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DEVELOPMENT OF DIFFERENTIATED TEACHING MATERIALS BASED ON PRIOR KNOWLEDGE TO IMPROVE MATHEMATICS LEARNING OUTCOMES OF JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

Classrooms in Indonesian junior secondary schools increasingly comprise students with diverse levels of prior mathematical knowledge, creating challenges for teachers in providing instruction that accommodates different learning needs. The availability of differentiated teaching materials is therefore essential for supporting effective implementation of differentiated instruction within the Merdeka Curriculum. This study aimed to develop differentiated teaching materials based on students' prior mathematical knowledge and to evaluate their validity, practicality, and effectiveness in improving mathematics learning outcomes on the topic of Flat-Sided Solid Figures. The study employed a Research and Development (R&D) approach using the ADDIE instructional design model. Three series of teaching materials were developed to accommodate students with low, moderate, and high levels of prior mathematical knowledge while maintaining common learning objectives. The validity of the materials was evaluated by three experts in mathematics content, language, and educational media. Practicality was assessed through teacher and student response questionnaires, whereas effectiveness was examined using a quasi-experimental Nonequivalent Control Group Design involving 63 Grade 8 students (experimental group, $n = 31$; control group, $n = 32$). The differentiated teaching materials achieved an overall validity score of 4.23 (Very Valid). Practicality evaluation indicated positive responses from students (79.92%; Practical) and teachers (85.27%; Very Practical). The effectiveness test showed that students in the experimental group achieved significantly higher mathematics learning outcomes than those in the control group ($t = 2.976 > t_{critical} = 1.670$, $\alpha = 0.05$). The findings indicate that differentiated teaching materials based on students' prior mathematical knowledge provide a valid, practical, and effective instructional resource for supporting differentiated mathematics instruction in Indonesian junior secondary schools.

Keywords: Differentiated Teaching Materials, Prior Mathematical Knowledge, Mathematics Learning Outcomes, ADDIE Model, Merdeka Curriculum

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PRELIMINARY

The implementation of the Merdeka Curriculum in Indonesia has fundamentally transformed the pedagogical paradigm of mathematics education at the junior secondary school level. Reflecting a global shift from teacher-centered instruction toward student-centered learning, the curriculum encourages teachers to design learning experiences that accommodate students' diverse characteristics, abilities, and learning needs (Ministry of Education, Culture, Research, and Technology, 2022). Although differentiated instruction has been widely recognized as an effective approach for addressing learner diversity, its successful implementation depends not only on teachers' pedagogical competence but also on the availability of well-designed instructional resources that systematically support differentiated learning.

One instructional context in which differentiated teaching has become increasingly important in Indonesia is the implementation of the zone-based school admission policy (Penerimaan Peserta Didik Baru [PPDB]). While this policy aims to promote equitable access to education, mathematics classrooms increasingly comprise students with diverse levels of prior mathematical knowledge and learning readiness. Such diversity is a natural characteristic of contemporary classrooms; however, it presents considerable instructional challenges when all students are expected to learn using identical teaching materials and learning activities. This situation is particularly evident in the topic of Flat-Sided Solid Figures, where conceptual understanding develops hierarchically and mastery of prerequisite concepts strongly influences subsequent learning success. At SMP Negeri 1 Sukoharjo, formative assessment data from the 2023/2024 academic year indicated that a considerable proportion of Grade 8 students did not achieve the expected level of learning mastery. Students with higher prior knowledge often experienced limited academic challenge, whereas those with lower prior knowledge required more structured instructional support than was provided by the available teaching materials. Consequently, the use of uniform teaching materials has become an important instructional constraint in addressing diverse student readiness levels.

Differentiated instruction (DI) provides a well-established pedagogical framework for responding to learner diversity. According to Maullina et al. (2025), differentiated instruction is an educational approach that recognizes students' diverse characteristics, learning needs, and readiness levels by adapting instructional strategies, learning materials, and classroom activities accordingly. Such adaptations foster greater student engagement, improve conceptual understanding, and enhance learning outcomes, particularly in academically diverse classrooms. Similarly, Tomlinson (2014) conceptualizes differentiated instruction as a proactive teaching philosophy in which instruction is systematically adjusted according to students' readiness, interests, and learning profiles to maximize individual learning growth. Within mathematics education, this approach enables teachers to provide learning experiences that better match students' varying levels of prior understanding while maintaining common learning objectives.

Despite its strong theoretical foundation, implementing differentiated instruction in everyday classroom practice remains challenging. Suprayogi et al. (2017) reported that many teachers experience difficulties in translating differentiation principles into classroom instruction because of limited instructional resources and the complexity of addressing diverse student needs simultaneously. These findings highlight that successful implementation of differentiated instruction requires not only pedagogical competence but also well-designed teaching materials that can support teachers in accommodating classroom heterogeneity. Empirical evidence further supports this perspective.

Prast et al. (2018) demonstrated that differentiated instruction based on students' prior mathematical knowledge significantly improved mathematics achievement when supported by structured instructional materials. Courtney (2021) also emphasized that the successful implementation of differentiated instruction depends substantially on the availability of carefully designed teaching materials that reduce teachers' instructional planning burden. More recently, Rahmatulloh et al. (2026) reported positive outcomes from implementing differentiated instruction in Indonesian secondary mathematics classrooms, particularly in enhancing student engagement across differentiated content, process, and product dimensions.

Despite the growing body of research on differentiated instruction, studies conducted in Indonesian mathematics education have predominantly focused on differentiated learning media, classroom implementation, or differentiation based on students' learning styles and learner characteristics. For example, Putra et al. (2023) developed differentiated mathematics teaching modules based on the Understanding by Design (UbD) framework, while Kindangen et al. (2023) developed an electronic module for the Flat-Sided Solid Figures topic using Flip PDF Professional. Similarly, Taufik & Adiastuty (2024) developed differentiated mathematics teaching modules based on multiple intelligences, whereas Safitri (2023)focused on differentiated learning media according to students' learning styles. Although these studies have contributed to differentiated mathematics instruction, they did not specifically develop teaching materials differentiated according to students' prior mathematical knowledge or comprehensively evaluate their validity, practicality, and effectiveness. Consequently, limited research has examined the systematic development of differentiated mathematics teaching materials that explicitly accommodate varying levels of prior mathematical knowledge while simultaneously evaluating their validity, practicality, and effectiveness through a comprehensive instructional design model. This gap is particularly important in geometry learning, where hierarchical conceptual relationships require instructional support that is responsive to students' prerequisite understanding.

Based on these considerations, this study aimed to develop differentiated teaching materials based on students' prior mathematical knowledge for the topic of Flat-Sided Solid Figures in Grade 8 mathematics using the ADDIE instructional design model. The developed materials were subsequently evaluated in terms of their validity, practicality, and effectiveness. By producing a structured set of differentiated teaching materials consisting of three readiness-based series, this study contributes an instructional resource that can support the implementation of differentiated instruction within the Merdeka Curriculum while providing empirical evidence regarding the quality and classroom implementation of readiness-based differentiated teaching materials in Indonesian junior secondary mathematics education.

METHODS

Research Design

This study employed a mixed-methods approach within a Research and Development (R&D) framework by integrating quantitative and qualitative methods. The instructional product was developed using the ADDIE model, which comprises five interconnected phases: Analyze, Design, Development, Implementation, and Evaluation. The model was selected because its systematic and iterative design supports the development of instructional materials through a structured process of needs analysis, design, expert validation, classroom implementation, and continuous evaluation. These characteristics are particularly suitable for developing differentiated teaching materials that require repeated refinement to accommodate students' varying levels of prior mathematical knowledge. Recent studies have also confirmed the continued relevance and adaptability of the ADDIE model for developing effective teaching and learning resources across diverse educational contexts (Al-Hikmah et al., 2024). Its suitability for developing differentiated instructional materials has been demonstrated in multiple recent studies in mathematics education (Munfarikhatin et al., 2024); Adeoye, 2024). To assess product effectiveness, a Nonequivalent Control Group experimental design was embedded within the implementation phase, following the classification by (Sugiyono, 2019).

Development Procedure

The Analyze phase focused on identifying instructional needs and classroom characteristics through classroom observations, semi-structured interviews with mathematics teachers, and an analysis of students' learning outcomes on the topic of Flat-Sided Solid Figures. Classroom heterogeneity was further examined using a diagnostic assessment administered to all Grade 8 students to identify variations in students' prior mathematical knowledge. The results revealed substantial differences in students' prerequisite understanding and confirmed that the existing teaching materials did not adequately accommodate these variations. These findings established the need to develop differentiated teaching materials based on students' prior mathematical knowledge.

The Design phase involved formulating learning objectives aligned with the Phase D Learning Outcomes (Capaian Pembelajaran) of the Merdeka Curriculum, designing the overall structure of the differentiated teaching materials, and developing the research instruments. Based on the diagnostic assessment results, students' prior mathematical knowledge was classified into three readiness levels using the school's Minimum Mastery Criterion (KKM) and consultation with mathematics teachers during the instructional design process. Students obtaining scores of 75 or above were categorized as having high prior mathematical knowledge (Series C), those scoring 51–74 were categorized as having moderate prior mathematical knowledge (Series B), and those scoring below 51 were categorized as having low prior mathematical knowledge (Series A). These classifications served as the basis for designing differentiated instructional support while maintaining equivalent curriculum objectives across all series.

During the Development phase, three series of differentiated teaching materials were produced to accommodate different levels of prior mathematical knowledge. Rather than differing solely in cognitive demand, the three series also varied in the depth of conceptual explanations, the number and complexity of worked examples, the intensity of instructional scaffolding, the level of guidance provided during learning activities, the complexity of practice tasks, and the degree of student independence expected during problem-solving. Nevertheless, all three series addressed the same mathematical topic, targeted identical learning objectives, and culminated in equivalent competency expectations. The draft materials subsequently underwent expert validation covering mathematics content, language, and educational media, followed by revisions based on the validators' recommendations.

Table 1 summarizes the distinguishing characteristics of Series A, Series B, and Series C. The three series were designed to accommodate different levels of students' prior mathematical knowledge while maintaining equivalent learning objectives and curriculum expectations.

Table 1. Characteristics of the Three Series of Differentiated Teaching Materials

Component	Series A (Low Prior Knowledge)	Series B (Moderate Prior Knowledge)	Series C (High Prior Knowledge)
Concept explanation	Detailed and explicit	Concise	Brief review
Worked examples	Many, step-by-step	Moderate	Limited
Teacher guidance	Intensive	Moderate	Minimal
Scaffolding	High	Moderate	Low
Task complexity	Basic to intermediate	Intermediate	Intermediate to advanced
Student independence	Guided	Partially guided	Independent

The Implementation phase consisted of a small-group trial involving 12 students, followed by a field trial employing a Nonequivalent Control Group Design. Prior to instruction, students in the experimental group completed the diagnostic assessment and were assigned to Series A, Series B, or Series C according to their prior mathematical knowledge. The assignment remained unchanged throughout the intervention to ensure that each student consistently received instructional support appropriate to his or her readiness level. Although students used different versions of the teaching materials, all participated in the same classroom lessons, studied identical mathematical content, and completed the same posttest at the end of the intervention. The control group received conventional teaching materials covering the same learning objectives.

Finally, the Evaluation phase integrated quantitative and qualitative findings to determine the quality of the developed teaching materials. Quantitative data from expert validation, teacher and student response questionnaires, and learning outcome tests were combined with qualitative feedback obtained during the development and implementation stages to evaluate the validity, practicality, and effectiveness of the differentiated teaching materials.

Research Participants

The population of this study consisted of all eighth-grade students at SMP Negeri 1 Sukoharjo, Central Java, Indonesia, during the 2024/2025 academic year. The research sample was selected using a quasi-experimental approach based on the Nonequivalent Control Group Design. Although this design shares the same general structure as the pretest–posttest control group design, it differs in that the experimental and control groups were formed without random assignment. Instead, an equivalence test was conducted to ensure that the selected classes had comparable initial abilities before being assigned as the research samples. Class VIII-I was designated as the experimental group (n = 31), which used the differentiated instructional materials, while Class VIII-C served as the control group (n = 32), which used conventional instructional materials. The two classes were confirmed equivalent in prior knowledge before the intervention through prerequisite testing and statistical balance tests.

Data Collection and Analysis

Data were collected using four research instruments: differentiated teaching materials, expert validation sheets, teacher and student response questionnaires, and a mathematics achievement test. The differentiated teaching materials consisted of three readiness-based series (Series A, Series B, and Series C) developed according to students' levels of prior mathematical knowledge. Although all three series addressed the same topic of Flat-Sided Solid Figures and the same learning objectives specified in the Phase D Learning Outcomes of the Merdeka Curriculum, they differed in the depth of conceptual explanations, the complexity of worked examples, the level of instructional scaffolding, guided learning activities, practice exercises, and the degree of learner independence. Prior to implementation, the teaching materials and research instruments were validated by experts in mathematics education, educational media, and language, and subsequently revised based on their recommendations.

The mathematics achievement test was developed based on the learning indicators of the Flat-Sided Solid Figures topic and consisted of one common pretest and one common posttest administered to all students in both the experimental and control groups. Therefore, the assessment instrument was not differentiated according to Series A, Series B, or Series C. Differentiation was implemented exclusively through the teaching materials, while all students were assessed using the same learning indicators and assessment instrument.

During the implementation stage, students in the experimental group first completed a diagnostic assessment to identify their levels of prior mathematical knowledge. Based on the results, students were assigned to Series A (low prior mathematical knowledge), Series B (moderate prior mathematical knowledge), or Series C (high prior mathematical knowledge). The classification was established using the school's Minimum Mastery

Criterion and consultation with mathematics teachers during the instructional design process. Students remained in their assigned series throughout the intervention to ensure that each learner consistently received instructional support appropriate to his or her level of prior mathematical knowledge. Although students used different versions of the teaching materials, all participated in the same classroom instruction, studied the same mathematical content, pursued identical learning objectives, and completed the same posttest at the end of the intervention. Meanwhile, students in the control group learned the same topic using conventional teaching materials.

Quantitative data were obtained from the expert validation sheets, teacher and student response questionnaires, and mathematics achievement tests, while qualitative data were collected through classroom observations, teacher interviews, and expert feedback during the development process. Descriptive statistics were used to analyze the validity and practicality of the developed teaching materials. Before hypothesis testing, prerequisite analyses consisting of the Lilliefors normality test, F-test for homogeneity, and an independent-samples t-test for balance were conducted. The effectiveness of the differentiated teaching materials was subsequently examined using an independent-samples t-test. Although the experimental class used three readiness-based teaching material series, these series constituted components of a single differentiated instructional intervention rather than separate experimental treatments. Therefore, the effectiveness analysis compared one experimental group with one control group, making the independent-samples t-test appropriate for the research design.

RESULT AND DISCUSSION

Validity of the Differentiated Teaching Materials

The differentiated teaching materials developed through the ADDIE model consisted of three readiness-based series (Series A, Series B, and Series C), which together formed a single differentiated instructional package. Although each series was designed to accommodate different levels of students' prior mathematical knowledge, all three addressed the same mathematical topic, learning objectives, and curriculum expectations. Therefore, the validity evaluation was conducted for the instructional package as a whole rather than for each series separately. Three experts in mathematics content, educational media, and language evaluated the overall quality of the materials, including the consistency of curriculum alignment, instructional design, and differentiation across the three series.

As summarized in Table 1, the differentiated teaching materials obtained an overall mean validation score of 4.23, placing them in the Very Valid category according to the conversion criteria adapted from (Budiyono, 2017). The mathematics content expert awarded the highest mean score (4.89), indicating strong alignment between the instructional content and the Phase D Learning Outcomes of the Merdeka Curriculum, as well as the appropriate implementation of differentiated instruction principles across the three series. The language expert assigned a mean score of 4.00 (Valid), confirming that the language used was appropriate for Grade 8 students. Meanwhile, the educational media expert awarded a mean score of 3.79 (Valid), indicating that the visual design was appropriate for classroom use, with minor revisions recommended regarding image quality and layout consistency.

Table 2. Summary of Expert Validation Results

Expert Validator	Aspects Assessed	Mean Score	Category
Content Expert	Content validity, presentation, differentiation	4.89	Very Valid
Language Expert	Language quality	4.00	Valid
Media Expert	Graphic design and layout	3.79	Valid
Overall Mean		**4.23**	**Very Valid**

These findings align with Nieveen's quality framework (Akker et al., 2006), which holds that a valid instructional product demonstrates consistency between its theoretical foundation and its practical implementation. The high content validity score reflects successful operationalization of differentiation-by-readiness principles: each series provides scaffolding calibrated to its target group's cognitive entry point, from concrete and guided support in Series A to open-ended, challenging tasks in Series C. This finding is consistent with Marks et al. (2021), who identified coherent content tiering as a foundational requirement of a differentiation practice framework for secondary mathematics. Revision suggestions from the media expert were incorporated prior to field implementation, particularly improvements in geometric illustration resolution and color contrast in section headers.

Practicality of the Differentiated Teaching Materials

Practicality was evaluated from two perspectives following the field trial. As shown in Table 3, student response reached 79.92% (Practical category), while teacher response reached 85.27% (Very Practical category).

Table 3. Practicality Assessment Results

Respondent	Percentage	Category
Students (n=31)	79.92%	Practical
Teacher	85.27%	Very Practical

Qualitative feedback from students revealed that Series A students found the step-by-step scaffolding and concrete visual representations substantially helpful in building prerequisite understanding before engaging with new content. Series C students described the open-ended problems and minimal guidance as appropriately challenging. Teacher responses highlighted that the pre-structured three-series format significantly reduced the planning burden associated with in-class differentiation. This finding echoes Courtney (2021) observation that DI implementation challenges are largely resolved when structured materials are provided, allowing teachers to focus on facilitation rather than ad hoc differentiation design. Comparison with Herwina (2021) work on optimizing student learning needs through differentiation reinforces that materials-supported differentiation enhances both student motivation and learning engagement, outcomes that extend beyond the measured practicality scores.

Effectiveness of the Differentiated Teaching Materials

The effectiveness of the differentiated teaching materials was evaluated by comparing the mathematics learning outcomes of the experimental and control groups following the classroom implementation. Before testing the research hypothesis, prerequisite statistical analyses were conducted to examine the assumptions of normality, homogeneity, and group equivalence based on the pretest scores. These analyses ensured that both groups were comparable prior to the intervention and that the assumptions for subsequent parametric analyses were satisfied.

Table 4. Normality Test Results for Prior Knowledge Data

Class	L-values	L-table	Decision	Conclusion
Control (VIII-C)	0.155	0.157	H_0 accepted	Normal
Experimental (VIII-I)	0.107	0.159	H_0 accepted	Normal

As shown in Table 4, the prior knowledge scores of both the experimental and control groups were normally distributed, as the calculated L-values were lower than the corresponding critical values. These results indicate that the normality assumption for parametric statistical analysis was satisfied in both groups.

Table 5. Homogeneity Test Results for Prior Knowledge Data

Variance (Control)	Variance (Experimental)	F-value	F-table	Conclusion
329.04	315.63	1.04	1.84	Homogeneous

Table 5 shows that the variances of the experimental and control groups were homogeneous ($F = 1.04 < 1.84$). This finding indicates that both groups exhibited comparable score variability, thereby satisfying the homogeneity assumption required for subsequent parametric analyses.

Table 6. Balance Test Results for Prior Knowledge Data

t-value	t-table	Decision	Conclusion
−0.415	1.999	H_0 accepted	The two groups were equivalent.

The balance test results presented in Table 6 indicate that there was no statistically significant difference in students' prior mathematical knowledge between the experimental and control groups before the intervention ($t = -0.415 < 1.999$). Therefore, the two groups were considered equivalent at the beginning of the study, ensuring that any differences observed in the posttest could be more confidently attributed to the instructional intervention rather than to initial differences in students prior knowledge.

After confirming that both groups had equivalent prior mathematical knowledge and satisfied the assumptions for parametric analysis, the effectiveness of the differentiated teaching materials was evaluated using students' posttest scores. The posttest data were first examined for normality and homogeneity before hypothesis testing.

Table 7. Normality Test Results for Posttest Data

Class	L-value	L-table	Decision	Conclusion
Control (VIII-C)	0.052	0.157	H_0 accepted	Normally distributed
Experimental (VIII-I)	0.092	0.159	H_0 accepted	Normally distributed

As presented in Table 7, the calculated L-values for both the control and experimental groups were lower than their respective critical L-values. These results indicate that the posttest scores of both groups were normally distributed. Therefore, the normality assumption required for subsequent parametric statistical analysis was satisfied.

Table 8. Homogeneity Test Results for Posttest Data

Class	Variance	F-value	F-table	Conclusion
Control (VIII-C)	115.54	1.51	1.84	Homogeneous
Experimental (VIII-I)	76.32			

The homogeneity test results presented in Table 8 show that the calculated F-value (1.51) was lower than the critical F-value (1.84). This finding indicates that the posttest score variances of the experimental and control groups were homogeneous, confirming that the homogeneity assumption for the independent-samples t-test was fulfilled.

Table 9. Posttest Results

Class	Student Enrollment	Average Posttest Score
Control (VIII-C)	32	71.06
Experimental (VIII-I)	31	78.42

Table 9 presents the descriptive statistics of the posttest scores for both groups. The experimental group achieved a higher mean posttest score (78.42) than the control group (71.06), indicating better mathematics learning outcomes following the implementation of the differentiated teaching materials. However, whether this difference was statistically significant was further examined using an independent-samples t-test.

Table 10. One-Tailed Independent *t*-Test Results for Posttest Data

Item	Value
t-value	2.976
t-table	1.670
Decision	H_0 rejected
Conclusion	The mean mathematics learning achievement of students in the experimental group was significantly higher than that of students in the control group.

The independent-samples t-test results presented in Table 10 indicate that the calculated t-value (2.976) exceeded the critical t-value (1.670) at the 0.05 significance level. Therefore, the null hypothesis was rejected, indicating the mean mathematics learning achievement of students in the experimental group was significantly higher than that of students in the control group. These findings confirm that the differentiated teaching materials were significantly more effective than the conventional teaching materials in improving students' mathematics learning outcomes.

The findings of this study demonstrate that the differentiated teaching materials developed based on students' prior mathematical knowledge effectively supported mathematics learning in a heterogeneous classroom. Rather than providing identical learning experiences for all students, the three readiness-based series enabled students to receive instructional support appropriate to their levels of prior mathematical knowledge while maintaining common learning objectives and assessment standards. This instructional design likely contributed to the higher mathematics learning outcomes achieved by the experimental group compared with the control group.

These findings are consistent with those reported by Prast et al. (2018), who demonstrated that differentiated instruction based on students' prior mathematical knowledge significantly improves mathematics achievement when supported by well-designed instructional materials. Similarly, Insorio (2024) found that tiered differentiated learning activities enhance mathematics learning outcomes across students with different levels of prior knowledge by providing instructional support that corresponds to learners' readiness. The present findings are also supported by the systematic review conducted by Ziernwald et al. (2022), which concluded that differentiated instruction implemented according to students' readiness consistently produces positive learning outcomes in heterogeneous classrooms. Collectively, these studies reinforce the present findings that differentiated teaching materials can effectively facilitate mathematics learning by accommodating variations in students' prior mathematical knowledge without altering curriculum expectations.

The present findings are further supported by Valiandes (2015), who reported that differentiated instruction improves not only students' academic achievement but also promotes more equitable learning opportunities in mixed-ability classrooms. Consistent with these findings, the differentiated teaching materials developed in this study enabled students with different levels of prior mathematical knowledge to achieve the same curriculum objectives through instructional support tailored to their readiness levels rather than through differentiated curriculum expectations.

Compared with previous studies conducted in Indonesia, the present study contributes to the growing body of research on differentiated mathematics instruction by emphasizing the systematic development of teaching materials rather than focusing solely on classroom implementation or learning media. For example, Safitri, (2023) developed differentiated learning media based on students' learning styles, whereas Nurasiah et al. (2020) investigated the implementation of differentiated instruction without developing structured instructional materials. In contrast, this study developed a differentiated teaching material package consisting of three readiness-based series that were systematically designed, validated, and evaluated through the ADDIE development model. Although the three series differed in the level of instructional support provided, all maintained identical curriculum objectives, mathematical content, and assessment standards, thereby ensuring equitable learning opportunities for students with different levels of prior mathematical knowledge.

The findings also provide practical implications for mathematics teachers implementing differentiated instruction under the Merdeka Curriculum. The developed teaching materials demonstrate that differentiated instruction can be implemented without modifying curriculum expectations or preparing entirely different lesson plans for individual students. Instead, differentiation can be achieved through systematic adjustments in conceptual explanations, instructional scaffolding, worked examples, guided learning activities, and practice tasks while maintaining common learning objectives. This approach may reduce teachers' instructional planning burden while providing learning support that is more responsive to students' diverse prior mathematical knowledge, consistent with the instructional framework proposed by Marks et al. (2021).

From a development research perspective, the study demonstrates that the ADDIE model provides a systematic framework for producing differentiated teaching materials that satisfy the three quality criteria of validity, practicality, and effectiveness. The positive evaluation obtained across these dimensions indicates that structured instructional development can support the successful implementation of differentiated instruction in Indonesian junior secondary mathematics classrooms. Consequently, the differentiated teaching materials developed in this study may serve as an alternative instructional resource for teachers seeking to accommodate learner diversity while maintaining curriculum consistency.

CONCLUSION

This study developed differentiated teaching materials for the topic of Flat-Sided Solid Figures based on students' prior mathematical knowledge using the ADDIE instructional design model. The findings demonstrated that the developed materials satisfied the established quality criteria of validity, practicality, and effectiveness. Students who learned using the differentiated teaching materials achieved significantly higher mathematics learning outcomes than those who learned using conventional instructional materials, indicating that the developed materials effectively supported learning in academically heterogeneous classrooms.

From a theoretical perspective, this study provides additional empirical evidence that students' prior mathematical knowledge can serve as an appropriate basis for designing differentiated teaching materials in mathematics education. Rather than emphasizing a single instructional approach for all learners, the findings illustrate how structured instructional materials can accommodate different levels of learning readiness while maintaining common curriculum objectives.

Practically, the three-series teaching materials offer mathematics teachers a ready-to-use instructional resource for implementing differentiated instruction within the Merdeka Curriculum. By providing different levels of instructional support without requiring separate lesson objectives, the materials may help teachers manage classroom diversity more effectively while reducing instructional preparation time.

Future studies are encouraged to expand the development of differentiated teaching materials to other mathematics topics and educational levels, examine their implementation in broader educational contexts, and integrate additional dimensions of differentiation, such as students' interests and learning profiles, to further enrich differentiated mathematics instruction.

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