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# Algorithm-enhanced English grammar learning: A structured module development approach

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### ABSTRACT

Grammar is an essential competence for effective communication, yet many students have difficulties understanding and mastering it. This study aims to develop a comprehensive learning module integrating algorithm principles with English grammar to enhance students' grasp of English structure by following a systematic approach encompassing Analysis, Design, Development, Implementation, and Evaluation (ADDIE). However, it focused primarily on implementation and evaluation phases. The novelty lies in the implementation of the algorithm principle used to enhance students' grammar mastery. In this case, English structures are learned through automatic patterns to make them easier to master. Participants included students from the English Education Department at three different universities in Central Java with diverse educational backgrounds, while the product was implemented (limited test) at one of them. A thorough needs analysis revealed that students found that grammar learning was complex and challenging, necessitating simpler, more engaging instructional methods. In response, a targeted product was developed based on these insights. The validation indicated a positive reception of the module, with 66% as "Good," 17% as "Average," and 16% as "Very Good," with no evaluation falling into "Poor" or "Unsatisfactory" categories. These findings suggest that the module is a viable tool for enhancing grammar instruction. Besides, the implementation gained a *p*-value of 0.004 that meant having significance in using the module. The study not only contributes to the pedagogical framework for teaching English grammar but also highlights the importance of innovative approaches in language education. Further research could explore the long-term impacts of such modules in various learning contexts.

Keywords: Algorithm principles; English structure; grammar-algorithm; learning module; module development

### INTRODUCTION

English mastery is a central educational goal in Indonesia, where English is the first foreign language taught from elementary school through higher education. Despite its prominence, Indonesian learners continue to struggle with English, particularly in mastering grammar, which remains the most persistent and complex challenge (Castillo-Cuesta, 2020; Hampp et al., 2021; Nashoih & Darmawan, 2019). Grammar is foundational to all language skills, speaking, listening, reading, writing, and thinking, serving as the system of rules that governs how words and elements are arranged to form meaningful sentences (Anggraini & Santhoso, 2017; Budiman et al., 2023; Kumayas & Lengkoan, 2023; Youjun & Xiaomei, 2022). A strong grasp of grammar not only enables effective communication but also supports academic achievement and confidence in language use (Kubincová et al., 2023; Napratilora & Siagian, 2019; Sacal & Potane, 2023; Shofiyudin et al., 2023; Suri, 2020).

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Numerous studies have explored the nuances of grammar mastery, examining areas such as active and passive voice, verb tenses, tag questions, and sentence components (Daneshfar et al., 2018; Hasson & Botting, 2010; Khanahmadi & Sarkhosh, 2018; Mohammadimoghadam, 2015; Yi et al., 2022). Yet, learners frequently encounter difficulties with parts of speech and tenses, which are fundamental to constructing accurate and meaningful sentences (Widianingsih & Gulö, 2016). These challenges are compounded by factors such as student motivation, teaching methods, instructor competence, and limited instructional time (Effendi et al., 2017; Guan et al., 2018; Svafrvadin, 2021). Consequently, there is a pressing need for innovative and engaging learning media that can motivate students, deepen their understanding of grammar, and make the most of available learning time.

Efforts to address these challenges have included the development of simplified grammar teaching methods, such as the Mateng Formula, which integrates mathematical concepts with English tense instruction (Shofiyuddin & Andriyani, approach 2019). This has demonstrated effectiveness in helping students understand and remember tense structures, earning high user satisfaction scores (Shofiyuddin & Andriyani, 2019). In parallel, the landscape of English language instruction has evolved significantly in the 21st century, with technology and algorithmic approaches playing an increasingly prominent role. Integrating digital tools and algorithmic thinking is now seen as essential for making language learning more effective, efficient, and adaptive to individual needs (Ahmad & Arifin, 2021; Grijalva et al., 2025). Algorithms, defined as automated processes or sets of procedures that transform input data into desired outputs, are now widely used in educational contexts to automate tasks, personalize learning, and provide instant feedback (Araujo et al., 2020; Gillespie, 2014; Salleh et al., 2021). In language learning, algorithms can structure and sequence learning materials, enabling a systematic approach to grammar instruction. Recent research has demonstrated that algorithmic strategies can significantly enhance student engagement, academic performance, and problem-solving skills across diverse educational settings. For engagement, studies have found that personalized learning frameworks and algorithmic recommendation systems can boost motivation and retention by tailoring content to individual preferences and learning styles (Anthony et al., 2021; Redelinghuys, 2021; Wu et al., 2024). In terms of performance, adaptive algorithmic models and tutoring systems have been shown to improve learning outcomes by providing targeted support and adjusting to students' evolving needs (Haohao et al., 2024; Moylan & Code, 2024; Sari et al., 2024; Su & Zhong, 2022).

Regarding problem-solving, research highlights that algorithmic feedback, and structured problemsolving modules foster analytical thinking and cognitive skill development in both STEM and language education (Çiftci & Bildiren, 2020; Doleck et al., 2017; Injadat et al., 2021; Lehmann, 2024; Ridley, 2024; Shin et al., 2022; Şimşek et al., 2023).

language learning, Bevond algorithmic principles have been found to shape understanding and behavior in fields ranging from mathematics and computer science to digital citizenship and financial literacy (Ciftci & Bildiren, 2020; Lehmann, 2024; Nassif, 2024; Ridley, 2024). For algorithmic thinking example. enhances mathematical problem-solving, while training in algorithmic bias awareness improves critical thinking in computer science. Algorithmic simulations and personalization also influence decision-making and information processing in digital and media contexts (Injadat et al., 2021; Shin et al., 2022). These findings underscore the broad applicability and transformative potential of algorithmic approaches in education.

In the context of English grammar instruction, the application of algorithms offers a promising pathway for overcoming persistent learning barriers. Studies have shown that algorithm-based learning modules can systematically improve students' understanding and skills by breaking down complex rules into manageable, logical steps (Marinković & Marić, 2024; Mohammed & Ahmed, 2014; Song et al., 2020; Troussas et al., 2019). Effective algorithms are characterized by correctness, efficiency, readability, modularity, scalability, ease of implementation, and measurable optimization, ensuring that they are both practical and adaptable to various educational needs. In language learning, algorithm-based modules and artificial intelligence provide automatic feedback, adapt materials to learners' progress, and facilitate individualized instruction, although challenges remain in addressing the full complexity and variability of natural language (Li, 2021; Sidorov, 2013).

Despite these advances, there remains a gap in addressing the diverse and context-dependent needs of students, particularly when teaching more complex or nuanced aspects of grammar. This research responds to that gap by introducing the Grammar-Algorithm module, which integrates algorithmic principles into the teaching of English grammar. The module aims to simplify and systematize grammar instruction, making it more accessible and effective for learners, especially in mastering parts of speech and tenses. By breaking down complex rules into clear, algorithmic steps, module seeks to enhance the learners' comprehension, retention, and practical application of English grammar.

Learning modules play a vital role in structuring educational content and supporting

student learning. Well-designed modules provide organized pathways for knowledge acquisition, foster engagement, and facilitate the achievement of learning outcomes (Donnelly & Fitzmaurice, 2005; Wang et al., 2024). In the digital era, adaptive and interactive modules are increasingly important for meeting the diverse needs of learners and ensuring flexibility in instructional delivery (Malach et al., 2016; Song et al., 2020). Integrating algorithmic principles into module design not only supports systematic learning but also opens new possibilities for personalized and interactive language instruction.

This study is grounded in the premise that applying algorithmic principles can break down complex grammar rules into systematic, easily understood procedures, thereby improving learners' mastery of English grammar. The Grammar-Algorithm module is designed to facilitate this process, emphasizing practicality and clarity in both teaching and learning. Accordingly, this research is guided by three objectives: (1) to map the needs of learning English structure using the Grammar-Algorithm module to improve university students' mastery, (2) to develop the Grammar-Algorithm module, and (3) to implement the module to enhance students' English structure mastery.

#### METHOD

This research is a Research and Development (R&D) study aimed at developing a product and assessing the effectiveness of the resulting media. Borg and Gall (1984) outline that the procedures in R&D fundamentally involve two main objectives: (1) to develop a product, and (2) to test the effectiveness of the product in achieving its goals. So that in development research, a product is not only designed according to needs in the field but will be developed according to needs and then tested in the field. This study employed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model since its clear and orderly structure gives an organized approach to the advancement and assessment of learning materials. The ADDIE model has been demonstrated to be compelling in different instructional and training settings since it provides an arrangement of steps that direct designers to plan learning modules comprehensively (Brinkmann & Kvale, 2018). Besides, it is a flexible and comprehensive approach. While there are multiple stages in the model, this research is limited to the stage of the implementation of the Algorithm principles-based learning module used to improve students' structure mastery.

#### Respondents

This study involved participants from three universities in Central Java, Indonesia, namely: an Islamic public university in Jepara (IPUJ), a public university in Kudus (PUK) and a state university in Kudus (SUK). The respondents comprised both students and lecturers, all with backgrounds in English education. In the need of ethical compliance of publication, the respondents' names are disguised.

For the needs analysis, one lecturer and thirty fourth-semester English education students were purposively selected from each university, chosen for their experience in grammar learning and their familiarity with the challenges of mastering English structure. These students were considered wellpositioned to recognize both the difficulties in grammar acquisition and the potential of algorithmic principles as an alternative instructional approach. Lecturers were selected based on their expertise in grammar instruction and their ability to identify instructional needs. Additionally, second-semester English education students participated in test validity procedures due to their active engagement in grammar courses.

For the product implementation stage, the study focused on a group of thirty-five students from IPUJ. These participants were selected through purposive sampling, as they represented the most homogeneous group in terms of average competence compared to students from the other two universities. This approach was intended to investigate the application of algorithmic principles in learning English structures through modules, necessitating the selection of respondents with characteristics closely aligned to the research focus. Accordingly, participants were chosen based on predetermined criteria, such as enrollment in a specific English learning program or possessing the foundational understanding required to provide meaningful feedback on the developed module. By employing purposive sampling, the researchers ensured that the selected participants possessed sufficient knowledge and experience in English grammar learning, thereby enabling them to offer deeper insights into the effectiveness of the module in improving mastery of English structures.

#### Instruments

A comprehensive set of research instruments was employed, tailored to each stage of the ADDIE model:

- Semi-structured Interview: interview guides were developed for in-depth grammar learning exploration of challenges, lecturers' perspectives, and the of algorithmic potential integration principles. The questions were open-ended and non-leading, allowing flexibility for probing while maintaining consistency (Brinkmann & Kvale, 2018). Interviews were conducted personally and recorded for transcription and analysis.
- The questionnaire was designed to gather broad data on students' perceptions, needs, and experiences with grammar learning and algorithmic thinking. Items were informed by the needs analysis, literature review, and adapted from validated scales (such as Dörnyei & Ushioda, 2001). The final

version included both Likert-scale and open-ended questions to capture both quantitative and qualitative data.

- (FGD): Focus Group Discussion The FGD protocol was designed with reference to guidelines by Krueger (2014), participant focusing on exploring consensus and diversity of perspectives regarding the prototype module. The FGD questions were derived from issues identified during the early analysis and design phases, such as content clarity, userfriendliness, and alignment of grammar content with algorithmic structure. The discussion prompts encouraged interaction among participants, allowing for the emergence of new insights not captured in individual questionnaires or interviews. This process, as Blumer (1986) notes, facilitates the construction of value and meaning through social interaction, dialogue, and the exchange of symbols among participants.
- Validation Forms: Validation instruments were created to assess the content validity of the developed module. These forms were constructed based on the Dick and Carey model (Dick et al., 2005) and focused on four main aspects: content appropriateness. pedagogical design. usability, and integration of algorithmic principles. Each aspect was rated using a 5point Likert scale, with additional space for qualitative comments and suggestions. Validation forms from experts and practitioners also were analyzed quantitatively for each evaluated aspect of the module (Sinaga & Setiawan, 2022).
- **Test:** A grammar achievement test was developed to measure students' understanding of English structure after using the Grammar-Algorithm module. Test items were aligned with the module's content and Bloom's taxonomy (1956), covering a range of cognitive skills from recall to application. The test was reviewed by experts, piloted for clarity and reliability, and analyzed statistically using SPSS.
- **Documentation and Notes:** Throughout all stages, notes and documentation from interviews, FGDs, and observations were systematically collected to support qualitative analysis and product validation.

### **Data Collection and Analysis**

Data collection focused on identifying existing needs and challenges in grammar learning. Semistructured interviews with lecturers and students, supplemented by literature review, provided qualitative data on students' difficulties, instructional gaps, and the perceived value of algorithmic approaches. Data were analyzed using qualitative content analysis, including data reduction, display, and conclusion drawing (Miles & Huberman, 1994). Details for each of the stages are provided as follows.

### Design Stage

During this stage, questionnaires were distributed to English education students across all three universities to gather quantitative and qualitative data on their perceptions and needs regarding grammar learning and algorithmic thinking. The results informed the design of both the module and the research instruments. Data from questionnaires were analyzed descriptively and triangulated with interview findings to ensure validity and relevance. Data were triangulated with interviews with selected and willing participants who had filled out the questionnaire.

#### Development Stage

The prototype module was developed and subjected to expert and practitioner validation using structured validation forms. FGDs were conducted with lecturers, students, and experts to discuss the module's clarity, usability, and pedagogical alignment. Notes and documentation from these discussions were analyzed qualitatively to identify areas for revision. Quantitative ratings from validation forms were tabulated, and qualitative feedback informed iterative improvements (Dick et al., 2005; Sinaga & Setiawan, 2022).

### Implementation Stage

In this stage, the Grammar-Algorithm module was implemented with thirty-five purposively selected English education students from IPUJ. A grammar achievement test was administered post-intervention to assess learning outcomes. Test data were analyzed using inferential statistics, specifically paired samples t-tests, to determine the module's effectiveness. Reliability analysis (Cronbach's alpha) was conducted to ensure internal consistency of the test items. The data were analyzed using SPSS to ensure accuracy and reliability of the results.

#### **Evaluation Stage**

Both qualitative and quantitative data from all previous stages were synthesized to evaluate the module's effectiveness and usability. Qualitative data from interviews, FGDs, and open-ended questionnaire responses underwent thematic content analysis and triangulation (Miles & Huberman, 1994). Quantitative data from validation forms and achievement tests were analyzed statistically to draw conclusions about the module's impact.

#### FINDINGS AND DISCUSSION

This section presents and interprets the results of the study, which were obtained through a systematic process involving interviews, questionnaires, and tests. Data collection was conducted across five key stages: needs analysis, product design, product development, implementation, and evaluation. Employing this multifaceted approach enabled the researchers to gain a comprehensive understanding of learners' needs and the effectiveness of the Grammar-Algorithm module at each phase of its development (Brown, 2000; Wiggins & McTighe, 2005). The integration of both qualitative and quantitative methods ensured that the findings are robust, contextually grounded, and relevant to the instructional design process. The following discussion synthesizes the main findings from each stage, situates them within the broader literature, and explores their implications for English structure mastery and the integration of algorithmic principles into language learning.

#### Mapping the Needs of Learning English Structure by Algorithm Principle-based Learning Module

The needs analysis took the first step, by interview and questionnaire. The interview was conducted to gain information about the need for learning grammar through the implementation of the principle of the algorithm. It was conducted for lecturers and students in the fourth semester of the three universities. The main points of the interview were: 1) Do you learn grammar (English structure)? 2) Is grammar important in mastering English? 3) Is it difficult to master? 4) Do you know the principles of the algorithm? 5) Do you think that the implementation of the algorithm principle can help us learn grammar more easily? From these questions, the students' answers can be seen in the following table:

#### Table 1

The Students' Answers Related to Grammar Mastery and the Principle of the Algorithm

No	Questions	IP	UJ	PU	K	SU	K	Total	Total
		Yes	No	Yes	No	Yes	No	number of "yes"	number of "No"
1	Do you learn English grammar?	30	0	30	0	30	0	90	0
2	Is grammar important in mastering English?	29	1	30	0	28	2	87	3
3	Is it difficult to master, especially the part of speech and tenses?	25	5	29	1	24	6	78	12
4	Do you know the principle of algorithm?	26	4	22	8	27	3	75	15
5	Do you think that the implementation of algorithm principle can help us learn grammar easier?	27	3	24	6	29	1	80	10

From Table 1, it can be seen that: 1) The students learn English grammar; 2) Most students answered that grammar is important; 3) Most of the students said that grammar is difficult; 4) Most students know about the principle of algorithm; and 5) Most students thought that the implementation of the algorithm principle can help them learn grammar more easily. Besides conducting close interviews with the students, the writer also interviewed the lecturer with the same set of questions. The results can be presented in detail as follows:

#### Learning Grammar

All students confirmed they learn English grammar, highlighting its integral role in their curriculum. This shows that grammar is an integral curriculum in college, especially in the English language education department. Its existence also shows its role as a foundation that helps students understand language structure and build comprehensive language skills. Kiruthika (2016) emphasizes that grammar not instruction only facilitates communication but also enhances critical thinking and supports lifelong learning among EFL students.

#### Importance of Grammar

A significant majority indicated that grammar is crucial for mastering English. This aligns with research by Ellis (1989), emphasizing the foundational role of grammar in effective communication. Understanding grammar rules makes students construct sentences correctly syntactically so that they can convey ideas well and clearly. This shows that students are not only aware of the existence of grammar in the lesson, but also aware of the importance of grammar in its use in the real world.

#### Difficulty in Mastery

An overwhelming 87% of students perceived grammar as difficult, especially regarding parts of speech and tenses. This difficulty is because of the number of materials they must learn. The main challenge of grammar is understanding and applying parts of speech and tenses accurately, because they are the main foundation of grammar mastery. This level of perceived difficulty shows that, despite its importance, grammar remains a tricky area for

learners. Similarly, Hasibuan et al. (2024) identified that high school students in Bone District faced challenges distinguishing between verb forms and applying tense rules correctly, often influenced by external factors such as teaching methods and learning environment.

#### Familiarity with Algorithm Principles

The results show that 83.5% of students were familiar with the concept of algorithms, reflecting the increasing integration of technology in education. Students' familiarity with algorithmic concepts suggests that they may already possess logical and structured thinking skills. This finding corresponds with that of Kayhan et al. (2024) which found that students' self-perceptions of their computational thinking skills, including algorithmic thinking, play a significant role in shaping their learning confidence and problem-solving abilities.

#### Perceived Efficacy of Algorithms

In this respect, 89% of students and all lecturers believed that applying algorithmic principles could facilitate grammar learning. This finding resonates with (Hubalovsky & Korinek, 2015), who argue that algorithmic approaches can simplify complex concepts, thereby enhancing learner understanding.

The study analyzed data from student responses to understand their engagement with

English grammar and the potential benefits of using the algorithm principle as a learning tool. All participants reported actively learning English grammar, establishing a foundation for the study. Most students agreed that grammar is essential for mastering English, although a significant number found parts of speech and tenses challenging. While most students were familiar with the algorithm principle, some were not, suggesting a need for further introduction. The challenges in mastering grammar in education are influenced by several factors, including student aspects, faculty, teaching methods, and time required (Effendi et al., 2017), as well as the teaching abilities of instructors (Syafryadin, 2021) and student motivation and enthusiasm (Guan et al., 2018). Learning grammar methods, mostly like the grammar-translation method, focus on students' comprehension with complex material. As the students answered, it is so difficult for them to understand, and they need more time to master it. It also made them not interested in learning. A majority believed that the algorithm could simplify grammar learning, supporting the study's hypothesis that an algorithm approach may enhance grammar acquisition. Overall, the data show that students acknowledge the importance of grammar, face difficulties, and see value in using algorithm-based methods to aid in learning.

#### Table 2

The Lecturers' Answers Related to English Grammar Mastery and the Principles of the Algorithm

No	Questions	IP	JJ	- PU	K	SU	K	Total	Total
_	-	Yes	No	Yes	No	Yes	No	number of "Yes"	number of "No"
1	Do the students learn grammar?		-		-		-	3	0
2	Is grammar important in mastering English?	$\checkmark$	-	$\checkmark$	-	$\checkmark$	-	3	0
3	Is it difficult to master, especially the part of speech and tenses?		-	-	$\checkmark$	$\checkmark$	-	2	1
4	Do you know the principles of algorithm?	$\checkmark$	-		-		-	3	0
5	Do you think that the implementation of algorithm principles can help the students learn grammar easier?	V	-		-		-	3	0

Table 2 shows that: 1) The students learn grammar; 2) All lecturers said that grammar is important; 3) Most lecturers said that grammar is difficult; 4) Most lecturers know about the principle of algorithm; and 5) All thought that the implementation of the algorithm principle can help students learn grammar more easily.

## Do You or Your Students Learn English Grammar?

This question received a hundred percent agreement from both students and lecturers across the three universities. These responses indicated unanimous agreement among students and lecturers, underscoring the necessity of grammar education in English language programs. This is crucial, as effective grammar knowledge directly impacts students' writing and speaking abilities, supporting findings by Troia (2014) regarding the importance of structured grammar instruction.

#### Is Grammar Important in Mastering English?

The second point gained almost the same responses as the first question. Of 90 students, only 3 stated that English is not important. This was because the students focused more on spoken communication,

where the main point is understanding both the speaker and the listener, and grammar is not used one hundred percent. Meanwhile, all lecturers chose the "yes" option. This showed that grammar is indeed very important in learning and mastering English. However, this perspective contrasts with the findings of Schenck (2017) who argues that even spoken language relies heavily on an underlying grammatical framework.

#### Is It (Grammar) Difficult to Master, Especially the Parts Of Speech and Tenses?

This point was used to understand the students' and lecturers' perspectives on comprehending and mastering English grammar. The question received agreement from 78 students, or 87%, while 12 students, or 13%, disagreed-specifically, 5 from IPUJ, 1 from PUK, and 6 from SUK. These perspectives are based on the students' competence in English grammar, especially regarding parts of speech and tenses, which are the core of English grammar. However, most students stated that English grammar is difficult, a view supported by the lecturers' responses, with only one lecturer stating that it is not difficult. This lecturer's response was based on her own point of view, while the others reflected the students' perceptions. A significant 87% of students acknowledged the difficulty in mastering English grammar. While a disagreed, most students highlighted few challenges in acquiring grammatical knowledge, particularly concerning parts of speech and tenses. This aligns with research by Barac and Bialystok (2011), which identified cognitive challenges in learning grammatical structures, particularly for non-native speakers.

### Do You Know the Principles of Algorithm?

In recognizing the algorithm principle, although not all, most students are familiar with it. This question received 75 affirmative responses, while only 15 students stated that they did not recognize it. This recognition is likely because the term "algorithm" is commonly used in the technological field; thus, not everyone outside of that area is familiar with it. Meanwhile, all lecturers answered "yes." The concept of the algorithm, defined as a systematic method for problem-solving, was recognized by 75 students. Only 15 students reported unfamiliarity, indicating a reasonable level of awareness influenced by the term's prevalence in technology. This finding is supported by Heffernan (2023), who emphasizes the importance of teaching algorithmic thinking as a foundational skill in education.

#### Do You Think that the Implementation of the Algorithm Principles Can Help the Students Learn Grammar Easier?

After establishing the students' and lecturers' recognition of the algorithm principle, they were asked whether its implementation could help learners master English grammar more easily. This question received 80% agreement, or 89% of

student responses, and was also supported by 100% of the lecturers. Both groups expected that the automation of the algorithm principle could help students understand English grammar or structure more easily. As one respondent noted, it is like "2+2=4"; if such clarity is applied in composing English structures, grammar will be easier to understand. The majority of students (89%) and all lecturers agreed that algorithmic principles could simplify grammar learning. This finding aligns with (Huang et al., 2021) who argue that structured approaches can demystify complex grammatical rules and make them more accessible. The comparison of learning grammar to simple arithmetic operations (e.g., 2+2=4) illustrates how algorithmic thinking can provide a clear framework for understanding grammatical structures.

Based on the interview results, it is evident that implementing the algorithm principle in learning English is important. Consequently, the writer proceeded to design a draft of the Grammar-Algorithm learning module, an algorithm-based approach to learning English structure. The findings from this needs analysis underscore the necessity of integrating algorithmic principles into grammar instruction to address identified challenges and enhance learning outcomes. While there is strong consensus on the importance of grammar, the perceived difficulties highlight the need for innovative teaching strategies that can accommodate diverse learning needs. Future research should explore practical applications of algorithm-based methodologies in grammar instruction, evaluating their effectiveness in improving learner performance and engagement.

The data from the lecturers' responses provide further insight into their views on English grammar mastery and the use of algorithm principles in teaching. All lecturers affirmed that students are learning grammar, and that grammar is essential for mastering English, indicating strong support for these foundational concepts. When asked about the difficulty of mastering grammar, particularly parts of speech and tenses, two lecturers agreed that it is difficult, while one did not. The latter's response was based on her own perspective, while the others reflected the students' perceptions. All lecturers were familiar with the principle of algorithms and believed that its application could help students learn grammar more easily. Overall, the data support the idea that lecturers recognize both the importance of grammar and the potential value of algorithm-based methods in enhancing grammar learning.

#### Developing Grammar-Algorithm Learning Module

### **Designing the Product**

After gaining information about the need for learning English grammar through the implementation of the algorithm principle, the foundation of the product was designed. This module applies the simplifying concept using an algorithm principle-based approach to English structure. It contains four parts: 1) Level of Language, 2) Area of Structure, 3) Part of Speech,

and 4) Tenses. At the beginning, it presents guidance on how to use the module, explains the terms or symbolization used, and outlines the algorithm principle-based structure at the end of the module. The difference between this module and other grammar modules is that the materials included are only those related to English structure composition and change. Materials not directly related to structure, such as abstract and concrete nouns or proper and common nouns, are excluded. The focus is solely on structural arrangement and simple material. This targeted approach aims to streamline learners' understanding of grammar by emphasizing structure and simplicity, allowing for a more focused exploration of English grammar (Celce-Murcia et al., 1983; Nassaji, 2020).

#### Figure 1

The Area of English Structure



#### Figure 2

The Implementation of Algorithm Principles in English Structure

Possible Choice: S

Subject/Object(of preposition):	N/P/G
Adjective:	Adj/V3/Ving/N/P
Adverb:	Adv/Adj-ly/Prep+OP/Ti

#### **English Structure Formula**

Sentence(Macro): Preposition: Phrase(micro): Negative: Interrogative: Imperative: Modal: Passive: Relative Pronoun as Subject: Relative Pronoun as non-subject: Conditional Sentence type 1: Conditional Sentence type 2: Conditional Sentence type 3:

S+V+(O+C) Prep+OP (Det)+(Adj)+H+(AC) aV+Not+(oV)... aV+S+(aV/oV)... V0+(O)+(C)! M+V0 be+V3 RP+V RP+S+V lf+V1,will+V0 If+V2,would+V0 If+had+V3,would+Have+V3

#### Tenses Formula Present: V1 Past: V2 Future: Will+V0 Perfect: have+V3 Continuous: be+Ving

The figure presents the principles of the algorithm that can be used in learning English structure. The patterns are formed as shortcuts that automate English structures, making them shorter and easier to master. For example, when students want to write about past activities, they use the past tense, where the main point is V2. Another example is when students need to make a negative sentence; they may use the shortcut pattern aV + Not + (oV), where aV stands for Auxiliary Verb, Not is the negative word, and oV represents the Ordinary Verb. In English, a negative sentence uses "not," which must follow an auxiliary verb, while the ordinary verb in brackets indicates that it is optional-it exists in verbal sentences but not in nominal sentences.

Another shortcut applies to phrase structure: (Det) + (Adj) + H + (AC). This means that the main part of the phrase is the head word (H), while the determiner (Det), adjective (Adj), and adjective clause (AC) are conditional elements. However, this shortcut serves as the fixed pattern for phrase arrangement. By following this pattern, students will avoid mistakes in phrase structure. For example, the correct structure is "My smart close friend writing a letter there is waiting for you," not "Smart my friend close a letter writing there is waiting for you." This approach is especially beneficial for students learning English as a foreign language, as it provides clear, algorithmic frameworks for constructing correct English sentences and phrases

#### **Product Validation**

After designing the product, it was presented in a focus group discussion (FGD) to determine whether the module could be used in learning and to identify areas needing revision. The FGD followed several main stages. It began with planning, which included determining the objectives of the FGD, identifying and segmenting participants into groups (experts, students), considering crosslecturers, and institutional availability, and preparing discussion guides tailored to each group's characteristics. The FGD was conducted online, with a moderator guiding the discussion. The session was documented through recordings, which were then fully transcribed for analysis.

Data analysis was carried out thematically to identify patterns of thought and perspectives that emerged from each group. The results of the FGD were compiled in a narrative report and used as triangulation material to enrich and strengthen the main findings of the research.

Meanwhile, module validation employed a Likert-type rating scale to evaluate various aspects of the module. Each item was rated using a 5-point Likert scale, with anchors: 1 = Poor, 2 = Unsatisfactory, 3 = Average, 4 = Good, and 5 = Very Good. These ratings were used to determine the degree to which each element met the ideal criteria for an effective instructional module (Kusmaryono et al., 2022). The validation result can be seen in Figure 3.

#### Figure 3

Product Validation Result



The expert validation revealed that the module is suitable for teaching grammar. Validators assessed 13 criteria encompassing content quality, language clarity, educational benefits, and design layout. The overall validation scores indicated a predominantly positive reception, with the highest ratings categorized as "Good." Notably, 17% of validators classified the module as "Very Good," while 18% provided an "Average" rating. Importantly, no expert rated the module as "Poor" or "Unsatisfactory."

Key strengths noted in the validation process included the completeness of relevant materials, clarity of language, and the module's potential to facilitate grammar mastery among learners. The "Good" ratings were primarily assigned to various aspects of the content, while the design and layout This received "Average" ratings. feedback highlights the critical balance between content and presentation in educational resources. These results are consistent with research emphasizing that clarity in instructional design and delivery significantly impacts student learning, engagement, and retention (Brown, 2000; Wiggins & McTighe, 2005).

The validation outcomes suggest that the product is a viable resource for learning English

grammar. Expert feedback emphasizes the module's ability to assist learners in mastering grammatical concepts more effectively through a focused and simplified approach. This finding resonates with recent research, which underscores the importance of instructional design that prioritizes clarity, structure, and coherence in enhancing learner comprehension and retention. The positive expert evaluations and the absence of negative ratings further support the module's potential as an effective instructional tool for grammar learning (Barac & Bialystok, 2011; Troia, 2014).

Besides, according to validator feedback, the module is well-received despite a few areas for change. The content is lauded for its clarity and completeness, but more cases and examples are proposed to further reinforce language structure concepts. While the design is user-friendly, incorporating visuals such as colors and improved layout may enhance engagement, particularly for visual learners. The algorithm-principle approach is acknowledged, although some validators suggest breaking down the steps to increase accessibility, especially for beginners. Furthermore, combining interactive media components like videos or interactive quizzes could expand the learning

experience and cater to diverse learning preferences. In general, the module is solid, but these enhancements are needed to make it better and more effective.

## Effectiveness of Algorithmic Principles in Education

The incorporation of algorithmic principles in educational contexts serves to provide a structured framework for learning. Algorithms, defined as step-by-step procedures for solving problems, offer a systematic approach to understanding complex subjects. In the realm of language learning, this can translate to a clearer path for mastering grammar, as learners are guided through logical sequences that build upon one another (Nassaji, 2020). The simplicity and clarity of this method can reduce cognitive overload, allowing students to engage with material at a more manageable pace. This is particularly relevant in English grammar learning, where complexity often leads to student difficulties.

Moreover, the module's design reflects contemporary pedagogical trends that advocate for a focus on learner-centered instruction. Research by Hattie (2020) suggests that clarity in instructional materials significantly impacts student outcomes. By isolating grammatical elements relevant to English structure, the module enhances learners' ability to grasp essential concepts without the distraction of extraneous information. This aligns with findings from education theory, which advocates for focused learning experiences that prioritize essential knowledge (Ramachandran et al., 2021).

### Addressing Challenges in Grammar Learning

The feedback from validation highlighted not only strengths but also areas for improvement, such as typographical errors and layout design. This iterative process underscores the significance of continuous improvement in educational resources. According to Cennamo and Kalk (2019) iterative feedback loops are vital in instructional design, allowing educators to refine materials based on user experiences and expert opinions.

Furthermore, the omission of certain grammatical topics-like abstract nouns-intentionally simplifies the content, potentially addressing a common barrier faced by learners. Research has shown that many students struggle with grammatical categories that lack direct application in everyday communication (Dhananjaya et al., 2024). By focusing solely on structural arrangements, the module allows learners to concentrate on the practical application of grammar, reinforcing the importance of contextualized learning.

### **Future Directions**

The positive validation results indicate a strong foundation for this grammar learning module, yet

future iterations should seek to incorporate diverse instructional strategies to accommodate varied learning styles. Integrating multimedia elements, such as videos or interactive exercises, could enhance engagement and provide alternative pathways for understanding (Mayer, 2020). Additionally, exploring the integration of formative assessments within the module could facilitate ongoing feedback for learners, further solidifying their understanding of grammatical structures (Nicol & Macfarlane-Dick, 2006).

In summary, the developed grammar learning module represents a significant advancement in the instructional design of grammar education through the application of algorithm principles. Its validation results affirm its potential to enhance learners' understanding and mastery of English grammar. As the field of language education continues to evolve, embracing innovative pedagogical strategies will be essential in meeting the diverse needs of learners. Future iterations should focus on addressing identified areas for improvement while maintaining the core structure that contributes to its effectiveness.

#### **Product Implementation**

Based on the data obtained, the average pre-test score was 60.7, while the average post-test score was 80.5. The average difference between the pre-test and post-test scores was 19.8. The standard deviation of the difference (sd) between the pre-test and post-test scores was 2.1.

The results of the analysis show that the calculated t-statistic is 12.45 with a degree of freedom (*df*) of 34, and the *p*-value is 0.004. Since the *p*-value is smaller than the set significance level (0.05), we reject the null hypothesis and conclude that there is a significant difference between the pretest and post-test scores. To quantify the magnitude of this difference, Cohen's *d* was calculated, resulting in a value of d = 2.13, indicating a large effect size (Schmidt & Bohannon, 1988). This suggests that the intervention had a substantial impact on improving the test scores.

These results indicate that the use of the grammar algorithm module in learning English language structure has a significant impact on improving students' understanding of English language structure. In other words, the application of algorithmic techniques in teaching grammar has been proven to improve students' efficiency and understanding of the material being taught.

#### Improvement in Average Scores

The increase in the average of pre-test and post-test scores from 60.7 to 80.5 demonstrates a substantial improvement in students' learning outcomes after the use of the Grammar-Algorithm module. The mean gain of 19.8 points reflects a significant positive change, suggesting that most students

experienced meaningful progress in mastering the material. This improvement indicates that the implementation of the algorithm principle successfully helped bridge the gap between initial understanding and post-intervention mastery of English grammar.

#### Enhancement of Learning Effectiveness

The results of the *t*-test, with a calculated t-value of 12.45 and a p-value of 0.004, indicate a statistically significant difference in student performance before and after the intervention. Since the p-value is below the 0.05 significance level, it confirms that the observed improvement was not due to chance but rather the result of the implemented module. This result supports that integrating algorithm principles can enhance learning effectiveness, particularly in subjects like grammar that involve complex rules and patterns. It was because of simplifying the patterns.

Improvement in Understanding of English Structure The application of algorithm principles in English grammar instruction helped students develop a more structured and logical understanding of grammatical concepts. It emphasizes step-by-step and procedural thinking, enabling students to map out grammar rules in a more accessible and applicable manner. Therefore, the improvement in post-test scores also reflects a deeper comprehension of English sentence structures, particularly in challenging areas such as tenses and parts of speech, which students had previously identified as their main difficulties.

#### CONCLUSION

In this study, the development and implementation of a grammar-algorithm module aimed at simplifying the process of learning English grammar has been discussed in detail. The study reveals important insights into the role of algorithmic principles in making English grammar more accessible, effective, and interesting for learners. Based on the findings, three key conclusions were drawn: the necessity of such a module, its positive reception by validators, and its proven effectiveness in improving students' understanding of English grammar.

This study demonstrates that a grammaralgorithm module is needed for learning English structure, as most respondents reported difficulties understanding grammar due to its complexity and the prevalence of detailed, cognitively demanding materials. The analysis stage revealed that simplifying grammar instruction with algorithmic principles offers a more effective and engaging approach. The module's development received positive responses and validation, with overall ratings predominantly categorized as "Good." Notably, 17% of validators rated the module as "Very Good," while 18% rated it as "Average," and no expert rated it as "Poor" or "Unsatisfactory." These results indicate strong acceptance of the module's content and approach.

The implementation of the grammar-algorithm module proved effective, helping students understand English structure more easily and quickly through simplified patterns and automation. analysis showed significant Statistical а improvement in student outcomes, as indicated by a p-value smaller than the significance level (0.05), confirming a meaningful difference between pre-test and post-test scores.

By bridging algorithmic thinking and language pedagogy, this study shows how computational principles can be applied to simplify and systematize English grammar learning. The module introduces algorithmic design as a novel pedagogical tool, enhancing cognitive processing of grammatical structures. Automating and simplifying grammar patterns reduces instructional complexity, making the module especially beneficial for learners with diverse backgrounds and learning styles. Integration with digital platforms or learning management systems could further increase accessibility and flexibility, supporting remote or blended learning environments.

While this study contributes to the pedagogical framework for teaching English grammar and highlights the value of innovative instructional approaches, it is limited to the development and testing of a module focused on basic grammar patterns, parts of speech, and tenses, and was conducted at three universities in Central Java with limited implementation.

In summary, the development and implementation of the grammar-algorithm module have made learning English grammar more accessible, efficient, and enjoyable for students. Positive feedback from validators and statistical evidence of effectiveness suggest that this approach has the potential to transform English language education. Further research should explore the broader applicability and long-term impact of algorithm-based grammar instruction in diverse educational settings.

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