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Artificial Intelligence-Based Interactive Learning Media Integrating Social Emotional Learning and Islamic Values in Elementary Science

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ABSTRACT

This study aimed to develop an Artificial Intelligence (AI)-based interactiv learning media integrated with Social Emotional Learning (SEL) an Islamic values for elementary science learning on the human circulato system topic, and to examine its validity, practicality, and effectivenes [Development Results] The development followed a modified Research an Development (R&D) design synthesizing the Borg and Gall and ADDI models into seven stages: research and information collection, planning preliminary product development, preliminary field testing, produ revision, main field testing, and final product refinement. The resultin product was a web-based learning environment consisting of interactiv visualization, three-dimensional organ animation, adaptive quizze storytelling activities, contextual reflection, and an AI-supported teach dashboard using a rule-based adaptive system. [Validity] Expert validatio involving four experts (media, instructional design, science content, an Islamic value integration) yielded an average score of 97.25%, categorize as very valid, with the highest score on instructional design (100%) and th lowest on Islamic value integration (91.50%). [Practicality] Practicalit testing with 30 fifth-grade students and three teachers showed averag scores of 90.90% (students) and 98% (teachers), both categorized as ver practical, with the highest student response on value integration (93.10% and the lowest on AI personalization features (89.50%). [Effectiveness] quasi-experimental design involving 60 students (30 experimental, 3 control) demonstrated that the experimental group achieved an N-Gain 95% (high/effective) compared with 58% (medium) in the control grou Statistical analysis confirmed significant within-group improvemer (Wilcoxon: $Z = -4.782$; $p < 0.001$) and significant between-grou differences (Mann-Whitney: $U = 112.5$; $p < 0.001$; effect size $r = 0.6$ large). SEL competence and Islamic value internalization also improve with teacher observation rising from 41.66 to 91.04 and student sel assessment from 42.70 to 92.61. [Limitations of the Evidence] Howeve these findings are limited by the involvement of a single elementary scho with 60 students, a relatively short intervention period, the use of rule-base rather than machine-learning-based AI, and the possible influence of teach involvement and researcher support during implementation. Therefor broader implementation across diverse school contexts, longer interventio periods, and more advanced AI approaches are recommended for futu research.

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1. INTRODUCTION

The rapid development of digital technology has transformed the educational landscape by encouraging the implementation of more adaptive, interactive, and personalized learning environments. Artificial Intelligence (AI) has become one of the emerging technologies that supports educational transformation through adaptive learning systems, automated feedback, and personalized learning pathways based on students' needs [1]–[4]. The implementation of AI in education provides opportunities to improve learning effectiveness by enabling students to receive appropriate learning support according to their abilities and learning progress

Elementary education plays an important role not only in developing students' cognitive abilities but also in shaping character, social awareness, and spiritual values. Science learning at the elementary level should therefore not be limited to knowledge acquisition but should encourage students to understand natural phenomena, develop curiosity, and build meaningful connections between scientific concepts and everyday life. One of the challenging topics in elementary science is the human circulatory system because students are required to construct mental representations of biological processes that cannot be directly observed. Such abstract concepts require appropriate visualization strategies to reduce cognitive load and support meaningful learning [8]–[10]. Based on preliminary observations conducted at SD 'Ainul Hayat Cicurug, learning outcomes on the circulatory system topic indicated that many students experienced difficulties in understanding the relationship between heart function, blood circulation, and supporting organs. Initial data showed that 65.8% of students obtained scores below the Minimum Learning Achievement Criteria. The learning process was also still dominated by conventional instructional approaches using textbooks and static images, resulting in limited opportunities for students to visualize complex biological processes.

In addition to conceptual understanding problems, science learning in elementary schools should also promote students' social-emotional development through empathy, collaboration, and responsible decision-making [14]–[16]. Furthermore, integrating ethical and spiritual reflection can support holistic learning experiences by connecting scientific understanding with students' values and beliefs [17]–[20]. Social Emotional Learning (SEL) emphasizes students' ability to recognize emotions, manage themselves, develop empathy, build positive relationships, and make responsible decisions. However, Social Emotional Learning (SEL) emphasizes students' ability to recognize emotions, manage themselves, develop empathy, build positive relationships, and make responsible decisions. Previous studies have developed SEL-integrated science learning through collaborative inquiry, reflective journaling, and project-based science activities [14]–[16]. However, these approaches remain largely teacher-mediated and non-adaptive, and no existing media simultaneously integrate SEL, Islamic values, and AI-based adaptive learning within a single interactive science learning environment. learning rather than being embedded within instructional media.

Previous studies have developed interactive learning media for science education, including augmented reality and animated learning media for the circulatory system [12], [13]. However, most studies primarily focus on improving cognitive understanding and have not integrated social-emotional competencies and Islamic values simultaneously. Similarly, Islamic value integration in science learning is often implemented as an additional component rather than being embedded within the learning experience. Therefore, a research gap exists regarding the development of interactive science learning media that combines cognitive, social-emotional, and spiritual dimensions within one integrated learning environment. This study proposes AI-based interactive learning media that integrates SEL and Islamic values through storytelling, adaptive quizzes, interactive visualization, and contextual reflection activities.

This study aims to develop AI-based interactive learning media integrated with SEL and Islamic values for elementary science learning and to examine its validity, practicality, and effectiveness in improving students' conceptual understanding, social-emotional competence, and Islamic value internalization.

2. METHOD

2.1 Research Design

This study employed a Research and Development (R&D) design aimed at developing an artificial intelligence-based interactive learning media integrated with Social Emotional Learning (SEL) and Islamic

values for elementary science learning. The development procedure was adapted from the synthesis of the Borg and Gall development model and the ADDIE instructional design model.

The combination of these models was selected because Borg and Gall provide a systematic product development procedure through empirical testing, while ADDIE provides a structured instructional design framework consisting of analysis, design, development, implementation, and evaluation stages. The development process was modified into seven stages: (1) research and information collection, (2) planning, (3) preliminary product development, (4) preliminary field testing, (5) product revision, (6) main field testing, and (7) final product refinement.

2.2 Development Procedure

The initial prototype was developed as a responsive web-based application using HTML5, CSS3, JavaScript, and the Bootstrap framework. The media consisted of interactive learning activities, three-dimensional organ visualization, animated videos, adaptive quizzes, reflection activities, and AI-based feedback mechanisms.

Definition of AI in This Study. In this study, Artificial Intelligence (AI) is defined as *the capability of a computer system to perform instructional tasks that normally require human intelligence, specifically the ability to perceive learner inputs, make decisions, and provide adaptive responses within a learning environment* [5], [6]. This definition follows the widely adopted characterization of AI in education as systems that exhibit *perception, reasoning, learning, and decision-making* to support instructional processes [5], [26].

Why the Rule-Based Adaptive System Is Categorized as AI. The AI component in this media was implemented as a rule-based expert system using if–then production rules. Although it does not employ machine learning or deep learning, a rule-based system is explicitly recognized as one of the classical branches of AI — specifically within the field of *symbolic AI* or *good old-fashioned AI (GOFAI)* — because it encodes expert knowledge into a knowledge base and uses an inference engine to reason and make decisions [30], [26]. In this study, the system:

1. Perceives learner input — captures students' responses to adaptive quizzes and interactive tasks;
2. Represents expert knowledge — encodes pedagogical rules derived from science content experts and instructional designers;
3. Reasons and decides — evaluates the input against a rule base and determines the appropriate instructional response;
4. Adapts instruction — directs correct answers to advanced questions and triggers conceptual explanations, hints, or additional learning support when answers are incorrect;
5. Provides feedback — delivers immediate, personalized feedback based on individual learner performance.

These five functions fulfill the core criteria of an *intelligent tutoring system* (ITS), which is a well-established AI application in education [6], [26]. Therefore, although the system relies on rule-based rather than statistical learning, it remains consistent with the definition of AI adopted in this study and with the broader classification of AI in educational technology literature [5], [30].

The adaptive pathways were designed not merely to branch content, but to personalize the learning sequence according to each student's conceptual progress — a function that distinguishes AI-based adaptive learning from static branching in conventional multimedia [26].

2.3 Participants

The research participants consisted of fifth-grade students at SD ‘Ainul Hayat Cicurug. A total of 60 students participated in the effectiveness testing phase.

The participants were selected using cluster random sampling from three parallel classes. Two classes were randomly selected and assigned as:

a. Experimental group: 30 students
b. Control group: 30 students

In addition, three fifth-grade teachers and four expert validators participated in evaluating the developed media.

Before implementation, the equivalence of the experimental and control groups was examined using the Mann-Whitney test on pretest scores. The results indicated no significant difference between groups ($U = 432.5$, $p = 0.782$), indicating that both groups had comparable initial abilities.

2.4 Research Instruments

Data collection instruments consisted of:

1. Expert Validation Sheet

The validation instrument evaluated four aspects:

a. media quality,
b. instructional design,
c. science content accuracy,
d. Islamic value integration.

The assessment used a 5-point Likert scale.

2. Practicality Questionnaire

Student and teacher response questionnaires were used to evaluate:

a. learning integration,
b. instructional aspects,
c. interest and satisfaction,
d. usability,
e. AI personalization features.

3. Conceptual Understanding Test

Students' conceptual understanding was measured using a pretest-posttest instrument consisting of ten multiple-choice questions covering:

a. heart function,
b. blood vessel types,
c. blood circulation mechanisms,
d. lung function,
e. healthy lifestyle concepts.

4. SEL Assessment Instrument

SEL competence was measured using:

a. teacher observation sheets,
b. student self-assessment,
c. peer assessment.

The instrument was developed based on five CASEL competencies:

1. self-awareness,
2. self-management,
3. social awareness,
4. relationship skills,
5. responsible decision-making.

5. Islamic Value Assessment

Islamic value internalization was measured through observation and self-assessment instruments focusing on reflection, gratitude, responsibility, and appreciation of Allah's creation.

2.5 Data Analysis

This study applied a mixed-method approach using an embedded experimental design. Quantitative data were analyzed using:

a. percentage analysis for validity and practicality,
b. N-Gain analysis for learning improvement,
c. Wilcoxon Signed Rank Test for paired comparisons,
d. Mann-Whitney U Test for comparison between groups.

Qualitative data obtained from interviews, observations, and field notes were analyzed using thematic analysis.

The media was categorized as valid and practical when the achievement level reached a minimum based of 81%. Effectiveness was determined on significant differences between experimental and control groups with $p < 0.05$ and improvement in learning outcomes

3. RESULTS AND DISCUSSION

3.1 Development Process of Artificial Intelligence-Based Interactive Learning Media

The development process followed a systematic Research and Development approach by synthesizing the Borg and Gall and ADDIE models [21]–[23].

The combination of these models enabled the product development process to consider both instructional design principles and empirical validation procedures. The ADDIE framework provided a structured process for analyzing learning needs, designing instructional strategies, developing learning materials, implementing the product, and evaluating effectiveness. Meanwhile, the Borg and Gall model strengthened the empirical testing process through gradON ual validation and field trials.

The development of the AI-based interactive learning media resulted in a web-based learning environment designed to support elementary science learning, particularly on the human circulatory system topic. The media was developed to overcome students' difficulties in understanding abstract biological processes through interactive visualization, adaptive learning features, and contextual learning activities. The developed media consisted of several integrated learning components, including learning orientation, interactive visualization, animated materials, adaptive quizzes, reflection activities, and evaluation features. The learning flow was structured into several stages to guide students through exploration, conceptual understanding, reflection, and evaluation activities

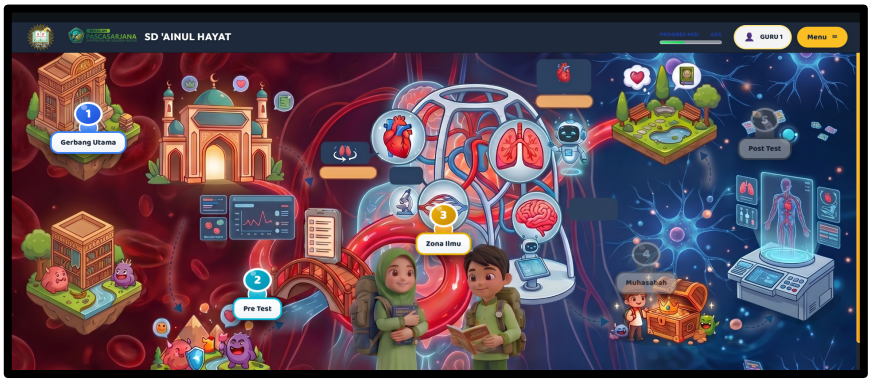

Figure 1. Learning Flow of AI-Based Interactive Learning Media

Figure 1 illustrates the learning flow of the developed AI-based interactive learning media. The learning sequence was designed to provide students with progressive learning experiences, beginning with exploration activities, followed by conceptual construction, reflection, and evaluation. Through this structured flow, students were encouraged to actively engage with scientific concepts while connecting their understanding with social-emotional and value-based learning activities. The integration of adaptive features enabled students to receive learning support based on their responses and progress. In addition to providing interactive learning experiences for students, the developed media also included a teacher monitoring system to support data-driven instructional decision-making.

Before implementation in classroom learning, the developed media underwent expert validation involving four experts: a media expert, an instructional design expert, a science content expert, and an Islamic value integration expert. The validation instrument was developed using a 5-point Likert scale (1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = very good) and consisted of 40 items distributed across four validation aspects: media quality (12 items), instructional design (10 items), science content accuracy (10 items), and Islamic value integration (8 items). The maximum possible score for each aspect was calculated by multiplying the number of items by the highest scale value (5). The validation criteria used in this study are presented in Table 1.

Table 1. Validation Criteria

No.	Achievement Level (%)	Category
1	81–100	Very Valid
2	61–80	Valid
3	41–60	Fairly Valid
4	21–40	Less Valid
5	0–20	Invalid

The detailed validation results, including the number of items, maximum possible score, actual score, and percentage for each aspect, are presented in Table 2.

Table 2. Expert Validation Results of AI-Based Interactive Learning Media

No.	Validation Aspect	Number of Items	Max Score	Actual Score	Score (%)	Category
1	Media Quality	12	60	59.04	98.40	Very Valid
2	Instructional Design	10	50	50.00	100.00	Very Valid
3	Science Content Accuracy	10	50	49.25	98.50	Very Valid
4	Islamic Value Integration	8	40	36.60	91.50	Very Valid

Average	40	200	194.89	97.25	Very Valid

As shown in Table 2, the developed media obtained an average validation score of 97.25% (194.89 out of a maximum of 200), indicating that the product achieved a very valid level. The highest evaluation was obtained from the instructional design expert with a score of 100% (50 out of 50), demonstrating that the learning sequence, instructional objectives, learning activities, and assessment strategies were considered appropriate. The media expert evaluation reached 98.40% (59.04 out of 60), indicating that the interface design, navigation system, accessibility, and interactive features were suitable for elementary students. The science content expert provided a score of 98.50% (49.25 out of 50), confirming that the representation of the circulatory system concepts was scientifically accurate. Meanwhile, the Islamic value integration aspect obtained the lowest score (91.50%; 36.60 out of 40), although it was still categorized as very valid.

Expert Comments and Revisions. In addition to quantitative scores, the experts provided qualitative comments and recommendations that were used to revise the product. The summary of expert comments and the corresponding revisions is presented in Table 3.

Table 3. Expert Comments and Revisions Made Following Expert Feedback

No.	**Expert**	**Comment / Recommendation**	**Revision Made**
1	Media Expert	The navigation icons on the main menu were too small for fifth-grade students and could cause misclicks.	Enlarged navigation icons by 30% and added hover labels on the main menu.
2	Media Expert	Color contrast between the background and text in the quiz section was insufficient.	Adjusted the color palette to meet WCAG 2.1 AA contrast standards (minimum ratio 4.5:1).
3	Instructional Design Expert	Learning objectives were not explicitly displayed at the beginning of each learning stage.	Added a learning objective banner at the start of each stage (orientation, exploration, reflection, evaluation).
4	Instructional Design Expert	Reflection activities needed clearer scaffolding to guide students' thinking.	Added guided reflection prompts using a four-step framework (experience–feeling–meaning–application).

5	Science Content Expert	The animation of blood circulation did not clearly distinguish between pulmonary and systemic circulation.	Revised the animation to separate pulmonary and systemic circulation using color-coded pathways (blue for deoxygenated, red for oxygenated blood).
6	Science Content Expert	The term "blood vessel" was used interchangeably with "artery" and "vein," potentially causing misconceptions.	Standardized terminology and added a glossary feature accessible throughout the media.
7	Islamic Value Integration Expert	Reflection activities tended to be "bolted-on" rather than meaningfully connected to science concepts.	Redesigned reflection activities to explicitly connect circulatory system concepts with gratitude, responsibility for health, and appreciation of Allah's creation.
8	Islamic Value Integration Expert	Qur'anic verses were presented without contextual explanation.	Added contextual explanations linking each Qur'anic verse with the relevant scientific concept.

The qualitative feedback from experts indicated that the revisions were not merely cosmetic but addressed substantive aspects of instructional design, scientific accuracy, and value integration. After the revisions were completed, the revised product was re-validated by the same experts, and all aspects achieved scores above the 81% minimum threshold, confirming that the media was ready for classroom implementation.

3.3 Effectiveness of AI-Based Interactive Learning Media in Improving Conceptual Understanding

The effectiveness analysis was conducted to determine whether the developed media could improve students' understanding of the circulatory system concept. The experimental group received learning treatment using AI-based interactive media, while the control group used conventional learning resources.

In addition to providing interactive learning activities for students, the developed media was equipped with an AI-supported teacher dashboard to facilitate learning monitoring and evaluation. The dashboard provided information regarding students' learning progress, assessment results, and AI-generated recommendations to support teachers in making data-driven instructional decisions.

Figure 2. Teacher Dashboard Monitoring System

Figure 2 illustrates the teacher dashboard developed as part of the AI-based learning environment. The dashboard integrates learning analytics features that allow teachers to monitor student achievement, review assessment patterns, identify learning difficulties, and obtain AI-generated recommendations for instructional improvement [5].

The effectiveness of the developed media was further evaluated by comparing learning improvement between the experimental and control groups. The comparison of learning improvement is presented in Table 3.

Table 3. Comparison of N-Gain Scores Between Experimental and Control Groups

No.	Group	N-Gain (%)	Category
1	Experimental Group	95	High / Effective
2	Control Group	58	Medium
	Difference	37	-

Table 3 demonstrates that the experimental group achieved an N-Gain score of 95%, considerably higher than the control group (58%). The difference of 37 percentage points indicates that AI-based interactive learning media provided a substantially greater contribution to students' conceptual improvement.

To ensure that the improvement was statistically meaningful, further hypothesis testing was conducted as shown in Table 4.

Table 4. Statistical Analysis of Conceptual Understanding Improvement

Statistical Analysis	Result	Interpretation
Pretest Equivalence Test	$U = 432.5$; $p = 0.782$	No initial difference between groups
Wilcoxon Signed Rank Test	$Z = -4.782$; $p < 0.001$	Significant improvement
Mann-Whitney U Test	$U = 112.5$; $p < 0.001$	Significant difference between groups
Effect Size	$r = 0.65$	Large effect

The pretest equivalence analysis showed no significant difference between experimental and control groups ($p = 0.782$), indicating that both groups had comparable initial abilities before treatment.

The Wilcoxon test demonstrated significant improvement within the experimental group ($p < 0.001$). Furthermore, the Mann-Whitney test confirmed that the posttest achievement of the experimental group was significantly higher than the control group ($p < 0.001$).

The effectiveness of the media can be explained through several instructional mechanisms. First, the adaptive quiz system provided immediate feedback, allowing students to identify errors and receive

corrective explanations [6], [26]. Second, interactive 3D visualization helped students construct mental representations of biological structures.

This finding supports the Cognitive Theory of Multimedia Learning, which emphasizes that students learn more effectively when abstract information is transformed into meaningful visual and verbal representations.

3.4 Improvement of Social Emotional Learning Competence and Islamic Value Internalization

One of the main contributions of this study is the integration of Social Emotional Learning (SEL) and Islamic values into science learning through AI-based interactive media. Unlike conventional science learning media that primarily emphasize cognitive achievement, the developed media was designed to facilitate students' cognitive, social, emotional, and spiritual development simultaneously.

The integration of SEL was implemented through storytelling activities involving learning characters, reflective questions, collaborative tasks, and contextual scenarios related to empathy, responsibility, emotional awareness, and social interaction. Meanwhile, Islamic values were integrated through contextual reflection activities that connected scientific phenomena with appreciation of human creation and spiritual awareness.

The improvement of SEL competence and Islamic value internalization was measured through teacher observation, student self-assessment, and peer assessment during five learning sessions. The results are presented in Table 5.

Table 5. Improvement of Social Emotional Learning Competence and Islamic Value Internalization

No.	Dimension	Instrument	P1	P5	Improvement	p-value	Effect Size (r)
1	SEL	Teacher Observation	45.83	95.83	+50.00	<0.001	0.62
2	SEL	Self-Assessment	41.66	90.83	+49.17	<0.001	0.61
3	SEL	Peer Assessment	47.06	83.82	+36.76	<0.001	0.60
4	BTQ	Teacher Observation	41.66	91.04	+49.38	<0.001	0.61
5	BTQ	Self-Assessment	42.70	92.61	+49.91	<0.001	0.62

Based on Table 5, students demonstrated significant improvement in both SEL competence and Islamic value internalization after using the developed media.

The teacher observation results showed that SEL competence increased from 45.83 in the first meeting to 95.83 in the fifth meeting, with an improvement of 50.00 points. Statistical analysis confirmed that the improvement was significant ($p < 0.001$) with a large effect size ($r = 0.62$).

Similarly, student self-assessment showed an increase from 41.66 to 90.83, while peer assessment increased from 47.06 to 83.82. The difference between self-assessment and peer assessment results provides an important interpretation. Students tended to perceive stronger internal development of emotional awareness and self-management, while peer assessment reflected observable social behaviors such as cooperation, communication, and relationship skills.

The improvement of SEL competence can be explained by the embedded storytelling approach used in the media. Students were not simply instructed to understand social values theoretically, but were placed in learning situations where they observed characters experiencing emotional challenges and social interactions. Through these experiences, students developed opportunities to reflect on empathy, responsibility, and decision-making.

This finding supports Bandura's Social Learning Theory, which explains that learning occurs through observation, imitation, and identification with models [27]. In this study, learning characters

functioned as social models that enabled students to understand emotional and social situations through meaningful experiences.

Furthermore, the integration of Islamic values also demonstrated significant improvement. Teacher observation increased from 41.66 to 91.04, while student self-assessment increased from 42.70 to 92.61. The average improvement reached 49.65 points, indicating that the media successfully facilitated value internalization.

The effectiveness of Islamic value integration was influenced by the embedded approach implemented in the media. The values were not presented as additional religious content separated from science concepts; instead, they were connected with scientific phenomena through reflection activities. For example, understanding the complexity of the human circulatory system was connected with awareness of human creation, gratitude, responsibility for health, and appreciation of life.

This approach differs from the commonly used *bolt-on integration*, where values are added separately after scientific explanation. The embedded approach allows students to construct connections between scientific knowledge and personal meaning, making learning more holistic.

3.5 Synthesis of Findings and Research Contribution

The overall findings demonstrate that the developed AI-based interactive learning media successfully addressed three important dimensions of elementary science learning:

1. Cognitive dimension
   represented by improvement in students' conceptual understanding of the human circulatory system.
2. Social-emotional dimension
   represented by improvement in SEL competencies, including awareness, empathy, cooperation, and responsible decision-making.
3. Spiritual/value dimension
   represented by improvement in Islamic value internalization through contextual reflection activities.

The success of this study cannot be attributed to a single component but resulted from the interaction between technological design, instructional strategy, and value integration.

First, the technological component contributed through AI-based adaptive learning mechanisms. The rule-based AI system provided personalized feedback according to students' responses, allowing learners to receive immediate support when facing difficulties.

Second, the instructional component contributed through multimedia learning design. The combination of animation, three-dimensional visualization, interactive activities, and storytelling helped transform abstract scientific concepts into more understandable representations.

Third, the value-based component strengthened learning meaning by integrating SEL and Islamic reflection into science activities. This approach expanded the role of learning media from merely delivering information into facilitating students' character and value development.

The findings extend previous studies on interactive science learning media. Previous research on augmented reality and animation-based learning media has demonstrated effectiveness in improving visualization and conceptual understanding. However, these approaches generally focus primarily on cognitive outcomes and provide limited integration of social-emotional and spiritual dimensions.

In contrast, this study proposes an integrated model where artificial intelligence functions not only as a technological feature but as part of a broader pedagogical system that connects knowledge, character, and values.

The novelty of this research lies in the development of AI-based interactive learning media that simultaneously integrates:

a. adaptive learning technology,

b. multimedia visualization,

c. Social Emotional Learning,

d. Islamic value education.

This integration provides a different perspective on educational technology development, where innovation is not measured only by technological sophistication but also by its ability to support holistic student development.

3.6 Research Limitations and Future Development

Although the findings demonstrate positive results, several limitations should be considered.

First, the research was conducted in only one elementary school context with 60 students. Therefore, broader implementation involving diverse school contexts is needed to examine the generalizability of the findings.

Second, the AI system implemented in this study was based on rule-based adaptation rather than machine learning or deep learning technology. Although the system successfully provided adaptive feedback, future studies may explore more advanced AI approaches that enable deeper personalization.

Third, SEL and Islamic value measurements were conducted within a relatively short intervention period. Longitudinal studies are needed to examine whether improvements in students' social-emotional competence and value internalization are maintained over time.

Fourth, the improvement of learning outcomes may also be influenced by teacher involvement, classroom interaction, and researcher support during implementation. Future studies should investigate the independent contribution of media effectiveness under more natural classroom conditions.

Despite these limitations, the study provides evidence that AI-based interactive learning media can become a promising approach for developing technology-supported holistic learning environments in elementary education.

CONCLUSION

This study developed an Artificial Intelligence-based interactive learning media integrated with Social Emotional Learning (SEL) and Islamic values for elementary science learning on the human circulatory system topic. The development process followed a modified Research and Development approach by synthesizing the Borg and Gall and ADDIE models into seven stages.

The developed media consisted of interactive learning activities, three-dimensional visualization, animated learning materials, adaptive quizzes, real-time feedback, storytelling activities, reflection features, and teacher monitoring facilities. The validation results showed that the media achieved a very high validity level with an average score of 97.25%. The practicality evaluation also demonstrated that the media was highly practical based on student responses (90.9%) and teacher responses (98%).

The effectiveness test revealed that the AI-based interactive media significantly improved students' conceptual understanding compared with conventional learning. The experimental group achieved a higher learning improvement with an N-Gain score of 95%, while the control group obtained 58%. Statistical analysis confirmed significant differences between groups.

Furthermore, the integration of SEL and Islamic values successfully improved students' social-emotional competence and value internalization. The findings indicate that the developed media can support holistic science learning by integrating cognitive, social, and spiritual dimensions.

This study contributes to educational technology research by demonstrating that AI-based learning media can be designed not only to improve academic achievement but also to support character development and value-based learning. However, the findings are limited to one school context, a relatively short implementation period, and rule-based AI technology. Future research should examine broader

implementation contexts and explore more advanced AI technologies, such as machine learning-based adaptive systems.

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