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Development of Local Instruction Theory Teaching Materials to Improve Mathematical Problem-Solving Ability

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Abstrak

Penelitian ini dilakukan untuk mengatasi kurangnya bahan ajar kontekstual yang dapat mendukung kemampuan pemecahan masalah siswa melalui pengalaman belajar yang bermakna. Tujuan dari penelitian ini adalah mengembangkan bahan ajar berbasis Local Instruction Theory (LIT) yang valid, praktis, dan efektif dalam meningkatkan kemampuan pemecahan masalah matematis. Penelitian ini menggunakan metode penelitian dan pengembangan (R&D) dengan model ADDIE, dan dilaksanakan pada bulan Maret hingga Juni 2024 di SMP Negeri 216 Jakarta. Subjek penelitian adalah 66 siswa kelas VIII yang dibagi ke dalam kelompok eksperimen dan kelompok kontrol. Teknik pengumpulan data meliputi angket validasi ahli, angket respon siswa, dan tes pemecahan masalah matematis. Data dianalisis secara kuantitatif melalui skala Likert, uji normalitas dan homogenitas, serta uji t sampel independen. Hasil penelitian menunjukkan bahwa bahan ajar yang dikembangkan memiliki tingkat validitas sangat tinggi (87,72%), kepraktisan tinggi (88,9%), dan efektif dalam meningkatkan kemampuan pemecahan masalah, ditunjukkan dengan perbedaan skor posttest yang signifikan antara kelompok eksperimen dan kontrol. Penelitian ini menyimpulkan bahwa bahan ajar berbasis LIT mampu meningkatkan kemampuan pemecahan masalah matematis siswa dan direkomendasikan untuk diimplementasikan dalam pembelajaran matematika secara lebih luas.
Kata Kunci: ADDIE; bahan ajar; kemampuan pemecahan masalah matematis; local instruction theory

Abstract

This research was conducted to address the lack of contextual teaching materials that can support students' problem-solving abilities through meaningful learning experiences. The purpose of this research is to develop teaching materials based on Local Instruction Theory (LIT) that are valid, practical, and effective in improving mathematical problem-solving abilities. This research used a research and development (R&D) method with the ADDIE model, and was conducted from March to June 2024 at SMP Negeri 216 Jakarta. The research subjects were 66 eighth-grade students who were divided into experimental and control groups. Data collection techniques included expert validation questionnaires, student response questionnaires, and mathematical problem-solving tests. Data were analyzed quantitatively using a Likert scale, normality and homogeneity tests, and independent sample t-tests. The results showed that the developed teaching materials had a very high level of validity (87.72%), high practicality (88.9%), and were effective in improving problem-solving skills, as indicated by a significant difference in posttest scores between the experimental and control groups. This study concluded that LIT-based teaching materials were able to improve students' mathematical problem-solving skills and were recommended for broader implementation in mathematics learning.
Keywords: ADDIE; teaching materials; mathematical problem-solving skills; local instruction theory

I. INTRODUCTION

Mathematical problem solving is a cornerstone of mathematics education, as it fosters logical reasoning, critical thinking, and the ability to apply mathematical concepts to real-world situations. Problem-solving skills are essential not only for academic success but also for preparing students to face complex challenges in everyday life. While the importance of mathematical problem-solving has been widely acknowledged in educational theory and practice (Polya, 1957; NCTM, 2000; Ulfa, Roza, & Maimunah, 2022), the methods by which students are taught to solve problems effectively remain a topic of ongoing debate and research.

Despite the emphasis on problem-solving in curriculum documents and mathematics standards, many students still struggle with translating mathematical knowledge into practical solutions (OECD, 2019). This is partly due to the dominance of procedural teaching approaches and a lack of contextual relevance in instructional materials. Research has shown that when students are presented with decontextualized problems, they often fail to develop deeper understanding or transferable skills (Schoenfeld, 2013; Anderson et al., 2021).

One widely recognized approach in mathematics instruction is Local Instruction Theory (LIT), which emphasizes context-based learning. LIT advocates for incorporating real-world scenarios into teaching materials, making the mathematical concepts more meaningful and accessible to students by connecting them to their everyday experiences (Tharp & Gallimore, 1988). However, while there is growing support for the effectiveness of contextual learning in various educational fields (Dewey, 1938; Brown, Collins, & Duguid, 1989), there has been limited exploration of its application in the development of teaching materials specifically designed to enhance mathematical problem-solving abilities. Although various instructional strategies have been examined, such as problem-based learning (Hmelo-Silver, 2004; Rahayu, Puspitasari, & Luritawaty, 2024), inquiry-based learning (Van der Meij, 2014; Luritawaty & Rahmawati, 2024), and realistic mathematics education (Gravemeijer & Doorman, 1999; Afriansyah et al., 2023), the explicit use of LIT in the development of mathematics teaching materials has not been sufficiently explored in the literature.

Several recent studies have begun to investigate the intersection of instructional theory and mathematical problem solving. For instance, research by Wijaya et al. (2020) found that context-based tasks significantly improved Indonesian students' problem-solving performance. Similarly, Widayati and Wahyudin (2022) emphasized the role of local culture and daily-life contexts in fostering engagement and comprehension in mathematics classrooms. Nevertheless, the integration of LIT with systematic instructional design frameworks like ADDIE remains scarce and fragmented, indicating a significant gap in both theory and practice.

This gap highlights the need to investigate how LIT-based materials can be designed, implemented, and assessed for their validity, practicality, and effectiveness in improving students' mathematical

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problem-solving skills. Despite significant advances in instructional design models like ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009), which have been widely used in educational research and practice, there remains a lack of comprehensive studies on the application of ADDIE specifically in the development of LIT-based teaching materials. Most existing research on instructional design focuses on general educational contexts, such as science and language arts, with limited attention given to the mathematics discipline (Morrison, Ross, & Kemp, 2015). Moreover, while many studies have examined the effectiveness of specific teaching methods or materials in improving mathematical problem-solving (e.g., peer tutoring, traditional textbooks, and digital tools) (Bennett, 2010; Dufresne et al., 1996), there is a need for studies that directly address how the ADDIE model can be employed to create and evaluate LIT-based teaching materials for mathematics.

Furthermore, there is limited empirical evidence comparing the effectiveness of LIT-based materials against traditional instructional methods in mathematics problem solving. Previous studies have mostly focused on general instructional approaches without assessing their specific impact on students' abilities to solve mathematical problems. This is particularly important in light of the growing call for instructional materials that are not only effective but also practical for use in real classroom settings (Miller & Brewer, 2015). As such, there is a pressing need to bridge this research gap by developing and evaluating teaching materials grounded in LIT, using a structured methodology like ADDIE, and comparing their effectiveness to conventional teaching practices.

This study aims to address both the theoretical and research gaps by developing teaching materials based on Local Instruction Theory, designed to enhance students' mathematical problem-solving abilities. Using the ADDIE model for instructional design, the study investigates the validity, practicality, and effectiveness of these materials in comparison to conventional teaching methods. By filling this gap in both theory and research, this study contributes to the growing body of knowledge in mathematics education and instructional design, providing practical insights for educators seeking to implement more contextually relevant and effective teaching strategies in their classrooms.

This paper will first explore the theoretical framework underpinning the Local Instruction Theory and its potential to improve mathematical problem-solving skills. It will then describe the research methodology used in the study, including the development process of the teaching materials and the data collection techniques. Following the results and discussion, the paper will conclude by highlighting the implications for educational practice and suggestions for future research.

II. METHOD

This study employed the Research and Development (R&D) method, which aims to create a specific product and evaluate its

effectiveness (Sugiyono, 2017). The development process followed the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation, as outlined by Branch (2009). The research was conducted from March to June 2024 at SMP Negeri 216 Jakarta, involving students of Grade VIII. The participants consisted of 66 eighth-grade students, divided into two groups: 33 students in the experimental group, who were taught using teaching materials based on Local Instruction Theory, and 33 students in the control group, who received instruction using conventional methods. The selection of the school and participants was based on purposive sampling, considering the similarity of student academic levels and curriculum standards.

The instruments used in this study included validation questionnaires for expert review of the teaching materials, student response questionnaires to assess practicality, mathematical problem-solving ability tests (pre-test and post-test) to measure effectiveness. Data collection was carried out in stages according to the ADDIE model. During the Development phase, expert validation was conducted by mathematics education specialists. In the Implementation phase, students used the developed materials, followed by testing and feedback collection.

The data was analyzed using both descriptive and inferential statistics. Descriptive analysis was used to assess the validity and practicality of the materials. Responses from validation and student questionnaires were measured using a Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The average percentage score was then categorized based on criteria for validity and practicality.

Inferential analysis was used to evaluate the effectiveness of the materials. Before conducting hypothesis testing, normality and homogeneity tests were applied to ensure that the data met the assumptions for parametric testing. Subsequently, an independent sample t-test was performed using SPSS to compare the mathematical problem-solving ability between the experimental and control groups based on post-test scores. The significance level was set at $\alpha = 0.05$.

These analytical procedures ensured that the developed materials could be assessed comprehensively in terms of content validity, practical usability, and their effect on student learning outcomes. Data were collected using questionnaires and tests. The questionnaires assessed the validity and practicality of the local instruction theory teaching materials, while the tests measured the mathematical problem-solving abilities of students in both groups. The testing process included a posttest which involved descriptive questions. The data gathered from this study comprised the results of the e teaching materials validity and practicality assessments, as well as the posttest scores on mathematical problem solving abilities.

III. RESULT AND DISCUSSION

This study produced a local instruction theory teaching materials on relation and function topic for student grade VIII Junior High School. The development was carried out using five stages of the ADDIE model:

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Analysis, Design, Development, Implementation, and Evaluation.

1) Analysis

A significant aspect of the analysis stage involved identifying the specific learning needs of students in relation to mathematical problem solving ability. Through diagnostic questionnaires at 216 Junior Hgh School Jakarta , the study found that students' mathematical problem-solving abilities varied widely, with many struggling to apply abstract mathematical principles to practical situations. This finding was further supported by the teachers' observations, which indicated that students often relied on memorized procedures without fully understanding the underlying concepts.

The analysis stage also highlighted the importance of aligning the teaching materials with the cognitive development of students. Vygotsky's (1978) theory of proximal development suggests that students are most likely to succeed in learning when instructional materials and methods are within their zone of proximal development, meaning that they provide appropriate challenges that can be overcome with guided assistance. Therefore, the teaching materials needed to be designed in a way that offered scaffolded support, enabling students to gradually improve their problem-solving skills.

Additionally, the analysis revealed that the students' cultural background and prior experiences were not sufficiently incorporated into the existing teaching methods. According to local instruction theory, learning is most effective when it connects with students' everyday lives and cultural contexts (Roth & Lee, 2007). This insight informed the development of the new teaching materials, ensuring that they were grounded in real-world problems that students could relate to, thus making mathematics more meaningful and accessible.

Furthermore, the analysis revealed that students had limited opportunities for active learning and collaborative problem-solving in the classroom. These findings are consistent with the conclusions of previous research, which emphasizes that traditional teaching methods often fail to promote critical thinking and problem-solving abilities among students (Loyens et al., 2008). The analysis stage therefore confirmed the need for a new set of teaching materials that could address these issues and enhance students' abilities to solve mathematical problems effectively.

2) Design

The design stage includes activities such as preparing the framework and validation questionnaire. The framework and expert validation questionnaires were validated by validator. The media design process started with creating the layout design of the teaching material, producing instructional videos, and then developing the initial draft (draft I) of the media. The design process used Canva as the main tool, while the instructional videos were created using OBS for screen recording and Microsoft Clipchamp for video editing. Subsequently, all module designs, text content, images, animations, and videos were combined and organized into a flipbook module using Heyzine on a web browser.

Figure 1. Front Cover and Back Cover.

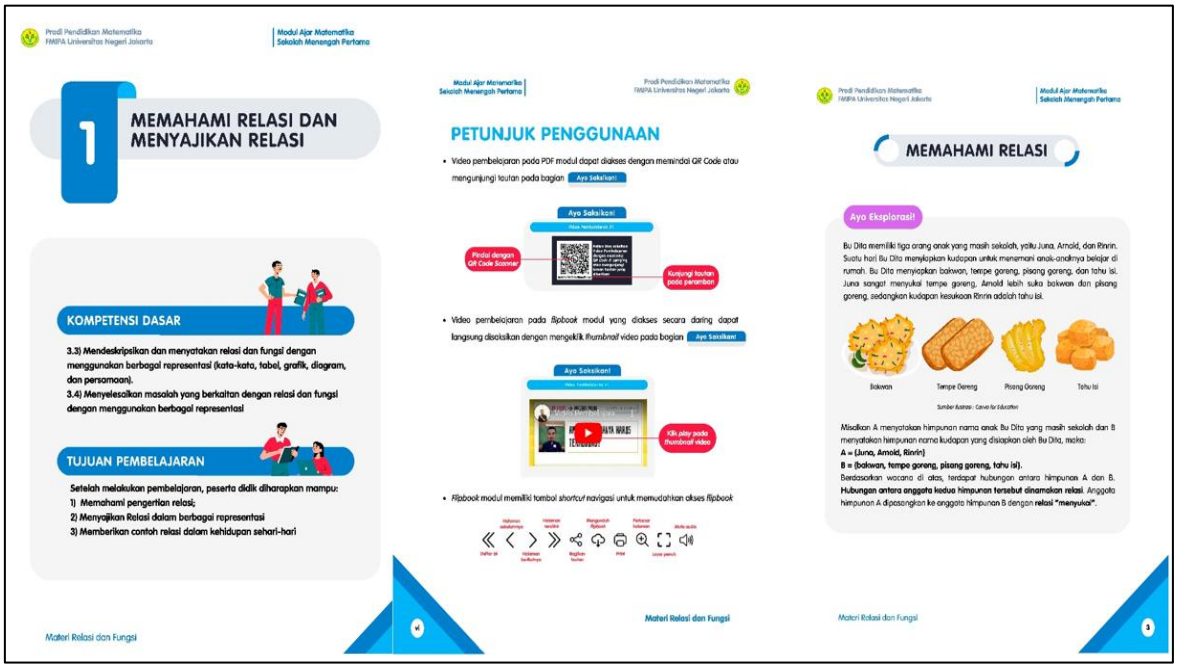

Figure 2. Example of Content from Teaching Materials.

3) Development

The product was developed based on the framework established in the previous phase and was then subjected to a validity test. The validity of the local instruction theory teaching materials was evaluated from three perspectives: content validity, linguistic validity, and presentation validity. Teaching materials are considered valid if they receive an assessment score greater than 60% (Riduwan, 2013). The validation process was conducted by two lecturers from the Mathematics Education Study Program at Universitas Negeri Jakarta,

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along with three mathematics teacher from 216 Junior High School Jakarta.

The local instruction theory teaching materials were classified as "very valid" based on the validity criteria, with a validity percentage of 87.72%. The results from the validity test conducted by the three validators are presented in Table 1 below.

Table 1.
Product Evaluation Results by the Validator

Validator	Percentage	Interpretation
Validator D1	87%	Very Valid
Validator D2	88.5%	Very Valid
Validator G1	88%	Very Valid
Validator G2	84.3%	Very Valid
Validator G3	90.8%	Very Valid
Average	87.72%	Very Valid

The percentage of validity of each aspect in the teaching materials is shown in Table 2 below.

Table 2.
Product Evaluation Results of Each Aspect

Aspect	Percentage	Interpretation
Content	84.6%	Very Valid
Linguistic	88.2%	Very Valid
Presentation	90,4%	Very Valid

Based on the assessment results in the table above, the overall average 87.72%, which is interpreted as very valid.

4) Implementation

The teaching materials based on local instruction theory were tested for their effectiveness and practicality in the learning process. This study included two sample classes: an experimental class and a control class. The sampling method used in this study was random sampling, with class VIII-F chosen as the experimental group and class VIII-E as the control group.

The practicality of a product is determined by the opinions of users who state that the developed product is usable, and the product is easy to use by consumers (teachers and students) according to the purpose of the development (Nieveen et al., 1999).

The practicality test was conducted with students after they had used the local instruction theory teaching materials to assess whether the materials were practical and easy for students to understand. The test used a questionnaire that covered four aspects: student interest, usability, and evaluation. A total of 35 students from class VIII-F at 216 Junior High School in Jakarta participated in the test. According to Riduwan (2013), the teaching material is considered easy to understand if the assessment score exceeds 60%. The results of the practicality test showed a practicality score of 88.9%. This indicates that the material was very practical and easy for students to understand. The results also revealed the practicality percentage for each aspect of the e-module, as shown in Table 3 below.

Table 3.
Practically Test Results of Each Aspect

Aspect	Percentage	Interpretation
Student interest	91%	Very Valid
Process of use	87.5%	Very Valid
Presentation	88,3%	Very Valid

The effective test of the teaching materials is an essential part of evaluating the effectiveness of the product, and it is based on determining whether there is consistency between the learning objectives, the experiences students have during the learning process, and the outcomes they achieve. According to Nieveen et al. (1999), in educational development research, the effectiveness of

a product is judged by whether or not it has an impact on the specific skills or abilities it is designed to improve. In this case, the test evaluates whether the teaching materials have an observable effect on students' learning outcomes.

Before conducting the t-test to assess the effect, prerequisite tests were first carried out to ensure that the data meets the necessary conditions for accurate analysis. These include the normality Test, which ensures that the data follows a normal distribution, and the homogeneity test, which checks whether the variance in the data is consistent across different groups. These tests help confirm that the subsequent statistical analysis will be reliable and valid when determining the effectiveness of the teaching materials.

Based on Table 4, the results of the normality test for the control and experimental classes can be seen in the Shapiro-Wilk significance values, which are 0.224 and 0.325, respectively. The significance values for both the control class and the experimental class are greater than 0.05. Therefore, based on the hypothesis, it can be concluded that both the experimental and control classes come from populations with a normal distribution.

Tabel 4.
Test of Normality

Tests of Normality

	Class	Shapiro Wilk		
		Statistics	df	Sig.
N-Gain	Control	.960	33	.224
	Experiment	.963	35	.325

The homogenity test for the experimental and control classes in this study was conducted using Levene's Test for Equality with a significance level of 0.05. The results of the homogeneity test can be seen in Table 5, which shows that the N-Gain data obtained a significance value greater than 0.05, specifically 0.084. Therefore, based on the hypothesis, it can be concluded that the N-Gain data comes from populations with equal variances, meaning that both classes are homogeneous.

Tabel 5.
Test of Homogenity

Test of Homogenity of Variance

	Levene Statistics	df1	df2	Sig.
Based on Mean	3.085	1	66	.084

The effect of the local instruction theory teaching materials on improving students' mathematical problem solving abilities was analyzed using two independent sample t-test. The results of the t-test can be seen in Table 6.

Table 6.
The Results of the t-test

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
-16,049	66	.000	-.32217	.02007

Based on the results of the t-test, the significance value is smaller than 0.05, specifically 0.000. According to the hypothesis, H0 is rejected. Therefore, it can be concluded that the students who used the local instruction theory teaching materials demonstrated higher mathematical problem solving abilities compared to the class that did not use the local instruction theory teaching materials.

5) Evaluation

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The local instruction theory teaching materials underwent a comprehensive evaluation based on the data collected during the implementation stage. This evaluation included a review of the results from the validity test, practicality test, and effectiveness test, all of which aimed to assess the materials' overall quality. The validity test checked whether the materials were appropriate and aligned with the learning objectives, while the practicality test examined how user-friendly and feasible the materials were for both teachers and students. Lastly, the effectiveness test focused on whether the materials successfully improved students' mathematical problem-solving abilities. After reviewing these results, it was concluded that the final product of the study had successfully met all the criteria for validity, practicality, and effectiveness.

This study aimed to develop and evaluate teaching materials based on Local Instruction Theory (LIT) to enhance students' mathematical problem-solving abilities. The results showed that the materials were very valid, highly practical, and effective, which aligns with several recent studies that emphasize the importance of context-based and student-centered learning designs.

The high validity score (87.72%) indicates that the materials met the essential criteria of content relevance, clarity, and alignment with instructional goals. This result is consistent with the findings of Abu-Rasheed et al. (2023), who stated that instructional materials designed with clear pedagogical goals and contextual alignment tend to gain high expert validation scores and are more readily accepted in classrooms.

From the students' perspective, the materials were practical and engaging, as reflected in the high practicality percentage (88.9%). Students reported that the materials were easy to understand, interesting, and helpful in supporting their learning. This supports Chiu and Churchill (2015), who emphasized that practicality in teaching materials is closely related to students' perception of clarity, visual appeal, and logical organization, which leads to greater motivation and engagement in mathematics learning.

The effectiveness of the materials in improving students' problem-solving abilities is evident from the significant difference between the experimental and control groups. The statistical analysis showed that students using LIT-based materials performed better on mathematical problem-solving tasks than those who followed conventional learning approaches. These findings are in line with Ulandari, Amry & Saragih (2019), who found that students exposed to instructional designs incorporating realistic contexts demonstrated improved problem-solving performance. Moreover, Reyes et al. (2019) noted that local contexts not only provide familiarity and relevance but also allow students to construct meaning and apply mathematical concepts more effectively.

Additionally, the findings resonate with the study of Sutarni et al. (2024), who reported that teaching materials developed using the principles of Realistic Mathematics Education (RME) and

grounded in local culture can significantly enhance students' higher-order thinking skills, especially problem-solving and reasoning.

In summary, the integration of local contexts, realistic scenarios, and clearly defined instructional objectives contributed to the success of the developed materials. The materials encouraged students to engage in meaningful mathematical activities, fostered better comprehension, and allowed them to transfer mathematical understanding to real-life situations. These findings reinforce the potential of Local Instruction Theory as a basis for developing effective instructional tools in mathematics education, particularly in promoting deep learning and 21st-century skills.

IV. CONCLUSION

This study developed and evaluated teaching materials based on local instruction theory, focusing on their validity, practicality, and effectiveness in enhancing students' mathematical problem-solving abilities. The materials were found to be highly valid, with an average validity score of 87.72%, indicating that they met the necessary educational standards and were closely aligned with the learning objectives. Additionally, the practicality of the materials was confirmed through feedback from students, who found them easy to use and engaging, with a high practicality score of 88.9%. This shows that the materials were user-friendly and well-received by students in the learning process. Furthermore, the effectiveness of the materials was demonstrated through statistical analysis, which showed that students who used the local instruction theory teaching materials outperformed those in the control group in terms of mathematical problem-solving abilities. This indicates that the materials were successful in improving students' skills.

Overall, the study highlights that teaching materials based on local instruction theory are not only valid and practical but also effective in improving students' mathematical problem-solving abilities. These findings suggest that such materials can be a valuable resource in enhancing the learning experience and should be considered for broader application in educational settings.

This study developed and evaluated teaching materials based on Local Instruction Theory (LIT), focusing on their validity, practicality, and effectiveness in improving students' mathematical problem-solving abilities. The materials were found to be highly valid (87.72%), indicating their strong alignment with curriculum standards and instructional objectives. They were also rated as highly practical (88.9%), as students found them easy to use, engaging, and relevant to their learning needs. Furthermore, the materials were statistically effective in enhancing students' problem-solving skills, as demonstrated by significantly higher post-test scores in the experimental group compared to the control group.

These findings highlight the potential of LIT-based materials to serve as meaningful and effective tools in mathematics instruction, particularly for promoting higher-order thinking skills and contextual understanding. Schools and educators are

encouraged to adopt and adapt LIT-based teaching materials, especially in contexts where students need more culturally relevant and realistic mathematical experiences. Future efforts should include teacher professional development programs that incorporate the principles of Local Instruction Theory to ensure effective implementation in classrooms. Additional studies should explore the long-term impact of LIT-based materials on student learning outcomes, including creativity, reasoning, and persistence in solving complex mathematical problems.

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