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The effect of learning media development on improving student motivation in islamic elementary schools

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ABSTRACT

Learning in Islamic elementary schools is often characterized by teacher-centered instruction and limited use of interactive learning media, resulting in low student motivation and passive learning behaviors. The lack of engaging, technology-integrated media hinders students' active participation, reduces learning interest, and limits the development of meaningful and motivating learning experiences. This study investigates how learning media development is designed, validated, and implemented to effectively enhance student motivation in Islamic elementary schools through feasible and engaging instructional media. This study used a research and development approach with the ADDIE model involving 25 fifth-grade students. Data were collected through observations, interviews, questionnaires, and pretest–posttest, and analyzed using Likert scales and N-Gain to assess feasibility and effectiveness. The study concludes that ADDIE-based Digital Crossword effectively enhances elementary students' motivation, engagement, and conceptual understanding in Natural and Social Sciences. Acting as a pedagogical mediator, the media combines multimodal elements, game mechanics, and immediate feedback to foster active, meaningful learning. High expert validation and positive student responses confirm its feasibility and pedagogical potential, with moderate N-Gain improvement observed. This study is significant as it provides empirical evidence that ADDIE-based Digital Crossword media effectively enhances student motivation, engagement, and conceptual understanding, offering a practical, scalable model for interactive, game-based learning in elementary education.

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INTRODUCTION

The main problem in learning at Islamic elementary schools is the low effectiveness of material delivery, which can hinder understanding and reduce student motivation. Schweder and Raufelder (2022) and Borgonovi et al. (2023) argue that without appropriate learning media, teachers often struggle to explain abstract concepts, while students may become bored and fail to understand the material properly. Abdulrahaman et al. (2020) emphasize the importance of learning media to create two-way interaction, replacing passive lecture methods that do not support active learning skills. Empirical data indicate that learning media facilitate understanding of abstract concepts while fostering critical thinking, creativity, and student competencies in accordance with learning objectives (Prayogi et al., 2024). Maier and Klotz (2022) and Hong et al. (2024) further note that mastery of digital media allows teachers to tailor learning to students' characteristics and 21st-century demands. Therefore, the development of creative and interactive learning media has been proven to effectively enhance motivation, participation, and student learning outcomes.

Previous research has shown that instructional media development can effectively enhance students' motivation and learning outcomes. Lubis et al. (2023) emphasize that learning methods and media should be relevant, aligned with objectives, and responsive to students' interests and abilities to improve comprehension, achievement, and skills. Bahrudin and Yogihati (2022) report that interactive media are valid, feasible, and strengthen conceptual understanding, engagement, and ease of use. Adawiyah et al. (2024) note that Articulate Storyline 3-based media supports active learning, multiple learning styles, and inclusivity, while Marini et al. (2023) find that digital comics increase reading interest and literacy. Afifa and Astuti (2024) indicate that digital media positively affects motivation (45.2%) and learning outcomes (20.2%), though other factors also contribute. However, most studies focus on media validation or effectiveness in isolation, with limited research examining integrated development, feasibility, and effectiveness in Islamic elementary schools, particularly regarding motivation, engagement, and meaningful learning experiences.

In Islamic elementary schools, teaching practices are generally dominated by lecture methods and limited media, such as blackboards, textbooks, or occasional YouTube videos, often constrained by time, administrative workload, and limited facilities. Barakat et al. (2022) argue that this conventional approach makes learning monotonous and less engaging, whereas students show a preference for interactive, game-based, and quiz-oriented media. Media use is generally limited to practicum activities, while other subjects rarely incorporate innovative learning tools. Adawiyah (2024) emphasizes that passive lecture methods do not promote active learning, and Sailer et al. (2021) highlight the importance of integrating technology for two-way interaction. Furthermore, Van Den Beemt et al. (2020) stress the research gap: the development of digital media tailored to student characteristics to enhance learning motivation remains underexplored in Islamic elementary school contexts. This study aims to fill that gap by examining the design, feasibility, and pedagogical impact of interactive digital media on student engagement and motivation.

This study aims to examine the effect of learning media development on improving student motivation in Islamic elementary schools. The research focuses on three main aspects: first, how the development process of learning media is conducted to enhance student motivation; second, the feasibility of the developed media in supporting learning motivation; and third, the effectiveness of media use in increasing student motivation. Accordingly, this study not only explores the stages and procedures of media development but also evaluates the quality, feasibility, and practical impact of the media on students' interest and engagement in the learning process. The study is expected to provide both practical and theoretical benefits. Practically, the results can guide teachers in developing and utilizing effective learning media to improve student motivation. Theoretically, this study adds insight into the relationship between learning media development, feasibility, and effectiveness in supporting student motivation.

Based on the research objectives, it can be concluded that the development of learning media is pivotal in enhancing student motivation in Islamic elementary schools. This study systematically examines the development process, the feasibility of the media, and its effectiveness in fostering

student engagement and learning interest. It is hypothesized that media developed in alignment with students' characteristics, validated by experts, and designed for ease of use will significantly improve motivation. Furthermore, feasible and user-friendly media are expected to promote active participation, strengthen conceptual understanding, and support the achievement of learning outcomes. Consequently, this study provides empirical evidence demonstrating the critical interplay between learning media development, feasibility, effectiveness, and student motivation within the context of Islamic elementary education.

RESEARCH METHOD

This study employed a research and development (R&D) approach aimed at producing an instructional product while simultaneously examining its feasibility and effectiveness in enhancing students' learning motivation (Biel, 2023). The research was designed to address three main objectives: (1) to describe the process of developing digital learning media capable of enhancing students' learning motivation, (2) to examine the feasibility of the developed media for classroom implementation, and (3) to evaluate the effectiveness of the media in improving students' learning motivation. The ADDIE instructional design model consisting of Analysis, Design, Development, Implementation, and Evaluation was adopted as a systematic and adaptive framework for media development (Spatioti et al., 2022; Divayana et al., 2021).

To assess the effectiveness of the developed Digital Crossword media, this study utilized a one-group pretest–posttest design, a common approach in educational development research for examining learning improvements after an instructional intervention. While this design does not permit robust causal inferences, it offers valuable empirical insights into changes in student learning outcomes and motivation. By triangulating pretest–posttest results with expert validation and student response data, the study provides a comprehensive evaluation of both the feasibility and pedagogical impact of the media. This approach allows researchers to capture practical evidence of effectiveness within real classroom settings, despite inherent design limitations.

During the Analysis stage, learning problems, student characteristics, and media needs were identified through classroom observations, semi-structured interviews with teachers, and reviews of existing instructional media. This stage aimed to ensure that the developed media addressed authentic classroom challenges and student motivational needs (Kushnir, 2025). In the Design stage, learning objectives, instructional strategies, and content structures were formulated in alignment with the curriculum and students' cognitive characteristics. A game-based learning strategy was selected to foster motivation, engagement, and active learning. The Development stage involved transforming the instructional storyboard into an interactive digital product. The Digital Crossword media integrated crossword puzzles, instructional videos, animations, visual illustrations, background music, and navigation elements using the Genially platform. The media was designed for easy access via QR codes, enabling flexible use across devices and learning contexts (Kraus et al., 2021).

During the Implementation stage, the validated media was applied in classroom learning with 25 fifth-grade students. Students engaged with the Digital Crossword media under teacher guidance, and their responses were collected to assess usability, attractiveness, and motivational impact. The Evaluation stage focused on assessing both the feasibility and effectiveness of the media. Feasibility was evaluated through expert validation and student response questionnaires, while effectiveness was measured by comparing pretest and posttest results.

The study involved 25 fifth-grade students from SD Islam Ar-Raudhoh Jember, comprising 12 boys and 13 girls, selected through purposive sampling based on their familiarity with the learning material and readiness to engage with digital media. In addition, a classroom teacher acted as a collaborator, assisting in the implementation of the Digital Crossword learning media and offering professional feedback on instructional feasibility and classroom management. This collaboration ensured that the media was applied effectively within the natural learning environment, while also allowing the researchers to gather informed observations and evaluations regarding usability, student engagement, and pedagogical suitability in a real-world elementary school context.

Data were collected using observations, interviews, and questionnaires. Observation and interview instruments were used to identify learning needs and contextual constraints (Buntins et al., 2021). Expert validation questionnaires were administered to material experts, media design experts, linguists, and learning experts to assess content validity, instructional design quality, language clarity, and media presentation (Wallwey & Kajfez, 2023). Student questionnaires measured perceived attractiveness, ease of use, and learning motivation. All questionnaires employed a five-point Likert scale, which is widely accepted for measuring perceptions and attitudes in educational research (Cheng et al., 2021).

Media feasibility was determined by calculating percentage scores from expert and student questionnaire responses and categorizing them according to predefined validity criteria. Learning effectiveness was evaluated using the Normalized Gain (N-Gain) test, which measures proportional improvement between pretest and posttest scores (Mendoza Diaz & Sotomayor, 2023). N-Gain values were interpreted using standard criteria (low, moderate, high) to determine the level of learning improvement.

The N-Gain formula applied was:

$$\text{Normal Gain} = \frac{\text{Skor Post test} - \text{Skor Pre test}}{\text{Skor Ideal} - \text{Skor Pre test}}$$

Pretests were administered prior to the implementation of the Digital Crossword media to assess students' initial learning motivation and understanding. Posttests were conducted after the intervention to measure improvement. The combined use of expert validation, student responses, pretest–posttest analysis, and N-Gain scoring enabled a comprehensive evaluation of the development process, feasibility, and effectiveness of the Digital Crossword learning media in enhancing students' motivation at Islamic elementary school Ar-Raudhoh Jember.

RESULTS AND DISCUSSION

Results

Media development for student learning

The development of learning media for students was carried out through five main stages: Analysis, Design, Development, Implementation, and Evaluation. The resulting product was a digital crossword media applied to fifth-grade elementary school students. This media was used in Natural and Social Sciences subjects, focusing on the topic of the human respiratory system. Each stage aimed to ensure that the developed media met students' learning needs, was engaging to use, and was effective in improving understanding and learning motivation. Through this approach, the learning media was not only informative but also interactive, thereby supporting a more active and enjoyable learning process.

Analysis stage

The first stage begins with identifying problems and analyzing the needs of students and teachers, including analysis of problems, performance, and needs for product development.

Table 1
Needs Analysis

No	Finding	Explanation
1	Students are less enthusiastic and bored	Learning is still teacher-centered with minimal media, causing students to be uninterested and have low learning motivation.
2	Limited media and teacher time	Projectors are limited, media only display videos/images, and creating new media is hampered by teachers' limited time; media are used alternately.
3	Need for interactive learning	Students prefer learning through games or quizzes; some students have smartphones; projector availability is inadequate in each classroom.
4	Positive response to digital media	Students and teachers find the Crossword Digital media interesting, easy to learn, and helpful for recalling learning material.

Based on the needs analysis, it can be concluded that students require interactive and engaging learning media. The Digital Crossword media is able to increase learning motivation, overcome media limitations, and facilitate enjoyable and effective learning for students.

Design stage

After analysis, the design stage includes determining learning objectives, selecting appropriate media strategies, and creating a prototype of the Digital Crossword media.

Table 2
Stages in Creating Digital Crossword Learning Media

No	Point	Explanation
1	Determining Learning Objectives	Aligning the Grade V Learning Objectives (LO) with the designed media so that students can achieve the LOs and indicators through post-test evaluation.
2	Selecting Learning Strategies	Using a Game-Based Learning strategy with five steps: selecting a game according to the topic, explaining the concept, explaining the game rules, playing the game, and conducting reflection.
3	Designing the Media	The media is created using applications such as Genially, Canva, Wordwall, and Labscrossword, containing text, audio, images, animations, and videos, and can be accessed via web links or QR Codes on various devices.
4	Media Development Flow	Developing a media prototype, adding interactive content, aligning it with learning strategies, and publishing it so that it can be used by students.

Based on the stages of developing the Digital Crossword learning media, it can be concluded that the process involves aligning learning objectives, selecting a Game-Based Learning strategy, designing interactive media using various applications, and organizing the media flow and publication. This media is designed to enable students to learn actively, understand the material in an enjoyable way, and access content across multiple devices, thereby supporting the effective achievement of learning indicators and enhancing students' motivation and engagement.

Development stage

The development stage of the Digital Crossword learning media begins with determining the product's format, transforming a conventional crossword puzzle into an interactive digital medium. This media is equipped with additional features such as icebreakers, learning videos, supporting materials, and can be accessed via QR Code, which is expected to effectively increase student interest, motivation, and learning engagement.

Table 3
Media Development Stages

No	Point	Explanation
1	Product Form	The Digital Crossword learning media was developed from conventional crosswords into a digital format, equipped with additional menus such as ice breaking, instructional videos, supporting materials, and accessible via QR Code.
2	Media Creation	Using Canva, Genially, Wordwall, Labscrossword, and YouTube to create icons, text, animations, user guides, and other interactive content.
3	Crossword Creation	Creating questions/keywords and answers in Wordwall and Labscrossword, then sharing them via link or assignment.
4	Interactive Slide Creation	Designing slides in Genially including cover, menu, materials, videos, animations, background music, and crossword links, with interactive settings, navigation, and animations for each icon.
5	Media Publication	Reviewing all content and interactivity, then publishing the media by copying the share link.
6	QR Code Creation	Creating a QR Code through Canva, adjusting the design, and downloading it in transparent PNG format so the media can be accessed on various devices.

Based on the development stages, the Crossword Digital learning media was successfully converted from a conventional format into an interactive digital format, complete with additional menus, interactive slides, animations, videos, and background music. The media was created using

various applications, tested for interactivity, published, and equipped with a QR Code for easy access across multiple devices. This process ensures that the media is engaging, effective, and optimally supports student learning.

Implementation stage

The next stage is implementation, which involves testing the Crossword Digital media to assess student responses and its effectiveness. Student responses are measured through questionnaires, while effectiveness is evaluated using pretests and posttests. The media was tested twice, on a small scale and a large scale, to ensure its feasibility and improvement in student learning outcomes.

Table 4
Implementation of Learning Media

No	Point	Explanation
1	Student Grouping Stage	Students are divided into four groups and then provided with a guidebook to facilitate the use of the Crossword Digital media.
2	Guidebook Explanation	The researcher explains the contents and usage of the guidebook so that students understand the steps in using the media correctly.
3	Media Usage	Students use the Crossword Digital media according to the instructions in the guidebook that has been explained previously, making the learning process structured.
4	Classroom Teacher Assistance	The trial is conducted with the assistance of the classroom teacher, who monitors the learning process and ensures the media is used according to the guidelines.
5	Media Flexibility	The Crossword Digital media can be used by the classroom teacher for other materials or subjects by accessing the media account previously developed using an e-mail.

Based on the implementation stage, the Crossword Digital media was used in a structured manner with the guidance of the classroom teacher, starting from student grouping, guidebook explanation, to media usage. The media is also flexible and can be applied to other materials or subjects, thus supporting effective learning and enhancing student motivation.

Evaluation stage

The Evaluation stage in the ADDIE model aims to determine the success of the developed media. Trials of the Crossword Digital learning media for Grade VB students at Ar-Roudhoh Islamic Elementary School, Patrang, Jember, showed very positive student responses, with scores of 90% and 89.5% in the "very good" category. Learning improvement was reflected in the N-Gain score of 62.32%, indicating moderate improvement and fair effectiveness. Focused on the human respiratory system, the media effectively increased students' interest, motivation, and understanding of science and social studies concepts. By integrating interactive games, digital activities, and engaging content, the Crossword Digital media not only enhances comprehension but also transforms learning into an enjoyable and meaningful experience, demonstrating its potential as an effective tool for promoting active and participatory learning.

Media feasibility test in learning

Based on expert assessment, the Digital Crossword learning media developed is considered highly feasible for use. Validation was conducted by five experts, including material experts, media experts, language experts, and learning experts, selected based on academic and professional competence to ensure credible evaluation. The media was assessed on various aspects, including content accuracy, instructional design, language clarity, visual presentation, and interactivity. The validation results showed an average score of 88.8%, categorized as "very valid," indicating high feasibility for use in learning.

Suggestions from experts were analyzed and used for media revision. Media experts recommended replacing images with anatomy illustrations according to theory, adding explanations for preventing respiratory system disorders, and creating a continuous-arrow flow diagram of the respiratory mechanism. Material experts suggested a student-centered module with subtopics linked to video QR codes, learning objectives (LO), learning outcomes (LOut), and a complete table of

contents. Language experts emphasized using direct instructional sentences to facilitate student understanding. The following are the results of the media validity test from the experts:

Table 5
Expert Validation Results

No	Validator	Presentation	Category
1	Material Expert 1	80%	Valid
2	Material Expert 2	92%	Very Valid
3	Media Expert	94%	Very Valid
4	Linguist	80%	Valid
5	Learning Expert	98%	Very Valid
Amount		**444%**	
Average percentage		**88,8 %**	**Very Valid**

Although the validation results indicate high feasibility, it should be noted that this assessment only reflects expert perspectives and does not directly measure the media's impact on student motivation or learning outcomes. Future research is recommended to conduct field trials to evaluate student engagement, usability, and learning outcomes as additional empirical evidence. Thus, Digital Crossword is pedagogically ready, interactive, and engaging for elementary education.

Effectiveness of using digital crossword learning media

This effectiveness test was conducted in one class with measuring instruments using pretest and postest (One Group Pretest-Postest). The pretest question was given with the aim of knowing the initial ability of students before using digital crossword learning media. Then after the pretest is done, it is continued with learning using digital crossword learning media on the material we breathe. After the use of digital crossword learning media, students are given a posttest question which aims to compare the value of the pretest results with the posttest.

Table 6
Student Response Results

No	Respondents	Total Value	Maximum Value	Presentation	Kriteria
1.	AA	47	50	94%	Very good
2.	AAF	40	50	80%	Very good
3.	BAA	50	50	100%	Very good
4.	DAMP	46	50	92%	Very good
5.	DD	44	50	88%	Very good
6.	ENK	46	50	92%	Very good
7.	FAI	39	50	78%	Good
8.	FNA	34	50	68%	Good
9.	KSW	45	50	90%	Very good
10.	MAN	43	50	86%	Very good
11.	MARS	45	50	90%	Very good
12.	MHFA	50	50	100%	Very good
13.	NAR	44	50	88%	Very good
14.	NNMA	46	50	92%	Very good
15.	QAZ	41	50	82%	Very good
16.	RYA	42	50	84%	Very good
17.	SKR	45	50	90%	Very good
18.	SNEA	48	50	96%	Very good
19.	SFA	50	50	100%	Very good
20.	YMA	50	50	100%	Very good
Amount		**895**	**1000**	**89,5%**	
Average		**44,75**	**50**	**Very good**	

Based on Table 6, the results of the large-scale test show an average percentage of 89.5%, which is interpreted as very good. The student response test was conducted after the Crossword Digital media received validation from media experts, material experts, language experts, and learning

experts. This media was tested on Grade VB students at Islamic elementary school Ar-Roudhoh Patrang Jember through two stages: small-scale and large-scale trials. In the small-scale trial, 5 students participated, and the questionnaire results showed an average percentage of 90%, indicating a very high level of learning motivation. This positive result served as the basis for conducting the large-scale trial, where 20 students participated, achieving an average motivation percentage of 89.5%, also in the very good category. These results indicate that the use of Crossword Digital media can significantly enhance students' motivation during the learning process. The following is a table of descriptive statistics:

Table 7
N-Gain Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	25	.35	1.00	.6232	.16169
NGain_Persen	25	35.48	100.00	62.3247	16.16889
Valid N (listwise)	25				

Based on table 7, it is known that the results of the N-Gain test obtained a value of 0.30 - 0.70, so that the increase in pretest and posttest scores is included in the moderate category with a fairly effective percentage. Although there was an increase in pretest scores to posttest scores, the use of N-Gain analysis was only used to see the increase in scores from pretest to posttest. This analysis does not provide statistical information about the significance of the effect of crossword learning media on the increase. In other words, N-Gain has limitations because it only describes an increase without being able to show the source of the increase specifically whether the increase is caused by the use of crossword media or by other factors such as understanding of the material presented during learning.

Discussion

Enhancing student motivation through media development

The findings of this study can be interpreted through the lens of systematic instructional design, which positions the ADDIE model as an adaptive approach to addressing learners' needs (Daryanes et al., 2024). The dominance of teacher-centered instruction and the limitations of conventional media, as widely critiqued in contemporary learning literature, have implications for low student motivation and engagement. In this context, the Digital Crossword functions as an interactive learning environment that reconstructs students' learning experiences through multimodal integration, aligning with Bereczki and Kárpáti's (2021) view on the importance of digital media in fostering active participation. The integration of text, visuals, animations, videos, and educational games affirms multimedia learning theory, which emphasizes the simultaneous activation of cognitive and affective processes (Hillmayr et al., 2020). Therefore, these findings strengthen the argument that interactive digital media can transform passive learning into active learning experiences that stimulate curiosity and enjoyment among students (Degner et al., 2022).

Furthermore, the findings indicate that the Digital Crossword functions as a mediating pedagogical tool, linking game-based learning strategies to enhanced student motivation and improved learning outcomes. The integration of game mechanics, structured challenges, and immediate feedback operates as a set of motivational stimuli, effectively activating the attention and satisfaction dimensions of Keller's ARCS motivation theory, as highlighted by Mena-Guacas et al. (2025). This activation of intrinsic motivation facilitates not only heightened engagement but also the deeper internalization of concepts, as evidenced by an N-Gain score of 62.32%, which falls into the moderate improvement category. These results reinforce Lyu et al.'s (2023) perspective that the effectiveness of digital learning media is not solely dependent on content accuracy, but is significantly shaped by thoughtful pedagogical design that encourages active participation, collaboration,

reflection, and iterative learning. Thus, the Digital Crossword exemplifies how interactive digital tools can transform learning from a passive to a meaningfully engaging cognitive experience.

Compared with previous studies that generally examine the use of digital media in a partial manner or through a single platform, this study offers a novel contribution through the integration of multimodal applications that are flexibly accessed via QR codes. These findings reinforce Piaget's constructivist perspective and Vygotsky's tool mediation theory, which conceptualize technology as a cultural tool in the process of knowledge construction (Wibowo et al., 2024). Within the context of Indonesian primary education, which continues to face constraints in infrastructure and teachers' instructional time, the Digital Crossword can be interpreted as a contextual, practical, and sustainable learning solution (Nofriza & Zen, 2024). Thus, this media is not only empirically relevant but also holds institutional implications as a model of digital learning innovation that supports active, enjoyable, and student-centered learning policies (Kwangmuang et al., 2021; Quaicoe et al., 2023).

Feasibility of digital crossword learning media

The findings indicate that the Digital Crossword learning media achieved an average score of 88.8%, categorized as "very valid," reflecting a very high level of feasibility according to expert evaluations. Theoretically, this supports Bereczki & Kárpáti's (2021) argument that digital media play a crucial role in fostering active student participation, and Hillmayr et al. (2020), who emphasize multimodal integration text, visuals, animations, videos, and games as a mechanism to simultaneously engage cognitive and affective processes. Expert suggestions, including accurate anatomical illustrations, student-centered modules with QR Code videos, and direct instructional sentences, underscore the necessity for media design to be responsive to learners' characteristics and needs. This aligns with Vygotsky's mediating tools theory (Nguyen & Diederich, 2023), in which media function as cultural instruments facilitating knowledge construction. Consequently, the high validity of the media reflects not only technical quality but also its pedagogical potential.

Furthermore, these findings suggest that high media validity has significant implications for student motivation and engagement. According to Aseery (2024), interactive and contextual media can enhance meaningful learning experiences, facilitate active involvement, and stimulate intrinsic motivation. The integration of game elements and immediate feedback in Digital Crossword serves as a motivational stimulus, activating the attention and satisfaction dimensions within Keller's ARCS theory (Chang, 2021; Banjar & Campbell, 2022). Although the media was rated highly valid, this study acknowledges its limitation in not directly measuring the impact on student motivation and learning outcomes. Therefore, future research employing field testing with students is recommended to evaluate interactivity, engagement, and learning achievement, providing more comprehensive empirical evidence on the pedagogical effectiveness of interactive digital media in elementary education.

Digital media as a mediator of student motivation and learning outcome improvement

The findings of this study can be interpreted as empirical evidence that the Digital Crossword functions as a pedagogical artifact that mediates students' cognitive and affective engagement in Natural and Social Sciences learning. The high level of student responses in the very good category (89.5%) does not merely indicate positive acceptance of the media, but rather reflects the formation of meaningful learning experiences oriented toward active engagement, as emphasized in engagement-based learning theory (Tombleson, 2024). From the perspective of digital capital theory, the average N-Gain score of 0.62 suggests that interactive digital media serve as cognitive resources that expand students' learning capacity through interaction, visualization, and continuous feedback (Rizk & Hillier, 2022). Accordingly, the effectiveness of the media in this study should be understood not only in terms of improved academic achievement, but also as an enhancement of learning process quality, characterized by sustained engagement, focused attention, and positive learning experiences.

Furthermore, the relational model of the findings indicates that the influence of the Digital Crossword on learning outcomes is indirect, with learning motivation acting as a key mediating

variable. Interactivity, game elements, and immediate feedback function as motivational stimuli that activate students' intrinsic motivation, as explained within the framework of self-determination theory and game-based learning (Chans & Castro, 2021). From Keller's ARCS motivational theory perspective, the dimensions of attention and satisfaction emerge as central mechanisms explaining how media design shapes student engagement and conceptual understanding (Mahalingham et al., 2022). The moderate N-Gain results further support the argument of Ribosa and Duran (2022) that digital media do not operate deterministically on learning outcomes, but rather function as facilitators whose effectiveness depends on instructional design quality and pedagogical interactions between teachers and students during the learning process.

Compared to prior studies that predominantly emphasize causal testing through experimental designs with control groups, this study occupies a distinct position by foregrounding media development processes and students' learning responses as indicators of pedagogical effectiveness (Kerimbayev et al., 2023). The novelty of this research lies in the integration of the Digital Crossword as a contextual, adaptive, and easily accessible game-based learning medium within primary education settings. In the institutional context of Indonesian primary education, which continues to face infrastructural limitations and diverse student abilities, these findings align with the argument of Haleem et al. (2022) that simple yet pedagogically well-designed digital technologies can yield significant impacts on learning engagement. Therefore, despite the limitations of N-Gain analysis in establishing causality, the findings of this study remain valuable as both a conceptual and empirical foundation for the development of digital learning media oriented toward student motivation, engagement, and meaningful learning experiences.

CONCLUSION

Based on the findings, the study concludes that the ADDIE-based Digital Crossword learning media is effective in enhancing student motivation, engagement, and conceptual understanding in Natural and Social Sciences at the elementary level. The media serves as a pedagogical mediator, bridging game-based learning strategies and learning outcomes, with intrinsic motivation playing a central role. High expert validation (88.8%) and positive student responses (89.5%) confirm the media's feasibility, interactivity, and pedagogical potential. Multimodal integration, immediate feedback, and game elements stimulate cognitive and affective engagement, aligning with constructivist and engagement-based learning theories. While N-Gain results indicate moderate learning improvement, the study highlights the media's role in fostering meaningful, active, and enjoyable learning experiences. Future research should include broader field testing to assess direct impacts on motivation and achievement.

Theoretically, this study underscores the role of interactive digital media, particularly game-based tools like Digital Crossword, as a mediator between pedagogical design and student motivation, aligning with Keller's ARCS theory and Piaget-Vygotsky's constructivist perspectives. Thoughtfully designed multimodal media can activate cognitive and affective processes simultaneously, promoting deeper understanding and sustained engagement. Practically, elementary teachers can use Digital Crossword as an effective alternative to teacher-centered instruction, enhancing interactivity, motivation, and comprehension, especially for abstract topics. Its flexibility supports use despite limited infrastructure or teacher time, offering a scalable, replicable model for student-centered, active learning. Policymakers and school leaders are encouraged to integrate such media to foster meaningful, motivation-driven learning.

This study has several limitations that should be considered. The use of a one-group pretest–posttest design without a control group limits the ability to draw strong causal conclusions regarding the effectiveness of the Digital Crossword media. In addition, the sample size was limited to a single class and school context, restricting the generalizability of the findings. Learning improvement was assessed solely through N-Gain analysis, which does not reveal statistical significance or deeper mechanisms of influence. Future research is therefore recommended to employ experimental or quasi-experimental designs with comparison groups, involve larger and more diverse samples, and integrate

quantitative and qualitative analyses. Further studies may also explore the effectiveness of similar media across different subjects and educational levels.

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