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Development of Differentiated Learning Tools with Mathematics Problem Solving Based on ESD to Improve Critical Thinking Skills of Junior High School Students

Dian Kurniati[1*], Afni Nur Rosyidah[2], Randi Pratama Murtikusuma[3], Didik Sugeng Pambudi[4], Nurcholif Diah Sri Lestari[5], Sharifah Osman[6], Percy Sepeng[7]

[1*,2,3,4,5]Mathematics Education, Universitas Jember
Jalan Kalimantan No. 37, Kampus Tegalboto, Jember, East Java, Indonesia
[1*]*dian.kurniati@unej.ac.id; afninurrr30@gmail.com*; [3]*randipratama@unej.ac.id*;
[4]*didikpambudi.fkip@unej.ac.id*; [5]*nurcholif.fkip@unej.ac.id*

[6]Mathematics Education, Universiti Teknologi Malaysia
81310 UTM, Skudai, Johor, Malaysia
[6]*sharifah.o@utm.my*

[7]Mathematics Education, University of KwaZulu-Natal
238 Mazisi Kunene Rd, Glenwood, Durban, 4041, South Africa
[7]*percy.sepeng@gmail.com*

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Abstrak

Rendahnya kemampuan berpikir kritis siswa SMP dan keterbatasan perangkat pembelajaran berbasis Education for Sustainable Development (ESD) menjadi latar belakang penelitian ini. Penelitian ini bertujuan mengembangkan perangkat pembelajaran matematika pada materi perbandingan (senilai, berbalik nilai, dan skala) untuk meningkatkan kemampuan berpikir kritis siswa. Menggunakan model pengembangan 4D (Define, Design, Develop, Disseminate), penelitian dilakukan terhadap 32 siswa kelas VII C SMP Negeri 12 Jember. Instrumen pengumpulan data meliputi lembar validasi, observasi keterlaksanaan, tes hasil belajar, dan angket respons siswa. Hasil penelitian menunjukkan perangkat pembelajaran memenuhi kriteria: Valid, dengan rerata 3,92; Praktis, dengan persentase respons siswa 87% dan keterlaksanaan 100%; serta Efektif, dengan peningkatan hasil belajar melalui skor N-Gain sebesar 87%. Simpulan penelitian ini menunjukkan bahwa perangkat pembelajaran berbasis ESD layak digunakan dan berpotensi menjadi alternatif untuk meningkatkan kemampuan berpikir kritis siswa.
***Kata Kunci**: Perangkat Pembelajaran; Pemecahan Masalah; ESD; Berpikir Kritis.*

Abstract

The low critical thinking skills among junior high school students and the lack of learning resources based on Education for Sustainable Development (ESD) underpin this research. This study aims to develop mathematics learning materials on the topic of ratios—covering direct proportions, inverse proportions, and scales—to enhance students' critical thinking skills. Employing the 4D development model (Define, Design, Develop, Disseminate), the study involved 32 seventh-grade students at SMP Negeri 12 Jember. Data collection instruments included validation sheets, observation forms for instructional implementation, learning achievement tests, and student response questionnaires. The results indicate that the developed materials meet the following criteria: Valid, with an average score of 3.92; Practical, evidenced by an 87% student response rate and 100% instructional implementation; and Effective, demonstrated by an N-Gain score of 87% in learning outcomes. In conclusion, the ESD-based learning materials are feasible for classroom use and serve as a viable alternative to improve students' critical thinking skills.
Keywords: Learning Tools; Problem Solving; ESD; Critical Thinking Skills.

I. INTRODUCTION

Critical thinking skills among Indonesian students remain relatively low, particularly at the junior high school level. This observation aligns with Paringin in Basthomi (2021), who states that the critical thinking abilities of junior high students are underdeveloped or insufficient. Critical thinking constitutes an individual's ability to manage information to make logical decisions based on facts (Kurniati et al., 2023). Students are expected to prioritize critical thinking as it involves analysis, evaluation, and problem-solving in complex situations (Dewi et al., 2025). Mathematical problem-solving trains students to think critically and analytically, discover creative solutions, and enhance logical reasoning (Herawati et al., 2025). This approach can be implemented within learning contexts utilizing Education for Sustainable Development (ESD) themes. According to Jumirah et al. (2021), environmental awareness among students remains low; thus, integrating ESD into instruction is crucial for facing future global challenges. ESD is not merely a thematic context but a pedagogical framework requiring students to analyze, weigh various perspectives, and make responsible decisions. In the context of mathematics, ESD provides authentic, ill-structured problems that can stimulate students' critical thinking (UNESCO, 2017).

As is widely acknowledged, every student possesses varying levels of ability (Alami et al., 2021). Consequently, teachers must create learning environments that accommodate these diverse critical thinking levels, such as through differentiated instruction, given that conventional methods are often ineffective (Andrian, 2024). Differentiated instruction can be optimized through the availability of adequate instructional materials. Instructional materials are a collection of tools and resources that enable students and teachers to carry out learning activities effectively (Hobri, 2010). These materials are considered a fundamental necessity in executing the learning process (Murtikusuma, 2015; Susilowati et al., 2025).

While Research and Development (R&D) on instructional materials is extensive, the development of differentiated learning materials integrating mathematical problem-solving based on ESD remains scarce. This is despite its high relevance for future generations and the enhancement of students' critical thinking within the context of sustainable development. Previous researchers have examined differentiation, mathematical problem-solving, or ESD separately; however, the simultaneous integration of these three approaches within junior high school mathematics remains limited. This limitation is attributed to the complexity of designing materials that must synergize individual adaptation (differentiation), mathematical cognitive processes (problem-solving), and sustainability values (ESD) into a coherent instructional unit. Theoretically, junior high school students are at a cognitive developmental stage where critical thinking and socio-environmental awareness begin to develop rapidly, suggesting that mathematics instruction integrating these three aspects could yield a more holistic and meaningful impact.

Previous studies, such as Hidayanti et al. (2016), focused on developing problem-

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solving-based materials to enhance critical thinking but require updates to align with the implementation of the Merdeka Curriculum in Indonesia. Furthermore, research by Puspitasari et al. (2020) and Suhaeri & Firdaus (2022) emphasized material development for senior high school (SMA) students using non-mathematical content. Additionally, Syafitri & Hamdu (2023) developed ESD-based e-modules for elementary school (SD) students. Therefore, there is a pressing need to develop ESD-based mathematics instructional materials specifically for the junior high school (SMP) level.

Based on this gap analysis, this research stems from the problem that existing mathematics instructional materials for junior high schools are inadequate. Consequently, instruction tends to be unresponsive to student diversity, fails to sufficiently train mathematical reasoning in real-world contexts, and minimizes the cultivation of sustainability awareness. Therefore, this study aims to develop mathematics instructional materials capable of enhancing students' critical thinking skills, meeting the criteria of validity, practicality, and effectiveness. Based on the aforementioned background, a development research study is conducted titled "Development of Differentiated Instructional Materials with ESD-Based Mathematical Problem Solving to Improve Critical Thinking Skills of Junior High School Students." The research questions addressed are: (1) How is the process of developing valid, practical, and effective differentiated instructional materials with ESD-based mathematical problem solving to improve junior high school students' critical thinking skills? (2) What are the results of the development of these valid, practical, and effective instructional materials?

II. METHOD

This study employs a Research and Development (R&D) approach to develop instructional materials comprising learning modules, student worksheets (LKPD), learning achievement tests, and usage guidelines. The development model adopted is the 4D model by Thiagarajan et al. (1974), consisting of four stages: Define, Design, Develop, and Disseminate.

In the Define stage, observations and interviews were conducted to identify learning needs, aimed at understanding the context and challenges faced by students and determining the necessary specifications for the instructional materials. The Design stage involved constructing tests, selecting media, and formatting the materials to align with student needs and established learning objectives. The designed materials incorporate critical thinking indicators, as exemplified in the construction of the achievement test shown in Figure 1 and Figure 2.

Di sekolah, terdapat program kesehatan untuk meningkatkan kebugaran siswa dengan melakukan aktivitas fisik seperti lari pagi. Setiap siswa disarankan untuk membakar minimal 200 kalori per minggu dan tiap kilometer yang ditempuh membakar 50 kalori. Saat ini, terdapat dua kelas yang mengikuti program yaitu kelas A dan kelas B. Kelas A terdapat 20 siswa dengan rata-rata tempuh tiap siswanya sejauh 6 km per minggu. Sedangkan kelas B terdapat 25 siswa dengan rata-rata tempuh tiap siswanya sejauh 4 km per minggu. Berapakah total kalori yang dibakar oleh masing-masing kelas? Kemudian tentukan apakah kedua kelas tersebut sudah mencapai target yang disarankan?

Figure 1. Example of test items.

Indikator	3	2	1	0
Interpretasi	Siswa dapat menuliskan yang diketahui dan ditanya pada soal secara tepat dan lengkap	Siswa dapat menuliskan yang diketahui dan ditanya pada soal, namun memiliki satu kesalahan	Siswa dapat menuliskan yang diketahui dan ditanya pada soal, namun memiliki lebih dari satu kesalahan	Tidak menuliskan yang diketahui dan ditanya
Analisis	Siswa dapat membuat model matematika dari soal yang diberikan dengan tepat dan benar disertai penjelasan	Siswa dapat membuat model matematika dari soal yang diberikan namun memiliki satu kesalahan	Siswa dapat membuat model matematika dari soal yang diberikan namun memiliki lebih dari satu kesalahan	Tidak Membuat model matematika dari soal yang diberikan

Indikator	3	2	1	0
Evaluasi	Siswa dapat menuliskan langkah penyelesaian dengan strategi yang lengkap dan tepat dalam perhitungan	Siswa dapat menuliskan langkah penyelesaian dengan strategi yang lengkap dan tepat namun ada kesalahan dalam perhitungan	Siswa dapat menuliskan langkah penyelesaian dengan strategi yang tidak tepat dan tidak lengkap	Tidak menggunakan strategi dan tidak menuliskan langkah penyelesaian
Inferensi	Siswa dapat menuliskan kesimpulan dengan tepat dan sesuai berdasarkan permasalahan yang ada pada soal	Siswa dapat menuliskan kesimpulan dengan lengkap namun tidak sesuai dengan jawaban	Menuliskan kesimpulan yang tidak lengkap dan tidak sesuai dengan jawaban	Tidak menuliskan kesimpulan

Figure 2. Example of an assessment rubric containing critical thinking indicators.

In the Develop stage, expert validation and field trials were conducted to measure the effectiveness of the materials, ensuring they met the criteria of validity, practicality, and effectiveness for classroom implementation. Finally, the Disseminate stage aimed to distribute the validated materials to a wider audience of teachers and students to maximize their positive impact. The modified 4D model diagram used in this study is presented in Figure 3.

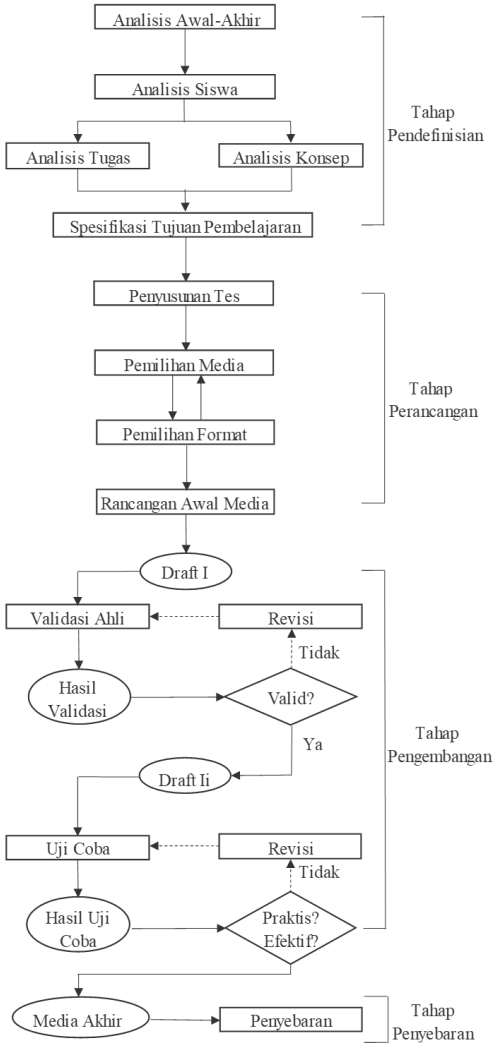

Figure 3. Diagram of the Modified 4D Model.

Differentiation strategies were implemented by grouping students based on their scores from a critical thinking diagnostic test. Each group worked on Student Worksheets (LKPD) with varying difficulty levels (high, medium, and low) but within the same ESD theme. The content of the LKPD differed for each group: the high-ability group encountered more gap-fill sections (*rumpang*) and higher-difficulty problems (open-ended analytical); the medium group faced a moderate number of gap-fill sections with standard-difficulty problems; while the low group had fewer

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gap-fill sections with standard-difficulty problems.

Furthermore, scaffolding strategies varied across groups. For the high-ability group, students were encouraged to explore answers independently through group discussion. For the medium group, the researcher provided occasional assistance when discussions stalled. For the low-ability group, the researcher provided intensive guidance throughout the completion process. During instruction, the researcher acted as the teacher. To minimize bias, two independent observers, a mathematics teacher and a mathematics education student, were involved to assess instructional implementation using structured observation sheets. Collected data were analyzed quantitatively (N-Gain, descriptive statistics) and qualitatively (thematic analysis of student responses and observation notes).

The research was conducted at SMP Negeri 12 Jember, with 32 students from Class VII C serving as trial subjects. The selection of the site and subjects was based on preliminary interviews with the mathematics teacher, which indicated low critical thinking skills among students, school availability, and the absence of ESD-based instructional materials at the institution.

Data analysis methods included assessments of the validity, practicality, and effectiveness of the instructional materials based on specific criteria. The materials were deemed valid if the average validation score (V_a) fell within the range of $3 \leq V_a \leq 4$. The materials were considered practical if the student response questionnaire percentage (P) was between $80\% \leq P \leq 95\%$ and the instructional implementation score ranged from 61% - 100%. Finally, the materials were classified as effective if the interpretation of N-Gain effectiveness showed a percentage of $P > 75\%$.

III. RESULT AND DISCUSSION

The product of this research is a set of instructional materials developed using Thiagarajan's 4D model, comprising the following stages: 1) Define Stage: This stage aimed to establish and define instructional requirements by analyzing learning objectives and material constraints relevant to the development of the instructional materials; 2) Design Stage: In this stage, instructional materials were designed based on the needs identified in the Define stage. This process resulted in the initial prototype (Draft I), which was subsequently subjected to expert validation and field trials upon meeting validity criteria; 3) Develop Stage: This stage involved expert validation of Draft I. Once validated and revised based on expert feedback and suggestions, and after the materials were declared valid, they proceeded to the field trial phase; 4) Disseminate Stage: This stage was executed once the materials were confirmed as valid, practical, and effective based on the validation and trial results. Dissemination was conducted at the research site, SMP Negeri 12 Jember, by distributing the digital files of the instructional materials to mathematics teachers. Additionally, online dissemination was carried out via Instagram by sharing a Google Drive link, allowing broader public access to the complete set of instructional materials. The developed

instructional materials successfully met the criteria for validity, practicality, and effectiveness. Validity of Instructional materials based on the analysis of the validation data, a validity coefficient was obtained for the instructional materials, as illustrated in Figure 4.

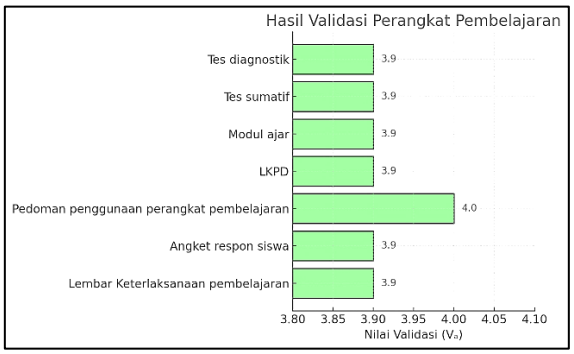

Figure 4. Validity Results of the Instructional Materials.

The validation results for all seven components of the instructional materials fall within the score interval $3 \leq V_a \leq 4$, categorizing them as valid. Several items on the validation sheet, specifically regarding adherence to standard spelling and grammar conventions, did not receive the maximum score of 4. This was attributed to minor typographical errors within the materials, which slightly impacted the overall validity score. Nevertheless, the obtained validation results confirm that the developed instructional materials meet the necessary validity criteria to proceed to the field trial phase.

Practicality was assessed based on student response questionnaires and instructional implementation observation sheets. The analysis revealed that the student response questionnaire yielded a score of 87%, which is classified in the "Good" category, as illustrated in Figure 5.

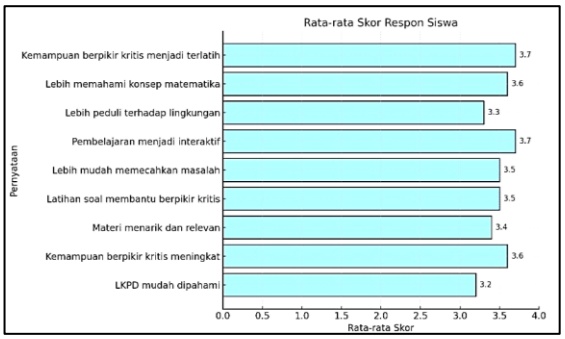

Figure 5. Student Response Questionnaire Results.

Regarding instructional implementation, a score of 100% was achieved, indicating that all learning activities structured within the teaching modules were successfully executed, classifying the implementation as "very practical." Meanwhile, the student response questionnaire yielded an 87% score, categorizing the materials as "practical." The score did not reach 100% due to specific factors; notably, some students encountered difficulties with challenging problems, which influenced them to provide lower ratings on the questionnaire. First, while the majority of students responded positively, a subset experienced difficulties understanding certain aspects of the materials, reflected in the variation of assessment scores. Second, differences in students' comprehension levels and abilities to follow the lesson may have influenced their assessment of the materials' practicality. Nevertheless, it can be concluded that the developed instructional materials are practical, as they demonstrated ease of use for both students and teachers.

Effectiveness criteria were measured using N-Gain categories derived from diagnostic and summative test scores. Based on the analysis, the average N-Gain for each student fell into the "high"

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category, with no subjects classified in the "low" category.

Tabel 1.
Results of Diagnostic and Summative Tests

	Diagnostic Test	Summative Test
Mean	17,03	33,66
Standard Deviation	4,69	2,47
Lowest Score	6	27
Highest Score	24	36
Interpretation	The majority of students were in the moderate ability category prior to using the LKPD.	The majority of students reached the high category after using the LKPD.

Table 1 indicates that following the use of LKPD integrated with differentiated instruction and ESD-based mathematical problem solving, there was a significant improvement in students' critical thinking skills. The score distribution shifted from the moderate to the high category, with the mean score increasing from 17.03 to 33.66. The decrease in standard deviation from 4.69 to 2.47 suggests that student achievement became more homogeneous following the instructional intervention.

Tabel 2.
N-Gain Analysis of Diagnostic and Summative Tests

	Value
Total Student Diagnostic Score	543
Total Student Summative Score	1070
Total N-Gain	27,98
Effectiveness Interpretation Percentage	$\frac{27,98}{32} \times 100 = 87\%$

As shown in Table 2, the effectiveness interpretation of the instructional materials was found to be **87%**, falling into the **effective** category. This indicates that while effective, individual outcomes from using the materials varied among students. However, based on the overall research results, the materials are deemed effective due to the observed increase in learning test scores before and after the use of the LKPD. The LKPD facilitated students' critical thinking, as it incorporated critical thinking indicators and mathematical problem-solving steps.

The developed instructional materials, having been declared valid, practical, and effective, can be accessed via the barcode presented in Figure 6.

Gambar 6. Barcode for the Valid, Practical, and Effective Instructional Materials.

Discussion

The instructional materials tested in this study met the criteria for validity, practicality, and effectiveness. Validity was demonstrated by a total average score (V_a) of 3.92 from three validators. Practicality was reflected in the student response questionnaire, which reached 87%, and the instructional implementation sheet, which achieved 100%, indicating that the materials were easy to use and implement. The analysis also demonstrated the effectiveness of the materials, with an N-Gain score of 87%, proving an improvement in students' critical thinking skills. This finding is supported by constructivist theory, where the ESD context (such as

waste management or energy consumption) presents authentic problems that stimulate students' innate curiosity. When facing real-world problems relevant to their lives, students are naturally driven to analyze information, compare options, and make data-based decisions, processes that constitute the core of critical thinking.

This study aligns with findings by Setiawan (2023) and Aisah et al. (2024), who underscored the importance of positive student responses and significant differences between pre-test and post-test results. The differentiated design facilitated this improvement by providing "learning ladders" appropriate for each student group. Students with high prior ability received more complex analytical challenges, while students with low prior ability received step-by-step guidance to build their confidence. The highest improvement observed in the low-ability group can be explained by appropriate scaffolding, which helped them access materials previously perceived as difficult.

These materials were designed to train students in critical thinking according to Facione's indicators by integrating sustainability issues into mathematics learning. This aligns with Mulyani & Prabowo (2022), who stated that incorporating sustainability issues in education helps form a generation that is more concerned and critical of their environment. Furthermore, Mulyadiprana et al. (2023) noted that linking mathematical concepts with sustainability issues allows students to develop better critical thinking skills as they learn to analyze and evaluate situations. This is particularly relevant given that junior high school students are at a stage of developing social awareness and self-identity, making sustainability issues highly relevant and motivating.

The study employed a differentiated instruction approach, wherein the developed Student Worksheets (LKPD) were tailored to students' critical thinking abilities. This approach was proven to enhance students' thinking skills, supported by Lestari, Alim & Noviyanti (2024), who stated that applying differentiated instruction increases student learning outcomes in mathematics as students feel more engaged and motivated. Learning need not be abstract; teachers can start with simple local problems around the school, offer tasks with varying difficulty levels, and focus discussions on thinking processes and mathematical argumentation rather than merely final answers. Through this approach, mathematics transforms from mere calculation into a tool for understanding and solving real-world problems, while simultaneously building a critical and environmentally conscious generation.

This study presents both strengths and limitations. The strengths of the instructional materials include learning modules aligned with the latest curriculum and LKPD that incorporate ESD themes solved through mathematical problem-solving steps capable of eliciting critical thinking indicators, consistent with Festina & Warniasih (2021). The limitation lies in the dissemination process, which remains restricted; thus, expanding the reach is recommended to allow more teachers access to these materials.

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Based on the research results, both practical and theoretical implications are derived. Practically, this study demonstrates that developing differentiated instructional materials with ESD-based mathematical problem solving can significantly improve junior high school students' critical thinking skills. Consequently, it serves as an effective solution to address low critical thinking abilities and can be integrated into the existing curriculum. Theoretically, the study suggests that ESD implementation can equip students with an awareness of critical sustainability issues for the future. It also serves as input for teachers to consider students' learning abilities through appropriate instructional approaches. Therefore, further development of these materials is expected to reach more schools and enhance the quality of education in Indonesia.

Although this study successfully developed valid, practical, and effective instructional materials, several limitations must be noted: 1) Limited Dissemination: The dissemination process was restricted to one school and limited online platforms, thereby constraining accessibility for teachers in other schools; 2) Scope of Material: The study focused solely on the topic of Ratio and Proportion in mathematics; thus, the effectiveness of the materials in other mathematical contexts or subjects remains unexplored; and 3) Potential Bias: The researcher acted as the model teacher during the study, which may have introduced bias. Consequently, it is recommended that future studies utilize a regular classroom teacher or another individual to ensure greater objectivity.

Based on these limitations, future research is recommended to expand the dissemination stage by involving more schools with diverse characteristics—in terms of location, school conditions, and student backgrounds—to enhance the generalizability and accessibility of the materials. Additionally, the development of differentiated instructional materials with ESD-based mathematical problem solving should be applied to other mathematics topics and different educational levels to test the consistency of their effectiveness in improving critical thinking skills. Future studies are also advised to involve classroom teachers or external teachers as model teachers to ensure that the instructional implementation is more objective and reflective of actual classroom conditions.

IV. CONCLUSION

The development of differentiated instructional materials integrated with ESD-based mathematical problem solving, utilizing Thiagarajan's 4D model (Define, Design, Develop, and Disseminate), successfully yielded a product capable of enhancing the critical thinking skills of junior high school students, particularly regarding the topic of ratios. The development results indicate that the instructional materials fulfill the criteria of validity, practicality, and effectiveness. Specifically, the materials achieved an average validity score of 3.92 from three validators; a practicality rating of 87% based on student response questionnaires and 100% based on instructional implementation sheets; and an effectiveness rating of 87% based on N-Gain

interpretations derived from pre-test and post-test learning outcomes.

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REFERENCES

Aisah, N. *et al.* (2024). Pengembangan Modul Pembelajaran Matematika Berdiferensiasi untuk Meningkatkan Kemampuan Berpikir Kritis Siswa, *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 08(50), pp. 367–380. Available at: https://doi.org/10.31004/cendekia.v8i1.2669

Alami N. I. O., Sutisnawati, A., & Uswatun, D. A. (2021). Analisis Kemampuan Berpikir Kritis Siswa Pada Pembelajaran Tematik Di Kelas Tinggi Sekolah Dasar. *Jurnal Elementaria Edukasia, 4(2), 311–320. https://doi.org/10.31949/jee.v4i2.3276*

Andrian, E. (2024). Pengembangan Keterampilan Berpikir Kritis Melalui Pembelajaran Berbasis Masalah. *Jurnal Pendidikan Sosial Indonesia*, *2*(1), 9–21. https://doi.org/10.62238/jupsijurnalpendidikansosialindonesia.v2i1.69

Basthomi, A. Y., Afrianti, N. L., & Khairiah, Y. F. (2021). Analisis Keterampilan Berpikir Kritis Siswa SMP. *Pekan Ilmiah Mahasiswa Fkip UNIS, 1(1), 346–355.*

Dewi, Y. K., Khalid, A., & Agam, A. A. (2025). *The Role of Critical Thinking Skills in Enhancing Problem-Solving Abilities among High School Students.* Journal of Education and Social Science, 2(1), 19–24. https://doi.org/10.70716/jess.v2i1.191

Festina, Z. I., & Warniasih, K. (2021). Pengembangan LKPD Berbasis Problem Based Learning untuk Memfasilitasi Kemampuan Pemecahan Masalah Matematika Kelas X MIPA SMA N 1 Kasihan. *Indonesian Journal Of Education,* 1(4), 185–194.

Herawati, H., Buditjahjanto, I. G. P. A., & Anifah, L. (2025). *The Effect of Analytical Thinking and Critical Thinking on Mathematical Problem Solving Ability. Jurnal Ilmiah Ilmu Pendidikan, 8(2), 1648–1652.* https://doi.org/10.54371/jiip.v8i2.6666

Hidayanti, D., As'ari, A. R., & Candra, T. D. (2016). Pengembangan Perangkat Pembelajaran Siswa Smp Kelas Ix. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *1*, 634–649. https://doi.org/10.17977/jp.v1i4.6215

Hobri (2010). *Metode Penelitian Pengembangan (Aplikasi Pada Penelitian Pendidikan Matematika).* Jember: Pena Salsabila.

Jumirah, J., Sari, P. A., Kusnadi, E., & Oktaviani, A. D. (2021). Analisis Kesadaran Lingkungan Siswa Sekolah Pada Kegiatan Green-Chemistry Dalam Kondisi New Normal Pandemi Covid-19. *DIKSAINS : Jurnal Ilmiah Pendidikan Sains*, *2*(1), 31–36. https://doi.org/10.33369/diksains.v2i1.19793

Kurniati, K., Chotimah, S., & Waluya, S. B. (2023). Berpikir Kritis Siswa Berkepribadian Sensing, Intuition, Thinking Dan Feeling Dalam

p-ISSN: 2086-4280
e-ISSN: 2527-8827

Menyelesaikan Masalah Dengan Informasi Kontradiksi. *Jurnal Edukasi Dan Sains Matematika (JES-MAT)*, *9*(1), 1–14. https://doi.org/10.25134/jes-mat.v9i1.8286

Lestari, F., Alim, J. A., & Noviyanti, M. (2024). *Implementation of Differentiated Learning to Enhance Elementary School Students' Mathematical Critical and Creative Thinking Skills.* International Journal of Elementary Education, 8(1). https://doi.org/10.23887/ijee.v8i1.64295

Mulyadiprana, A., Rahman, T., Hamdu, G., & Yulianto, A. (2023). Kesadaran Keberlanjutan Siswa pada Aspek Pengetahuan Melalui Penerapan Program Education For Sustainable Developmnet (ESD) di Sekolah Dasar. *Edukatif : Jurnal Ilmu Pendidikan*, *5*(1), 577–585. https://doi.org/10.31004/edukatif.v5i1.5147

Mulyani, S., & Prabowo, H. (2022). Pengaruh Pendekatan ESD Terhadap Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan dan Teknologi*, 110(2), 99-110. https://doi.org/10.22236/jpt.v110i2.8379

Murtikusuma, R. P. (2015) 'Pengembangan Perangkat Pembelajaran Matematika Model Problem-Based Learning Berbantuan Media Powerpoint Untuk Siswa Kelas XI SMK Materi Barisan dan Deret', *Saintifika*, 17(2), pp. 20–33. Available at: http://jurnal.unej.ac.id/index.php/STF/article/view/2733

Puspitasari, V., Rufi'i, R., & Walujo, D. A. (2020). Model Diferensiasi Menggunakan Book Creator Untuk. *Education and Development*, *8*(4), 310–319. https://doi.org/10.37081/ed.v8i4.2215

Setiawan, M. N., Fatahillah, A., & Adawiyah, R. (2023). Pengembangan Media Pembelajaran Berbantuan Lectora Inspire dan Plotagon pada Materi SPLDV untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Tadris Matematika*, 6(2), 275–290. https://doi.org/10.20414/jtq.v6i2.8176

Suhaeri, S., & Firdaus, D. (2022). Pengembangan Perangkat Pembelajaran Berbasis Diferensiasi dalam Pembelajaran Biologi Pada Kelas X SMA Negeri 16 Bone. *Journal of Biological Education*, *7*(1). https://doi.org/10.33474/jobe.v7i1.15712

Susilowati, S., Sajidan, & Ramli, M. (2025). Keefektifan perangkat pembelajaran berbasis inquiry lesson untuk meningkatkan keterampilan berpikir kritis siswa. Jurnal Penelitian dan Evaluasi Pendidikan. https://doi.org/10.21831/pep.v22i1.17836

Syafitri, N. F. dan Hamdu, G. (2023). Pengembangan E-Modul Berbasis Education for Sustainable Development Untuk Kelas Iv Sekolah Dasar. *Jurnal Pendidikan Dasar*, 11(1), pp. 12–25. https://doi.org/10.46368/jpd.v11i1.763

Thiagarajan, S. , Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Indiana: Indiana University Bloomington.

UNESCO. (2017). *Education for Sustainable Development Goals: Learning objectives*. United Nations Educational, Scientific and Cultural Organization. https://doi.org/10.54675/CGBA9153