

PRACTICALITY OF PROBLEM-BASED MATHEMATICS WORKSHEETS ASSISTED BY GEOGEBRA TO ENHANCE STUDENTS' MATHEMATICAL CONCEPTUAL UNDERSTANDING

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Abstract

Problem-Based Learning (PBL) is an instructional model that uses authentic problems. Integrating PBL with GeoGebra promotes active engagement and exploration of mathematical concepts. It also helps develop creativity and supports the use of critical thinking skills in problem solving. This combined approach leads to a more comprehensive understanding of mathematics. Effective implementation requires a structured strategy. Instructional tools must be accessible to both teachers and students throughout the process. This study aims to identify and describe the practicality of student worksheets (LKPD). The research method used in this study is Research and Development (R&D), following the ADDIE model. Although the ADDIE model consists of 5 stages, this research only consists of 3 stages, namely the analysis, design stages and development stages, as it aims to describe the practicality of the instructional tools. Practicality was carried out by teachers and students. The results showed that the device, on average, received a positive response from students and teachers. These instructional tools are designed for Grade XI senior high school students. The practicality results indicate that LKPD also received an excellent rating across all assessed aspects. Therefore, the LKPD is deemed suitable to improve the mathematical concept understanding of students.

Keywords: linear program, mathematical conceptual understanding, problem-based learning, worksheets

Introduction

Mathematics serves as a foundational discipline that underpins the progress of various scientific fields. Mathematics is a discipline that serves as a tool for solving various problems encountered in daily life. Its development has been closely linked to other sciences, which rely on mathematical concepts to facilitate their advancement. Along with the advancement of science and technology, mathematics plays a crucial role in fostering systematic, critical, and logical thinking. Therefore, it is expected to be one of the most accessible and understandable subjects for students (Ernest et al, 1991; Resnick & Ford, 2012). According to Permendiknas No 22 of 2006 (Kementerian Pendidikan Nasional Republik Indonesia, 2006), the aim of learning mathematics is for students to grasp mathematical concepts, explain the relationships between them, and apply them or the relevant algorithms effectively, accurately, and efficiently in problem-solving situations.



One important aspect of achieving this goal is students' conceptual understanding, which refers to their ability to master and meaningfully apply various mathematical concepts (Nurdin et al., 2019; Suraji et al., 2018; Zetriuslita et al., 2025). This means that students not only understand the concepts being studied but can also express them in different, easily understandable forms (Septiadi & Wahidah, 2022). Furthermore, there are several indicators of conceptual understanding that students are expected to master: 1) restating a concept; 2) classifying specific characteristics; 3) providing examples; 4) representing concepts; and 5) applying concepts to solve problems (Faizah, 2019). Despite the recognized importance of conceptual understanding, recent assessments indicate a gap in students' actual performance, as shown in the PISA results. The PISA assessment emphasizes reading, writing, and mathematics accuracy, focusing on students' competencies and skills that can be applied in everyday life (OECD, 2009). The components of the PISA questions require the ability to reason, understand mathematical concepts, make estimations, and then express these in numerical form while performing calculations mentally (OECD, 2013), where Indonesia ranked 73rd out of 80 participating countries in the mathematics category, with an average score of 379. In contrast, China ranked first with an average score of 591 (Wulaningsih et al., 2021). This indicates that students in Indonesia struggle with mathematics. The low mathematical proficiency among students can be attributed to various internal and external factors. The external factors are the choice of learning tools and the strategies used in educational materials.

Learning tools guide teachers in conducting lessons and act as benchmarks for implementing the learning process (Angraini et al., 2021). According to Ariawan and Putri (2020), learning tools are resources that teachers and students can utilize during teaching and learning. One of the learning tools focused on in this research is worksheets. According to Wati & Haryati (2017), the integration of worksheets into the learning process enables students to demonstrate their abilities and skills while fostering the development of critical thinking through activities such as inquiry, hypothesis generation, and logical reasoning. Worksheets provide a series of activities in the form of theoretical and practical steps that facilitate independent learning and help students understand the material (Aprilianti & Astuti, 2020). Furthermore, the use of worksheets contributes to an effective learning process, stimulates students' interest, fosters curiosity to enhance motivation, and improves their problem-solving ability (Pratiwi, 2021). Based on the results from the researcher's interview with a mathematics teacher at the school revealed several issues regarding the current worksheets. These issues include: 1) There is no evidence that worksheets that incorporate GeoGebra software technology are being utilized at the school. 3) The available worksheets contain only a summary of the material and practice questions, without any completion guidance provided. 4) The existing worksheets are limited to a few topics and are infrequently used due to time constraints and the excessive time required to complete them.

The issues surrounding worksheets have hindered students' understanding of mathematical concepts. Therefore, it is essential to implement a suitable learning model to assist students in grasping these concepts. One effective alternative is the PBL model. According to Saleh et al (2020), problem-based learning is an instructional approach in which students engage with real problems and apply

scientific methods to develop solutions. Worksheets can be designed to incorporate the principles of PBL. This model encourages students to "learn how to learn" by collaborating in groups to find solutions to real-life challenges (Ariawan & Putri, 2020). Problem-based learning stimulates students to face and solve problems. As Kotto et al. (2022) showed, this approach requires students to think critically, reason, communicate, seek, analyze facts, and draw conclusions. To facilitate these skills, teachers present relevant problems, encouraging reasoning through group discussions. In this way, PBL lets students demonstrate critical thinking, reasoning, and share ideas. Furthermore, according to Alfiah et al. (2021), problem-based learning starts with contextual problems, centers on students, builds understanding, and fosters discussion. The advantages of the PBL model include making learning more meaningful, fostering student independence, enhancing students' creative thinking, and improving their understanding of concepts (Sinaga et al., 2021). Additionally, PBL can actively contribute to improving learning outcomes and students' comprehension of concepts and attitudes towards learning (Zetriuslita & Andrian, 2019).

While the PBL model has the potential to enhance students' understanding of mathematical concepts, its effectiveness has certain limitations. Therefore, it is crucial to improve this approach by incorporating innovative media, such as GeoGebra software, as learning resources. GeoGebra is a tool that enables users to create simple representations of mathematical objects, making it easier to discover, solve, and visualize ideas they already have (Zetriuslita et al., 2021). Using PBL models supported by computer technology actively engages students and allows them to explore various mathematical concepts. This method promotes creativity and integrates critical thinking skills, enabling students to grasp the material independently. Furthermore, GeoGebra is particularly effective for visualizing and demonstrating mathematical concepts, especially in geometry and algebra (Zetriuslita et al., 2020; Nur'aini et al., 2017).

Consequently, the use of GeoGebra can facilitate understanding of mathematical concepts, as it supports the application of indicators of comprehension, including the presentation of concepts in different mathematical forms, such as graphs and tables. Supporting this, research conducted by Wahyuni and Rahmadhani (2020) indicates that learning mathematics using the GeoGebra-assisted PBL model is more engaging than the standard PBL model without GeoGebra. This approach enhances students' understanding of mathematical concepts. The researcher chose to focus on linear programming, as this material highlights the concept of optimizing values, which can be effectively illustrated using GeoGebra software. Furthermore, linear programming aligns well with the indicators for assessing the ability to understand mathematical concepts, which can be promoted through PBL models alongside GeoGebra. Based on the description above, the development of problem-based learning (PBL) model devices assisted by GeoGebra plays a crucial role in enhancing students' understanding of mathematical concepts. The purpose of this study is to evaluate the practicality of student worksheets based on PBL models supported by GeoGebra, specifically aimed at facilitating students' understanding of mathematical concepts related to linear program.

Method

This research is a development study that aims to produce and test the practicality of worksheets with a problem-based learning model assisted by GeoGebra to enhance the understanding of mathematical concepts. The development used in this study is an ADDIE model consisting of analysis, design, development, implementation, and evaluation (Hawa, 2021). Educational practitioners develop ADDIE models in developing training or learning program tools and infrastructure that are effective, dynamic, and support the learning process (Branch, 2009; Molenda, 2003; Junaedi, 2019). In this research, it only reached 4 stages: the analysis stages, design stages and development stages, and implementation stages. The analysis stage starts with analysis, including problem analysis of worksheets and need analysis of curriculum, competencies, and indicators. The design stage aims to produce an initial draft of worksheets, teacher, and student response questionnaires. At the development stage, validation is carried out with a very valid category, and in this study, furthermore, the validity of student worksheets was tested on a limited class XI SMAN 1 Bangkinang to determine the effectiveness and practicality. This research is limited only to the development stage, where this study only discusses the practicality of the worksheets.

The practicality of the developed student worksheets was evaluated based on the results of the student response questionnaire and observations of the learning implementation. The data collection technique was carried out using a teacher and student response questionnaire. The data analysis technique used to measure the practicality of worksheet use involves tabulating results. The criteria consist of very practical, practical, practical enough, less practical, and not practical (Riduwan & Akdon, 2013) as follows:

$$P = \frac{\sum f}{N} \times 100\%$$

The results obtained are interpreted using the criteria according to the modification Riduwan & Akdon (2013), as in the following table.

Table 1. Practical Criteria

Score (%)	Validity Level
$80 < P \leq 100$	Very Practical
$60 < P \leq 80$	Practical
$40 < P \leq 60$	Practical enough
$20 < P \leq 40$	Less Practical
$0 < P \leq 20$	Not Practical

Findings and Discussion

The practicality of the student worksheets that have been developed was obtained from the student response questionnaire. The practicality test of the student worksheets was carried out on 30 students in a class. The results of the questionnaire analysis of the practicality test can be seen in Table 2.

Table 2. Average Results of Student Questionnaire on the Worksheet

No.	Indicators	Percentage of Worksheets' Achievement			Average	Category
		1	2	3		
1	This worksheet helps me solve mathematical problems presented as real-life word problems	83,33	87,00	90,38	86,90	Very Practical
2	This worksheet facilitates my understanding of the material being studied	81,48	82,00	88,48	83,98	Very Practical
3	The instructions for using GeoGebra in this worksheet are clearly understandable	86,11	89,00	91,34	88,81	Very Practical
4	The combination of solving problems through conventional methods and GeoGebra enables me to better understand the concept of linear programming	85,18	86,00	84,61	85,26	Very Practical
5	The integration of GeoGebra software in this student worksheet increases my motivation and enthusiasm for learning	83,33	83,00	88,46	84,93	Very Practical
6	The language used in the student worksheets is easily comprehensible.	83,33	85,00	87,50	85,27	Practical
7	The practice questions in this worksheet are aligned with the material presented	89,81	86,00	93,26	89,69	Very Practical
8	The dimensions of the images, the font, and the color scheme in this student worksheet are appropriate, which facilitates readability	86,11	86,00	91,34	87,81	Very Practical
9	The color scheme and design of the worksheets are appropriate, which increases my interest in learning and practicing the problems	87,96	90,00	93,26	90,40	Very Practical
10	The student worksheet has an appealing design that encourages reading	86,11	86,00	87,50	86,53	Very Practical

11	The allocated time is adequate for completing the questions in the student worksheets	81,48	86,00	88,46	85,31	Very Practical
12	The use of GeoGebra software helps me check the correct answers to linear programming problems	88,89	88,00	87,50	88,13	Very Practical
Average (%)					86,91	Very Practical

Table 3. Results of Questionnaire Analysis of Student Responses to LKPD

Percentage Validity (%)			Average Validity (%)	Validity Level
Pert-1	Pert-2	Pert-3		
85.26	86.16	89.34	86.92	Very Practical
Total Average (%)			86.92	Very Practical

Based on the results of the study, as shown in Tables 2 and 3, the worksheets using the PBL model assisted by GeoGebra to enhance mathematical conceptual understanding received positive responses from students. This can be seen from the average results of the responses that give “very practical” for each indicator. This indicates that students are more motivated to learn with the PBL model integrated with GeoGebra. This is in line with research conducted by Asmiati et al. (2020), which shows that by developing learning tools that include student worksheets with the PBL model assisted by GeoGebra, the practicality results from the teacher response questionnaires form were very good, indicating that the learning tools are practical to be implemented in schools. Further research indicates that the student worksheet assisted by GeoGebra demonstrates practicality, as evidenced by data from student, teacher questionnaire form, and observation sheets (Nurlisna et al, 2019). Other research findings indicate that the development of GeoGebra-based worksheets using the PBL model, as shown in the practicality test, received positive responses from students. They found the worksheets engaging, easy to understand, and encouraging more active participation in the learning process (Astuti et al., 2025). Based on the above findings as well as previous studies, it can be concluded that the student worksheet is practical and feasible to be implemented in schools.

Conclusion

Based on the analysis of the research data, the practicality results from the students' response questionnaire are highly positive. The student worksheets with the Problem-Based Learning model assisted by GeoGebra are very practical in enhancing mathematical conceptual understanding abilities. The student worksheets have been demonstrated to be valid and practical across all evaluation aspects. These student worksheets are suitable for high school students in XI in linear program subjects. However, this research only involved practicality from student response questionnaires and validation from experts in another research.

References

- Alfiah, S. K., Kadar, S., & Hatip, A. (2021). Pengaruh problem based learning terhadap kemampuan penalaran matematis dan kemampuan pemecahan masalah. *GAUSS Jurnal Pendidikan Matematika*, 4(2), 51-61. <https://doi.org/10.30656/gauss.v4i2.3950>
- Angraini, L. M., Wahyuni, P., Wahyuni, A., Dahlia, A., Abdurrahman., & Alzaber. (2021). Pelatihan pengembangan perangkat rencana pelaksanaan pembelajaran (RPP) bagi guru-guru di Pekanbaru. *Community Education Engagement Journal*, 2(2), 62–73. <https://doi.org/10.25299/ceej.v2i2.6665>
- Aprilianti, P. P., & Astusi, D. (2020). Pengembangan LKPD berbasis stem pada materi bangun ruang sisi datar SMP kelas VIII. *Jurnal Pembelajaran Matematika Inovatif*, 3(6), 691-702. <https://journal.ikipsiliwangi.ac.id/jpmi/article/view/5500>
- Ariawan, R., & Putri, K. J. (2020). Pengembangan perangkat pembelajaran matematika dengan model pembelajaran problem based learning disertai pendekatan. *Juring (Journal for Research in Mathematics Learning)*, 3(3), 293–302. <http://dx.doi.org/10.24014/juring.v3i3.10558>
- Asmiati, T., Ikhsan, M., & Subianto, M. (2020). Pengembangan perangkat pembelajaran problem based learning berbantuan software Geogebra di SMP. *Numeracy: Jurnal Ilmiah Pendidikan Matematika*, 7(1), 109–122. <https://doi.org/10.46244/numeracy.v7i1.1036>
- Astuti, D., Yumiati, & Sudirman. (2025). Development of problem based e-worksheet assisted by GeoGebra to improve numeracy literacy, and student learning activeness in junior high school. *EDUMATSAINS: Jurnal Pendidikan Matematika dan Sains*, 10(1), 419-430. <https://ejournal.uki.ac.id/index.php/edumatsains/article/view/6944>
- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer
- Ernest, P., Skovsmose, O., van Bendegen, J. P., Bicudo, M., Miarka, R., Kvasz, L., & Moeller, R. (1991). *The philosophy of mathematics education*. Springer Open
- Faizah, H. (2019). Profil pemahaman konseptual mahasiswa calon guru matematika tentang grup ditinjau dari kemampuan matematika. *Jurnal Didaktik Matematika*, 6(2), 84-97.
- Hawa, A. A., Supriadi, B., & Prastowo, S. H. B. (2021). Efektivitas pengembangan perangkat pembelajaran model pbl berbantuan simulasi Phet pada materi termodinamika untuk meningkatkan kemampuan berpikir kritis siswa. *ORBITA: Jurnal Pendidikan dan Ilmu Fisika*, 7(2), 327-334. <https://doi.org/10.31764/orbita.v7i2.6041>
- Istikomah, E., Zetriuslita, & Nofriandi. (2021). Improving students' mathematics communication ability through GeoGebra. *Pedagogia: Jurnal Pendidikan*, 10(2), 113–126. <https://doi.org/10.21070/pedagogia.v10i2.1266>
- Junaedi, D. (2019). Desain pembelajaran model ADDIE. *Jurnal Pendidikan Islam*, 28, 2-18.
- Kementerian Pendidikan Nasional Republik Indonesia. (2006). *Peraturan Menteri Pendidikan Nasional Republik Indonesia Nomor 22 Tahun 2006 tentang standar isi untuk satuan pendidikan dasar dan menengah*.

- Kotto, M. A., Babys, U., dan Gella, N. J. M. (2022). Meningkatkan kemampuan penalaran matematika siswa melalui model PBL (problem based learning). *Jurnal Sains dan Edukatif Sains*, 5(1), 24-27. <https://doi.org/10.24246/juses.v5i1p24-27>
- Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement*, 42(5), 34-36. <https://doi.org/10.1002/pfi.4930420508>
- Nur'aini, I. L., Harahap, E., Badruzzaman, F. H., & Darmawan, D. (2017). Pembelajaran Matematika Geometri Secara Realistis dengan GeoGebra. *Matematika : Jurnal Teori dan Terapan Matematika*, 16(2), 1-6. <https://doi.org/10.29313/jmtm.v16i2.3900>
- Nurudin, E., Ma'aruf, A., Amir, Z., Risnawati, Noviarni, & Azmi, M. P. (2019). Pemanfaatan video pembelajaran berbasis Geogebra untuk meningkatkan kemampuan pemahaman konsep matematis siswa SMK. *Jurnal Riset Pendidikan Matematika*, 6(1), 87-98. <https://doi.org/10.21831/jrpm.v6i1.18421>
- Nurlisna, Anwar., & Subianto. (2019) Development of student worksheet to improve mathematical representation ability using realistic mathematics approach assisted by GeoGebra software. *Journal of Physics: Conference Series*, 1460, Article 012041. <https://doi.org/10.1088/1742-6596/1460/1/012041>
- OECD. (2009). *Creating effective teaching and learning environments: First results from TALIS*. TALIS, OECD Publishing. <https://doi.org/10.1787/9789264068780-en>
- OECD. (2013). *PISA 2012 results: What students know and can do (Volume I)*. OECD Publishing. https://www.oecd.org/en/publications/pisa-2012-results-what-students-know-and-can-do-volume-i_9789264201118-en.html
- Pratiwi, L. N. (2021). *Development of learning materials for student's worksheets (LKPD) based on Lampung culture for cultural arts and crafts subjects*. UIN Raden Intan Lampung
- Resnick, L. B., & Ford W. W. (2012). *Psychology of mathematics for instruction*. Routledge
- Riduwan, & Akdon. (2013). *Rumus dan data dalam analisis statistika*. Alfabeta
- Saleh, A., Ahda, Y., & Fitria, Y. (2020). Improving science learning activities and outcomes by using problem based learning model at elementary school. *Jurnal Basicedu*, 4(4), 1388-1397. <https://doi.org/10.31004/basicedu.v4i4.578>
- Septiadi, D. D., & Wahidah, A. (2022). Perbandingan pemahaman konsep matematis siswa pada pembelajaran kooperatif tipe TPS dengan TSTS. *Lattice Journal: Journal of Mathematics Education and Applied*, 1(2), 91-100. <https://doi.org/10.30983/lattice.v1i2.4742>
- Sinaga, W., Purba, T. N., Telaumbanua, F., & Simanjuntak, R. (2021). Pengembangan perangkat pembelajaran berdasarkan problem based learning terhadap peningkatan kemampuan pemahaman konsep siswa. *Jurnal Pendidikan Matematika: Judika Education*, 4(1), 71-77. <https://doi.org/10.31539/judika.v4i1.2057>
- Suraji, Maimunah, Saragih, S. (2018). Analisis kemampuan pemahaman konsep matematis dan kemampuan pemecahan masalah matematis siswa SMP pada

- materi sistem persamaan linear dua variabel (SPLDV). *Suska Journal of Mathematics Education*, 4(1), 9-16. <https://doi.org/10.24014/sjme.v3i2.3897>
- Wahyuni, S., & Rahmadhani, E. (2020). Kemampuan pemahaman konsep matematis siswa dengan pembelajaran problem based learning berbantuan Geogebra. *Jurnal Pembelajaran Matematika Inovatif*, 3(6), 605–614. <https://journal.ikipsiliwangi.ac.id/jpmi/article/view/4907>
- Wati, D., & Haryati, S. (2017). Pengembangan lembar kegiatan peserta didik (LKPD) berbasis discovery learning pada pokok bahasan makromolekul. *Jurnal Keguruan dan Ilmu Pendidikan*, 4(2), 1–15.
- Wulaningsih, S. A., Sumarni, & Riyadi, M. (2021). Pengembangan perangkat pembelajaran materi program linear berbasis Problem-Based Learning berbantuan GeoGebra Android. *Jurnal Edukasi dan Sains Matematika (JES-MAT)*, 7(2), 101–114. <https://doi.org/10.25134/jes-mat.v7i2.4515>
- Zetriuslita, & Andrian, D. (2019). Constructivism of problem-based learning: Failure in increasing students' critical thinking and strategy of cognitive conflict. In *Proceedings of the Second International Conference on Social, Economy, Education and Humanity ICoSEEH - Volume 1*, (pp. 367–372). <https://doi.org/10.5220/0009158703670372>
- Zetriuslita, Fitri, Y. C., & Suripah, S. (2025). Pengembangan perangkat pembelajaran matematika dengan model problem based learning berbantuan Geogebra untuk meningkatkan pemahaman konsep matematis siswa. *JIPMat: Jurnal Ilmiah Pendidikan Matematika*, 10(1), 135-148. <https://doi.org/10.26877/1tmzf947>
- Zetriuslita, Nofriyandi, & Istikomah, E. (2020). The effect of GeoGebra- assisted direct instruction on students' self-efficacy and self-regulation. *Infinity Journal*, 9(1), 41-48. <https://doi.org/10.22460/infinity.v9i1.p41-48>