STEM Education International, *e-ISSN: 3124-0755*
Vol. 2, No. 2, December 2026, Pages 73- 80

STEM-EI
STEM Education International

The Development of a STEM-Based Student Worksheet on Flat-Surface Solid Geometry for Ninth-Grade Junior High School

Nisrina Clarissa Sedar*, Elli Kusumawati, Taufiq Hidayanto

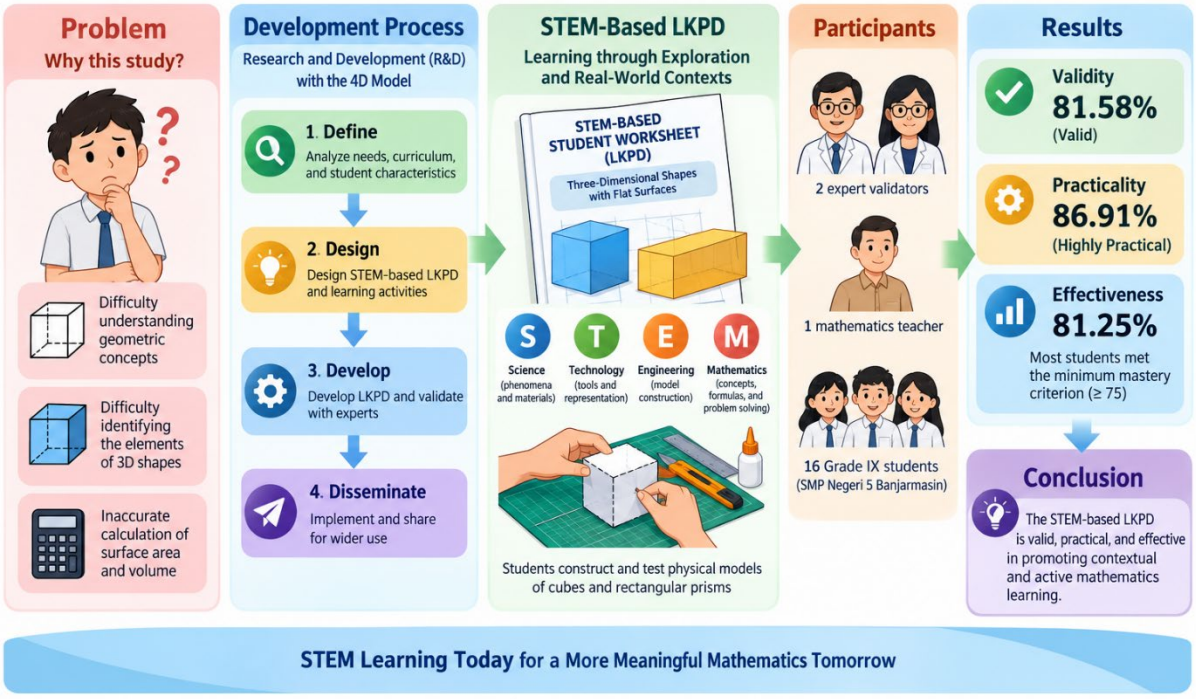
Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Indonesia

Corresponding author: nisrinaclarissa@gmail.com

Abstract: This study aimed to develop a Science, Technology, Engineering, and Mathematics (STEM)-based Student Worksheet (LKPD) on three-dimensional shapes with flat surfaces for Grade IX junior high school students and to determine its validity, practicality, and effectiveness. The development was motivated by students' difficulties in understanding geometric concepts, identifying the elements of three-dimensional shapes, and accurately calculating surface area and volume. The study employed a Research and Development (R&D) approach, utilising the 4D model, which comprises the Define, Design, Develop, and Disseminate stages. The participants included two expert validators, one mathematics teacher, and 16 students from SMP Negeri 5 Banjarmasin. Data were collected through validation sheets, student response questionnaires, and evaluation tests, and were analysed quantitatively using a Likert scale and classical learning mastery percentage with a minimum mastery criterion of 75. The developed STEM-based LKPD encourages students to construct and test physical models of cubes and rectangular prisms, enabling them to explore relationships among mathematics, science, and engineering in real-world contexts. The results indicated that the LKPD achieved a validity score of 81.58% (valid), a practicality score of 86.91% (highly practical), and an effectiveness score of 81.25%, with most students meeting the minimum mastery criterion. These findings demonstrate that the STEM-based LKPD is valid, practical, and effective in promoting contextual and active mathematics learning.

Keywords: Student Worksheet, STEM-based learning, solid geometry with flat surface

Graphical Abstract



INTRODUCTION

Mathematics plays an essential role in education as it fosters students' critical, creative, systematic, and logical thinking skills, while also supporting their problem-solving abilities in everyday life (Jayanto & Noer, 2017). Therefore, mathematics instruction should emphasise not only computational skills but also conceptual understanding and problem-solving competence. In general, mathematics is often taught procedurally, leading students to memorise formulas rather than develop a deep understanding of underlying concepts. While technological tools can help students perform calculations, effective reasoning is strongly supported by problem-solving skills (Cipta et al., 2020). One topic in mathematics that requires strong conceptual understanding and visualisation skills is three-dimensional geometry with flat surfaces. In this topic, students are expected to comprehend abstract three-dimensional objects, which requires both visualisation skills and the ability to connect mathematical concepts with their graphical representations.

Observations among Grade IX junior high school students identified difficulties in mastering three-dimensional shapes with flat surfaces. These difficulties included errors in identifying faces, edges, and vertices; misconceptions about using units for surface area and volume; and inaccurate calculations. These findings align with Putra et al. (2022), who reported that students struggled to determine appropriate problem-solving procedures for cubes and rectangular prisms, particularly when calculating surface area and volume. Therefore, classroom instructional materials have not fully encouraged students' active engagement during the learning process, highlighting the need for a more effective approach.

Instructional materials play an important role in promoting students' active participation in learning. They also help students develop a more meaningful understanding of concepts and connect them to real-life situations. One approach to achieve this goal is STEM (Science, Technology, Engineering, and Mathematics). STEM is a learning approach that emphasises solving real-world problems as its primary focus (Mulyani, 2019). This approach makes learning more contextual while encouraging students to think creatively, collaborate effectively, and actively participate in the learning process.

The STEM approach can be implemented through Student Worksheets (LKPD). An LKPD is instructional material containing a series of systematically designed learning activities intended to support the teaching and learning process (Rusmini et al., 2025). Well-designed worksheets can enhance students' conceptual understanding and promote active engagement in learning (Basri et al., 2020). In STEM-based worksheets, the domains of science, technology, engineering, and mathematics are integrated into a coherent sequence of activities. The science component focuses on the concepts being studied, the technology component involves using tools or media, the engineering component emphasises product design and testing, and the mathematics component involves calculations and analytical processes (Sumaji, 2019).

Although previous studies have developed STEM-based worksheets, the engineering component is often limited to model construction without a clearly defined testing process. Consequently, the integration of the four STEM domains has not been fully optimised. To address this issue, the present study developed a STEM-based worksheet that guides students in constructing cube and rectangular prism models and requires them to test the models as part of the engineering design process. This study describes the worksheet's development process and evaluates its feasibility in terms of validity, practicality, and effectiveness.

METHOD

This study used a Research and Development (R&D) approach based on the 4D model developed by Thiagarajan et al. (1974). The 4D model consists of four stages: Define, Design, Develop, and Disseminate. The procedures carried out in this study were as follows: (1) the Define stage, which included front-end analysis, task analysis, concept analysis, and the formulation of learning objectives; (2) the Design stage, in which the researcher developed research instruments, selected the presentation format, and prepared the initial product design; (3) the Develop stage, during which the developed product was evaluated by expert validators to determine its validity and subsequently tested with students to assess its practicality and effectiveness; and (4) the Disseminate stage, which involved distributing the validated, practical, and effective STEM-based worksheet to Grade IX mathematics teachers at the junior high school level.

The study participants included two expert validators, one mathematics teacher, and 16 students from SMP Negeri 5 Banjarmasin. The study focused on the STEM-based Student Worksheet (LKPD) on three-dimensional shapes with flat surfaces, which was evaluated for validity, practicality, and effectiveness. The research instruments included both non-test and test instruments. The non-test instruments comprised validation

sheets and student response questionnaires. The validation sheets assessed the worksheet's validity, while the response questionnaires gathered information on its practicality. The test instrument included an evaluation test administered after students used the worksheet to determine its effectiveness.

Data were analysed quantitatively to evaluate the developed product's validity, practicality, and effectiveness. The validity of the worksheet was assessed using validation questionnaires on a four-point Likert scale to determine its feasibility category. Practicality was measured through student response questionnaires using the same scale. Effectiveness was determined from students' evaluation test results, with the criterion that at least 75% of students achieved classical learning mastery. The minimum mastery criterion (MMC) applied at SMP Negeri 5 Banjarmasin was 75.

RESULTS AND DISCUSSION

This study developed a STEM-based Student Worksheet (LKPD) using the 4D model. In the initial stage, the Define stage, students struggled to connect mathematical concepts to real-world contexts, identify the elements of three-dimensional shapes with flat surfaces, and accurately calculate surface area and volume. In response, the worksheet was designed to include observation activities, physical model construction, and the application of cube and rectangular prism concepts through a STEM approach, enabling it to serve as supporting instructional material for classroom mathematics learning.

During the Design stage, the researcher developed research instruments, including validation sheets and student response questionnaires. The researcher also determined the worksheet format and designed an initial prototype based on the selected format. During the Develop stage, the researcher submitted the completed worksheet to expert validators for validity assessment. After the validators declared it valid, the researcher implemented the worksheet in a school setting to evaluate its practicality and effectiveness.

Validity

Table 1 presents the results of the worksheet validity assessment. Two validators conducted the validity test: a lecturer in Mathematics Education from the Faculty of Teacher Training and Education, Lambung Mangkurat University, and a mathematics teacher from SMP Negeri 5 Banjarmasin. Each validator received a validation sheet to evaluate the worksheet based on the specified assessment criteria.

Table 1. Results of the Validation Assessment

Aspect	Score		Obtained Score	Maximum Score	Percentage (%)
	V_1	V_2			
Format	17	28	35	40	87,5
Content Feasibility	16	28	34	48	70,83
Language	26	29	55	64	85,94
Total	59	65	124	152	81,58

Based on the validation results, the LKPD obtained an overall validity percentage of 81.58%, which falls into the valid category. The format aspect achieved the highest score of 87.5%, indicating that the LKPD is systematically organised and easy to understand. The language aspect was also classified as highly valid at 85.94%, while the content feasibility aspect obtained 70.83%. Based on these validation results, the LKPD is considered valid and feasible for use. This finding is consistent with Herayani et al. (2024), who stated that LKPD that meets validity criteria based on expert judgment can proceed to the trial stage. Overall, the results indicate that the LKPD is appropriate for field testing.

Practicality

After revising the LKPD based on the validators' feedback, the researcher conducted a trial implementation of the validated LKPD with students in class IX F at SMP Negeri 5 Banjarmasin. The researcher determined practicality through a trial involving 16 students from class IX F. The researcher assessed practicality using a student response questionnaire, in which students selected predefined rating scales. Table 2 presents the analysis results.

Table 2. Student Practicality Assessment Results

Number of questionnaire indicators	8
Number of students	16
Average practicality score	3,48
Percentage of student response practicality: 86.91%	86,91%
Category	Very practical

From the practicality test results, a percentage score of 86.91% was obtained, which is classified as "very practical." This indicates that students can easily use the developed LKPD and respond positively to it. The LKPD is considered practical for learning activities because it facilitates the teaching and learning process. This finding aligns with Daud (2022), who used student response questionnaires to assess LKPD practicality and concluded that teaching materials receiving positive student feedback are practical and suitable for use in learning activities.

Effectiveness

Based on the evaluation test results that students completed after learning with the LKPD, the researcher obtained data on students' learning mastery. Students' scores indicated the mastery level, with the minimum mastery criteria (KKM) at SMP Negeri 5 Banjarmasin set at 75. Table 3 presents the results of the effectiveness assessment.

Table 3. Effectiveness Assessment Results

Criteria	Number of Students	Mastery (%)	Category
≥ 75	13	81,25%	Effective
< 75	3		

Table 3 shows that 13 of 16 students scored 75 or higher, meaning 81.25% met the minimum mastery criteria (KKM). Therefore, based on the predetermined effectiveness criteria, the developed LKPD can be classified as effective. This finding aligns with Veliesa et al. (2021), who stated that LKPD effectiveness is determined by students' learning mastery after using the LKPD. Furthermore, the dissemination stage was carried out after the LKPD met the criteria of validity, practicality, and effectiveness. At this stage, the LKPD was distributed to grade IX mathematics teachers at the school where the research was conducted.

The developed STEM-based LKPD encourages students to construct physical models in the form of cubes and cuboids while also testing their understanding of the relationship between mathematics and the principles of science and engineering in real-world contexts. This aligns with Piyah (2019), who explained that STEM-based LKPD in learning activities can enhance student motivation and promote independent, active learning, thereby increasing students' interest in learning. Furthermore, Thovawira et al. (2021) noted that the advantage of the STEM approach in teaching and learning activities is that it trains students to integrate cognitive, affective, and psychomotor aspects. In addition, this study followed all established procedures, resulting in a STEM-based LKPD that meets the criteria of validity, practicality, and effectiveness. This is consistent with Muafiah (2019), who stated that LKPD can be utilised when it fulfils the criteria of validity, practicality, and effectiveness.

CONCLUSIONS

After the research was conducted, the developed STEM-based LKPD was found to be feasible for use in classroom learning. The validation analysis results for format, content feasibility, and language feasibility obtained an average validity score of 81.58%, categorised as valid. The student response questionnaire analysis after using the product was categorised as practical, with a score of 86.91%. Meanwhile, the effectiveness analysis based on students' evaluation test results scored 81.25%, which is categorised as effective. Thus, the STEM-based LKPD meets the criteria for validity, practicality, and effectiveness. For future research, researchers should vary and further deepen the integration of science, technology, and engineering contexts to strengthen the content of STEM-based LKPD on solid geometry materials.

AI-ASSISTED TECHNOLOGY STATEMENT

The authors used ChatGPT to generate a graphical abstract while preparing this paper. After using this tool, the authors assessed and modified the material as needed and assumed full accountability for the publication's content. We also used Grammarly to polish the language and correct grammatical errors.

ACKNOWLEDGEMENT

We thank SMPN 5 Banjarmasin for granting us permission to collect data.

REFERENCES

Basri, Tayeb, T., Abrar, A. I. P., Nur, F., & Angriani, A. D. (2020). Pengembangan lembar kerja peserta didik berbasis masalah untuk meningkatkan pemahaman konsep aljabar. *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *8*(2), 173–182. https://doi.org/10.24256/jpmipa.v8i2.1542

Cipta, D. A. S., Kartika, E. D., & Kurniawati, A. (2020). Analisis berpikir kritis siswa penyintas pervasive developmental disorder-not otherwise specified dalam matematika Montessori. *Jurnal Ilmiah Pendidikan Matematika*, *5*(2), 159–164.

Daud, F. (2022). Kepraktisan lembar kerja peserta didik berbasis pendekatan sains. *Jurnal Amal Pendidikan*, *3*(3), 189–197. https://doi.org/10.36709/japend.v3i3.23516

Herayani, L., Ilhamdi, M. L., & Syazali, M. (2024). Pengembangan LKPD (Lembar Kerja Peserta Didik) berbasis PBL (Problem-Based Learning) pada materi IPA. *Journal of Classroom Action Research*, *6*(2), 342–348. https://doi.org/10.29303/jppipa.v6i1.7607

Jayanto, I. F., & Noer, S. H. (2017). Kemampuan berpikir kreatif dengan pembelajaran guided discovery. *Seminar Nasional Matematika Dan Pendidikan Matematika*, *1*, 253–262.

Muafiah, A. F. (2019). *Pengembangan lembar kerja peserta didik (LKPD) berbasis Project-Based Learning (PJBL) pada materi keanekaragaman hayati siswa kelas X SMA Negeri 3 Pangkep*. Universitas Islam Negeri Alauddin.

Mulyani, T. (2019). Pendekatan pembelajaran STEM untuk menghadapi revolusi industry 4.0. *Seminar Nasional Pascasarjana 2019*, *7*(1), 455–460. https://proceeding.unnes.ac.id/index.php/snpasca/article/download/325/351

Piyah, P. (2019). *Pengembangan lembar kerja peserta didik berbasis STEM (science, technology, engineering, and mathematics) untuk melatih keterampilan proses sains.* Universitas Lambung Mangkurat.

Putra, D. A., Amelia, R., & Fitriani, N. (2022). Analisis kesulitan siswa dalam menyelesaikan soal-soal pada materi bangun ruang sisi datar (BRSD). *JPMI: Jurnal Pembelajaran Matematika Inovatif*, *5*(1), 123–130. https://doi.org/10.22460/jpmi.v5i1.123-130

Rusmini, Azizah, U., Yonata, B., & Napasti, F. (2025). Pelatihan penyusunan lembar kegiatan peserta didik (LKPD) berbasis proyek dalam implementasi Kurikulum Merdeka. *KOMATIKA*, *5*(1), 30–36. 10.34148/komatika/v5i1.1263

Sumaji. (2019). Implementasi pendekatan STEM dalam pembelajaran matematika. *Prosiding Seminar Nasional Pendidikan Matematika (SNAPMAT)*, 7–15. https://conference.umk.ac.id/index.php/snapmat/article/view/112/132

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook*. Leadership Training Institute/Special Education, University of Minnesota.

Thovawira, F. A., Safitri, I., Supartik, S., Sitompul, N. N. S., & Anggriyani, I. (2021). Systematic literature review: implementasi pendekatan STEM (manfaat dan tantangan) di Indonesia. *HISTOGRAM: Jurnal Pendidikan Matematika*, *4*(2), 355–371. https://doi.org/10.31100/histogram.v4i2.682

Veliesa, G., Hanifah, H., & Maulidiya, D. (2021). Efektivitas LKPD berbasis pendidikan karakter menggunakan model guided discovery pada materi garis dan sudut di kelas VII SMP Negeri 2 Kota Bengkulu. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS)*, *5*(3), 406–426. https://doi.org/10.33369/jp2ms.5.3.406-426