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DEVELOPING AN INTERACTIVE DIGITAL FLIPBOOK TO ENHANCE JUNIOR HIGH SCHOOL STUDENTS' CREATIVE THINKING SKILLS

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Abstract

This study aims to develop and evaluate an interactive digital flipbook as a digital learning medium in science education to foster the creative thinking abilities of junior high school students, particularly in learning about physical and chemical changes and mixture separation. This research utilized a Research and Development (R&D) approach guided by the Four-D model, encompassing the phases of definition, design, development, and dissemination. The research population comprised all seventh-grade students of SMP Muhammadiyah 3 Baron, Nganjuk Regency, in the 2024/2025 academic year. The sample consisted of 13 seventh-grade students selected using a saturated sampling technique. Data were collected through material and media expert validation, pre-test and post-test of creative thinking skills, student response questionnaires, classroom observations, and teacher interviews. The data sources included primary data and secondary data in the form of curriculum documents and relevant literature. Data analysis was conducted using descriptive quantitative and qualitative techniques through percentage analysis and N-Gain calculation. The results indicated that the developed digital flipbook demonstrated a very high level of validity, with scores of 93% from material experts and 99% from media experts. The practicality test showed that the teaching material was very practical, as reflected by a student response score of 84%. The effectiveness test revealed an improvement in students' creative thinking skills, with the mean score increasing from 61.11 to 74.79 and an N-Gain value of 0.35 (moderate category). Therefore, the interactive digital flipbook is feasible and effective for supporting science learning focused on strengthening creative thinking skills.

Keywords Digital Flipbook, Interactive Learning Media, Creative Thinking Skills, Science Learning, Learning Innovation.

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INTRODUCTION

The rapid advancement of science and technology in the 21st century has introduced new challenges in instructional methods, learning resources, and educational media. Contemporary educational transformation no longer emphasizes the mastery of factual knowledge alone, but also focuses on the development of critical, creative, collaborative, and communicative thinking skills (Sodik, 2024). Education is increasingly expected to produce students who are capable of solving problems through creativity and analytical thinking (Ichsan et al., 2023; Inayah et al., 2023; Khan et al., 2022; Supit & Winardi, 2024). Among these skills, creative thinking plays a central role, as it serves as a fundamental competence for generating innovative solutions applicable to various real-life contexts (Cahya et al., 2024; Lasmana et al., 2024).

However, fostering students' creative thinking skills remains a significant challenge, particularly in junior high school science learning. Previous studies indicate that students often demonstrate passive learning behaviors, experience difficulties in understanding abstract concepts, and struggle to connect theoretical knowledge with real-world phenomena (Chen et al., 2022; Mróz & Ocetkiewicz, 2021; Thu et al., 2021). Science topics such as physical and chemical changes and mixture separation are considered particularly challenging, as they require advanced observational, analytical, and reasoning skills (Kusumaningtyas et al., 2024; Lestari et al., 2021; Muhammad & Triansyah, 2023). These conditions highlight the urgent need for innovative, contextually relevant, and engaging instructional strategies to promote active participation and enhance students' creative thinking skills in science learning (Jabbar et al., 2024; Yuliana et al., 2024).

In response to these challenges, the implementation of the Independent Curriculum (*Kurikulum Merdeka*) in Indonesia encourages a paradigm shift from teacher-centered to student-centered learning. This curriculum emphasizes contextual and meaningful learning experiences that support the development of students' creative character (Hasanah, 2023). Teachers are therefore expected not only to deliver content but also to design innovative learning experiences that stimulate curiosity and creative thinking. One promising approach to achieving these goals is the integration of interactive digital learning media. Research has shown that multimedia-based learning tools significantly improve student engagement and academic achievement (Nasution & Nusa, 2021; Papadopoulos & Bisiri, 2020; Sakiah & Effendi, 2021).

Advances in digital technology have provided educators with broad opportunities to utilize interactive learning platforms, one of which is the use of interactive digital books or *digital flipbooks*.

These media integrate text, images, animations, videos, and audio into a single, user-friendly learning environment (Roemintoyo & Budiarto, 2021; Sari & Ahmad, 2021). Interactive digital books function not only as instructional materials but also as exploratory media that facilitate students' visual and contextual understanding of scientific concepts. Erna et al. (2021) reported that multimedia-based digital books enhance student engagement by presenting dynamic learning experiences and allowing students to learn at their own pace. The effectiveness of interactive digital learning platforms has been further corroborated by studies indicating significant improvements in student participation and achievement (BG et al., 2024; Ricky et al., 2025).

The integration of interactive digital books into science instruction has considerable potential to enhance students' creative thinking skills. This perspective aligns with the creative thinking framework proposed by Hake (1998), which includes fluency, flexibility, originality, and elaboration (Anas & Hasibuan, 2023). Through interactive digital flipbooks, students can develop these dimensions by exploring, observing, and analyzing scientific phenomena presented in visual and interactive formats. Furthermore, the incorporation of simulations and simple experiments enables students to solve problems independently, generate new ideas, and bridge theoretical concepts with practical applications in real-life contexts (Park et al., 2025; Roemintoyo & Budiarto, 2021).

Field observations and preliminary interviews conducted at SMP Muhammadiyah 3 Baron indicate that science learning practices have not yet optimally utilized digital learning media. Teachers predominantly rely on printed textbooks and verbal explanations, while the use of interactive digital media remains limited. As a result, learning activities tend to be one-directional and less contextual, providing minimal space for students to explore ideas, ask questions, or connect scientific concepts with real-life phenomena. Documentation of learning activities further shows that students are generally passive during lessons and depend heavily on examples provided by the teacher.

In terms of students' cognitive abilities, pre-research observations reveal that students' creative thinking skills are still relatively low. Most students experience difficulties in generating diverse ideas, developing answers in detail, and producing original solutions when solving science-related problems. Analysis of students' assignments and initial assessments shows that responses are often short, uniform, and procedural, indicating limited fluency, flexibility, originality, and elaboration. This condition highlights a gap between the expected learning outcomes of the Independent Curriculum, which emphasizes creativity and student-centered learning, and the

actual learning conditions in the classroom.

A growing body of empirical research supports the effectiveness of digital learning media in improving learning outcomes and fostering creativity. Tobing et al. (2024) reported a positive relationship between the use of digital media and the enhancement of students' skills, while Gumilar et al. (2025) reported that contextual learning strategies based on digital media significantly improved students' critical and creative thinking skills. Furthermore, Anjasti et al. (2024) reported that locally contextualized digital modules effectively enhanced students' conceptual understanding and creative thinking skills in chemistry learning. Similarly, Rahayu et al. (2022) found that Android-based interactive multimedia supported the development of science process skills and conceptual understanding among students. Findings by Rahayu et al. (2022) and Nuraini et al. (2023) further emphasize that interactive multimedia and teachers' competence in technology integration (TPACK) play a crucial role in creating meaningful and engaging digital learning experiences. Overall, these findings confirm that technology integration in science education is an effective approach to developing students' creative thinking skills.

Despite these positive findings, most previous studies have not explicitly focused on the systematic integration of creative thinking indicators into digital learning media. To address this gap, there is a need for learning media that are not only visually appealing but also intentionally designed to stimulate creative thinking skills. Interactive digital flipbooks were chosen as a learning medium because they allow the integration of text, images, animations, videos, and interactive activities within a structured learning environment. When systematically designed, flipbooks can facilitate active learning and support the development of creative thinking through exploration, reflection, and problem-solving activities.

The novelty of this study lies in the development of an interactive digital flipbook that explicitly integrates creative thinking indicators, namely fluency, flexibility, originality, and elaboration, into science learning activities aligned with the Independent Curriculum. Unlike previous studies that mainly focus on student motivation or learning outcomes, this research emphasizes the structured design and evaluation of digital learning media as a tool to foster creative thinking skills. Therefore, this study aims to develop and evaluate an interactive digital flipbook in terms of its validity, practicality, and effectiveness in enhancing junior high school students' creative thinking skills. The findings are expected to contribute theoretically to the development of digital learning media research and practically to supporting teachers, students, and educational

developers in designing innovative, meaningful, and technology-integrated science learning experiences that meet the demands of 21st-century education.

METHOD

In this study, the Research and Development (R&D) approach is applied, specifically adopting the Four-D development model proposed by Thiagarajan, Semmel, and Semmel (1974), This model provides a systematic framework for developing educational products and consists of four sequential stages: define, design, develop, and disseminate, each of which plays a crucial role in ensuring the effectiveness and practicality of the resulting teaching materials. This model was chosen because it is able to describe the systematic process of developing learning products, starting from needs analysis to producing valid, practical, and effective media for use in the classroom. The product developed is a Digital Flipbook teaching material to enhance students' ability to think creatively.

The present study was conducted during the second semester of the 2024/2025 academic year at SMP Muhammadiyah 3 Baron, Nganjuk Regency. The research population comprised all seventh-grade students enrolled at the school. The research sample consisted of 13 seventh-grade students selected using a saturated sampling technique, in which all members of the population were included as research participants due to the limited population size. The study focused on science learning, particularly on the topics of physical and chemical changes and mixture separation. This setting was chosen to examine the implementation and effectiveness of the Digital Flipbook as an innovative learning medium for improving students' ability to think creatively.

The data used in this study consisted of primary and secondary data. Primary data were obtained directly from research participants and validators, including expert validation data from material and media experts collected through feasibility assessment sheets, students' creative thinking skills data obtained from pre-test and post-test results, practicality data collected through student response questionnaires, learning activity data obtained from classroom observation sheets, and qualitative data in the form of teacher feedback collected through interviews. Meanwhile, secondary data were obtained from supporting documents, such as curriculum documents, science learning outcomes, syllabi, textbooks, and relevant scientific literature related to the development of digital learning media and creative thinking skills.

At the *define* stage, a needs analysis was conducted through classroom observations, teacher interviews, and curriculum document analysis to identify learning problems, student characteristics,

and relevant learning objectives. The *design* stage involved structuring the interactive digital flipbook, including content organization, multimedia integration, learning activities, and creative thinking indicators (Rizal et al., 2022). At the *develop* stage, the product was developed and validated by material and media experts, followed by revisions based on expert feedback before limited field testing. The *disseminate* stage involved limited classroom implementation and sharing the finalized product with science teachers at the school.

The research instruments included material and media expert validation sheets, creative thinking skills tests administered as pre-tests and post-tests, student response questionnaires, classroom observation sheets, and teacher interview guidelines. The creative thinking test items were constructed based on established creative thinking dimensions, namely fluency, flexibility, originality, and elaboration (Rizal et al., 2022).

The feasibility of the developed digital flipbook learning media was measured in terms of validity, practicality, and effectiveness (Plomp, 2013). Validity was assessed through evaluations by experts, including one material expert and one media expert. Practicality was examined via observations conducted by two observers regarding its implementation and the challenges encountered. Effectiveness was evaluated based on the enhancement of students' ability to think creatively and their responses. The improvement in students' creative thinking ability was analyzed using N-gain analysis, and a t-test was conducted for further statistical analysis. Data analysis was performed by scoring using a Likert scale model (Habibiy, 2017). The obtained scores were then analyzed using percentage analysis. According to Arikunto (2020), the formula used in percentage analysis is as follows: $P = \frac{\sum x}{\sum xi}$ x 100%

Description:

P	= percentage
∑x	= total number of respondents' answers
∑xi	= total number of idea values in an item
100%	= constant

The results of the qualitative assessment percentages are then converted into quantitative descriptive data based on the feasibility criteria for the validation results of the development product, presented in the following table format (Arikunto, 2020).

Table 1. Feasibility Criteria for Science Teaching Materials

No.	Score Interval	Criteria	Description
1.	85 % - 100 %	Very suitable	No revision required
2.	75 % - 84 %	Suitable	No revision required
3.	65 % - 74 %	Quite suitable	Revised

4.	55 % - 64 %	Less suitable	Revised
5.	0 % - 54 %	Not suitable	Revised

The practicality value of the teaching materials from the calculations is then described as indicated by the practicality criteria in Table 2.

Table 2. Interpretation of Practicality Assessment

No.	Score Interval	Criteria
1.	81 % - 100 %	Very practical
2.	61 % - 80 %	Practical
3.	41 % - 60 %	Quite practical
4.	21 % - 40 %	Not practical
5.	≤20 %	Not practical

The degree to which the digital flipbook teaching materials were effective was assessed by comparing students' scores before and after instruction, along with gathering feedback from both students and teachers regarding their use during the learning process. The outcome of the N-gain computation was determined using the following formula.

$$g = \frac{Posttest - Pretest}{100 - Pretest}$$

The outcomes obtained from the N-gain calculation were subsequently organized into specific categories that indicate the degree of improvement in students' critical-thinking abilities. These categories follow predetermined criteria, which serve as a reference for evaluating students' progress, and are detailed in Table 3.

Table 3. N-Gain Categories (Hake, 1998)

No.	N-Gain Range	Criteria
1.	$g \geq 0{,}70$	High
2.	$0{,}30 \leq g < 0{,}70$	Medium
3.	$g < 0{,}30$	Low

In addition to analyzing the N-gain results, to further assess the impact of the digital Flipbook teaching materials, a survey was carried out to gather students' and teachers' feedback regarding the use of the teaching materials in learning.

FINDINGS AND DISCUSSION

Findings

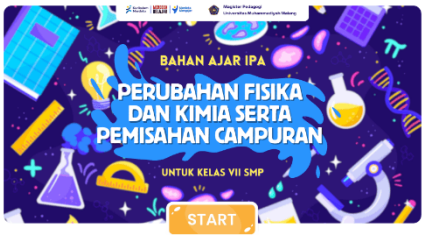
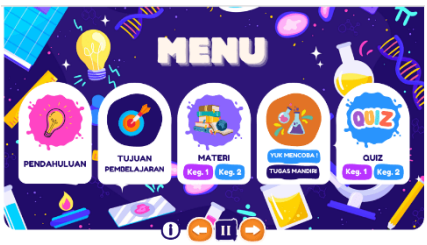
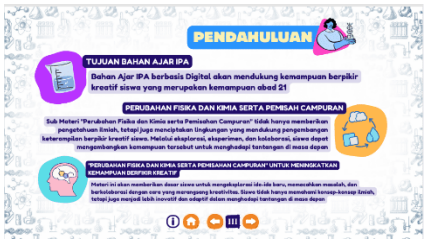
Analysis of Learning Needs and Product Development

The preliminary analysis revealed that students experienced difficulties in understanding science concepts, expressing problem-solving ideas, and generating original ideas independently. Teachers reported that students tended to rely on existing answers rather than actively engaging in

creative thinking processes. These findings indicate the need for instructional materials that can facilitate active learning and support the development of creative thinking skills.

Based on this analysis, a digital flipbook teaching material was developed on the topic of physical and chemical changes and the separation of mixtures. This topic was selected because it requires higher-order thinking skills, scientific observation, and analytical reasoning. The developed digital flipbook consists of a main page, an interactive navigation menu, introductory material, learning objectives, two learning activities supported by videos and simulations, and an evaluation quiz. The structure of the digital flipbook teaching materials is presented in Table 4.

Table 4. Digital Flipbook Teaching Materials

No.	Part Digital Teaching Material Flipbook	Description
1.		On the main page of the learning materials, students can view the topics to be studied along with supporting information related to the content. This section also includes a "Start" button that students can use to begin the learning process using the digital learning materials.
2.		On the next page, an interactive menu displays several main sections: Introduction, Learning Objectives, Learning Materials, Experimental Classes, and Quizzes. Each menu is designed to guide students directly to the desired page, making it easier for them to navigate the digital learning materials. Through this display, students have the freedom to choose learning activities according to their needs and interests.
3.		The introduction provides initial information about the learning materials being developed. This section begins with an explanation of the objectives of the science learning materials, followed by a brief description of the concepts of physical and chemical changes and the separation of mixtures, which are then linked to efforts to improve students' creative thinking skills.
4.		The Learning Objectives display provides a detailed explanation of the learning goals expected to be reached during instructional activities, while also outlining the competency indicators that students need to understand and master so they can engage in the learning process effectively and achieve optimal outcomes.

No.	Part Digital Teaching Material Flipbook	Description
5.		In the learning activity display, two main activities are presented, namely Activity 1 and Activity 2. Each activity is equipped with a learning video link and several interactive menus that allow students to carry out simulations or simple experiments independently.
6.		At the end, there's a quiz designed to strengthen and evaluate students' grasp and mastery of the content delivered in the learning materials. This quiz allows students to self-evaluate their learning outcomes and receive feedback to help them refine and deepen their understanding of the concepts they've learned.

(Author, 2025)

Validity of the Digital Flipbook Teaching Materials

Next, the developed digital flipbook teaching materials were tested for validity. Validation by material experts was conducted to verify the suitability of the developed digital flipbook teaching materials with the requirements of the teaching materials used, namely the alignment of the content with learning outcomes, the use of appropriate and communicative language, the quality of the evaluations, and the extent to which the material can support and enhance students' ability to think creatively. The validity data obtained from material experts is presented in Table 5 as follows.

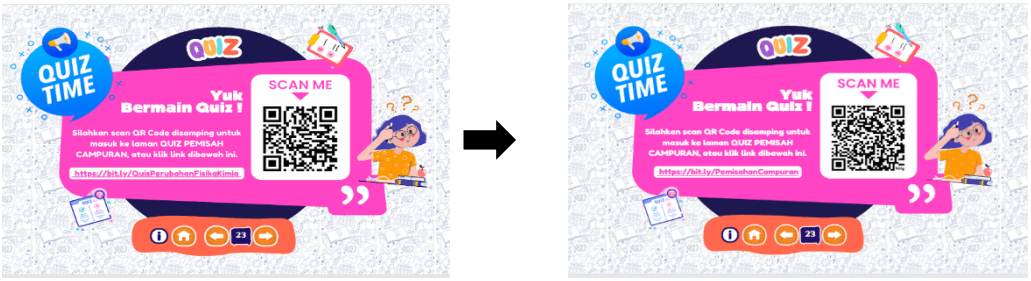
Table 5. Outcomes of the Material Experts' Review

No.	Aspect	Average Score	Criteria
1.	Content Suitability	88%	Very suitable
2.	Language	94%	Very suitable
3.	Evaluation	92%	Very suitable
4.	Students' creative thinking skills	100%	Very suitable
Overall Assessment		93%	Very suitable

(Author, 2025)

Drawing upon the recommendations and feedback offered by the material expert validators, the researchers carried out revisions to the teaching materials in order to enhance and refine the aspects identified as requiring further improvement. The following are suggestions for improving the material aspects by the material experts:

Table 6. Results of Subject Matter Expert Revisions



Before the revision the QR code could not be opened

After resetting, the QR code can be read

(Author, 2025)

Validation by media experts on digital learning materials was conducted to evaluate the structure and quality of the digital learning materials from various aspects, including: safety of use, content suitability, display design, language, application in the learning context, and systematic presentation of the material. This evaluation aims to ensure that the developed learning materials comply with established pedagogical requirements and can be effectively utilized during instructional activities, thereby supporting a structured learning environment and helping students achieve the intended educational goals. Validity data from media experts is presented in Table 7 as follows:

Table 7. Expert Review of Instructional Media Materials

No.	Aspect	Average Score	Criteria
1.	Security	100%	Very suitable
2.	Content	96%	Very suitable
3.	Design	96%	Very suitable
4.	Language	100%	Very suitable
5.	Implementation	100%	Very suitable
6.	Presentation	100%	Very suitable
Overall Assessment		99%	Very suitable

(Author, 2025)

The following are the critical notes and suggestions from the teaching materials expert validator:

1. The UI (User Interface) and UX (User Experience) are attractive, simple, and equipped with supporting videos.
2. Please include sources/YouTube as a reference (link).

Based on the suggestions provided by the teaching materials expert validator, improvements were made by adding a source/YouTube item.

Table 8. Results of the Teaching Materials Expert Revision

Before the revision YouTube sources were not listed

After revision YouTube source is listed

(Author, 2025)

Practicality of the Digital Flipbook Teaching Materials

The practicality of the digital flipbook teaching materials is evaluated through students' responses during their use, which serve as an important indicator of how easily and effectively the materials can be applied in real learning situations. The following data provides a detailed overview of students' perceptions, attitudes, and experiences while interacting with the digital flipbook, offering insights into its usability and overall practicality in the learning process. Furthermore, the results of this practicality assessment can be viewed in Table 9, which summarizes the students' response data comprehensively.

Table 9. Student Responses to the Use of Digital Flipbook Teaching Materials

No.	Statement	Student Response (%)	Criteria
1.	Students can easily access and use the teaching materials.	94	Very practical
2.	The teaching materials are attractively presented.	87	Very practical
3.	The content of the teaching materials relates to the students' environment.	81	Very practical
4.	The teaching materials do not burden students in learning.	85	Very practical
5.	The language used is easy to understand.	77	Practical
6.	Students can easily complete assignments.	79	Practical
7.	The teaching materials help explain examples of transformations in matter, both in its physical properties and chemical composition.	94	Very practical

No.	Statement	Student Response (%)	Criteria
8.	The teaching materials assist students in analyzing the connection between observable alterations in matter, whether involving its physical traits or chemical structure and the concept of simple mixture separation.	75	Practical
9.	The teaching materials can help students design experiments or creative projects that demonstrate the separation of mixtures and physical or chemical changes with a unique approach.	90	Very practical
10.	The teaching materials can help students explain how the separation process works.	81	Very practical
	Overall Response	84	Very practical

(Author, 2025)

Based on Table 9, regarding student responses to the use of digital flipbook learning materials, it generally shows that the learning materials generally received positive responses. The overall average score for student responses reached 84%, which is included in the "Very practical" category for use in learning, because it met the indicators of ease of use, attractive appearance, material relevance, communicative language, and its effectiveness in supporting student understanding and creativity. This statement is also supported by teacher responses to the use of the learning materials. Teachers stated that the visual design of the learning materials was attractive and informative, with a structured and gradual presentation of material that facilitated student understanding.

Effectiveness of the Digital Flipbook Teaching Materials

After conducting validity and practicality tests, the next step was to assess the effectiveness of the developed teaching materials. This was done by examining learners' scores before and after the learning activities, calculating the N-gain values, and reviewing feedback from both students and teachers regarding the use of the materials in instruction. Pre-test and post-test assessments were carefully carried out to provide a thorough evaluation of students' creative thinking abilities. The results, including pre-test scores, post-test results, and N-gain values, can be seen in Table 10.

Table 10. Student Pre-test, Post-test, and N-Gain Results

No.	Students	*Pre-test*	*Post-test*	N-Gain	Category
1.	S-1	78	89	0,50	Medium
2.	S-2	67	83	0,48	Medium
3.	S-3	78	78	0,00	Low
4.	S-4	67	83	0,48	Medium
5.	S-5	61	72	0,28	Low
6.	S-6	44	61	0,20	Low
7.	S-7	56	72	0,36	Medium
8.	S-8	56	72	0,36	Medium
9.	S-9	72	100	1,00	High
10.	S-10	67	78	0,33	Medium
11.	S-11	61	72	0,28	Low
12.	S-12	50	61	0,22	Low
13.	S-13	39	50	0,18	Low
	Mean	61,11	74,79	0,35	Medium

(Author, 2025)

Based on Table 10, there was an increase in scores from the pre-test to the post-test, indicating that the use of flipbook-based digital teaching materials had a positive effect on improving students' creative thinking skills. This increase indicates that the use of digital flipbooks helps students understand the material better through interactive and visual presentations. The N-Gain value of 0.35 is included in the moderate category, which means that this teaching material is moderately effective in helping students understand the material on physical and chemical changes, as well as the separation of mixtures. Students with high initial abilities (such as S-9) experienced greater improvements, while students with low initial abilities also showed improvements, although not very significant. This indicates that digital flipbook teaching materials are able to facilitate differentiated learning, helping each student learn at their own pace and learning style.

The observed improvement in learners' ability to think creatively, which resulted from the implementation of digital flipbook teaching materials, clearly corresponds with each of the key indicators of creative thinking. To provide a more detailed understanding of this correspondence, the present study specifically examined four main indicators of creative thinking: fluency, flexibility, originality, and elaboration. The performance scores for each of these indicators, encompassing the results from the pre-test and post-test assessments as well as the calculated N-gain values, are comprehensively presented in Table 11, allowing for a clear visualization of the students' progress and the effectiveness of the instructional intervention.

Table 11. Achievement of Students' Creative Thinking Ability Indicators

No.	Indicators of Creative Thinking Ability	Mean Pre-test Score	Mean Post-test Score	N-Gain Value	N-Gain Classification	Explanation
1.	Fluency	60	76	0,40	Medium	Students are better able to express various ideas and examples of physical and chemical changes from everyday life.
2.	Flexibility	59	73	0,34	Medium	Students begin to be able to relate the concept of changes in matter to various contexts, such as separating different mixtures.
3.	Originality	58	72	0,33	Medium	Increasing students' ability to design ideas or solutions that are different from existing examples.
4.	Elaboration	63	78	0,41	Medium	Students can explain in more detail the process of changing and separating mixtures accompanied by scientific reasons.
	Mean	60	74,75	0,37	Medium	Digital flipbook teaching materials effectively improve students' creative thinking skills in the moderate category.

(Author, 2025)

Based on the interpretation of the data in Table 11, all four indicators of creative thinking (fluency, flexibility, originality, and elaboration) showed score improvements when comparing students' performance before and after the learning intervention. The mean N-Gain score reached 0.37, indicating that it falls within the moderate category. The highest increase occurred in the elaboration aspect (0.41), indicating that the digital flipbook learning materials helped students develop ideas in depth and structure. The lowest increase was in originality (0.33), indicating that

although students' creativity improved, they still needed further guidance to generate truly original ideas.

To further confirm and validate these results, a paired t-test analysis was carefully conducted on the pre-test and post-test scores in order to determine the statistical significance of the differences in students' creative thinking abilities before and after the implementation of the digital flipbook learning materials. This analysis provides a systematic evaluation of how effectively the instructional intervention influenced students' performance. The detailed results of the paired t-test, including the test statistics, significance levels, and relevant comparisons, are comprehensively presented in Table 12 as follows, offering a clear and precise depiction of the impact of the learning materials on students' creative thinking development.

Table 12. Paired-Sample Test Outcomes for Students' Pre- and Post-Instruction Scores

No.	Analysis Aspects	Calculation Results
1.	Number of Students (N)	13
2.	Pre-test Mean	61,23
3.	Post-test Mean	74,69
4.	Mean Difference	13,46
5.	Pre-test Standard Deviation	12,08
6.	Post-test Standard Deviation	12,97
7.	t-value	7,78
8.	p-value (Sig. 2-tailed)	0,000005
9.	Significance Level	0,05

(Author, 2025)

Based on the results derived from the statistical examination employing a paired-sample statistical procedure, the computed significance value of 0.000005 ($p < 0.05$) demonstrates a clear and meaningful difference between students' performance before and after the intervention. These findings show that incorporating the digital flipbook as part of the learning experience produced a substantial improvement in students' capacity for creative thought. Consequently, the instructional media that were developed proved to be effective in fostering this capacity, particularly in the areas of elaboration and cognitive flexibility. This improvement could be observed in the way students generated ideas, addressed problems, and proposed innovative solutions related to topics such as changes in matter and methods of separating mixtures.

Discussion

The findings of this study indicate that the interactive digital flipbook developed and implemented in science learning at SMP Muhammadiyah 3 Baron meets the criteria of validity,

practicality, and effectiveness. The high validity scores obtained from material and media experts demonstrate that the content, instructional design, language use, and learning components are well aligned with the Independent Curriculum and the indicators of creative thinking skills, namely fluency, flexibility, originality, and elaboration (Arikunto, 2020). The implementation of the digital flipbook also showed a positive impact on students' learning activities and creative thinking performance, as reflected in the improvement of post-test scores compared to pre-test results. These findings are consistent with previous studies emphasizing that pedagogically sound and technically feasible digital instructional media can enhance student engagement and learning effectiveness (Anjasti et al., 2024; Wibowo, 2023). Furthermore, this result aligns with Santosa et al. (2025), who reported that expert-validated instructional materials significantly contribute to the effectiveness of learning interventions aimed at improving students' creative thinking skills.

Beyond validity, the practicality results indicate that the digital flipbook is feasible for classroom implementation. Its structured and sequential presentation, combined with multimedia elements such as videos and simulations, facilitates students' understanding of abstract science concepts and encourages active engagement during learning activities. These findings are consistent with prior research showing that interactive digital media can enhance student motivation, reduce learning difficulties, and improve learning experiences in science education (Antara & Dewantara, 2022; Saraswati et al., 2023). Santosa et al. (2025) similarly found that contextual and interactive teaching materials encouraged active student participation and improved learning engagement, indicating high practicality in classroom implementation.

In terms of learning outcomes, the effectiveness analysis revealed a moderate improvement in students' creative thinking skills, as indicated by the N-gain score, which falls within the medium category according to Hake's criteria (Hake, 1998). Improvements across the four creative thinking indicators, fluency, flexibility, originality, and elaboration, suggest that the digital flipbook provides meaningful learning experiences that support idea exploration, conceptual connections, and deeper explanations. The highest gain observed in elaboration indicates that visual representations and interactive features effectively support students in developing detailed and well-structured explanations, consistent with findings (Roemintoyo & Budiarto, 2021).

However, the relatively lower improvement in originality indicates that although students' creative thinking skills improved, additional instructional strategies may be required to further stimulate the generation of novel and unique ideas. Previous studies suggest that incorporating

more open-ended tasks and problem-based learning activities can strengthen originality and innovation in students' thinking processes (Ismiati, 2024; Namukasa, 2024).

These quantitative improvements are further supported by inferential analysis. The statistically significant difference between pre-test and post-test scores further confirms that the implementation of digital flipbook teaching materials has a positive effect on students' creative thinking skills. This result is consistent with the study by Santosa et al. (2025), which also demonstrated a significant difference between pre-test and post-test scores, reinforcing the effectiveness of interactive and contextual instructional materials in enhancing creative thinking. This finding reinforces earlier research indicating that technology-integrated instructional media can effectively support the development of higher-order thinking skills and prepare students to meet the demands of 21st-century learning (Antara & Dewantara, 2022; Park et al., 2025).

From a theoretical perspective, the effectiveness of the digital flipbook can be attributed to its role as an interactive learning medium that combines visual representations, multimedia features, and structured learning pathways. Prior studies have shown that flipbooks not only improve learning quality but also strengthen students' logical reasoning and conceptual understanding (Antara & Dewantara, 2022; Roemintoyo & Budiarto, 2021). Therefore, the findings of this study reinforce the view that interactive and contextual digital learning media can enhance student engagement, understanding, and higher-order thinking skills. Consequently, the digital flipbook developed in this study can be considered a relevant and effective learning strategy to address the demands of 21st-century science education.

CONCLUSION

This research produced interactive digital flipbook teaching materials on the topics of Physical and Chemical Changes and Separation of Mixtures for seventh-grade students. The results showed that the developed teaching materials met three main aspects: validity, practicality, and effectiveness. Validation results showed an average score of 93% from material experts and 99% from media experts, both categorized as very appropriate. Student responses obtained an average score of 84%, categorized as very practical, indicating that the flipbook was easy to use, engaging, and facilitated interactive and contextual understanding of science concepts.

In terms of effectiveness, the analysis results showed an increase in students' creative thinking skills with an average N-Gain score of 0.37 (moderate category) and a paired t-test result (t

= 7.78; p = 0.000005 < 0.05), indicating a significant difference between the pre-test and post-test results. Thus, the interactive digital flipbook teaching materials proved effective and innovative in improving students' creative thinking skills, particularly in the aspects of elaboration and flexibility. This study recommends further development of digital flipbook teaching materials on other science topics and their application in project-based learning models or blended learning to improve students' creativity and learning independence in the digital era.

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