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Innovation in Algorithm Learning through "Bahasa Algo" and "Kartu Algo" in Informatics Subjects at SMA Negeri 1 Kalidawir

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ABSTRACT

Algo Language is a semi-formal language designed to help students understand algorithms without requiring in-depth knowledge of programming languages. Meanwhile, Algo Cards are teaching aids used to teach algorithms in an interactive and fun way. This study aims to develop interactive teaching materials in the form of the Algo Language Module and Algo Cards to enhance students' algorithmic abilities in the Informatics subject at SMAN 1 Kalidawir. The research employed a Research and Development (R&D) design using the ADDIE model, which includes the stages of analysis, design, and development. Research instruments consisted of questionnaires and structured interviews, and data were analyzed both qualitatively and quantitatively. The results revealed that: (1) the Algo Language Module and Algo Cards were successfully developed to facilitate students' understanding of algorithmic concepts; (2) material expert validation obtained a score of 93.42% (highly feasible), while media expert validation achieved 90.38% (highly feasible); and (3) the small-group trial produced a feasibility score of 78.81% (feasible), which increased to 93.82% (highly feasible) in the large-group trial. These findings indicate that the developed interactive learning materials are feasible, easy to understand, effective, and capable of enhancing students' motivation and comprehension in learning algorithms.

A. INTRODUCTION

Generally, learning about algorithms in informatics classes is still conducted conventionally, with teachers simply explaining the material verbally or using textbooks and whiteboards. While this method is quite effective in providing basic understanding, it tends to be boring and uninteresting for most students. This results in a lack of student engagement, which in turn impacts their learning outcomes. Furthermore, students often struggle to apply the theory taught in real-world settings.

According to Ardiyanti (2022), conventional learning that is monotonous and does not stimulate active learning for students can result in reduced interest in learning for students, so that it can make it difficult to achieve national education goals optimally. Examples of conventional methods based on monotony are conventional teacher-centered learning, for example lectures in front of the class with blackboard media, textbooks, and markers, where students passively receive information; while monotonous learning is a conventional practice that is boring, such as only listening to the teacher without a variety of media or interaction, which can cause boredom, low interest, and decreased achievement, even though both can be overcome with interactive methods (discussions, simulations) and interesting media (videos, images) (Angelika et al., 2024) Observations at SMAN 1 Kalidawir show that algorithm learning lacks interactive media, highlighting the need for effective technology-based materials.

Innovative and interactive teaching materials can address these issues by enabling students to learn independently, engagingly, and contextually while offering a more personalized learning experience (Adha & Faridi, 2024). Learning materials are essential components of the learning process, serving as structured tools that organize concepts and content to help students understand lessons more effectively (Magdalena et al., 2020). High-quality learning materials not only serve as resources for students but also as guides for teachers to deliver lessons systematically and purposefully. Well-designed materials help teachers present content effectively and ensure the learning process aligns with its objectives. Therefore, learning materials should be developed gradually based on students' developmental levels to make learning more engaging and motivating (Mustika et al., 2023). Moreover, teachers' understanding of effective learning material design is crucial, as it enables them to better foster student interest. In the context of the Sekolah Penggerak curriculum, learning material development is integrated into lesson planning that takes into account students' developmental stages and the relevance of the subject matter.

The limitations of Algo Language in learning algorithms are the availability of students' readiness to use teaching materials, the scope of the material is still limited to the basic use of algorithms and the role of teachers in the learning process is still lacking, for example, if teachers are less creative in integrating teaching materials, the potential effectiveness of using algorithmic language is not optimal. According to Rio et al. (2024), Algo Language helps students learn algorithms while building a solid foundation for advanced programming. Research by Diasri et al. (2025) shows that using Algo Language effectively improves students' understanding of basic algorithmic concepts and facilitates their transition to advanced programming.

Furthermore, learning with Algo Language can be supported by Algo Cards as visual aids. These cards make algorithm learning more interactive and enjoyable through an unplugged approach, enabling students to grasp concepts via games or simulations without using digital devices. Research by Diasri et al. (2025) Studies show that Algo Cards effectively improve students' understanding of algorithmic concepts and boost classroom motivation. They help train logical and systematic thinking key foundations in programming. By constructing algorithms with the cards, students can visually solve problems and see the relationships between procedural steps, gaining a more practical and tangible learning experience. Wibowo et al. (2024) also confirmed that applying Algo Cards not only improves conceptual understanding but also fosters collaboration and communication among students, as they work together in groups to construct and complete given algorithmic tasks.

Algorithm learning innovation has several shortcomings in algorithm learning in schools in terms of simplifying the algorithm language, namely it is still dominated by conventional methods that tend to be boring, characterized by students experiencing difficulties with algorithms, and often forgetting the theory when switching to programming practice (Bouty et al., 2024). Not only that, especially at SMAN 1 Kalidawir, algorithm learning has minimal use of interactive media, and students have difficulty applying Algo Cards not only improving conceptual understanding, but also being able to encourage cooperation and communication between students, because they work in groups to compile and complete the given algorithms, connecting algorithm theory including visualizing logic and translating it into program code.

The integration of Language Algo (Algo Language) and Cards Algo (Algo Cards) should be formalized into a clear, structured conceptual framework or model for algorithmic learning. By explicitly linking these tools to established computational thinking theories or learning progression models such as how language simplification reduces cognitive load while visual aids support logic visualization the study would offer a more robust theoretical contribution. Furthermore, moving beyond feasibility scores to empirically test and analyze the impact of

these materials on students' actual algorithmic thinking processes would provide the rigorous evidence needed to establish this approach as a globally relevant pedagogical innovation.

The urgency of this research is based on the gap between the competency demands of the Industry 4.0 era and the reality of informatics learning at SMAN 1 Kalidawir. On the one hand, mastery of algorithms is a crucial foundation for students to compete in the digital world. This gap creates a research gap, where existing learning resources are unable to bridge conceptual understanding with practical implementation that is engaging for students.

Based on the identified challenges, this innovative research on algorithm learning integrates Algo Language and Algo Cards in Informatics subjects. Therefore, this research aims to develop interactive teaching materials that can improve students' understanding and skills in learning algorithms, with the hope of creating a more interesting, effective and efficient learning process.

B. METHODS

The research method used is Research and Development (RnD), which aims to produce a specific product and test its feasibility. This research uses the ADDIE development model because it is considered most relevant to the topic being studied. The ADDIE model applies a systems-based approach that emphasizes structured and systematic learning planning. The process is divided into several interrelated stages, where the results of each stage serve as the basis or input for the next stage. The ADDIE development model can be observed and understood in the following figure 1.

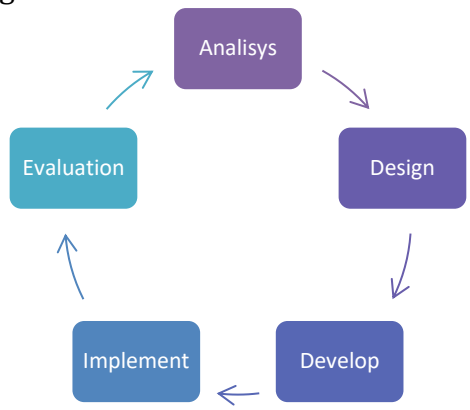

Figure 1. Research stages Model ADDIE

A Figure 1 illustrates the research procedure, which begins with the first stage, Analysis, in which researchers identify existing needs and problems through interviews and direct field surveys. This process is crucial for a deep understanding of the problems faced and determining the steps necessary to develop teaching materials. The second stage, Design, includes formulating clear learning objectives, developing relevant teaching materials, and selecting appropriate media to support the learning process. In this design stage, validation of the selected materials and media is conducted to ensure their suitability for the learning objectives.

The third stage is Development, where product trials are conducted. Trials are conducted through both limited and larger-scale experiments on the products developed in the analysis and design stages. Data from these trials are used to refine the product before its wider application in learning activities. Although the Implementation and Evaluation stages are essential parts of the ADDIE model, this research was limited to the development stage due to time constraints and the conditions at the school where the research was conducted. Thus, the results achieved will be more focused on developing products that are ready for further testing.

The developed teaching material, which had been validated by subject-matter and media experts, was subsequently tested with tenth-grade students at SMAN 1 Kalidawir through two stages: a small-group trial and a large-group trial. The small-group trial involved 10 students,

while the large-group trial involved 30 students. These stages aimed to evaluate the effectiveness and feasibility of the developed product (Zef et al., 2022).

The trial subjects were categorized into three groups: (1) material expert validators, consisting of Informatics lecturers or teachers with a minimum educational qualification of a bachelor's degree (S1) and over ten years of teaching experience; (2) media expert validators, consisting of lecturers or teachers with expertise in instructional media development and similar qualifications; and (3) students of grade X at SMAN 1 Kalidawir, who participated in both small-group (10 students) and large-group (30 students) trials.

The data collected in this study were interviews and questionnaires. Interviews were used to elicit information related to the research problem, particularly when researchers wanted to gain a deeper understanding from a limited number of respondents. Meanwhile, the questionnaires from the two validators were used to assess and provide feedback on the developed digital teaching materials. These results, obtained from students in both trial groups, were used to determine their responses to the use of the digital teaching materials.

To determine the validity of the resulting digital teaching materials, the researchers conducted data analysis. The data obtained in this study consisted of qualitative and quantitative data. The processed data was then interpreted to determine the results. The guidelines used to interpret the results of the data analysis were to establish assessment criteria: very inadequate, inadequate, moderately adequate, adequate, and very adequate.

Data analysis in this study was conducted through interviews, questionnaires, and a Linkert scale. The researcher sought information from respondents regarding the existing problems, then the interview results were filled out on a questionnaire. The use of a questionnaire is considered appropriate if the researcher already knows the variables to be measured, as this instrument is considered efficient and effective in obtaining data.

In this study, the questionnaire was administered to two validators: a material expert and a media expert, as well as to students who were the subjects of the small and large group trials. To assess the feasibility of the aspects described above, the researcher used a questionnaire. The questionnaire used four levels of assessment based on a Likert scale. The scale used in the questionnaire responses was a Likert scale in checklist form. The validity of the developed digital teaching materials was assessed through systematic data analysis. The data obtained consisted of both qualitative and quantitative forms. Qualitative data were analyzed descriptively to summarize feedback, critiques, and suggestions from validators and respondents.

To determine the validity of the resulting digital teaching materials, researchers conducted data analysis. The data obtained in this study consisted of qualitative and quantitative data. The qualitative data were analyzed using descriptive methods to describe the findings narratively, while the quantitative data were analyzed based on questionnaire results, the scores of which were calculated using the following scoring formula :

$$P = \frac{Sp}{Si} x\ 100\ \% \qquad (1)$$

Description:

P : Validity percentage
s_i : Ideal score
s_p : Obtained score
100% : Constant

(Ridwan & Akdon, 2010)

The processed data is then interpreted to determine the results. The guidelines used to interpret the results of the data analysis include establishing assessment criteria: very inappropriate, inappropriate, fairly appropriate, appropriate, and very appropriate (Ridwan & Akdon, 2010). The following are the qualifications and criteria guidelines for analyzing data in the questionnaire :

Table 1. Criteria for the Feasibility of Teaching Material Questionnaire Data

No	Interval Score	Category
1	0% - 20%	Very Infeasible
2	21% - 40%	Feasible
3	41% - 60%	Fairly Feasible
4	61% - 80%	Less Feasible
5	81% - 100%	Not Feasible

Source: (Arikunto, 2010).

C. RESULT AND DISCUSSION

The ADDIE model consists of five main interrelated stages, namely: (1) Analysis; (2) Design; (3) Development; (4) Implementation; and (5) Evaluation, which aims to provide feedback to improve the quality of the training and materials that have been implemented. This research was only conducted up to the development stage due to time constraints in its implementation. Although the model used includes five stages, this research only focuses on the first three stages of the model. The series of stages are as follows:

1. Analysis Stage

The results of a field survey conducted through direct interviews with teachers and students at SMAN 1 Kalidawir. Thirty students were selected for the field trial, and researchers found that most students still experienced difficulties in understanding concepts, especially technical material. This was because available learning resources, in the form of textbooks, were considered too complex, lengthy, and did not provide concise and to-the-point explanations.

This condition resulted in students experiencing difficulties in grasping important information that would support their practical work in the field. Second, during practical activities, students tended to perform procedural steps incorrectly and appeared haphazard. This situation indicated that their understanding of the basic material, including the required algorithmic skills, was still weak. In other words, they were unable to fully connect the theory learned with real-world practice. Third, from the teachers' perspective, there is a pressing need to develop more innovative, interactive teaching materials that align with the demands of 21st-century learning. Teachers believe that alternative, contextual media or teaching materials can help improve students' focus during the learning process, reduce boredom, and deepen their understanding of the material presented. .

These findings align with Mensan et al. (2020), who reported that unplugged activities strengthen logical thinking and problem-solving abilities among elementary students with limited digital access. Similarly, Malik et al. (2021) found that using visual and interactive media can enhance understanding of logic, decomposition, and abstraction among beginner programming students. Based on the alignment between field findings and existing literature, the development of interactive teaching materials such as Bahasa Algo and Kartu Algo was considered relevant to address these problems. Bahasa Algo helps students grasp logical sequences before transitioning to more complex programming languages, while Kartu Algo visualizes algorithmic steps concretely and engagingly.

2. Design Stage

Interviews at SMAN 1 Kalidawir revealed that students struggled with algorithmic concepts due to complex, lengthy textbooks, leading them to follow procedures without understanding the logic. Teachers emphasized the need for interactive, innovative materials for 21st-century learning. The first chapter introduces computational problem-solving through concept mapping, search and sorting techniques, and basic data structures, forming a foundation for improving problem-solving and digital literacy (Zaini et al., 2025).

The second, Information and Communication Technology (3 hours), focuses on integrating office applications and managing digital information—key 21st-century skills for productivity and communication (Reddy et al., 2023). The third, Algorithms and Programming (6 hours), introduces the C language and Bahasa Algo to build technical proficiency, aligning with national standards emphasizing computational literacy (Kemdikbudristek, 2022). The Fourth, Algorithms and Programming (6 hours), introduces Impacts and Opportunities in Informatics (4 hours), covers computing history, economic and legal aspects, and career or education prospects, fostering both technical skills and socio-economic awarenesshe C language and Bahasa Algo to build technical proficiency, aligning with national standards emphasizing computational literacy (Selwyn, 2021). Midterm and final tests (1 hour each) evaluated students' achievements formatively and summatively.

This curriculum mapping shows a balanced integration of hard skills (programming, computational thinking) and soft skills (critical awareness of informatics). It aims to boost motivation, strengthen 21st-century competencies, and prepare students for complex technological challenges. Figures 1 and 2 illustrate the interactive module's design, including the cover and table of contents, adapted to students' needs identified in the analysis stage.

Figures 1. and 2. Design of Teaching Materials Based on Algo Language and Algo Card

3. Validation Results

Material validation by two experts produced an overall score of 93.42% ("very feasible"), with content 93.75%, language 85%, presentation 96.88%, and technical quality 100%. These results show that most criteria met feasibility standards, though some language indicators such as spelling, structure, tone, and clarity still need improvement. The validation results are summarized in Table 2.

Table 2. Summary of Expert Validation Results on Material Aspects

No	Aspect	Score Obtained	Max. Score	Percenta-ge
1	Material Aspect	45	48	93,75%
2	Language Aspect	34	40	85%
3	Material Presentation	31	32	96,88%
4	Technical Quality	32	32	100%
	Total	**142**	**152**	**93,42**

The quantitative data from the questionnaire indicated that the developed teaching module met high-quality standards. This is reflected in the "very feasible" category scores for most aspects content, presentation, and technical quality. However, minor weaknesses were found

in the language aspect, particularly regarding spelling accuracy, sentence simplicity, and clarity of discussion. This finding is significant because language plays a central role in mediating students' understanding of both abstract and technical concepts.

Such linguistic weaknesses can be explained through the Cognitive Load Theory Sweller et al. (2019), which posits that overly complex language can increase students' cognitive load. When students must allocate a large portion of their cognitive capacity to decipher convoluted language, less capacity remains for processing the core material, thereby reducing learning effectiveness even when content is well-designed. Thus, linguistic simplicity is not merely a matter of stylistic preference but a pedagogical factor that directly affects learning quality.

This result aligns with Susanti and Wilda (2021), who emphasized the importance of using simple, communicative, and learner-appropriate language in interactive modules. Concise, clear, and accessible language helps students focus on key material without being distracted by textual complexity. This is especially relevant in Informatics learning, where technical terminology and algorithmic procedures are inherently complex. Simplifying language enables students to connect abstract concepts with computational problem-solving practices more effectively.

Table 3. Summary of Expert Validation Results on Media Aspects

No	Aspect	Score Obtained	Max. Score	Percentage
1	Teaching Material Completeness	14	16	87,5%
2	Graphic Aspect	52	56	92,86%
3	Media Quality	28	32	87,5%
	Total	**94**	**104**	**90,38%**

The validation results in Table 3 from the two media experts indicate that the developed digital teaching materials achieved a total score of 90.38%, categorizing them as "very suitable" for use in learning. More specifically, the completeness of the teaching materials achieved an average score of 87.5% (very suitable), the graphical display aspect scored 92.86% (very suitable), and the overall quality of the teaching materials achieved a score of 87.5% (very suitable). These findings are consistent with Rahmanto et al. (2023), who demonstrated that interactive learning media can significantly improve student engagement, but inconsistent visual design may decrease learning focus. Similarly, Akgül and Uymaz (2022) emphasized that graphical quality plays a vital role in enhancing student engagement in digital modules. Thus, developing interactive modules requires attention not only to content but also to aesthetic and design consistency to optimize learning effectiveness.

Although generally meeting the "very suitable" criteria, several indicators fell below the minimum threshold for this category, particularly in terms of content completeness, clarity of visual grammar, such as spelling, color harmony, and the suitability of the teaching materials for learning practices. This indicates that there are opportunities for improvement, especially in optimizing the visual design to be more consistent and adjusting the content details to be more comprehensive (Listiani et al., 2024).

Furthermore, visual consistency including typography, color schemes, image layout, and graphic organization has been proven to support comprehension in instructional design. Inconsistent visual variation may confuse students and reduce the module's appeal, diverting attention from the learning material. Conversely, consistent design helps students develop visual familiarity, allowing them to focus more quickly on the content. Rohman and Handoko (2023) found that well-structured graphical presentation and systematic layouts received high validation scores (around 88.4%), with students reporting that visual design strongly affected their motivation. Consistent and aesthetic visual elements significantly enhanced students' positive responses to multimedia learning modules.

These findings emphasize that visual and aesthetic elements are vital to the module's effectiveness. Poor visuals—such as blurry images, inconsistent colors, or uneven layouts—can hinder comprehension, especially in algorithm learning that relies on attention to procedural details. Therefore, continuous improvement of the Bahasa Algo and Kartu Algo module's visual design is essential. Clear and consistent visuals not only improve aesthetics but also align with Cognitive Load Theory, reducing unnecessary cognitive strain and helping students focus on the content. Integrating strong material, engaging visuals, and clear language is expected to create a more effective and enjoyable learning experience.

During the development phase, questionnaires were distributed to small-scale trial subjects (10 students) and large-scale trial subjects (30 students) from Grade X Informatics at SMAN 1 Kalidawir. These trials aimed to collect user feedback on the developed materials. Results from the small-scale trial showed an average score of 78.81% (feasible), indicating suitability for classroom use. Specifically, the content aspect reached 79.28%, the language aspect 79.16%, and the graphical aspect 77.91%, all within the "feasible" category but with potential for improvement. The small-scale trial results are summarized in Table 4.

Table 4. Feasibility Scores of Learning Materials (Small Group Trial)

No	Aspect	Score Obtained	Max. Score	Percentage
1	Material Aspect	222	280	79,28%
2	Language Aspect	190	240	76,16%
3	Graphical Aspect	187	240	77,91%
Total		**599**	**760**	**78,81%**

The small group trial showed that the developed interactive learning materials achieved an average score of 78.81% ("feasible" category), with the material aspect scoring 79.28%, language 79.16%, and graphics 77.91%. These results indicate positive evaluations, though some indicators still need improvement. After revisions, the large group trial involving 30 Grade X Informatics students at SMAN 1 Kalidawir showed a significant increase, with an overall score of 93.82% ("highly feasible" category). The material aspect reached 94.64%, language 92.92%, and graphics 93.75%, confirming that the learning materials met quality standards in content, language, and design for instructional use.

Table 5. Feasibility Scores of Learning Materials (Large Group Trial)

No	Aspect	Score Obtained	Max. Score	Percentage
1	Material Aspect	795	840	94,64%
2	Language Aspect	669	729	92,92%
3	Graphical Aspect	675	720	93,82%
Total		**4040**	**4560**	**93,82%**

The comparison between the two testing stages shows clear progress: the small group trial (10 students) scored 78.81% ("feasible"), while the large group trial (30 students) reached 93.82% ("highly feasible"). In the large group test, all aspects material, language, and graphics—scored above 90%. This improvement demonstrates that the iterative revision process effectively enhanced the module's overall quality. Moreover, the increased scores emphasize the importance of repeated validation and testing in R&D methodologies to ensure educational products are continually refined to meet learners' needs.

This finding aligns with the study conducted by Diasri et al. (2025), which emphasized that multi-phase trials from small-scale to large-scale can significantly improve the effectiveness of digital learning media. Similarly, Pernanda et al. (2024) in their international study reported that student engagement increases substantially when instructional media undergo systematic validation and iterative testing. These studies corroborate the current research results,

confirming that structured development cycles contribute directly to user satisfaction and learning effectiveness.

D. CONCLUSION AND SUGGESTIONS

The factors that cause an increase in students' understanding of algorithms at SMAN 1 Kalidawir lie in the use of interactive teaching materials with interesting module visualizations, such as the material presented in different ways and not monotonously, so that students learn comfortably and not bored. Conventional learning methods were found to be less effective, prompting the creation of more engaging and interactive materials. Expert validation showed high feasibility, with scores of 93.42% for content and 90.38% for media, while field trials improved from 78.81% to 93.82% after revisions. The module proved effective in increasing motivation, comprehension, and creativity. Future development is recommended to transform it into a digital interactive platform with quizzes and videos, and to expand its scope to advanced topics. Overall, this innovation supports the Merdeka Curriculum and 21st-century learning, fostering critical thinking, creativity, and digital literacy.

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