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The Development of *Komfun CT* Learning Media Based on Scratch to Enhance Computational Thinking Skills

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Abstract: This research is motivated by the low level of students' computational thinking skills in mathematics learning, particularly in the topic of function composition. To address this issue, a Scratch-based learning media was developed with the aim of helping students understand the concept of function composition while also enhancing their computational thinking skills. The aim of this study is to produce *Komfun CT* learning media based on Scratch for function composition material. The research was conducted in the 2024/2025 academic year using the Research & Development (R&D) method based on the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The quality of the developed media must meet the criteria of validity, practicality, and effectiveness. The instruments used in this study include observation sheets, interview guidelines, questionnaires, and tests. The observation sheets were used to obtain information about mathematics learning activities conducted by the teacher at school. The interview guidelines were used with students to collect qualitative data regarding the practicality of the developed media. The questionnaires consisted of a student response questionnaire, a material expert questionnaire, and a media expert questionnaire. Finally, the computational thinking test, which included a pre-test and post-test, was used to assess students' computational thinking skills before and after using the media.The results showed that: (1) the media developed using the ADDIE model successfully produced *Komfun CT* learning media based on Scratch; (2) the *Komfun CT* learning media was declared feasible based on expert validation (material and media), covering aspects of validity, practicality, and effectiveness; (3) the developed media met the validity criteria with an average percentage of 93.86%. The practicality test results showed an average percentage of 83.60% from student responses. The effectiveness test based on N-Gain analysis showed an average gain score of 85.43%, indicating that the media is effective in enhancing students' Computational Thinking.

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INTRODUCTION

Amidst the dynamics of this modern era, *Computational Thinking* is a critical skill for every individual. Its importance is further highlighted by its inclusion as one of the six core components of student soft skills assessment, alongside *Critical Thinking, Creative Thinking, Collaboration, Communication*, and *Compassion* (Vhalery et al., 2022). This emphasis demonstrates that CT is not merely an additional skill, but a fundamental element in the holistic development of students' competencies.

One of the skills currently emphasized in education is *Computational Thinking (CT)*, which refers to the ability to solve problems systematically and logically through computational approaches, encompassing four main components: decomposition, pattern recognition, abstraction, and algorithmic thinking (Wing, 2006). As Wing (2006) emphasized, computational thinking is a fundamental skill for everyone, not just computer scientists; it should be considered as essential as reading, writing, and arithmetic. Decomposition is the ability to break down complex problems into smaller, more manageable parts, allowing students to focus on specific aspects and thereby improve their overall understanding. Pattern recognition involves identifying similarities and differences to find effective solutions. Abstraction entails simplifying a problem by removing irrelevant details, while algorithmic thinking involves developing a logical and structured sequence of steps to solve a problem. Therefore, integrating CT instruction into the education curriculum is essential in preparing students to adapt to rapid technological advancements in the digital age.

Despite its significance, the development of CT is often hindered by conventional teaching approaches and learning media that tend to be static, passive, and insufficiently challenging. Traditional instructional methods, such as lectures, textbooks, and written exercises, often focus on rote memorization and narrow procedural application rather than encouraging students to think creatively and critically. Several studies have shown that such traditional methods do not provide enough space for students to practice CT in real-world contexts. The lack of active engagement and interaction in the classroom results in limited development of students' critical and analytical thinking skills (Jun et al., 2017). Hence, innovation in learning media is urgently needed—media that can facilitate active and collaborative learning to enhance students' CT skills.

Based on preliminary observations in class XI-2 of SMAN 8 Surakarta, it was found that students' understanding of *Computational Thinking* concepts requires significant improvement. Initial test results showed that students were able to apply decomposition by identifying known and unknown elements in a problem. However, in the pattern recognition stage, some students struggled to identify similarities and differences. In the abstraction stage, many students found it difficult to disregard irrelevant information in solving problems. Furthermore, in the algorithmic thinking stage, students' problem-solving processes were often incomplete and lacked systematic reasoning. These findings indicate that students' CT skills are still at a low level. Additionally, interviews with mathematics teachers at the school revealed that the learning approach applied in the classroom is still predominantly lecture-based. Furthermore, students also experience difficulties in solving higher-order mathematics problems. This is one of the contributing factors to the students' low Computational Thinking (CT) skills. The following is an excerpt from the researcher's interview with the mathematics teacher:

R : *"Good morning, Sir. May I ask what teaching method is usually used in your class?"*
T : *"I mostly use the lecture method."*
R : *"Do you use any learning media during mathematics lessons, Sir?"*
T : *"Learning media is rarely used. If used at all, it's usually just the textbook."*
R : *"Have you ever used any digital-based learning media before?"*
T : *"I once used Quizizz."*
R : *"Besides Quizizz, have you ever used a learning media based on Scratch?"*
T : *"Never, what is that?"*
R : *"Scratch is a visual programming-based learning media, Sir. It is considered effective in improving students' Computational Thinking skills. Speaking of which, how would you assess your students' Computational Thinking abilities?"*
T : *"Oh, I see. That skill hasn't been taught specifically. Usually, students struggle with higher-level math problems."*

Overall, the results of the preliminary observations provide a clear indication that students' Computational Thinking skills are still relatively low and have not yet been explicitly taught. Therefore, it is necessary to develop and improve learning practices that focus on enhancing Computational Thinking in the school.

One way to introduce and reinforce CT skills is through the use of visual programming-based learning media, such as *Scratch* (Syarah Aulia, 2021). *Scratch* is a program developed by the Massachusetts Institute of Technology (MIT) specifically designed to introduce basic computer programming concepts in an accessible and user-friendly manner (Mardiyanto, 2018). As a visual programming tool created for educational purposes, *Scratch* enables users to learn programming concepts without prior knowledge of programming languages.

The topic of function composition in Grade XI (Phase F) of senior high school is often perceived as challenging by students. Observations revealed that students struggled particularly with solving story-based problems involving function composition. Students experience difficulties in identifying the appropriate operations to solve problems based on the given information, and they also face challenges in understanding the context or intent of the questions. They are often confused about determining the initial steps and tend to be unable to connect the information provided in the problem with relevant mathematical concepts. Students frequently overlook important details when drawing conclusions. As a result, they struggle to focus on the core of the problem and to relate it to the appropriate mathematical concepts. Moreover, they find it difficult to formulate logical and systematic steps for solving problems based on the information presented. According to research by Pramesti et al. (2021), the most common difficulty students face when solving function composition problems is a lack of conceptual understanding, followed by difficulties in skills and problem-solving.

The use of Scratch as an instructional media for teaching function composition is a logical and appropriate approach to addressing students' low *Computational Thinking* (CT) skills. Although students do not create their own programs, the Scratch-based media was specifically designed to incorporate CT thinking processes such as decomposition, pattern recognition, abstraction, and algorithmic thinking. Through its use, students are guided to understand problems using a structured and visualized thinking flow. For example, they are prompted to identify parts of a function, organize the sequence of operations, and solve problems step by step, following the logical flow embedded within the media. In this way, the Scratch-based media not only helps students grasp mathematical concepts more concretely but also stimulates their CT skills—without requiring them to learn programming directly.

Therefore, a more interactive and contextual approach is needed to facilitate more effective learning. The use of Scratch as a learning media for teaching function composition provides students with opportunities to visualize abstract mathematical concepts, solve problems through practical exercises, and develop their Computational Thinking more deeply. This approach not only enhances students' understanding of function composition but also prepares them to face technological challenges in the future (Pou et al., 2022). Furthermore, this study makes a significant contribution to mathematics education by demonstrating how the integration of visual programming tools like Scratch can bridge the gap between abstract mathematical theory and students' real-world thinking skills. It offers a practical model for designing learning experiences that are engaging, accessible, and aligned with 21st-century competencies, thus supporting both curriculum innovation and teacher practice.

Based on the issues outlined above, this study aims to develop *Scratch*-based learning media for teaching function composition in Grade XI (Phase F) of senior high school, with the goal of improving students' CT skills. Therefore, the proposed research is titled "The Development of *Komfun CT* Learning Media Based on Scratch to Enhance Computational Thinking."

METHOD

This study employs a type of Research and Development (R&D) methodology. The development model used is the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it is easy to understand and is systematically structured based on theoretical foundations of instructional design. It provides a clear framework for developing instructional media that aligns with students' needs and characteristics. The procedures in this study follow the ADDIE model, as illustrated in Figure 1.

Data Collection

The data collection techniques used in this research include observation, interview, questionnaire, and achievement tests. The following techniques were applied:

1. Observation
   Observation is a technique for collecting data by directly observing the object or phenomenon being studied. The observation activities include how the teacher teaches, the methods used during learning, and how students learn.
2. Interviews
   Interviews were conducted to obtain student feedback regarding their responses to the Scratch learning media after the post-test was administered.
3. Questionnaire:
   According to Sugiyono (2017:142), a questionnaire is a data collection technique by providing a set

of written questions or statements to respondents. Questionnaires were used to collect validation data from material experts, media experts, and students' responses to the Scratch learning media.

4. Test
According to Brown (2006), a test is a measurement instrument used to evaluate the extent of a student's achievement in specific competencies. In educational settings, tests are classified as part of formative or summative assessments and are designed to systematically measure students' knowledge, skills, or behavior. In this study, pre-tests and post-tests were employed to assess students' Computational Thinking skills before and after the use of Scratch-based learning media. The test results were analyzed using average N-Gain scores to determine the level of improvement in students' skills.

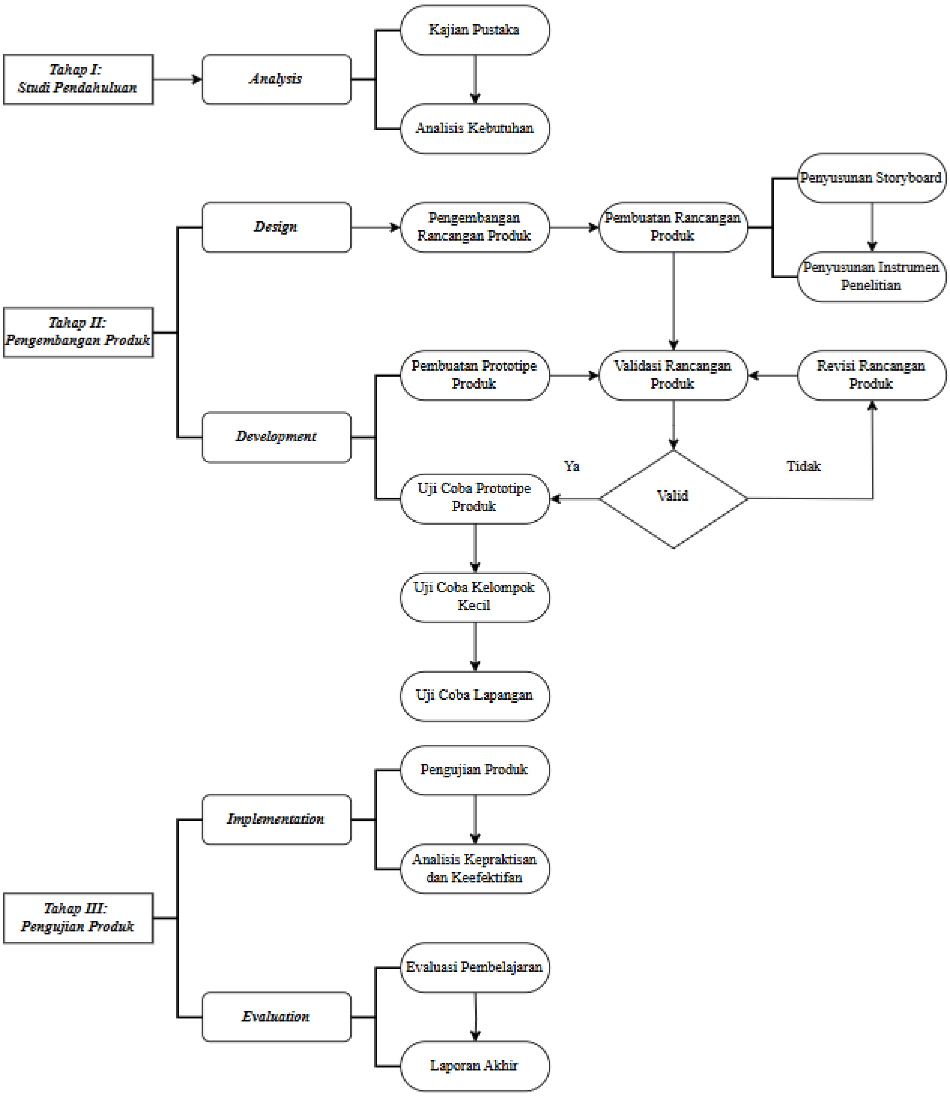

Figure 1. Flowchart ADDIE

The data analysis techniques used in this study are descriptive quantitative and qualitative analysis. The collected data were analyzed as follows:

Media Validity Analysis

The data collected from this research includes validation results by experts, analyzed using quantitative analysis. Each answer is linked to a statement rated as shown in Table 1.

Table 1. Rating Scale for Validation Instruments by Material and Media Experts

Score	Criteria
5	Strongly Agree
4	Agree
3	Fairly Agree
2	Disagree
1	Strongly Disagree

The data is processed using the percentage formula:

$$P = \frac{f}{N} \times 100\%$$

Where:
P = final score
f = total score obtained
N = maximum possible score
Then, the result is interpreted using the criteria in Table 2.

Table 2. Validity Criteria of Learning Media

Percentage Score	Category
100%	Very Valid
75% ≤ P < 100%	Valid
50% ≤ P < 75%	Fairly Valid
25% ≤ P < 50%	Less Valid
0% ≤ P < 25%	Not Valid

(Source: Riduwan in Motu, 2024)

Explanation:
Very Valid: Can be used without revision
Valid: Can be used with minor revision, no need to revalidate
Fairly Valid: Usable with minor revision and revalidation
Less Valid: Usable with major revision and revalidation
Not Valid: Cannot be used

Practicality Analysis

Data collected from student response questionnaires were used to determine the practicality of the developed learning media. The media is considered practical if it can be applied in the field with minor revisions and receives a "practical" or "very practical" category based on student responses.
The practicality score is calculated using the formula (Suherman, 2013):

$$P = \frac{f}{N} \times 100\%$$

Then interpreted based on the criteria in Table 3.

Table 3. Practicality Criteria of Learning Media

Percentage Score	Category
80% < P ≤ 100%	Very Practical
60% < P ≤ 80%	Practical
40% < P ≤ 60%	Fairly Practical
20% < P ≤ 40%	Less Practical
0% < P ≤ 20%	Not Practical

(Source: Riduwan in Motu, 2024)

Effectiveness Analysis

Effectiveness was assessed by measuring students' Computational Thinking after using the Scratch-based media. The initial step is interpreting post-test scores based on the criteria in Table 4:

Table 4. Effectiveness Criteria

Score	Category
≥ 70.00	Mastery
< 70.00	Not Mastery

The percentage of mastery is calculated using the formula:

$$PT = \frac{Number\ of\ students\ who\ achieve\ mastery}{Total\ students} \times 100\%$$

Where PT is the percentage of students achieving mastery.
The product is considered effective if at least 75% of students achieve a score in the mastery category.

N-Gain Analysis

N-Gain is used to assess the effectiveness of the treatment. It measures the difference between pre-test and post-test scores. Students' improvement in Computational Thinking is interpreted in Table 5.

Table 5. N-Gain Criteria

N-Gain	Category
0.7 ≤ N-Gain ≤ 1	High
0.3 ≤ N-Gain < 0.7	Medium
N-Gain < 0.3	Low

(Source: Meltzer in Motu, 2024)

The formula used:

$$N\ Gain = \frac{Posttest\ score\ -\ Pretest\ score}{Maximum\ score\ -\ Pretest\ score}$$

The effectiveness level is then interpreted using Table 6.

Table 6. Effectiveness Interpretation Criteria (Hake, 1999)

Percentage (%)	Interpretation
< 40	Not Effective
40−50	Less Effective
56−75	Fairly Effective
> 76	Effective

RESULT

The preliminary stage includes the Analysis phase, which is divided into two sub-stages: literature review and needs analysis.

Literature Review

In this stage, the researcher reviewed several studies related to the research topic. In addition, the researcher analyzed various sources that served as references in this study.

Needs Analysis

1. Observation of Learning Implementation

   Based on the learning observation conducted by the researcher, the learning process was still predominantly teacher-centered, with minimal use of interactive learning media. Moreover, students appeared to be less enthusiastic in participating in the learning activities, as indicated by their reluctance to ask questions and passive behavior, especially when learning abstract concepts.

2. Analysis of Student Characteristics

   The analysis revealed that most students tended to be passive and rarely asked questions, even when given the opportunity. Only a few students responded actively when the teacher asked questions, while the others waited for their peers' answers. Although the students completed the given assignments, the results indicated a lack of deep conceptual understanding of the material.

3. Initial Test

   The initial test results showed that students still had difficulty understanding the problems and designing systematic steps to solve them. Most students had not yet completed the decomposition stage, which involves identifying and recording known and unknown information from the questions. In terms of Computational Thinking (CT), students were generally only able to perform pattern recognition, while algorithmic thinking was not yet evident, as seen from the unsystematic problem-solving steps. Abstraction skills had also not yet been applied. Therefore, it can be concluded that students' CT skills were still in the low category.

4. Identification of Student Needs

   Based on the results of the observations, students' low Computational Thinking (CT) skills require an engaging and interactive learning approach. One proposed solution is the use of Scratch as a learning media. The selection of this media is supported by its significant impact on improving CT skills. Dewi et al. (2021) stated that Scratch has a strong positive influence on enhancing Computational Thinking abilities. Through Scratch, students are guided to gradually understand decomposition, algorithmic thinking, pattern recognition, and abstraction. Thus, Scratch is considered highly relevant and appropriate to be used both as a learning media and a tool to develop CT skills.

Product Development

Design

After completing the analysis stage, the next step is the Design stage. In this phase, the researcher developed a product design, including the creation of a storyboard and the preparation of research instruments. In the storyboard design, the researcher created both content and interface designs. The content design includes learning materials used in the Scratch-based mathematics learning media, namely modules or teaching materials for Grade XI (Phase F) on the topic of function composition, as well as several online references used for sample problems. The next step was designing the initial appearance of the learning media. This design served as a framework containing the elements to be displayed in the media. The research instruments used in this study consist of four main types: an observation guide sheet, an interview guide sheet, a questionnaire (including student response questionnaire, material expert questionnaire, and media expert questionnaire), and a computational thinking test consisting of a pre-test and post-test.

Development

In this stage, the researcher created a product prototype, conducted product design validation, revised the product design, and tested the product. The following are the details of each step:

1. Product Prototype Development

   This prototype is the initial version of the product being developed. The development of the Scratch-based mathematics learning media prototype followed the media design created during the design stage. The development process was carried out step by step, starting from creating the homepage, menu options, settings, and other pages. As a result, the researcher produced the *Komfun CT* Scratch-based learning media, which can be accessed via the following link:
   https://scratch.mit.edu/projects/1128230426
   The initial appearance of the *Komfun CT* media is as follows in Figure 2.

Figure 2. Initial Display of *Komfun CT* Learning Media

2. Product Design Validation

This validation involved analysis, testing, or evaluation by a subject matter expert and media experts. The material validation was conducted by a mathematics teacher at the school, while the media validation was carried out by two mathematics education lecturers. If the product design is declared valid, it proceeds to the next stage, which is prototype testing. If the product design is not yet valid, revisions are made to improve the prototype based on feedback, and the validation process is repeated.

a. Material Validation

The results of the material expert validation are presented in Table 7 below:

Table 7. Material Expert Validation Results

No.	Assessment Aspect	Indicator	Score	Total Score	Percentage	Category
1	Content Feasibility	Clarity in formulating learning objectives	5	32	91.43%	Valid
		Alignment of material with learning objectives	4			
		Ease of understanding the material presented	5			
		Completeness of material presented	4			
		Systematic presentation of material	5			
		Appropriateness of example questions and discussions	4			
		Alignment of quiz questions with the material presented	5			
2	Language Feasibility	Accuracy of grammar and spelling	5	15	100.00%	Valid
		Correct use of terminology	5			
		Language suitability to students' cognitive level	5			
		Average	4.7	23.5	95.71%	Valid

The results of the material expert validation are also presented in a bar chart, as shown in Figure 3.

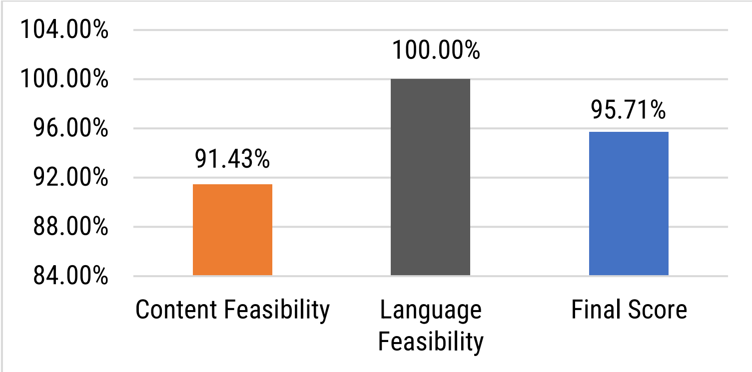

Figure 3. Bar Chart of Material Expert Validation Results

Based on the table and categorized figure, the content feasibility aspect scored 32 points with a percentage of 91.43%, as valid. This indicates that the learning objectives are clear, the material is appropriate and complete, and the examples and quizzes align well with the material. Meanwhile, the language feasibility aspect received a perfect score of 15 with 100%, which was also categorized as valid. This shows that grammar, terminology, and appropriateness of language for the students' cognitive level are all excellent.

Overall, the average score was 4.7 with a final percentage of 95.71%, classified as "Valid". This category indicates that the material is generally excellent, with perfect language aspects and only minor improvements needed in the content.

The subject matter expert also provided the following suggestions for improvement:
a) In learning objective number 2, the word "solve" should be replaced with "determine."
b) Add more example problems.
c) The material is appropriate; apply it to real-life contexts and problem examples.

Based on this feedback, the researcher made revisions to the content in the media design. Since the initial validation was declared valid, the media proceeded to the testing phase without revalidation.

b. Learning Media Validation

The media expert validation results are presented in Table 8 below:

Table 8. Media Expert Validation Results (Phase I)

No.	Assessment Aspect	Indicator	Score		Total Score		Percentage		Avg. Percentage	Category
			L1	L2	L1	L2	L1	L2		
1	Functionality	Menu navigation	4	5	10	10	90%	100%	95%	Valid
		Usage instructions	5	5						
2	Appearance	Font	4	3	36	32	90%	80%	85%	Valid
		Spacing	5	4						
		Text readability	4	3						
		Images	4	4						
		Layout	5	5						
		Navigation buttons	5	5						
		Background color	4	4						
		Page transitions	5	4						
Average			4.5	4.2	22.5	21	90%	90%	90%	Valid

The results of the media expert validation are also presented in a bar chart, as shown in Figure 4.

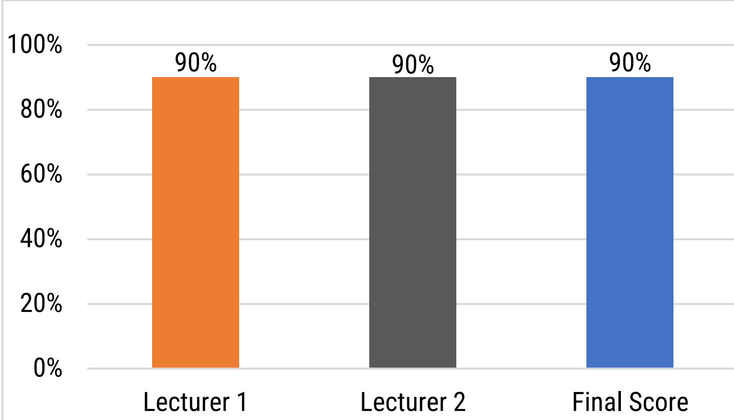

Figure 4. Bar Chart of Media Expert Validation Results (Phase I)

Based on the table and figure above, two major aspects were assessed: functionality and appearance. For functionality, Lecturer 1 gave a total score of 9 with a percentage of 90%, and Lecturer 2 gave a score of 10 with 100%. The average functionality percentage was 95%, thus categorized as valid. Regarding appearance, Lecturer 1 gave a total score of 36 (90%), while Lecturer 2 scored 32 (90%), resulting in an average percentage of 85%. Although slightly lower than functionality, this aspect is still considered valid.

Overall, both lecturers gave an identical final validation percentage of 90%. Therefore, the learning media was declared "Valid". These validation results indicate that the learning media meets the criteria in both functionality and appearance, although some improvements are needed based on Lecturer 2's input regarding font and text readability.

c. Product Design Revision

1) Material Revision

Based on the material expert validation, the learning media was declared valid without requiring revalidation. However, minor improvements were made based on the expert's suggestions.

2) Media Revision

Although the media was declared valid by both media experts, some suggestions were given by Lecturer 2. Therefore, the product was refined according to the feedback before revalidation. After the revision process was completed, the learning media was revalidated by the media experts. The results of the second-stage media validation are presented in the next section.

Table 9. Media Expert Validation Results (Phase II)

No.	Assessment Aspect	Indicator	Score		Total Score		Percentage		Avg. Percentage	Category
			L1	L2	L1	L2	L1	L2		
1	Functionality	Menu navigation	4	5	10	10	90%	100%	95%	Valid
		Usage instructions	5	5						
2	Appearance	Font	4	3	36	32	90%	80%	85%	Valid
		Spacing	5	4						
		Text readability	4	3						
		Images	4	4						
		Layout	5	5						

No.	Assessment Aspect	Indicator	Score		Total Score		Percentage		Avg. Percentage	Category
			L1	L2	L1	L2	L1	L2		
		Navigation buttons	5	5						
		Background color	4	4						
		Page transitions	5	4						
		Average	4.5	4.2	22.5	21	90%	90%	90%	Valid

The results of media expert validation are also presented in the form of a bar chart, as shown in Figure 5.

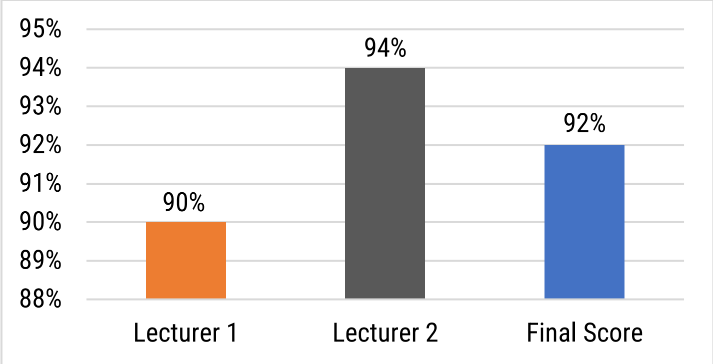

Figure 5. Bar Chart of Media Expert Validation Results (Phase II)

Based on the table and bar chart of the Phase II media validation results, in the functionality aspect, Lecturer 1 gave a total score of 9 with a percentage of 90%, while Lecturer 2 gave a total score of 10 with a percentage of 100%. The average percentage for the functionality aspect was 95%, which is categorized as valid. For the display aspect, Lecturer 1 gave a total score of 36 with a percentage of 90%, and Lecturer 2 gave a total score of 35 with a percentage of 88%, resulting in an average percentage of 89%. Although this percentage is slightly lower than the functionality aspect, the display aspect is also categorized as valid.

Overall, the media validation by Lecturer 1 resulted in a final percentage of 90%, while Lecturer 2 gave a final percentage of 94%. Therefore, the average validation score from both validators is 92%, indicating that the instructional media is valid and feasible for use in learning.

3. Product Prototype Testing

The product prototype testing was divided into two stages: small group testing and field testing. The explanation of each test is as follows:

a. Small Group Testing

The small group test was conducted on 5 heterogeneous students from grade XI. The results showed that the developed media was engaging and easy to use. However, one student experienced difficulty using the application due to long loading times, which was later found to be caused by a weak internet signal. Overall, the small group testing ran smoothly without significant issues.

b. Field Testing

The field test was conducted in class XI-2 with a total of 33 students. This stage aimed to assess the media's suitability for the needs of grade XI students in understanding the topic of function composition and to measure its impact on learning outcomes.

Product Trial Results

The results of the *Komfun CT* media trial showed that the media is effective, user-friendly, and engaging in supporting the learning process. Its effectiveness was evident from the increase in students' understanding, as reflected by the differences in pre-test and post-test scores after using the media. The interactive presentation of the material helped students connect theory with practice, creating a more meaningful and applicable learning experience. Ease of use is also a strength of *Komfun CT*. Its intuitive interface, simple navigation, and clear instructions enabled both students and teachers to operate the media with minimal obstacles.

Moreover, the appeal of this media was supported by its attractive visual design, cheerful color scheme, and animated elements that increased student enthusiasm. The addition of quiz challenges further motivated students to actively engage in every learning phase. The trial proceeded smoothly with minimal technical issues that did not disrupt the learning process. Based on the test results, *Komfun CT* has strong potential for widespread use in supporting the development of Computational Thinking skills. In conclusion, *Komfun CT* has proven to be an innovative, enjoyable, and meaningful learning tool for students.

Product Testing

The product testing phase consisted of two stages: Implementation and Evaluation, detailed as follows:

1. Implementation

The product testing was conducted over two meetings. In the first meeting, students were asked to complete a pre-test before using the *Komfun CT* instructional media. Afterward, the researcher shared the media link via a WhatsApp group, and students accessed it through Google Chrome. Additionally, the researcher explained the features within the learning media to ensure students understood how to use it. Students could access the materials, Computational Thinking aspects, and practice questions.

On the second day, students continued learning using the same media and completed the quiz. As the final step, students took a post-test to measure their understanding after using the *Komfun CT* media. The pre-test and post-test results were then analyzed to determine the media's effectiveness in improving Computational Thinking skills. After completing the learning activities, students were asked to fill out a student response questionnaire as a form of evaluation. The questionnaire data were then analyzed to assess the practicality of the media in supporting the learning process. The student response data from class XI-2 is presented in Table 10.

Table 10. Student Response Questionnaire Results

No.	Evaluation Aspect	Total Score	Percentage	Category
1	Learning	540	81.82%	Very Practical
2	Learning Media	563	85.30%	Very Practical
3	Media Functionality	277	83.94%	Very Practical
	Average	1380	83.60%	Very Practical

The results of the student response questionnaire were also presented in a bar chart, as shown in Figure 6.

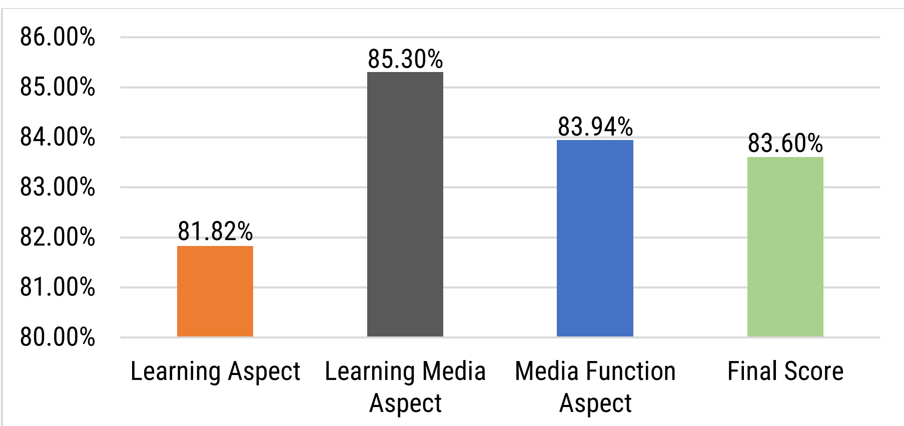

Figure 6. Bar Chart of Student Responses

Based on the table and the figure showing the student response questionnaire data, the practicality assessment conducted by the students indicates that the tested product possesses a very high level of practicality across all evaluated aspects. The assessment covers three main aspects: Learning, Learning Media, and Media Function. The learning aspect received a score of 540 with a percentage of 81.82%, indicating that the product is highly practical in supporting learning activities. In the learning media aspect, the product obtained the highest score of 563 with a percentage of 85.30%, suggesting that the media is very easy to operate and helps students achieve learning objectives. Meanwhile, the media function aspect scored 277 with a percentage of 83.94%, demonstrating that the *Komfun CT* learning media is well-suited to students' learning needs and can be accessed anytime and anywhere. Overall, the final score across all assessed aspects totaled 1380 with a percentage of 83.60%, which falls into the "Very Practical" category.

After completing the student response questionnaire, the researcher also interviewed five randomly selected students to gather their opinions regarding the *Komfun CT* learning media they had used. This interview aimed to identify student responses to the developed learning media. Based on the interviews with the five subjects, it can be concluded that the *Komfun CT* learning media received very positive feedback in helping students understand the concept of function composition.

Student 1 (S1) felt that the material was easier to understand due to the structured and engaging presentation, which included elements such as quizzes and background music. Student 2 (S2) also found the media very helpful, particularly because of the practice questions, comprehensive explanations, and systematic delivery. Student 3 (S3) added that the animations and appealing colors were the main attractions, making the learning process enjoyable and less monotonous. Student 4 (S4) emphasized that the media was easier to use because of its appealing, concise, and interactive design, offering a more exciting learning experience compared to traditional media like PowerPoint. Student 5 (S5) expressed a similar opinion, stating that the *Komfun CT*-based learning method was more engaging and easier to understand. S5 especially appreciated the feature that provided automatic feedback on incorrect answers, which directly helped in grasping the material.

In terms of appearance, all five students agreed that the media was visually attractive and interactive, supported by additional elements such as background music that made the learning atmosphere more relaxed. Furthermore, the clearly structured format—such as the division of material, exercises, and quizzes—helped students follow the learning process more easily. S4 appreciated the challenging quiz feature, while S5 highlighted the user-friendly interface, including clearly labeled buttons, helpful summaries, and sample problems.

However, notes from S2 and S3 emphasized that a stable internet connection is crucial, as poor signal strength could slightly interfere with the learning experience. Overall, the *Komfun CT* learning media was considered easy to use, effective, and helpful in enhancing understanding of function composition concepts. It can thus be concluded that *Komfun CT* is a highly practical tool for learning.

Evaluation

In the evaluation stage, student pre-test and post-test results were compared to measure the improvement in Computational Thinking skills achieved through the use of the *Komfun CT* learning media. The evaluation results were then summarized in a final report to provide an overview of the product's effectiveness in supporting learning. Two analyses were conducted for effectiveness testing: the mastery percentage analysis and the N-Gain test. The mastery percentage analysis was based on the students' post-test results. The analysis results are presented in Table 11.

Table 11. Mastery Percentage Analysis Results

No.	Variation	Score
1.	Highest Score	100
2.	Lowest Score	65
3.	Average	88.03
4.	Number of Students Achieving Mastery	30
5.	Number of Students Not Achieving Mastery	3
6.	Mastery Percentage	90.91%

Based on the effectiveness test results from 33 students (as shown in Table 11), a mastery percentage of 90.91% was obtained. Since this percentage exceeds 75%, it can be concluded that the *Komfun CT* learning media effectively improves students' Computational Thinking skills. After calculating the percentage of students who achieved mastery in each Computational Thinking aspect, the next step was to test the effectiveness using the N-Gain method. The N-Gain test results are presented in bar charts.

a. Decomposition Aspect

Based on Figure 7, the N-Gain test for the decomposition aspect shows an improvement in students' Computational Thinking after using the *Komfun CT* learning media. The average pre-test score was 11.52, which increased to 20.45 in the post-test. The effectiveness level reached 0.69 with a percentage of 68.94%. According to the N-Gain category, this score falls into the moderate category, indicating that *Komfun CT* is moderately effective in improving students' decomposition skills.

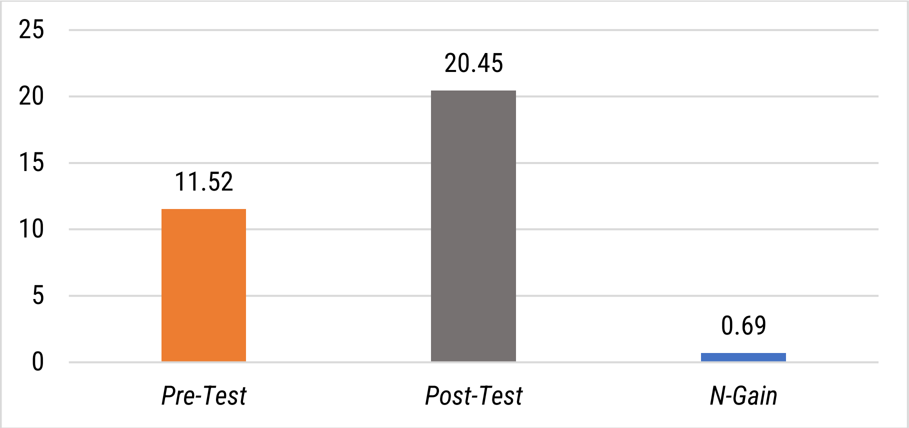

Figure 7. N-Gain Test – Decomposition Aspect

b. Algorithmic Thinking Aspect

Based on Figure 8, the N-Gain test for the algorithmic thinking aspect shows an increase in students' Computational Thinking after using the *Komfun CT* learning media. The average pre-test score was 9.55, which increased to 22.27 in the post-test. The effectiveness level reached 0.83 with a percentage of 82.98%. According to the N-Gain category, this score falls into the high category, indicating that *Komfun CT* is effective in improving algorithmic thinking.

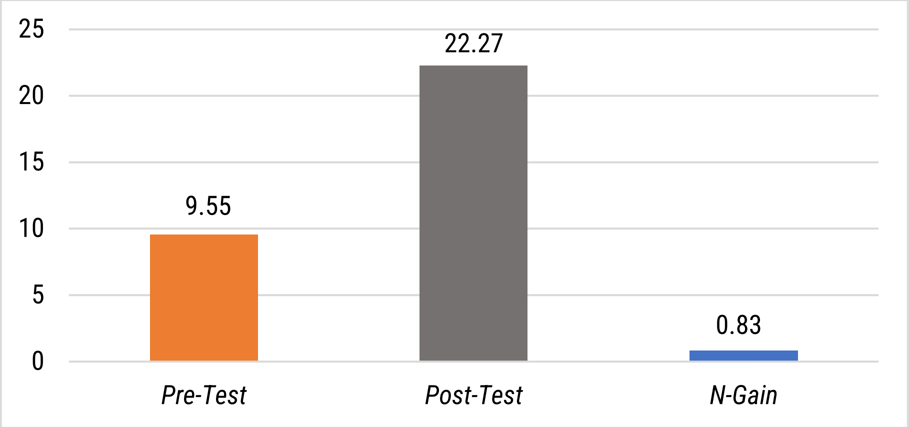

Figure 8. N-Gain Test – Algorithmic Thinking Aspect

c. Pattern Recognition Aspect

Based on Figure 9, the N-Gain test for the pattern recognition aspect shows a significant increase in students' Computational Thinking after using the *Komfun CT* learning media. The average pre-test score was 14.24, which rose to 23.03 in the post-test. The effectiveness level was 0.84 with a percentage of 84.14%. This score is categorized as high, meaning that *Komfun CT* is effective in enhancing students' pattern recognition skills.

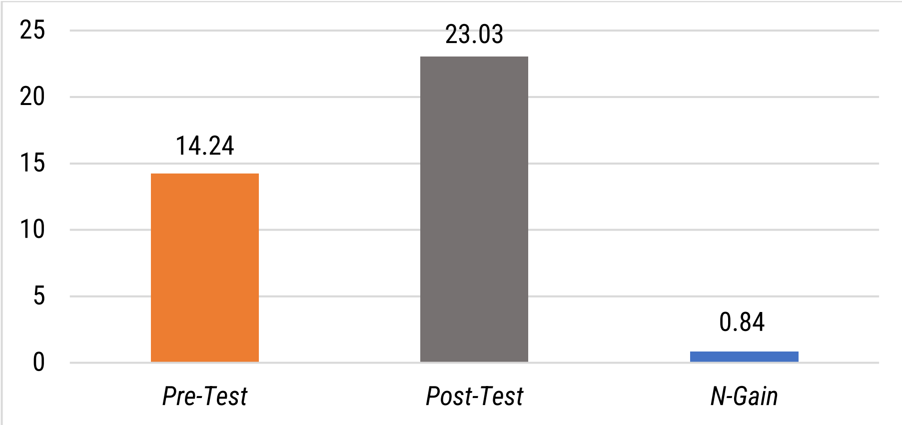

Figure 9. N-Gain Test – Pattern Recognition Aspect

d. Abstraction Aspect

Based on Figure 10, the N-Gain test for the abstraction aspect shows an increase in students' Computational Thinking after using the *Komfun CT* learning media. The average pre-test score was 10.15, which increased to 22.27 in the post-test. The effectiveness level reached 0.84 with a percentage of 83.74%. According to the N-Gain category, this score falls into the high category, indicating that *Komfun CT* is effective in improving abstraction skills.

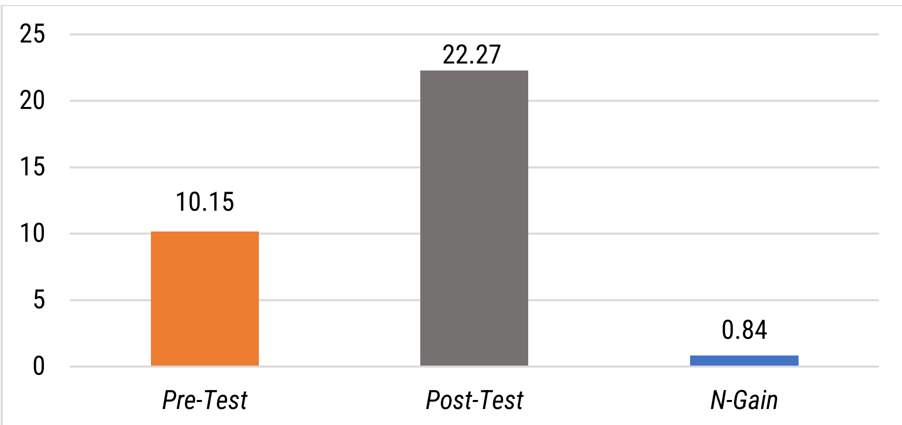

Figure 10. N-Gain Test – Abstraction Aspect

Conclusion on the Effectiveness Based on N-Gain Test

Table 12. N-Gain Analysis for Each Aspect of Computational Thinking

Assessment Aspect	Pre-Test	Post-Test	Avg. N-Gain	Category	Avg. N-Gain (%)	Interpretation
Decomposition	11.52	20.45	0.69	Medium	68.94%	Fairly Effective
Algorithmic Thinking	9.55	22.27	0.83	High	82.98%	Effective
Pattern Recognition	14.24	23.03	0.84	High	84.14%	Effective
Abstraction	10.15	22.27	0.84	High	83.74%	Effective
Average	11.37	22.01	0.80	High	79.95%	Effective

Based on Table 13, the N-Gain analysis results indicate an increase in scores from the pre-test to the post-test across all aspects of Computational Thinking. Specifically, the aspects of Algorithmic Thinking, Pattern Recognition, and Abstraction showed significant improvement with average N-Gain percentages above 80%, thus classified as effective. This indicates an optimal improvement in students' understanding of these three aspects. Meanwhile, the Decomposition aspect recorded the lowest N-Gain score of 0.69 with an average N-Gain percentage of 68.94%, placing it in the medium category and considered fairly effective.

Overall, the *Komfun CT* learning media effectively enhances students' Computational Thinking skills. This is evidenced by the average pre-test score of 11.37, which increased to 22.01 in the post-test. This improvement is reflected in the average N-Gain score of 0.80, classified as high, with an average percentage of 79.95%, indicating that learning using *Komfun CT* media is effective in improving students' Computational Thinking.

DISCUSSION

Development Procedure of *Komfun CT* Learning Media

The development of Scratch-based learning media followed a systematic process using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to ensure its quality and effectiveness in supporting student learning. The process began with the analysis phase, which included a literature review and needs analysis, such as observing classroom instruction, identifying student characteristics, administering a pre-test, and analyzing learning gaps. Based on the analysis, *Komfun CT* was designed to address students' needs, especially to improve their Computational Thinking (CT) skills in learning function composition. Pre-test results showed relatively low CT skills, particularly in algorithmic thinking and abstraction. This aligns with Nuraisa et al. (2019), who found that students often only reach the decomposition and pattern recognition stages in problem-solving. These findings guided the development of an engaging and interactive Scratch-based learning media.

In the design phase, both content and visual aspects of the media were outlined. The content design, developed as a storyboard, served as the instructional framework and preceded the visual design to ensure alignment between learning objectives and user interface. During the development phase, the *Komfun CT* media was created based on the storyboard and visual plan. The product was then validated by experts to determine its feasibility and identify improvement areas. Results showed that the media met the required validity standards and were ready for classroom implementation.

The implementation phase involved testing the media with 33 students in a classroom setting. The results indicated that *Komfun CT* was easy to use and facilitated an engaging and enjoyable learning experience. Finally, the evaluation phase was conducted continuously throughout the development process to assess, refine, and improve the product based on expert and user feedback.

Feasibility of *Komfun CT* Learning Media

The feasibility of *Komfun CT* was evaluated based on three aspects: validity, effectiveness, and practicality.

1. Validity Analysis

   Expert evaluation resulted in an average score of 94% for content validity and 92% for media validity. The overall average score of 93% falls within the "Valid" category, indicating that *Komfun CT* is appropriate for use in mathematics learning.

2. Effectiveness Analysis

   In terms of student learning outcomes, 90.91% of students achieved mastery, surpassing the minimum 75% threshold. This shows that *Komfun CT* is effective in enhancing students' CT skills. N-Gain analysis further indicated that three CT components, algorithmic thinking, pattern recognition, and abstraction, were in the "effective" category, while decomposition was "fairly effective." The overall N-Gain average was 79.95%, and the final effectiveness score was 85.43%. These results align with Wing's (2006) assertion that computational thinking includes algorithmic approaches and abstraction processes that can be nurtured through structured problem-solving environments.

The relatively lower performance in decomposition may suggest the need for more explicit scaffolding to help students break down problems into manageable parts, consistent with Bruner's theory of scaffolding in cognitive development.

3. Practicality Analysis

Komfun CT received a strong positive response from students, with an average practicality score of 83.60%, placing it in the "Very Practical" category. Interviews confirmed that students found the media easy to use, engaging, and helpful in understanding function composition. These findings suggest that *Komfun CT* supports student-centered and accessible learning, consistent with constructivist principles in instructional design.

Based on the analysis of validity, effectiveness, and practicality, *Komfun CT* meets the criteria for a high-quality learning media. It is suitable for enhancing students' Computational Thinking in the context of function composition. Moreover, it offers several distinct advantages over conventional media. With an engaging interface and interactive activities, *Komfun CT* supports the development of key CT skills: decomposition, algorithmic thinking, pattern recognition, and abstraction.

These skills are essential in mathematics learning, particularly in abstract topics like function composition. *Komfun CT*'s animation and simulation features help visualize abstract concepts, making them more accessible. Additionally, its web-based, freely accessible format allows for flexible, anytime-anywhere learning, further empowering students with essential 21st-century skills such as logical reasoning, creativity, and digital literacy. In summary, *Komfun CT* not only addresses current gaps in CT instruction but also provides a pedagogically sound, engaging, and practical solution to enhance meaningful mathematics learning in the digital age.

CONCLUSION

Based on the *research and development* (R&D) study using the ADDIE development model, a mathematics learning media based on Scratch named "*Komfun CT*" has been successfully developed. The feasibility test results for the *Komfun CT* mathematics learning media are as follows: The validity test results showed an average final score of 93.86% from two expert evaluations, indicating that the *Komfun CT* learning media is valid and can be used in the mathematics learning process. Based on students' responses, the practicality test results showed a final score of 83.60%, which falls under the "Very Practical" category. Furthermore, interview results also indicated that the *Komfun CT* learning media is considered practical for use in classroom learning. The effectiveness test results showed an average final score of 85.43%, indicating that the *Komfun CT* learning media effectively enhances students' Computational Thinking in the topic of Function Composition.

Overall, the *Komfun CT* mathematics learning media meets the criteria of being valid, effective, and practical. Therefore, this media is considered suitable for use as a learning tool to enhance students' Computational Thinking skills in the topic of Function Composition. The *Komfun CT* learning media is superior to previously used conventional learning media, as it has undergone expert validation and product testing, demonstrating its feasibility and ability to enhance students' Computational Thinking.

REFERENCES

Aulia, S. (2021). *Development of interactive multimedia-based learning media using Scratch with a computational thinking method on trigonometry material in Grade X at SMA Negeri 7 Mandau* (Doctoral dissertation, Universitas Islam Riau).

Brown, H. D. (2006). *Language assessment: Principles and classroom practices*. Pearson Education, Inc.

Dewi, A. N., Juliyanto, E., & Rahayu, R. (2021). The effect of science learning with a computational thinking approach assisted by Scratch on problem-solving ability. *Indonesian Journal of Natural Science Education, 4*(2), 492–497.

Hadi, M., Atiqoh, K., & K., K. (2021). Improving students' mathematical computational thinking using Scratch program through project-based learning: A development research during pandemic

COVID-19. In *2021 9th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1–5). IEEE. https://doi.org/10.1109/CITSM52892.2021.9588856
Hake, R. R. (1998). Interactive-engagement vs. traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64–74. https://doi.org/10.1119/1.18809
Jun, S., Han, S., & Kim, S. (2017). Effect of design-based learning on improving computational thinking. *Behaviour & Information Technology, 36*, 43–53. https://doi.org/10.1080/0144929X.2016.1188415
Kadir, A., & Suryantoro, F. S. (2016). *Scratch for Arduino (S4A): Panduan untuk mempelajari elektronik dan pemrograman*.
Kwon, K., Jeon, M., Guo, M., Yan, G., Kim, J., Ottenbreit-Leftwich, A., & Brush, T. (2021). Computational thinking practices: Lessons learned from a problem-based curriculum in primary education. *Journal of Research on Technology in Education, 55*, 590–607. https://doi.org/10.1080/15391523.2021.2014372
Maharani, P. P., Juandi, D., & Nurlaelah, E. (2024). Analysis of junior high school students' computational thinking ability in solving mathematical problems in terms of mathematical habits of mind. *SIGMA DIDAKTIKA: Journal of Mathematics Education, 12*(1), 1–20.
Manik, H., Sihite, A. C. B., Manao, M. M., Sitepu, S., & Naibaho, T. (2022). The theory of humanistic philosophy in mathematics learning. *Edumaspul: Journal of Education, 6*(1), 348–355. https://doi.org/10.33487/edumaspul.v6i1.3037
Mardiyanto, H. (2018). *Development of Komfun CT learning media in science subjects for Grade V on water conservation material* [Bachelor's thesis, Universitas Sanata Dharma Yogyakarta]. http://repository.radenintan.ac.id/20523/
Motu, C. I. (2024). *Development of Scratch-based mathematics learning media to improve students' computational thinking skills* [Undergraduate thesis, Universitas Katolik Widya Mandira Kupang]. http://repository.unwira.ac.id/id/eprint/14900
Pou, A., Canaleta, X., & Fonseca, D. (2022). Computational thinking and educational robotics integrated into project-based learning. *Sensors (Basel, Switzerland), 22*(10), Article 3746. https://doi.org/10.3390/s22103746
Pramesti, P., & Ferdianto, F. (2021). An analysis of students' difficulties in learning mathematics on the topics of function composition and inverse function in Grade X at SMA Negeri 1 Rajagaluh. *Journal of Mathematics and Science Education, 7*(2), 74–79.
Rayanto, Y. H. (2020). *Developmental research with the ADDIE and R2D2 models: Theory & practice*. Lembaga Academic & Research Institute.
Sugiyono. (2017). *Quantitative, qualitative, and R&D research methods*. Alfabeta.
Vhalery, R., Setyastanto, A. M., & Leksono, A. W. (2022). Independent learning and Kampus Merdeka curriculum: A literature review. *Research and Development Journal of Education, 8*(1), 185. https://doi.org/10.30998/rdje.v8i1.11718
Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33–35.
Yulianisa, A., & Sudihartinih, E. (2022). Development of Scratch-based mathematics learning media on algebraic multiplication materials. *Journal of Mathematics Education, University of Lampung, 10*(2), 142–156.