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Development of Bilingual Teaching Materials for Logical Reasoning Through Visual Studio Code

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ABSTRACT

The demands of 21st-century learning emphasize strengthening logical reasoning and digital literacy, while schools and Islamic boarding schools still lack technology-based bilingual teaching materials that are proven to be valid, practical, and effective..This study aims to develop and test the feasibility, practicality, and effectiveness of bilingual teaching materials (Indonesian and Arabic) on the subject of Two-Variable Linear Equation Systems through Visual Studio Code (VS Code) to improve students' mathematical logical reasoning. This research is motivated by the low ability of students' mathematical logical reasoning and the limitations of innovative learning resources that integrate bilingual aspects and digital technology. The method used is Research and Development (R&D) with the ADDIE model, implemented on grade VIII students at Darul Falah Islamic Boarding School and Nashihuddin Islamic Junior High School in Bandar Lampung. The results of the study show that the teaching materials developed are declared Very Valid/Very Appropriate based on expert assessments (material experts 96.88%, media experts 87.5%, and language experts 100%) and are considered Interesting (practical) by students with an average positive response above 80%. Furthermore, the effectiveness test proved that the use of bilingual teaching materials based on Visual Studio Code was significant in improving mathematical logical reasoning, as evidenced by the average N-gain value which was in the medium category (Small Trial 0.563 and Large Trial 0.596). Thus, it can be concluded that bilingual teaching materials through Visual Studio Code are feasible, practical, and effective to be used as a learning innovation to improve students' mathematical logical reasoning abilities.

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Introduction

Global education places the ability to think logically and systematically as a core competency for the 21st century (Hein & Prediger, 2024; Nugroho et al., 2018; Sochanski, 2018). In mathematics, this skill is manifested in mathematical logical reasoning, which is crucial in helping students not only memorize facts and procedures but also make predictions and gain meaningful conceptual understanding (Lee et al., 2023). The National Council of Teachers of Mathematics (NCTM) emphasizes that learning to reason (mathematical reasoning) plays a central role in mathematics learning (Zulkardi et al., 2020). However, in the national context, this ability still faces serious challenges. The 2022 PISA results showed that Indonesian students' mathematics scores were still relatively low, indicating fundamental weaknesses in their mathematical reasoning abilities (Habibi & Suparman, 2020; Tohir, 2019). This issue is crucial and must be addressed immediately to produce a globally competitive future generation. The PISA 2022 assessment and analytical framework (Qadry et al., 2022; Safrudiannur & Rott, 2019) contains more detailed definitions and descriptions of the topics evaluated in PISA 2022. Mathematics encompasses concepts, procedures, facts, and tools for explaining and predicting phenomena. Mathematics helps individuals make informed judgments and decisions about constructive 21st-century citizenship. These mathematics scores of Indonesian students can be a sign that their mathematical abilities, including reasoning abilities, are still relatively low.

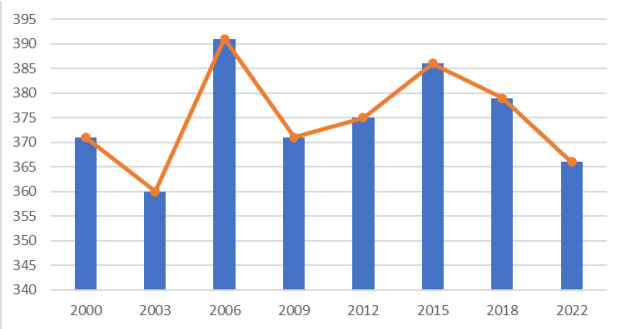

Figure 1. Average Indonesian PISA mathematics score

The low level of mathematical logical reasoning ability is largely due to a less varied teaching approach and a lack of learning resources capable of actively engaging students and meeting their needs (Tallman & Frank, 2020). Particularly in educational institutions that implement a bilingual system (such as Islamic boarding schools), there is an additional need to develop teaching materials that can integrate mathematical content with dual language aspects (Indonesian and Arabic) (Klein & Leikin, 2020; Regier & Savic, 2020). Conventional teaching materials are generally inadequate to meet modern pedagogical demands while addressing language barriers (Listiawati et al., 2023). Therefore, researchers believe that a relevant solution is to create learning innovations that can bridge the logical reasoning deficit while facilitating students' language needs in an integrated manner with digital technology, in accordance with the teachings to change oneself for the better

Several studies have explored the use of technology to improve mathematics learning outcomes. A review of relevant previous research indicates that Artificial Intelligence (AI)-based applications in bilingual learning successfully improve conceptual understanding and mathematical logical reasoning (González-Calero et al., 2020; Moring et al., 2011). This highlights the significant potential of adaptive technology in delivering learning materials. However, field findings indicate that the availability of innovative and integrated learning materials remains limited. Pre-research results at Darul Falah Islamic Boarding School and Nashihuddin Islamic Junior High School in Bandar Lampung confirmed that students

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experience deficiencies in mathematical logical reasoning and that reference learning materials are still limited. This research gap lies in the suboptimal integration between the need for structured bilingual learning materials, the use of AI, and a technological environment relevant to current digital developments, particularly in the topic of Systems of Linear Equations in Two Variables (SLETV).

To address this gap, this study proposes a novel approach by developing AI-assisted bilingual (Indonesian–Arabic) learning materials implemented through the Visual Studio Code (VS Code) software development platform. VS Code was chosen because it provides a feature-rich and interactive environment, enables the development of more adaptive learning materials, and aligns with the demands of the Society 5.0 era (Patahuddin et al., 2022). This learning material utilizes AI principles to facilitate personalized learning and is supported by the theory that effective learning requires systematic and generalized knowledge acquisition (Harris et al., 2023). The integration of AI into VS Code is expected to provide a viable, practical, and effective alternative learning resource for learners in bilingual environments. Thus, based on the importance of mathematical logical reasoning ability and the need for innovative learning resources, this study aims to develop, test the feasibility, practicality, and measure the effectiveness of bilingual teaching materials (Indonesian and Arabic) on the Two-Variable Linear Equation System (SLETV) material through Visual Studio Code (VS Code) to improve students' mathematical logical reasoning.

Method

Design

This research focuses on the development of bilingual teaching materials (Arabic and Indonesian) using AI to improve students' mathematical logical reasoning, which is a type of R&D (Research and Development) development research. The model used by the author in this research is the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The ADDIE model was chosen because of its systematic framework with logically structured steps ranging from analysis to evaluation. This is in line with the reasons explained by Sutyetno that the ADDIE model development procedure is structured in detail and simply, is suitable for developing teaching materials, and has specific objectives that the learning being developed wants to achieve.

Population and Sample

The subjects of this study were MTs students at the Darul Falah Islamic Boarding School and Nashihuddin Middle School. The population was Darul Falah Islamic Boarding School in Bandar Lampung and Nashihuddin Islamic Middle School in Bandar Lampung. The sample consisted of two schools: eighth-grade students at Darul Falah Islamic Boarding School and eighth-grade students at Nashihuddin Islamic Middle School. The number of students in each class was approximately 20-30 students.

Instrument

In this study, the main instruments are a mathematical logical reasoning test, questionnaires, and observation sheets. The author conducted research in the field, namely data collection, analyzing data until the final stage, namely conclusions. At this stage, the test used is a descriptive question totaling 5 questions on the material of the Two-Variable Linear

Equation System. This test is used to measure students' mathematical logical reasoning abilities. Then, students will be given an evaluation after going through the learning process. Thus, the evaluation will be analyzed by the author to match it with the existing completeness value whether it is met or not. So the author can know and see the effectiveness of the bilingual teaching material. If the student's completeness value is not met, the product is not effective.

Table 1. Mathematical Logical Reasoning Instrument Test Grid

No	Logical Reasoning Indicator	Question Indicator	Material	Question Format	Cognitive Level
1	Drawing logical conclusions	Determining SLETV solutions from contextual problem models	SLETV	Description	C4
2	Constructing mathematical arguments	Explaining the steps for solving SLETV			C4
3	Analyzing relationships	Testing the correctness of SLETV solution pairs			C4
4	Constructing a mathematical model	Converting story problems to SLETV form			C4
5	Making generalizations	Interpreting the meaning of SLETV solutions in real contexts			C5

In determining the assessment of students' mathematical logical reasoning abilities, the author uses a Likert scale with a score range of 0-4 based on scoring guidelines.

Table 1. Mathematical Logical Reasoning Scoring Test Grid

Rated aspect	Score	Information
Presenting mathematical statements in writing	0	Students cannot present mathematical statements in solving problems.
	1	Students write down what is known and asked but make mistakes in solving the problem.
	2	Students write down what is known and what is asked correctly.
	3	Students write down what is known and asked correctly and solve the questions correctly.
Submitting allegations	0	Students do not write the formula or write it incorrectly when solving the problem.
	1	Students write the formula correctly to solve the problem.
Performing Mathematical Manipulations	1	Students cannot carry out mathematical manipulation or make all the mistakes in carrying out mathematical manipulation in solving problems.
	2	Students can carry out mathematical manipulations partially correctly in solving problems.
	4	Students can perform mathematical manipulation perfectly in solving problems.
Draw a conclusion	0	Students cannot draw conclusions in solving problems.

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	1	Students can draw partially correct conclusions.
	2	Students can draw conclusions correctly.

Table 3. Indicators of Students' Mathematical Logical Reasoning

No	Indicator	Description	Measurement Style
1.	Ability to Identify Patterns	Students can recognize and explain patterns in series of numbers or shapes.	Written test with questions about number series or shapes.
2.	Deductive Reasoning	Students can draw conclusions from the premises given.	Questions that ask students to draw conclusions from premises.
3.	Inductive Reasoning	Students can make generalizations from observations.	Questions that ask students to make generalizations.
4.	Solve the problem	Students can apply concepts to solve mathematical problems.	Project assessment or tests with open problems.
5.	Analyzing Arguments	Students can analyze the evaluation of the validity of mathematical arguments.	Group discussion or argument analysis test.
6.	Mathematical Representation.	Students can use graphs, tables, or diagrams to solve problems.	Questions that ask for a visual representation of the data.
7.	Critical thinking	Students can question assumptions and evaluate evidence in a mathematical context.	Debate or critical essay activities.
8.	Connecting Concepts	Students can construct logical arguments to support solutions to problems.	Questions that ask students to link concepts.
9.	Arguing	Students can construct logical arguments to support solutions to problems.	Presentation or writing of mathematical arguments.
10	Problem Solving Strategy	Students can choose and apply appropriate strategies to solve problems.	Observation when students solve problems.

Procedure

This research procedure follows the steps of the ADDIE model, which include Analysis, Design, Development, Implementation, and Evaluation. In the Analysis stage, the researcher identified the needs of students and teachers in mathematics learning and determined the competencies to be achieved through interviews with mathematics teachers, group discussions with students, and classroom observations to observe teaching methods and student interactions with the material. In this study, the analysis focused on analyzing student needs and teaching materials, as well as analyzing the software requirements used in the development. The software requirements analysis was directed at ensuring that Visual Studio Code meets the demands of developing web-based bilingual teaching materials, including functional requirements such as the ability to write and edit code, support for HTML, CSS, and JavaScript, and facilities for running and displaying results in a browser. The analysis also included non-functional requirements such as ease of use, stability on the operating system, and lightweight and

responsive performance. In addition, suitability for the development objectives was examined through the ability to display Indonesian text and Arabic text with harakat, as well as support for an easily accessible interface. Availability and accessibility aspects were also considered, especially since Visual Studio Code is easily obtained, easy to install, and is free or open source. Within the ADDIE framework, the Analysis stage serves as the basis for subsequent design phases, as it emphasizes that this stage focuses on analyzing needs, development objectives, and resources to ensure the product meets user needs. However, curriculum analysis was not conducted due to the researcher's limited resources, so the analysis focused on user needs and teaching materials.

In the Design stage, researchers designed teaching materials according to the identified needs by compiling SLETV materials in Indonesian and Arabic, designing question formats, and determining the structure of the teaching materials, which included an introduction, material explanations, and practice questions. The Development stage was carried out by developing the design into an AI-assisted bilingual teaching material product using Visual Studio Code. At this stage, researchers wrote content and questions in two languages, utilized AI to generate question variations according to difficulty level, and tested the resulting questions to ensure their quality was maintained and relevant to learning objectives. Development also included the preparation of instructional and evaluation materials such as assignments and exercises, as well as the development of media with supporting features needed by students. The output of this stage was a bilingual teaching material product structured according to competencies, accompanied by a questionnaire instrument to measure the validity and responses of research subjects.

The Implementation stage is carried out by applying the developed teaching materials in the classroom learning process through structured teaching, accompanied by recording student interactions and observing the learning process during the use of the teaching materials. At this stage, researchers also ensure the readiness of the devices, including the minimum specifications of the hardware and software required to run the teaching materials, especially the need to use Visual Studio Code as a development environment. The Evaluation stage aims to measure the effectiveness of the teaching materials in improving students' logical mathematical reasoning while also providing a basis for improvements to the Analysis, Design, Development, and Implementation stages. Evaluation is carried out through a pre-test to measure initial abilities, a post-test to see improvements after using the teaching materials, and data collection through questionnaires to obtain feedback on students' experiences. The results of the pre-test and post-test are analyzed to determine the improvements that have occurred, while the validator's assessment uses a Likert scale of 1–4 to facilitate the validation process. Evaluation is also understood to take place at the end of each stage as a formative evaluation, which includes expert reviews, individual evaluations, small group evaluations, and field tests. After the product is declared suitable by experts, individual tests and small group tests are carried out, and if deficiencies are still found, the evaluation is repeated to perfect the bilingual teaching materials being developed.

Analysis

Pretest and posttest data were analyzed using a statistical approach combined with descriptive analysis to interpret expert input and user responses. Descriptive analysis was used to process data from validation by material experts and media experts, as well as teacher and student questionnaire responses. Researchers grouped the suggestions, input, responses, and criticisms contained in the assessment sheet, then reviewed them as a basis for improving and refining the developed teaching materials. In addition, descriptive analysis was also used to

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describe the level of product feasibility based on the validator's assessment and the level of attractiveness of the teaching materials based on teacher and student responses.

The product feasibility and validity analysis was obtained from the assessment results of material experts and media experts using a four-level Likert scale. Each assessment item was scored according to the validator's level of agreement with the product's quality. The scores obtained were then calculated as a percentage to describe the feasibility and validity of the developed teaching materials. The results were then interpreted into specific categories to determine whether the teaching materials were very feasible, feasible, less feasible, or not feasible for use in learning. The appeal analysis was conducted based on a questionnaire of student responses to the developed teaching materials. The assessment also used a four-level Likert scale to describe the level of student interest in the presentation, ease of use, and clarity of the material. The response scores obtained were calculated as a percentage to determine the level of appeal of the teaching materials. These results were then interpreted in terms of appeal to illustrate the extent to which the teaching materials were able to attract students' attention and increase their learning motivation.

The effectiveness of the teaching materials was analyzed by comparing pretest and posttest results. The average pretest score was used to describe students' initial abilities before using the teaching materials, while the average posttest score indicated students' abilities after learning using the bilingual teaching materials. Comparing the two results provides an overview of the improvement in students' logical mathematical reasoning abilities. To more comprehensively determine the level of improvement in students' abilities, this study also used normalized gain (N-Gain) analysis. This analysis aims to determine the level of improvement in learning outcomes after using the teaching materials compared to the students' initial abilities. The results of the N-Gain calculation are then classified into specific improvement categories to provide an overview of the effectiveness of the developed teaching materials in improving students' mathematical logical reasoning.

Research Findings

This development research aims to produce a product in the form of Bilingual Teaching Materials through Visual Studio Code that is feasible, attractive, and effective in improving mathematical logical reasoning in eighth grade students. The development model used is ADDIE, which consists of five stages: analysis, design, development, implementation, and evaluation. Each stage is accompanied by an evaluation process to ensure the quality of the developed product.

The initial stage of this research was an analysis aimed at identifying mathematics learning problems faced by students at Nadhihuddin Islamic Junior High School and Darul Falah Islamic Boarding School in Bandar Lampung. The analysis showed that students' mathematical logical reasoning abilities were still relatively low, as learning was still dominated by memorizing formulas and solving procedural problems. Furthermore, PISA results showed that Indonesian mathematics achievement remained low, particularly in the reasoning and problem-solving aspects. In terms of teaching materials, the textbooks used were not designed to train logical reasoning in depth, and bilingual teaching materials in Indonesian and Arabic that suited the characteristics of madrasas and Islamic boarding schools were not yet available. Another problem was the minimal use of technology-based media in the Society 5.0 era, so that mathematics learning remained conventional. Preliminary study data also showed a low level of learning completion on the mathematical logical reasoning test. These findings became the

basis for the development of Bilingual Teaching Materials through Visual Studio Code as an innovative solution.

The design of this teaching material has several design components consisting of an introductory section, learning and quizzes as an evaluation. The introductory section consists of an introduction to learning, the learning section consists of: starter questions, learning materials, learning summaries and learning tips. The evaluation section consists of: quiz questions as individual student practice. In the learning section of this teaching material, the concept of bilingualism (Indonesian and Arabic) is used. The design of the teaching material is also directed to integrate elements of technology, logical reasoning, and religious values, so that it can support the characteristics of madrasah and Islamic boarding school students. At this stage, research instruments are also designed in the form of student response questionnaires and pretest posttest questions to measure product effectiveness. The development stage is the process of creating Bilingual Teaching Materials through Visual Studio Code in accordance with the design that has been designed. The product was developed using an interactive digital approach that combines visual displays, bilingual language, and reasoning-based material structures.

After the product was developed, validation was carried out by experts, including validation by material experts, media experts, language experts and questionnaire validation. The validation results showed that the validation by material experts obtained a percentage of 96.88% (Very Appropriate), validation by media experts obtained a percentage of 87.50% (Very Appropriate), validation by language experts obtained a percentage of 100% (Very Appropriate), and validation by questionnaires obtained a percentage of 98.61% (Very Appropriate). These results indicate that the developed teaching materials are very valid and suitable for use. Furthermore, product revisions were carried out based on the validators' suggestions, especially in the learning introduction, learning materials, learning tips, and logical reasoning questions.

The feasibility test was conducted at the Development stage through expert validation (Material Experts, Media Experts, and Language Experts) using a Likert-scale questionnaire. Quantitative data analysis in the form of a feasibility percentage (P) was calculated from the total score obtained by the validator compared to the maximum score. The results of the analysis showed that the bilingual teaching material product based on Visual Studio Code (VS Code) was declared Very Valid (Very Feasible).

Table 4. Feasibility Test Results

Validator	Eligibility Percentage	Criteria
Subject Matter Expert	96.88%	Very Valid
Media Expert	87.5%	Very Valid
Linguist	100%	Very Valid

The high percentages from the three experts demonstrate that the teaching materials meet the established eligibility standards in terms of content, presentation, media, and grammar. Qualitatively, input from the expert validators has been followed up to produce a final product ready for implementation.

The implementation phase aims to determine the attractiveness and effectiveness of the teaching materials in improving students' mathematical logical reasoning. The trial was conducted through a small group test on 20 students at the Darul Falah Islamic Boarding School and a large group test on 35 students at Nashihuddin Islamic Middle School. Based on the results of the student response test, in the small group, 82.02% obtained a percentage with the criteria of "interesting", while in the large group, 85.34% obtained a percentage with the criteria of "very interesting". These results indicate that the developed bilingual digital teaching

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materials are liked by students, are easy to understand, increase learning motivation, and support active learning.

The results of student responses are presented in the form of a small-scale trial with 20 students and a large-scale trial with 35 students. The following are the results of the small-scale trial:

Table 5. Small-Scale Trial Results

No	Indicator	Percentage	Criteria
1	Ease of Understanding	80.83%	Interesting
2	Learning Activity	82.08%	Interesting
3	Benefits of Technology	84.58%	Interesting
4	Motivation to learn	81.25%	Interesting
5	Attraction	81.67%	Interesting
6	Material	80.42%	Interesting
7	Language	83.33%	Interesting
	Overall	**82.02**%	Interesting

The results of a small-group assessment of student responses to the Bilingual Teaching Materials Through Visual Studio Code showed that the product developed received a very positive response. Overall, the product received a rating of 82.02%, indicating that the Bilingual Teaching Materials Through Visual Studio Code were deemed engaging. The results of the large-scale trial are as follows:

Table 6. Large-Scale Trial Results

No	Indicator	Percentage	Criteria
1	Ease of Understanding	83.57%	Very interesting
2	Learning Activity	84.05%	Very interesting
3	Benefits of Technology	85.95%	Very interesting
4	Motivation to learn	82.86%	Very interesting
5	Attraction	85.71%	Very interesting
6	Material	86.90%	Very interesting
7	Language	88.33%	Very interesting
	Overall	**85.34**%	Very interesting

The results of a large-group assessment of student responses to the Bilingual Teaching Materials Through Visual Studio Code showed that the developed product received a very positive response. Overall, it achieved a percentage of 85.34%, indicating that the Bilingual Teaching Materials Through Visual Studio Code were deemed very engaging.

The results of the small group responses were interesting, while the large group was very interesting, showing a significant increase in percentage that Bilingual Teaching Materials Through Visual Studio Code were able to provide a better, consistent, and adaptive learning experience in a broader context of use. This indicates that the teaching materials have support for ease of understanding, learning activity, technological benefits, learning motivation, interestingness, material, language. Thus, both in small and large scale trials, Bilingual Teaching Materials Through Visual Studio Code were considered interesting and very interesting to be applied in learning to improve students' mathematical logical reasoning.

This is relevant to the use of Visual Studio Code in developing bilingual digital teaching materials, as the software enables the creation of structured, consistent, and well-organized learning materials. The segmented and clear presentation of the material helps students process mathematical information logically, understand the relationships between concepts, and improve their logical mathematical reasoning skills in a gradual and meaningful manner.

Effectiveness testing was conducted through pretests and posttests to determine improvements in students' mathematical logical reasoning after using the teaching materials. Data processing results showed a significant increase in mathematical logical reasoning scores, indicating that these teaching materials are effective in mathematics learning.In this testing phase, the effectiveness of improving students' Mathematical Logical Reasoning was evaluated through a pretest and posttest. The pretest was conducted before the product was tested, while the posttest was conducted after students used the Teaching Materials product.BilingualUsing Visual Studio Code, the comparison of pretest and posttest results was analyzed using the Normalized Gain (N-Gain) formula. The following table shows the results of the (N-Gain) calculation:

Table 7. Average N-Gain Result

No	Types of Trials	Average N-Gain	Information
1	Small Trial	0.563	Currently
2	Big Trial	0.596	Currently

Based on the analysis of the improvement in students' mathematical logical reasoning abilities after using bilingual teaching materials based on Visual Studio Code, the average N-Gain value obtained in the small-scale trial was 0.563, which is in the moderate category. This result indicates that the developed teaching materials are able to provide a fairly effective improvement in students' mathematical logical reasoning abilities in the initial implementation stage. Furthermore, in the large-scale trial, the average N-Gain value increased to 0.596 and remained in the moderate category. Based on the results of the pretest analysis, students' initial abilities were in a relatively homogeneous range and did not show extreme differences between students. Therefore, the N-Gain value which is in the moderate category is not influenced by students' initial abilities. The moderate N-Gain value is more due to the character of mathematical logical reasoning as a higher-order thinking ability (HOTS) that develops gradually through learning experiences. Because mathematical reasoning itself involves the process of analysis, evaluation, and proof that requires more time than just learning.

Discussion

The results of this study indicate that bilingual teaching materials based on Visual Studio Code have a clear design foundation, namely integrating technology, mathematical logical reasoning, and religious values to align with the characteristics of students in madrasas and Islamic boarding schools. This integration is important because the needs of students in these contexts not only require mastery of SLETV concepts but also demand learning methods that support the formation of coherent reasoning and remain in line with a religious learning culture (Kontorovich, 2020; Rohimah et al., 2022; Zandieh & Andrews-Larson, 2019). When the design of teaching materials includes introductory learning components, study tips, and logical reasoning questions, the teaching materials no longer function as "textbooks," but as learning tools that guide the flow of thought (Björklund & Palmér, 2022). However, a common assumption is that including religious elements automatically improves the quality of learning. This is not always true. Religious elements should serve as reinforcements of motivation and values, not as ornaments that distract from the focus of reasoning.

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The development process in the Development phase demonstrates a direction consistent with these objectives. The product is created in an interactive digital format that combines visual displays, bilingual presentation, and a reasoning-based material structure. Pedagogically, the reasoning-based structure provides students with the opportunity to understand SLETV through relationships between concepts, not simply elimination or substitution procedures. From a skeptical perspective, the use of Visual Studio Code could be viewed as "irrelevant" because VS Code is not a learning platform, but rather an editor. This criticism is reasonable if VS Code is positioned as a direct learning medium for students. However, in this study, VS Code serves as a development tool that allows researchers to create neat, consistent, and modular web content (David et al., 2018; Harris et al., 2023). Therefore, what determines effectiveness is not the "software name," but the quality of the instructional design produced through it.

Expert validation findings strengthen the argument for product feasibility. Expert validation scores for content (96.88%), media (87.50%), language (100%), and questionnaire (98.61%) indicate that the product meets standards for content, presentation, language, and measurement instruments. This provides strong evidence that the learning materials are “ready to use” from an internal quality perspective. However, caution should be exercised in assuming that a high validation percentage automatically guarantees a high learning impact. Expert validation assesses the suitability and quality of the design, not the extent to which changes in learner abilities are measured. Further strengthening these results is the revisions based on validator suggestions, particularly for the learning introduction, materials, study tips, and logical reasoning questions. These revisions demonstrate a cycle of improvement that enhances the coherence between objectives, materials, and exercise formats.

During the implementation phase, student responses in small-group (82.02% “interesting”) and large-group (85.34% “very interesting”) tests confirmed that the product was well-received by users. These responses indicate that the teaching materials are easy to understand, encourage motivation, and support active learning. However, positive responses remain perceptual. Skeptics might say, “Just because students enjoy the material doesn’t mean they’re better at reasoning.” This is true. Therefore, student responses should be viewed as evidence of practicality and acceptability, not primary effectiveness. Nevertheless, high acceptance remains crucial, as effective but unpopular teaching materials often fail to be consistently implemented in the classroom (Dello Iacono et al., 2024; Khozaei et al., 2022; Talib et al., 2024).

The connection between these findings and Mayer's Cognitive Theory of Multimedia Learning (Cognitive Theory of Multimedia Learning) provides a relevant theoretical basis. Systematically and modularly structured digital materials help learners organize information and reduce cognitive overload (Alqahtani & Powell, 2017). This explanation makes sense for SLETV, as students often fail not because they can't calculate, but because they can't organize steps and reason logically. Segmented presentations help students process information bit by bit, connecting concepts like equations, variables, and the relationship between two equations into a system (Stewart et al., 2019). Here, VS Code functions as a "production machine," facilitating consistent visual design, page structure, and material segmentation. However, you still need to test the assumption that good segmentation occurs automatically. Segmentation should be evident in the product, for example through small units, step-by-step examples, tiered exercises, and clear feedback.

The effectiveness of the teaching materials is demonstrated by significant improvements in pretest and posttest results, and the average N-gain is in the moderate category in both small and large trials. This indicates that the product is not only valid and engaging, but also has an

impact on improving mathematical logical reasoning. However, a logical gap you need to anticipate is whether this improvement is solely due to the teaching materials, or is influenced by other factors such as teaching style, training intensity, or the effect of media novelty. Overall, a comprehensive evaluation at each stage of ADDIE confirms the conclusion that the teaching material meets three key requirements: feasibility, attractiveness, and effectiveness. The combination of very high expert validation, positive student responses, and improved mathematical logical reasoning skills demonstrates that the product is suitable for use as an innovation in mathematics learning in madrasas and Islamic boarding schools. An important alternative perspective is to view this product as a development model, not just a SLETV product. This means that the bilingual digital approach based on reasoning structures can be extended to other topics, such as systems of equations in three variables or functions, provided that the design principles maintain coherence of objectives, segmentation of material, and exercises that truly measure reasoning, not just procedures.

Conclusion

This study shows that bilingual Visual Studio Code-based teaching materials for SLETV are feasible, engaging, and effective in improving students' mathematical logical reasoning in madrasah and Islamic boarding school contexts. The significance of these findings lies in three things. First, the structured, segmented presentation of the material, supported by digital displays, helps students organize their thinking steps in a coherent manner. Second, the bilingual format provides added value because students can access concepts and exercises in two languages without reducing the focus on reasoning. Third, the integration of technological elements and religious values can work harmoniously when placed as a motivational and character enhancer, rather than as ornamentation. These findings emphasize that teaching material innovation is not simply "digital," but must guide the reasoning process through appropriate material and exercise design.

This study has limitations. The trial was conducted in a specific school context and the number of subjects was limited, so generalization of the results requires caution. The study also did not clearly separate the influence of the teaching materials from other factors, such as the role of the teacher, the intensity of the training, or the novelty of the digital media. Furthermore, the measurement focused more on improvements in pretest–posttest scores and student responses, so detailed evidence on reasoning processes, types of logical errors, and changes in thinking strategies was not fully explored. Another limitation is that the scope of the material was limited to SLETV, so its effectiveness on other mathematics topics cannot be confirmed.

Future research should test these materials on a broader and more diverse sample, including comparisons between schools or between types of institutions, to increase the strength of generalizability. Researchers should also employ more robust test designs, such as those involving a clear control group, measurement of learning implementation, and effect size analysis, to better isolate the materials' contributions. Further recommendations include adding qualitative data focused on the process, such as analysis of solution steps, task-based interviews, or mapping of reasoning errors, to reveal which parts of the materials are most helpful and which are weak. Finally, development could be expanded to other materials and include adaptive feedback features to provide students with more personalized scaffolding, particularly in areas requiring proof and logical argumentation.

Conflict of Interest

The author declares no conflict of interest.

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Authors' Contributions

The first author, M.A.S., conceived the research idea presented and collected the data. N., R.A. and F.N. were the supervisors in this research who actively participated in the development of theory, methodology, organization and analysis of data, discussion of results, and approval of the final version of the work. All authors declare that the final version of this paper has been read and approved. The total percentage of contributions to the conceptualization, preparation, and correction of this paper are as follows: M.A.S.: 40%, N.: 30%, R.A.: 15% and F.N.: 15%.

Data Availability Statement

The author declares that the data supporting the results of this study will be made available by the corresponding author, [M.A.S], upon reasonable request.

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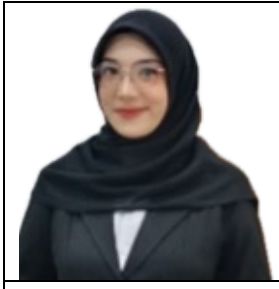	**Mutiara Ani Sabina** is a student in the Mathematics Education Study Program, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Raden Intan Lampung, Lampung, Indonesia. Email: mutiaraanisabina3@gmail.com
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