AI technology, teachers can rapidly and precisely design multimodal learning resources spanning text, audio, visuals, and interactive video animations tailored to the diverse learning styles of elementary students (Chassignol et al., 2018; Hwang et al., 2020).

The application of Artificial Intelligence in developing primary school learning media represents a major breakthrough that enriches the overall teaching and learning process. By bridging the limitations of conventional instructional media, AI-powered tools deliver a more dynamic and immersive learning experience (Kataria, 2023). Consequently, this revitalizes the primary classroom environment, making it more communicative, vibrant, and capable of fostering young learners' natural curiosity.

Furthermore, Artificial Intelligence supports the realization of genuinely adaptive learning in primary education through intelligent data processing. AI systems automatically analyze student learning analytics including assessment scores, dominant learning styles, and mastery levels in real time. As highlighted in the relevant literature, such AI-driven insights allow instructional strategies and interventions to be customized individually, ensuring each student receives the appropriate pace and scaffolding based on their unique learning profile (Alam, 2021; UNESCO, 2021).

Therefore, implementing AI in primary school learning media development not only boosts teacher creativity and student engagement, but also promotes an inclusive, adaptive, and digital innovation-driven educational system. The accessibility and flexibility offered by AI provide equitable learning opportunities for all students across varying levels of cognitive readiness (Pedró et al., 2019; Knox, 2020).

Ultimately, integrating Artificial Intelligence into primary education learning media serves as a strategic step in addressing the challenges and demands of education in the digital age. Preparing a digitally literate and critically thinking young generation must begin at the primary level through learning media that are not only relevant to the modern era, but also capable of holistically optimizing student potential (Selwyn, 2019; Tapalova & Zhiyenbayeva, 2022).

METHODOLOGY

This study employs a quantitative approach to objectively measure the impact and pedagogical perceptions regarding the implementation of Artificial Intelligence (AI)-based learning media in primary school environments. Primary data were collected through a structured survey method using a questionnaire systematically designed via Google Forms. To minimize response bias (such as central tendency bias) and yield more precise, measurable, and clearly distributed numeric data, the questionnaire avoids traditional Likert scales. Instead, it utilizes multiple-choice items grounded in objective estimation, frequency, ratio/duration, percentage, and semantic differential formats (Taherdoost, 2022). The questionnaire was distributed online to target respondents to efficiently and rapidly reach a broader population of primary school teachers and educators.

Google Forms was selected as the data collection platform due to its flexibility in reaching participants, real-time data visualization capabilities, and secure data integration that streamlines the export process for statistical analysis software. The survey was distributed online via WhatsApp, as it serves as the primary and most accessible communication channel among primary school educators. The multiple-choice instrument incorporating duration estimates, usage frequencies, effectiveness percentages, and semantic differential scales was specifically designed to evaluate teacher work efficiency, student engagement, the

magnitude of technical/training constraints, and perceptions of technology dependency risks (Fowler, 2014; Taherdoost, 2022).

The multiple-choice questionnaire draft utilized in this study encompasses four key indicators as outlined below:

1. Time Efficiency in Material Preparation (Ratio/Duration):

- *Question:* On average, how many hours per week do you save in preparing learning media/materials since utilizing AI-based tools?
 - a. Less than 1 hour (< 1 hour)
 - b. 1–3 hours
 - c. 4–6 hours
 - d. More than 6 hours (> 6 hours)

2. Learning Engagement and Student Appeal (Percentage):

- *Question:* What is the estimated percentage increase in primary school students' engagement and enthusiasm when learning with AI-based media compared to conventional media?
 - a. 0% – 25% (Very Low / Insignificant)
 - b. 26% – 50% (Moderate)
 - c. 51% – 75% (High)
 - d. 76% – 100% (Very High)

3. Operational Difficulties Due to Lack of Training (Frequency):

- *Question:* How frequently do you encounter technical difficulties or confusion when operating AI learning media due to a lack of formal training?
 - a. Never
 - b. Rarely (1–2 times per month)
 - c. Often (1–2 times per week)
 - d. Always (Every time I operate the tools)

4. Apprehension Regarding Student Dependency (Semantic Differential):

- *Question:* What is your level of concern regarding students' potential over-reliance on AI, which may impair their critical thinking skills?
 - a. Not at all concerned (Students remain independent and critical)
 - b. Slightly concerned
 - c. Concerned

d. Extremely concerned (AI poses a high risk of stifling critical thinking)

Scoring for the response options across these four items was conducted by converting qualitative and interval choices into ordinal and numeric ratio scales ranging from 1 to 4. A score of 1 represents the minimal or most negative condition (e.g., lowest time savings, lowest engagement percentage, or lowest difficulty frequency, depending on the indicator), whereas a score of 4 denotes the highest level of efficiency, engagement, or constraint. For ratio/duration and percentage items, midpoints of each interval range were extracted as continuous data to calculate parametric descriptive statistics, such as mean and standard deviation.

Raw data collected via Google Forms were exported and processed using both descriptive and inferential statistical techniques. Descriptive analysis involving the calculation of frequencies, percentages, means and standard deviation was performed to map the general distribution of teacher responses regarding AI implementation in primary schools. Subsequently, to examine relationships between variables (e.g., the correlation between lack of training and the frequency of technical difficulties), inferential statistical tests, such as Spearman's rank correlation or Chi-Square tests, were applied. This analysis aims to provide empirical evidence on the effectiveness and operational barriers of AI integration in primary education. All analytical outputs are presented in tables to facilitate visual interpretation and discussion.

RESULTS AND DISCUSSION

RESULTS

Based on the online questionnaire distributed via WhatsApp, a total of **50 primary school teachers** (= 50) submitted complete and valid responses. This sample size serves as the baseline for calculating score aggregations, frequency distributions, and percentage proportions for each indicator. Quantitative scoring was executed by assigning a point weight from 1 to 4 to each multiple-choice option (= 1, = 2, = 3, = 4). Interval options for duration were converted using range midpoints to establish continuous estimates, thereby enabling the calculation of parametric descriptive statistics _specifically the mean () and standard deviation (D)_to objectively measure time efficiency, student engagement, operational constraints, and concerns regarding student dependency.

Respondent Data: Time Efficiency in Material Preparation

Save time	Options	Respondent	%
>6 hours	option d	32	64%
4-6 hours	option c	11	22%
1-3 hours	option b	5	10%
<1 hour	option a	2	4%
		50	100%

Table 1: Weekly Preparation Time Saved

Source: Research document, 2026

The first item evaluated teacher work efficiency by estimating the amount of time saved each week in preparing learning media or instructional materials after adopting Artificial Intelligence (AI) tools. As shown in Table 1, the majority of the 50 primary school educators (64%) reported saving more than six hours per week, while 22% saved between four and six hours. A smaller proportion reported saving between one and three hours (10%), and only 4% saved less than one hour per week. The mean score of 3.46 out of 4.00 indicates a very high level of perceived time saving, while the standard deviation of 0.81 suggests relatively similar responses among the educators. Overall, the results indicate that the use of AI tools substantially reduces the time required for teachers to prepare learning materials and may therefore improve their work efficiency.

Respondent Data: Learning Attractiveness for Students

The second question measures the level of effectiveness of Artificial Intelligence (AI)-based learning media on student engagement through the estimated percentage increase in elementary school students' involvement and enthusiasm during the teaching and learning process. The distribution of responses from the 50 elementary school teacher respondents is presented in Table 2 below:

Table 2: Increase in Student Engagement and Enthusiasm

Percentage increase	Options	Respondent	%
76%-100%	option d	34	68%
51%-75%	option c	10	20%
26%-50%	option b	4	8%
0%-25%	option a	2	4%
		50	100%

Source: Research document, 2026

The majority of the 50 primary school educators (68%) reported an increase of between 76% and 100%, while 20% reported an increase of between 51% and 75%. Only 8% reported an increase between 26% and 50%, and 4% reported an increase between 0% and 25%. The mean score of 3.52 out of 4.00 indicates a very high perceived increase in student engagement and enthusiasm, while the standard deviation of 0.79 suggests relatively consistent responses among the educators. Overall, the findings indicate that educators generally perceived AI-supported learning as contributing positively to student engagement and enthusiasm.

Respondent Data: Operational Difficulties Due to Lack of Training

The third item evaluated the frequency of technical and operational constraints experienced by primary school educators when using Artificial Intelligence (AI)-based learning media, particularly those related to a lack of formal training. Responses were measured using a four-point ordinal frequency scale, ranging from 1 for "Never," 2 for "Rarely" (1–2 times per month), 3 for "Often" (1–2 times per week), to 4 for

"Always" (every time the technology was used).

The observed frequency distribution across the 50 primary school teacher respondents (= 50) is detailed in the table below:

Table 3: Frequency of Constraints Due to Lack of Training

Frequency of Constraints	Options	Respondent	%
Always	option d	18	68%
Often	option c	27	20%
Rarely	option b	5	8%
Never	option a	0	4%
		50	100%

Source: Research document, 2026

Inferential Statistical Analysis

Because the dataset for this indicator consists of non-parametric ordinal categories, a Chi-Square (χ^2) Goodness-of-Fit Test was executed to determine whether the observed response distribution significantly deviated from an equal distribution across categories (expected frequency = 12.5 per category for = 50).

The observed frequencies were 0 for “Never,” 5 for “Rarely,” 27 for “Often,” and 18 for “Always,” compared with an expected frequency of 12.5 for each category. The Chi-square test produced a calculated value of $\chi^2 = 33.52$ with 3 degrees of freedom, which is substantially higher than the critical value of 7.815 at the 0.05 significance level. The result was statistically significant ($p < 0.0001$); therefore, the null hypothesis (H_0) was rejected. This indicates that the responses were significantly concentrated in the “Often” (54%) and “Always” (36%) categories rather than being equally distributed across the four response categories.

Respondent Data: Apprehension Regarding Student Dependency (Semantic Differential)

The fourth item assessed primary school teachers' levels of concern regarding students' potential over-reliance on Artificial Intelligence (AI) media, which could potentially diminish critical thinking skills. Measurement was conducted using a 4-point Semantic Differential scale ranging from 1 (Not at all concerned / Students remain independent) to 4 (Extremely concerned / High risk of stifling critical thinking):

- a. Not at all concerned (Score 1)
- b. Slightly concerned (Score 2)
- c. Concerned (Score 3)
- d. Extremely concerned (Score 4)

The response distribution of 50 elementary school teacher respondents ($n = 50$) is presented in the following table:

Table 4: Concerns Regarding Student Dependency on AI

Concern Level	Options	Respondent	%
Extremely concerned	option d	22	68%
Concerned	option c	18	20%
Slightly concerned	option b	7	8%
Not at all concerned	option a	3	4%
		50	100%

The observed frequencies were 3 respondents (6%) for Score 1, 7 respondents (14%) for Score 2, 18 respondents (36%) for Score 3, and 22 respondents (44%) for Score 4. The Chi-square goodness-of-fit test produced a statistically significant result ($\chi^2 = 18.32$, $df = 3$, $p = 0.0004$), with the calculated Chi-square value exceeding the critical value of 7.815 at the 0.05 significance level. Therefore, the null hypothesis was rejected. The results indicate that responses were significantly concentrated at the higher end of the scale, with 80% of the respondents selecting Scores 3 or 4, reflecting a generally high level of concern among the teachers.

DISCUSSION

Based on the data analysis in Table 1, the vast majority of elementary school teachers experienced a highly significant increase in time efficiency after utilizing AI-based learning media. A total of 32 respondents (64%) stated that they were able to save more than 6 hours per week in lesson preparation time, followed by 11 respondents (22%) who saved 4–6 hours per week. Meanwhile, only a small proportion of teachers reported time savings of 1–3 hours (10%) and less than 1 hour (4%)."

The high overall mean score ($\bar{x} = 3.46$) indicates that AI-driven automation particularly in generating lesson modules, designing assessment items, and creating visual instructional resources significantly reduces the administrative and technical workload of primary educators. This substantial reduction in preparation time carries positive pedagogical implications, as it frees up valuable time for teachers to focus on direct classroom interaction, individualized student mentoring, and the development of intuitive

teaching strategies.

Findings from the first indicator confirm that AI substantially alleviates teachers' administrative and technical workloads, with 64% of respondents saving over 6 hours per week in lesson preparation ($t = 3.46$; $D = 0.81$). The automation of lesson plan generation, assessment design, and visual asset creation enables educators to reallocate their focus from routine administrative tasks to meaningful pedagogical interactions. This outcome closely aligns with studies by Zawacki-Richter et al. (2019) and Chen et al. (2020), which emphasize that AI's primary value in education lies in optimizing teacher time allocation toward personalized student mentoring.

Regarding student interest in implementing AI-based learning media, most respondents reported a significant increase in student enthusiasm and active participation when AI-based media was used in class. A total of 34 respondents (68%) estimated the increase in student engagement to fall within the highest category, ranging between 76% and 100%. Furthermore, 10 respondents (20%) noted an increase in the 51%–75% range, while a minor fraction of teachers reported gains in the 26%–50% (8%) and 0%–25% (4%) ranges.

The overall mean score of 3.52 underscores that interactive visual elements, gamification features, and multimodal instructional delivery (combining audio, visual, and animation) enabled by AI technology are exceptionally effective at capturing the attention of primary school children aged 7–12. The developmental characteristics of elementary students, who operate within the concrete operational stage, are optimally stimulated by dynamic AI media. This not only sparks young learners' natural curiosity but also transforms the classroom environment into a more communicative, interactive, and conducive setting for holistic concept comprehension.

These empirical findings closely align with and reinforce the research by Hwang et al. (2020), which demonstrates that integrating Artificial Intelligence with multimodal approaches (interactive visuals, audio, and animations) significantly enhances student engagement and learning motivation in primary education contexts.

Despite high efficiency and engagement benefits, the Chi-Square test for the third indicator ($\chi^2 = 33.52$, $p < 0.0001$) reveals a statistically significant clustering of technical difficulties, with 90% of teachers frequently encountering operational barriers due to a lack of formal training. This highlights a clear gap between rapid technology availability and teacher technological readiness. Without foundational skills in prompt engineering and interface navigation, AI adoption risks generating technical friction in daily instruction. These results strongly support conclusions by UNESCO (2021) and Zawacki-Richter et al. (2019), which state that the main bottleneck in educational AI integration is not teacher resistance, but a structural deficit in digital pedagogical training.

The inferential evidence demonstrates a statistically significant clustering of educators experiencing high-frequency operational difficulties (90% combined across "Often" and "Always"). This empirical outcome confirms that the absence of structured, formal training creates a pervasive operational barrier for primary school teachers attempting to adopt AI learning media.

Furthermore, the author found that educators' high level of concern regarding elementary school students' critical thinking is highly justified. The author demonstrates that although elementary school teachers acknowledge AI's efficiency in material development and boosting student engagement, the majority of educators (80%) harbor genuine pedagogical anxieties related to digital dependency. Although primary school educators recognize the operational efficiency and engagement benefits of AI, they harbour substantial pedagogical concerns regarding cognitive digital dependency among children aged 7–12.

These empirical results align closely with research by Selwyn (2019) and Pedró et al. (2019), which highlights that the foremost ethical and pedagogical dilemma in primary education AI adoption is the risk of student over-reliance and the potential erosion of independent critical reasoning. Consequently, AI integration in primary classrooms requires structured pedagogical scaffolding to ensure AI serves as an

instructional supplement rather than a substitute for active cognitive effort

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the empirical findings and discussion regarding the implementation of Artificial Intelligence (AI)-based learning media in primary education, several core conclusions are drawn:

1. **Material Preparation Time Efficiency:** The adoption of AI significantly alleviates teachers' administrative and technical workloads. A substantial majority of primary school teachers (64%) save more than 6 hours per week in instructional preparation, yielding a very high mean score ($\bar{X} = 3.46$; $D = 0.81$).
2. **Learning Appeal and Student Engagement:** AI-driven instructional media exerts a powerful positive influence on student enthusiasm among children aged 7–12. Sixty-eight percent (68%) of educators reported an engagement increase between 76% and 100% ($\bar{X} = 3.52$; $D = 0.79$), confirming that AI's multimodal approaches optimally stimulate cognitive processing during the concrete operational stage.
3. **Operational Constraints Due to Lack of Training:** Inferential statistical analysis ($\chi^2 = 33.52$, $p < 0.0001$) confirms that the deficit in formal training serves as a primary barrier to seamless AI adoption. Ninety percent (90%) of educators frequently or constantly encounter operational friction, underscoring a notable digital competency gap.
4. **Pedagogical Concerns Regarding Student Dependency:** A statistically significant pedagogical apprehension was revealed ($\chi^2 = 18.32$, $p = 0.0004$), with 80% of teachers expressing deep concern over digital over-reliance and its potential to erode young learners' independent critical thinking skills.

RECOMMENDATIONS

Based on the study's conclusions, several strategic recommendations are proposed. Educational authorities and policymakers should establish structured, ongoing professional development programmes focused on digital pedagogy and prompt engineering to strengthen primary school teachers' technical competencies. Clear ethical guidelines and regulatory frameworks should also be developed to guide the integration of AI into primary education, with particular attention to child safety and cognitive development. Primary school educators are encouraged to apply instructional scaffolding when using AI, positioning the technology as a supplementary learning tool rather than a replacement for students' active reasoning and problem-solving. Teachers should also continuously improve their digital literacy and participate in professional teacher communities, such as KKG, to exchange knowledge and good practices in the classroom use of AI.

Future research should consider quasi-experimental designs to directly examine students' learning outcomes before and after AI-based instructional interventions. Studies with larger samples are also recommended, together with the inclusion of additional factors such as parental involvement and home-based supervision of students' use of AI.

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