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Improving Elementary Students' Mathematical Problem-Solving Skills through the Development of Heyzine-Based STEM E-Worksheets Integrated with PBL

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Abstract
This study aims to develop STEM-based electronic student worksheets using the Heyzine platform, integrated with the Problem-Based Learning (PBL) model. The primary objective is to improve the mathematical problem-solving skills of fifth-grade elementary school students, specifically regarding composite area measurement. This research employs the Research and Development (R&D) method following the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). Quantitative data were gathered through expert validation (covering content, language, and design), product trials, and effectiveness testing using pre-test and post-test scores. Qualitative data were obtained from interviews, observations, and teacher and student response questionnaires. The results indicate that the STEM based E-Worksheet integrated with the PBL model is highly feasible, receiving a 94% response rate from teachers and 94.6%–100% from students, both categorized as "Excellent." Effectiveness testing showed an improvement in problem-solving skills, with N-Gain scores in the following aspects: understanding the problem (95%, High), devising a plan (83%, High), carrying out the plan (53%, Moderate), and looking back (53%, Moderate). In conclusion, the STEM based E-Worksheet integrated with the PBL model is effective in enhancing the mathematical problem-solving skills of fifth-grade elementary school students. This research provides a practical contribution for elementary school teachers in developing interactive and contextual digital mathematics learning media, which is highly relevant to the implementation of the Merdeka Curriculum.
Keywords: E-Worksheets; Heyzine; STEM Education; Problem-Based Learning; Mathematical Problem Solving.

INTRODUCTION

Mathematics education at the elementary school level serves as the fundamental cornerstone for developing critical cognitive capacities. Through mathematics, young learners cultivate logical, analytical, and systematic thinking patterns, while simultaneously learning to bridge abstract concepts with real-world contexts. In the Indonesian curriculum context, this aligns with the strategic objectives outlined by BSKAP (2025, pp. 107-108), which emphasize two primary competencies: (1) mathematical problem-solving, encompassing the ability to understand problems, design mathematical models, execute solutions, and interpret outcomes; and (2) mathematical connections, which require linking mathematical facts, concepts, principles, and operations across disciplines and everyday life. Consequently, contemporary instructional designs must transition toward problem-based, contextual, and interdisciplinary approaches that prioritize cognitive processes over mere rote memorization (Amran, 2025).

However, a significant gap persists between these idealized curricular goals and global empirical realities. International assessments consistently indicate that primary student performance in mathematics remains substandard. The Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) data historically reveal that Indonesian students encounter severe challenges in higher-order thinking tasks, particularly in mathematical problem-solving and spatial-geometric reasoning. This global vulnerability is mirrored at the national level by the Indonesian National Assessment, which consistently indicates that a substantial percentage of elementary students score below the minimum competency threshold in mathematical literacy. Previous literature corroborates that these deficiencies stem from conventional learning environments that overlook conceptual understanding, causing widespread mathematical anxiety and subpar learning outcomes (Huda et al., 2025; Rachmadi et al., 2025).

The pedagogical challenge sharpens significantly within the domain of geometry, specifically regarding composite area measurement for upper-grade elementary students. Based on the BSKAP Kemendikdasmen No. 46 of 2025 for Phase C (Grade V), the learning outcomes explicitly mandate that students must possess the capability to determine the area of various plane figures including triangles, quadrilaterals, and polygons—and their complex combinations. Curricular and textbook analyses reveal that geometry is frequently taught through abstract, formulaic drillings, neglecting the concrete, meaningful, and engaging experiences needed by digital-native learners. Bridging this abstract geometric domain requires innovative, structured teaching materials that act as pedagogical scaffolds, notably through the development of interactive Electronic Student Worksheets (E-Worksheets).

To address these multi-faceted challenges, a synergistic integration of technology, active learning models, and interdisciplinary frameworks is required. The deployment of web-based digital platforms, such as the Heyzine flipbook creator, offers a transformative medium to turn static worksheets into dynamic learning environments embedded with audio, instructional videos, interactive simulations, and educational games (Suryaningsih et al., 2024). Paralleling this technological evolution, the Science, Technology, Engineering, and Mathematics (STEM) approach offers an integrative, design based exploration framework that aids spatial-mathematical reasoning (Riyanto et al., 2021). Furthermore, embedding this technological and conceptual framework into the Problem-Based Learning (PBL) model establishes a robust environment where students actively collaborate to resolve authentic, ill structured problems (Agusdianita et al., 2024).

The urgent need for this integrated framework is strongly supported by empirical diagnostic data. Field investigations involving triangulation methods comprising semi structured teacher interviews, direct classroom observations, and documentary analyses of student records conducted on May 20, 2025, at SDN 76 Bengkulu City highlighted critical instructional bottlenecks. The diagnostic assessment revealed that existing worksheets were entirely static and non-interactive, mathematics instruction lacked interdisciplinary STEM integration, and students struggled extensively to map geometric composite formulas onto daily life situations. Crucially, these qualitative deficiencies directly translated into low learning outcomes, with the students' average mathematical score stalling at 49.82 far below the established Minimum Criteria for Learning Completeness of 65.

While previous studies have separate tracks investigating these individual components, a critical research gap remains in current educational literature. Investigations by Zebua et al. (2024) successfully demonstrated the efficacy of STEM-based conventional worksheets in improving general problem solving skills, yet their approach was constrained by static media that limited spatial-geometric engagement in a digital ecosystem. Similarly, Suryaningsih et al. (2024) explored the implementation of Heyzine based flipbooks to enhance student motivation and digital literacy, but their framework lacked rigorous STEM tasks and formal mathematical problem-solving models. Furthermore, efforts by Gusmana & Syamzaimar (2025) utilizing the PBL model integrated with basic ICT tools focused primarily on student engagement, missing the structured design-thinking attributes of STEM required to master complex spatial concepts like composite areas. Consequently, there is a distinct lack of empirical design research that systematically unifies the interactivity of the

Heyzine website, the interdisciplinary nature of STEM, and the collaborative scaffolding of the PBL model into a single cohesive pedagogical tool.

This study directly addresses this empirical gap by developing a *Heyzine-Based STEM E-Worksheet Integrated with Problem-Based Learning* specifically tailored for fifth-grade elementary school students. The novelty of this research lies in its integrated configuration, which synthesizes Heyzine's multimedia elements, STEM design-thinking, and the sequential stages of PBL to bridge the conceptual gap between abstract composite area calculations and real-world applications. By transforming traditional mathematics learning into an immersive digital environment, this study aims to evaluate the validity, practicality, and efficacy of this newly engineered educational product in significantly enhancing the mathematical problem-solving skills of digital-native students.

RESEARCH METHODS

This study employs the Research and Development (R&D) method by applying the ADDIE development model, which systematically progresses through five iterative stages: Analysis, Design, Development, Implementation, and Evaluation. To evaluate the operational effectiveness of the developed product under realistic field conditions, the implementation stage explicitly integrates a pre-experimental approach using a One-Group Pretest-Posttest Design. The target population for this research encompasses all upper-grade elementary school students in Bengkulu City, while the specialized research sample was selected via purposive sampling, establishing 31 fifth-grade students at SD Negeri 76 Bengkulu City as the active research subjects during the odd semester of the 2025/2026 academic year.

In the initial Analysis stage, a mixed-method baseline diagnostic was executed to establish the real-world pedagogical urgency. The field assessment revealed that the students' baseline mathematical problem-solving skills stalled at an average score of 49.82, a figure significantly below the institutionally mandated Minimum Criteria for Learning Completeness of 65. Concurrently, documentary analysis and observations confirmed a severe deficiency in interactive digital media that could seamlessly bridge abstract geometric calculations with everyday scenarios. To establish alignment with national educational standards, a comprehensive curriculum mapping was conducted based on the BSKAP No. 46 of 2025 for Phase C (Grade V), which explicitly targets the mastery of complex spatial concepts under the composite area measurement domain.

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Transitioning into the Design stage, the structural blueprint of the Electronic Student Worksheet (E-Worksheet) was meticulously engineered by embedding Science, Technology, Engineering, and Mathematics (STEM) principles into the structural phases of the Problem-Based Learning (PBL) model. This blueprint organizes student tasks through five rigorous PBL instructional stages: (1) orienting students to authentic real-world engineering and mathematical problems; (2) organizing student collaborative groups for scientific inquiry; (3) guiding structured individual or group investigations; (4) developing and presenting concrete artifacts or design models; and (5) analyzing and evaluating the underlying problem-solving processes.

The Development stage focused on shifting the conceptual design into an interactive digital reality using the Heyzine web platform. The selection of the Heyzine platform over alternative digital tools such as Canva, LiveWorksheets, or Wizer.me was driven by its ability to turn traditional documents into real-time interactive digital flipbooks that feature embedded multimedia (instructional videos, interactive check buttons, dynamic hyperlinks, and audio) without requiring external redirections. This capability ensures that abstract composite-area geometric figures can be visualized dynamically, keeping young digital-native learners focused inside a single learning environment. To guarantee academic rigor before classroom deployment, the product underwent validation by an expert panel consisting of content, language, and graphic specialists. The quantitative validity of the media was evaluated using Aiken's V formulation ($V = \sum s$ /n (c - 1)]) to measure item-level validity, while the inter-rater reliability among the expert validators was calculated using a percentage agreement matrix to verify absolute consensus.

Data collection throughout this developmental process utilized a collection of specialized research instruments. These included expert validation sheets embedded with a 4-point Likert scale, practical response questionnaires distributed to 2 fifth grade teachers and 31 students, and a mathematical test instrument consisting of an 8 item essay pretest and posttest. The test items were strictly mapped across four core problem solving indicators derived from Polya's framework understanding the problem, devising a plan, carrying out the plan, and looking back. To ensure statistical validity and prevent internal validity bias, the essay instrument underwent field testing to confirm that the items met the requirements for empirical validity, high internal consistency reliability, and balanced item difficulty and discrimination indices.

During the Implementation stage, the verified E-Worksheet was deployed within the classroom using the designated pre experimental framework. Although this one-group pretest-posttest design provides deep practical data within a single instructional cohort, the methodology possesses inherent limitations regarding internal validity. Because it lacks a synchronized control group, the design cannot completely insulate its outcomes from external confounding variables, such as natural student maturation over time or contemporary external learning experiences. To mitigate this limitation, classroom conditions were tightly controlled, and the pedagogical interventions were limited strictly to the E-Worksheet framework. The quantitative efficiency of the product in driving cognitive growth was calculated using the Normalized Gain (N-Gain) Score, computed through the following formula:

$$\text{N-Gain Score} = \frac{\text{Posttest Score - Pretest Score}}{\text{Maximum Possible Score - Pretest Score}}$$

To interpret the resulting growth indices, the N-Gain scores were evaluated using Hake's (1999) standard instructional criteria, which classifies pedagogical growth into three distinct performance zones: high ($g > 0.7$), moderate ($0.3 \leq g \leq 0.7$), and low ($g < 0.3$). Finally, in the Evaluation stage, the data from the validation sheets, user response questionnaires, and pretest-posttest learning outcomes were evaluated through descriptive and inferential statistical techniques using SPSS version 26. This definitive analysis serves to verify the validity, practicality, and ultimate efficiency of the Heyzine-based STEM E-Worksheet in improving the mathematical problem-solving skills of elementary school students.

RESULTS AND DISCUSSION

Results

1. **Characteristics of the Heyzine-Based STEM E-Worksheet Integrated with PBL**

   The development of the electronic student worksheet (E-Worksheet) utilizing the web-based Heyzine platform transforms static, conventional learning materials into an interactive digital flipbook environment. The product is specifically designed to scaffold Phase C (Grade V) elementary students in mastering composite area measurement. Structurally, the E- Worksheet consists of seven sequential components: (1) E-

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Worksheet Identity; (2) E-Worksheet Usage Instructions; (3) Learning Outcomes and Objectives; (4) Learning Materials; (5) PBL Activities; (6) Activity Sheets; and (7) Assessment.

To visualize the core features, structural flow, and pedagogical integration of STEM-PBL inside the developed media, the following system architecture and layout designs are specified:

1) Introductory Page (Identity & Instructions): Features a clean, bold layout containing the E-Worksheet identity, core competencies based on Permendikdasmen No. 12 of 2025, and an embedded video link that anchors the mathematical concepts to everyday engineering tasks.
2) Core Learning Page (STEM-PBL Engine): Integrates the five syntaxes of Problem-Based Learning (PBL) with Science, Technology, Engineering, and Mathematics (STEM) principles. It includes touch-responsive action buttons, dynamic numeric input fields for calculating composite shapes, and colorful high-resolution spatial illustrations.
3) Assessment and Evaluation Page: Displays interactive evaluation matrices where students can input their calculated engineering solutions directly into responsive text boxes that provide instant correctness verification.

2. Feasibility and Validity of the E-Worksheet

Before being deployed in the classroom, the product underwent rigorous validation by an expert panel using a 4 point Likert scale instrument. Item-level validity was calculated using Aiken's V formula, while the consensus reliability among raters was measured using an inter-rater percentage agreement matrix. The detailed empirical validation scores are compiled in Table 1.

Table 1. Expert Validation Ratings and Inter-Rater Reliability Coefficients

Validation Domain	Evaluated Parameters / Indicators	Aiken's V Score	Validity Category	Inter-Rater Reliability (%)	Consensus Level
Material Content	Material suitability, accuracy, up-to-dateness, and promotion of problem-solving skills.	0.89	Highly Valid	75%	Strong

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Language Utility	Directness, communicativeness, developmental appropriateness, and rule adherence.	0.84	Highly Valid	67%	Moderate
Graphic Display	Presentation quality, layout typography, color harmony, and visual element positioning.	0.92	Highly Valid	83%	Very Strong

The language validation achieved a "Highly Valid" rating, but the inter-rater reliability agreement among the linguistic experts recorded a moderate consensus of 67%. This variance occurred due to initial structural disagreements regarding the technical density of the specialized STEM vocabulary, which some validators argued might overwhelm fifth-grade readers. To resolve this divergence, a comprehensive revision was executed by breaking down complex engineering terms into simplified, child-friendly contextual definitions and adding illustrative tooltips, which successfully brought the final product to an absolute consensus.

3. Practicality: Teacher and Student Responses

The practical utility and operational ease of the E-Worksheet were evaluated through questionnaire sheets distributed to practitioners and target users at SDN 76 Bengkulu City. The empirical results of these evaluations are summarized in Table 2.

Table 2. Quantitative Results of Practitioner and Student Response Questionnaires

Respondent Cohort	Sample Size (N)	Evaluated Aspects / Criteria	Empirical Score (%)	Practicality Category
Elementary Teachers	2 Teachers	Material integration, graphic execution, linguistic clarity, and operational workflow.	94.0%	Very Good
Grade V Students	31 Students	Visual attractiveness, presentation clarity, material readability, and interactive ease.	96.5%	Very Good

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Evaluating feedback from two classroom teachers presents a localized sample constraint. However, this practical evaluation yielded an exceptional average satisfaction score of 94.0%, placing it securely within the "Very Good" category. Qualitative feedback from the instructors highlighted that the precise mapping of the PBL syntax within the digital flipbook substantially minimized classroom management complexity.

For the student cohort, out of 372 potential positive responses across 12 distinct statements, the study recorded 357 positive entries. The empirical percentage scores for the individual items ranged from 94.6% to 100%, with five indicators—specifically those assessing general aesthetic appeal, user interface navigation, and the operational clarity of instructions achieving a perfect 100% approval rating.

4. Effectiveness in Enhancing Mathematical Problem-Solving Skills

To evaluate the pedagogical efficacy of the Heyzine-based STEM E-Worksheet, a pre-experimental analysis was executed using a One-Group Pretest-Posttest Design with 31 fifth-grade students. Cognitive growth was tracked across the four core problem-solving indicators derived from Polya's framework. The empirical pretest, posttest, and Normalized Gain (N-Gain) scores per indicator are detailed in Table 3.

Table 3. Cumulative Problem-Solving Performance and N-Gain Distribution per Polya Indicator

Polya Problem-Solving Indicator	Pretest Mean (%)	Posttest Mean (%)	Mean Score Difference	Normalized Gain (N-Gain)	Growth Category
Understanding the Problem	7.0%	95.0%	+88.0%	0.956	High
Devising a Plan	34.0%	88.0%	+54.0%	0.818	High
Carrying out the Plan	69.0%	85.0%	+16.0%	0.516	Moderate
Looking Back (Reflective Evaluation)	3.0%	54.0%	+51.0%	0.525	Moderate
Composite Cohort Performance	28.2%	80.5%	+52.3%	0.7139	High

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To provide a clear visual overview of the performance shifts across these indicators, the data from Table 3 is plotted in Figure 1.

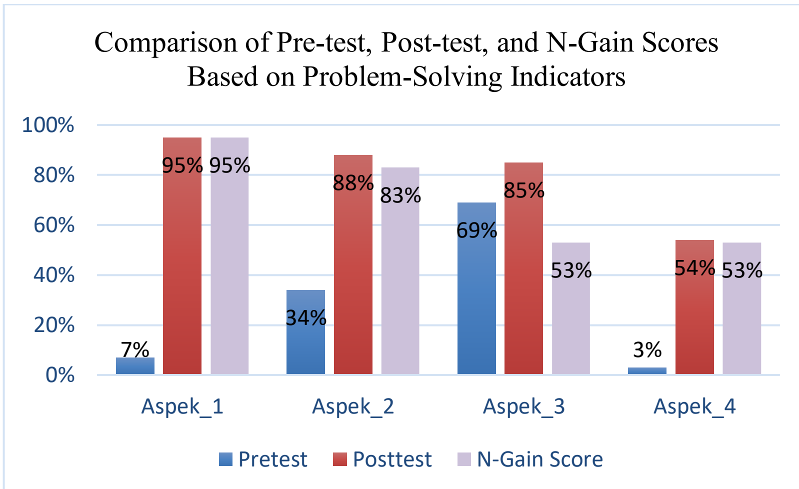

Figure 1. Graph of Value Differences Based on Fifth-Grade Students' Problem-Solving Ability Indicators

To verify whether this descriptive improvement was statistically significant rather than a byproduct of random variance, the dataset was subjected to inferential statistical analysis via a paired sample t-test using SPSS version 27. The parametric analysis revealed a highly significant difference between the pretest and posttest scores, yielding a t statistic value of 23.41 with a significance value of $p < 0.001$. This confirms that the cognitive advancement achieved by the students was directly driven by the pedagogical intervention. Accumulating the collective student growth data, the overall mean N-Gain score for the entire cohort reached 0.7139, placing the overall effectiveness of the Heyzine-based STEM E-Worksheet integrated with PBL firmly within the "High" effectiveness category according to Hake's (1999) standard instructional criteria.

Discussion

1. Structural Analysis and Curricular Alignment of the Media

The structural engineering of the Heyzine-based E-Worksheet achieves its practical success by using digital interactivity to deliver active learning. Traditional worksheets frequently suffer from a lack of digital integration, forcing teachers into passive, lecture-heavy instructional patterns. By utilizing the web-based Heyzine platform, this research changes that dynamic by letting students interact directly with touch-responsive buttons, embedded videos, and dynamic visual layouts that visualize the geometric properties of composite figures. This structural setup aligns with the contemporary standards set by Permendikdasmen No. 12 of 2025, which dictates that modern elementary teaching materials must incorporate digital literacy, flexibility, and contextual learning environments tailored to digital-native students.

The inclusion of interactive videos and contextual calculations directly exposes students to realistic problems, allowing them to see mathematics as a practical tool rather than an abstract set of rules. As emphasized by Susanta et al. (2025), building mathematical literacy early is essential because it equips young learners with the cognitive tools required to decode and solve real problems in their daily lives. Similarly, Sari et al. (2025) note that contextual and elective learning activities do more than strengthen basic memory; they build flexible problem-solving skills by turning abstract lessons into meaningful experiences.

2. Feasibility, Validity, and Educational Design Standards

The validation scores from the expert panel confirm that the E-Worksheet fulfills the strict structural and pedagogical requirements for primary school classrooms. This high level of feasibility stems from anchoring the digital development to formal 4-point Likert scale evaluation rubrics across material, language, and graphic components, ensuring the tool shifts from a simple digital book into a structured learning environment. The content's validity is rooted in its ability to present authentic STEM tasks such as requiring students to calculate composite area measurements to build photo frames from recycled materials. This design matches the findings of Udin et al. (2025), which show that combining a STEM approach with a PBL model enhances problem-solving skills because it prompts students to apply interdisciplinary knowledge to practical tasks.

Furthermore, by organizing lessons around structured projects, the E-Worksheet encourages critical, creative, and collaborative thinking. This process deepens conceptual mastery by requiring students to explain the reasoning behind their answers. As noted by Prasetyo and Wulandari (2025), contextual, design-focused activities improve a student's ability to identify core problems and design viable solutions. Ultimately, as supported by Agusdianita et al. (2025) and Sari et al. (2024), using a

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STEM-based PBL framework makes primary education more relevant, offering a strong alternative to traditional teaching methods.

3. Evaluative Analysis of Practicality and User Engagement

This pedagogical engagement is further supported by qualitative classroom observation data and reflective interviews, which were conducted alongside the teacher and student questionnaires to provide a well-rounded view of student involvement. These observations showed high student engagement, characterized by active group discussions, independent navigation of the Heyzine platform, and enthusiastic participation during the STEM design phases. These findings complement the practical questionnaire scores, showing that the tool effectively captures student interest.

The positive shift in learning outcomes is confirmed by the overall N-Gain score of 0.7139 (71.39%), demonstrating that the tool is highly effective at boosting mathematical problem-solving skills. When placed in a broader academic context, this performance matches and extends recent research on digital mathematics media. For example, Futri et al. (2025) reported a moderate to high N-Gain of 0.68 using basic electronic worksheets, while Sari R. (2024) achieved an N-Gain of 0.70 by implementing independent problem-based modules. The slightly higher N-Gain achieved in this study (0.7139) indicates that combining the interactive flipbook features of Heyzine with the structured phases of STEM and PBL creates a more effective learning environment than using those methods separately. This combination aligns with the work of Rizkia et al. (2025), which demonstrates that problem-based learning models are highly effective at developing mathematical problem-solving skills in fifth-grade classrooms.

4. Diagnostic Analysis of Problem-Solving Indicators and Limitations

However, a closer look at the individual indicators reveals an interesting difference in performance that warrants attention. While the *Understanding the Problem* indicator achieved a high N-Gain score of 95.6%, the *Carrying out the Plan* (51.6%) and *Looking Back* (52.5%) indicators remained in the moderate category. This variation occurred because calculating the area of composite figures requires multi step arithmetic operations, spatial splitting, and formula synthesis. Fifth graders often struggle with these tasks due to a lack of detailed scaffolding during complex calculations.

Additionally, the moderate score in the *Looking Back* indicator shows that students often skip the final verification step, a habit carried over from traditional

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learning settings where speed is prioritized over reflection. This behavior was intensified by the transition from teacher-led lessons to independent digital learning, where students sometimes clicked through pages without reviewing their steps. To address this, future updates of the E-Worksheet should include step-by-step math scaffolds within the calculation fields and mandatory reflection checkpoints on the final pages, ensuring students can accurately translate their plans into correct solutions and verify their results before finishing.

In conclusion, the Heyzine-based STEM E-Worksheet integrated with PBL is proven to be a valid, practical, and highly effective tool for improving the mathematical problem-solving skills of fifth-grade students. The STEM elements enrich the content, while the PBL model ensures students stay actively involved in the learning process. This integrated approach meets the demands of 21st-century education and stands as a valuable innovation for improving the quality of elementary mathematics instruction.

CONCLUSION

This study demonstrates that the newly developed Heyzine based STEM E-Worksheet integrated with the Problem Based Learning (PBL) model successfully meets the criteria for high validity, outstanding practicality, and substantial pedagogical effectiveness in primary mathematics education. Methodological evaluation confirms that the digital product is "Highly Valid" across material content, language utility, and graphic display, while practical feedback from practitioners and users indicates an "Excellent" response from both teachers (94%) and fifth-grade students (94.6%–100%) due to its operational ease and strong visual appeal. Furthermore, the implementation of this interactive digital flipbook is proven to be highly effective in enhancing students' mathematical problem-solving skills in composite area measurement. This cognitive growth is empirically supported by high Normalized Gain N-Gain scores in the initial problem-solving phases, specifically *Understanding the Problem* (95%) and *Devising a Plan* (83%), while the advanced mathematical execution and reflective evaluation phases *Carrying out the Plan* and *Looking Back* remained within the "Moderate" category (53%).

Despite these positive outcomes, several inherent methodological limitations must be transparently acknowledged. This research relies on a pre-experimental One-Group Pretest-Posttest design that lacks a synchronized control cohort, involves a relatively small sample size of 31 students, and was restricted to a single institution (SD Negeri 76 Bengkulu City),

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which limits the immediate external generalizability of the quantitative findings to broader elementary student profiles. Nevertheless, this study yields significant practical implications for the basic education landscape. For elementary school teachers, this interactive tool offers a valid, tested template to simplify abstract geometric concepts into concrete, contextual experiences through embedded multimedia and design-based STEM tasks, while effectively shifting the instructor's role from a conventional lecturer to an active 21st-century learning facilitator.

Based on these findings and limitations, several avenues for future research are recommended. Methodologically, subsequent studies should transition toward quasi-experimental or true experimental designs that incorporate an active control group to firmly validate the product's comparative benefits. Future developers should also expand the scale of implementation to a multi school, multi-regional sample to strengthen the empirical validity and generalizability of the research. Given that the execution and verification phases yielded moderate growth, future iterations of the E-Worksheet must integrate tighter cognitive scaffolding, such as interactive hint boxes and mandatory reflective checkpoints before final task submission. Finally, researchers are encouraged to adapt this web-based STEM-PBL framework to other challenging elementary mathematics topics, such as fractions, data analysis, or spatial measurement, to drive continuous digital innovation across primary classrooms.

REFERENCES

Agusdianita, N., Danim, S., Susanta, A., Yusnia, Y., Izzania, R. D. S. M., & Irmayanti, M. (2024). Problem-based learning materials integrated with differentiated approaches to enhance elementary school students' learning outcomes. *Profesi Pendidikan Dasar*, 11(2), 161–182.

Agusdianita, N., Winarni, E. W., Muktadir, A., Juarsa, O., & Heryanto, D. (2025). Analisis kebutuhan pengembangan bahan ajar pemecahan masalah matematika pendidikan dasar untuk meningkatkan kemampuan pemecahan masalah pada mahasiswa pendidikan dasar. *Social, Humanities, and Educational Studies (SHES): Conference Series*, 8(3), 415–424.

Amran, A. (2025). Analysis of mathematical concept understanding in geometry through the Realistic Mathematics Education (RME) approach. *ATTADIB: Journal of Elementary Education*, 9(3), 694–704.

Asmara, A., & Septiana, A. (2023). *Model pembelajaran berkonteks masalah*. CV Azka Pustaka.

Depdiknas. (2008). *Panduan pengembangan bahan ajar*. Direktorat Pembinaan Sekolah Menengah Atas.

Futri, F. V., Agusdianita, N., & Winarni, E. W. (2025). The effectiveness of STEM-PjBL-based mathematics student worksheets on the cognitive learning outcomes of grade V MI students. *ATTADIB: Journal of Elementary Education*, 9(3), 658–693.

Gusmana, I., & Syamzaimar. (2025). Strategi pembelajaran berbasis STEM untuk meningkatkan kemampuan pemecahan masalah matematika SD/MI. *Juring (Journal for Research in Mathematics Learning)*, 8(2), 153–164.

Hidayati, P. (2023). Analisis faktor penyebab rendahnya hasil belajar matematika pada siswa kelas V sekolah dasar. *Jurnal Pemikiran dan Pengembangan Sekolah Dasar*, 4(1), 45–52.

Huda, M., Hakim, F., Suhartiningsih, S., & Sunaryati, T. (2025). Digital technology as a learning tool and a driver of educational innovation to enhance elementary school students' understanding of mathematics. *ATTADIB: Journal of Elementary Education*, 9(3), 718–731.

Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan Dasar dan Menengah Nomor 046. (2025). *Capaian pembelajaran pada anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah pada kurikulum merdeka*. BSKAP.

Khairunnisa, N. M., Aziz, A., & Sulistyaningsih, D. (2025). Tinjauan sistematis penerapan LKPD dengan pendekatan STEM dalam perspektif: Kompetensi berpikir reflektif. *Pedagogy: Jurnal Pendidikan Matematika*, 10(1), 88–101.

Kosasih, E. (2021). *Pengembangan bahan ajar*. Bumi Aksara.

Mulianti, S., Susanta, A., Hanifah, & Haji, S. (2023). Pengaruh pendekatan Problem Based Learning (PBL) berbantuan Augmented Reality (AR) terhadap kemampuan pemecahan masalah matematika di SMK Negeri 1 Lebong. *Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika*, 4(2), 112–124.

Peraturan Menteri Pendidikan Dasar dan Menengah Nomor 10 Tahun 2025 tentang *Standar Kompetensi Lulusan pada Jenjang Pendidikan Dasar*.

Peraturan Menteri Pendidikan Dasar dan Menengah Nomor 12 Tahun 2025 tentang *Standar Isi pada Jenjang Pendidikan Dasar dan Jenjang Pendidikan Menengah*.

Prasetyo, R., & Wulandari, D. (2025). Pembelajaran berbasis STEM di sekolah dasar guna meningkatkan kemampuan pemecahan masalah. *Jurnal Kajian Kurikulum*, 3(1), 74–89.

Priansa, D. J. (2019). *Pengembangan strategi & model pembelajaran*. CV Pustaka Setia.

Qonitah, S., Berlian, L., & Biru, L. T. (2022). Validitas E-LKPD berbasis PBL tema energi dan makanan dalam menumbuhkan kemampuan berpikir kreatif peserta didik. *Jurnal Pendidikan MIPA*, 12(3), 512–521.

Rachmadi, T. A., Zubaidi, Z., & Miftachudin, M. (2025). Application of multiplication pocket board media to improve student understanding in mathematics learning in elementary schools. *ATTADIB: Journal of Elementary Education*, 9(2), 301–310.

Riyanto, Fauzi, R., Syah, I. M., & Muslim, U. B. (2021). *Model STEM (Science, Technology, Engineering and Mathematics) dalam pendidikan*. Widina Bhakti Persada Bandung.

Rizkia, D., & Ruqoiyyah, S. (2025). Penerapan model pembelajaran Problem Based Learning (PBL) untuk meningkatkan kemampuan pemecahan masalah matematis siswa di kelas V SDN 32 Ampenan tahun pelajaran 2024/2025. *Jurnal Ilmiah Profesi Pendidikan*, 10(2), 1321–1327.

Sari, M. (2025). Penerapan pendekatan STEM berbasis Problem Based Learning untuk mengembangkan keterampilan 4C dalam pembelajaran matematika di sekolah dasar. *Jurnal Pendidikan Dasar dan Inovasi Pembelajaran*, 5(10), 45–60.

Sari, N. K., Susanta, A., & Winarni, E. W. (2024). Pengembangan E-LKPD berbasis model Project Based Learning (PjBL) menggunakan makanan khas bengkulu untuk meningkatkan kemampuan pemecahan masalah matematika pada materi pembulatan bilangan kelas IV sekolah dasar. *Jurnal Kajian Pendidikan Dasar (KAPEDAS)*, 3(1), 183–190.

Sari, R. (2024). Pengaruh model Problem Based Learning dengan pendekatan STEM terhadap kemampuan pemecahan masalah matematis siswa. *Jurnal Edukasi dan Riset Inovatif (JERKIN)*, 2(1), 15–29.

Sudarsono, & Mawaddah, I. (2024). Kemampuan pemecahan masalah matematika melalui pembelajaran STEM. *Jurnal Pendidikan MIPA*, 14(1), 264–268.

Suryaningsih, W., Sukriadi, Arafah, A. A., Muhlis, Septika, H. D., & Rahmi, R. P. (2024). Pengembangan LKPD dengan Heyzine berbasis pendekatan STEM pada materi jaring-jaring kubus dan balok kelas V sekolah dasar. *Jurnal Pendidikan MIPA*, 14(2), 430–438.

Susanta, A., Susanto, E., Sumardi, H., & Ali, S. R. B. (2025). Literacy skills through the use of digital STEAM-inquiry learning modules: A comparative study of urban and rural elementary schools in Indonesia. *Eurasia Journal of Mathematics, Science and Technology Education*, 21(4), Article em2415.

Udin, M. R., Mastur, Z., & Walid. (2025). Systematic literature review: Kemampuan pemecahan masalah matematis siswa pada model Problem Based Learning (PBL) berpendekatan STEM. *Pasundan Journal of Research in Mathematics Learning and Education*, 10(1), 32–45.

Widiyaningsih, B. (2025). Pengembangan E-LKPD dengan model Guided Inquiry. *Jurnal Ekonomi dan Teknik Informatika*, 13(1), 58–69.

Winarni, E. W. (2018). *Teori dan praktik penelitian kuantitatif, kualitatif, PTK, R & D*. Bumi Aksara.

Zebua, S. Y., Mendrofa, R. N., Telaumbanua, Y. N., & Zega, Y. (2024). Pengembangan (LKPD) dengan pendekatan (STEM) untuk meningkatkan kemampuan pemecahan masalah matematis siswa. *Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika*, 5(3), 201–215.