

IMPLEMENTATION OF A PROBLEM-BASED LEARNING MODEL ASSISTED WITH STUDENT WORKSHEETS TO IMPROVE MATHEMATICAL REASONING SKILL FOR STUDENTS OF GRADE X SMK

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Article Info

Article History

Received: 03-06-2023

Revised: 22-06-2023

Accepted: 05-08-2023

Keywords

Problem-Based
Learning;
Student Worksheets;
Math Reasoning Skill

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Abstract

This study aims to analyze application problem based learning assisted by student worksheets to improve the mathematical reasoning skill of class X Vocational High School students in the matter of a system of two-variable linear equations for the 2022/2023 Academic Year. The research method used is pre-experimental design. The subjects of this study were 35 students of class at a SMK in Cimahi City. Research data was collected using tests and questionnaires. The data collection technique used in this study was in the form of the test instruments in the form of pretest and posttest as well as questionnaires to analyze student responses. The results of the research show 1) the application of the problem based learning can improve students' mathematical reasoning skill, this is shown from the average score N-Gain student size $0,78 > 0,70$ are in the high criteria, where as many as 11 students with the category N-Gain medium and 24 students are in the category N-Gain tall, 2) student responses are in the category of strongly agree, meaning that students strongly agree with the application of the learning problem-based learning which can improve mathematical reasoning ability.

How to Cite:

Azzahrah, A., Putra, H. D., & Habibullah, H. (2023). Implementation of a problem-based learning model assisted with student worksheets to improve mathematical reasoning skill for students of grade X SMK. *Pi Radian: Journal of Mathematics Education*, 1(2), 55-64.

INTRODUCTION

Mathematics is a branch of science that plays an important role in the development of science and technology. The development of mathematics creates an integrated structure between patterns and relationships and ways of thinking to understand the world around us. This can be realized in its entirety when applied early on starting from the school environment. Skill taught in the school environment. Skill taught in the school

environment such as thinking systematically, logically, critically, and creatively. In addition, learning in schools also has certain goals in order to maximize student potential (Pramudita et al., 2023).

Success in learning mathematics is marked by the emergence of students' skill in dealing with their problems. According to the National Council of Teachers of Mathematics (NCTM) in Agoestanto & Shinta (2023), basic mathematical skill consist of five basic skill, namely problem solving skill, communication skill, connection skill, reasoning skill, and representation skill.

Ross in Cahyani & Sritresna (2023) states that one of the most important goals of learning mathematics is to teach students about reasoning. Students' mathematical reasoning ability can be measured by several indicators. According to the Regulation of the Director General of Elementary and Secondary Education, Ministry of National Education Number 506/C/Kep/PP/2004 dated November 11, 2004 in Anggraini et al., (2023) the indicators of mathematical reasoning ability are as follows: 1) the ability to present mathematical statements orally, in writing, in pictures, and in diagrams. 2) the ability to make conjectures. 3) the ability to carry out mathematical manipulations. 4) the ability to compile reasons/evidence for the truth of the solution. 5) the ability to draw conclusions from statements. 6) check the validity of an argument. 7) find patterns or properties of mathematical phenomena to make generalizations.

Reasoning ability is very much needed to achieve success in learning mathematics. The importance of reasoning ability is explained by Nababan (2020) that reasoning ability has a very important role in a person's thinking process, with reasoning ability students will be able to draw conclusions or make new statements based on previous statements. This is in line with research by Arida & Ikhsan (2023) that if students have good reasoning skills, students will easily demonstrate their mathematical ideas to a problem based on their own experiences and ideas. With reasoning skills, students will also be able to think carefully, logically, analytically, creatively, and critically.

However, in reality, students' mathematical reasoning skills are relatively low, there are several indicators that are not mastered by students. This is shown by the results of research conducted by Laily & Adirakasiwi (2021) that there are several indicators of reasoning skill that are not mastered by students so that students have not been able to answer and explain the steps to solve the problem completely. These indicators include: 1) submitting an alleged answer accompanied by logical reasons, 2) assessing the validity or validity of a statement, and 3) providing reasons or evidence for several solutions correctly and completely. Similar research results occurred in a study conducted by Tanjung & Panjaitan, (2022) on 31 students, only 1) 9 students were able to solve problems on the mathematical manipulation indicator, 2) 4 students were able to solve problems on the indicator of providing reasons or evidence for the truth of the solution, 3) 5 students were able to solve problems on the indicator of drawing conclusions from a statement, and 4) 2 students were able to solve problems on the indicator of submitting conjectures.

The low mathematical reasoning ability of students can be seen from several factors, one of which is indicated by the students' ability to solve problems. According to Sukmawati et al., (2023) that the low mathematical reasoning ability of students is indicated by the

students' ability to solve problems, such as: 1) students have not been able to submit conjectures from a problem in writing by stating what is asked and known in the problem, 2) students have not been able to write a complete conclusion at the end. Arida & Ikhsan (2023) also added that the low mathematical reasoning ability of students can be seen from the students' inability to compile evidence from a problem.

Things that can expand and improve students' mathematical skill are by using good and appropriate learning models (Marfu, 2022). One of the learning models that can improve students' mathematical reasoning skills is by implementing the problem-based learning model. The problem-based learning model is a learning model that uses real-world problems as a learning context and demands optimal student activity in problem-solving skills and self-direction in handling them (Indah & Nuraeni, 2021). The problem-based learning model is thought to be in line with the indicators of students' mathematical reasoning skills because the learning carried out presents real-world problems as a learning context and demands optimal student activity in their reasoning skills.

This is because the problem-based learning model requires students to be active in thinking, reasoning, communicating, searching for and processing data, and ending with concluding a problem (Kotto et al., 2022). In addition to learning models, learning media can also be a solution to improve students' mathematical reasoning skills. One of the learning media that can help students improve their reasoning skills is by using learning media in the form of Student Worksheets (LKS) (Suryani et al., 2023). Student worksheets are printed teaching materials in the form of worksheets that help students in investigation and problem-solving activities, the contents of which are materials, summaries, and also work instructions (Sugiarti & Hayati, 2021). The use of learning media in the form of LKS in the learning process is expected to make it easier for teachers and support and encourage students to be able to think, analyze, and compile the results of their activities themselves with their skill.

The LKS used in this study is a LKS that has been compiled based on the steps of the problem-based learning model, namely starting by orienting students to the problem, then with the LKS students are expected to be able to define and organize solutions related to the problem with their group. Furthermore, students and their groups divide tasks to collect appropriate information and carry out experiments to find solutions to existing problems. After that, students plan and prepare reports from the investigations that have been carried out in the previous stage. The last stage is that students conclude the results of the investigation and work on evaluation questions that contain questions with indicators of mathematical reasoning ability. With the LKS that are adjusted to the steps of the problem-based learning model, it is hoped that it can improve students' mathematical reasoning skill.

Based on the problems and findings of the experts above, the researcher is interested in conducting research with the title "Implementation of the Problem Based Learning Model assisted by Student Worksheets (LKS) to improve the mathematical reasoning skill of Grade X SMK students.

METHOD

This research is a quantitative research used to measure students' mathematical reasoning skill. This type of research is a pre-experimental design using only one class in the sampling without a comparison class as a control class. This research was conducted at one of the Vocational High Schools (SMK) in the Cimahi City area in the odd semester of the 2022/2023 academic year with 35 students as research subjects. The sampling technique in this study was the purpose sampling technique in one class as a whole. The first stage in this study, students were given pretest questions to measure students' reasoning skill before being given problem-based learning treatment. The second stage, namely students were given posttest questions to measure students' mathematical reasoning skill after being given problem-based learning treatment. The following stages of pre-experimental design research are presented in Figure 1.



Figure 1. Research Stage

The instrument in this study was a test with descriptive questions that indicated reasoning ability totaling 5 questions. The indicators of students' mathematical reasoning ability that will be measured in this study are 1) the ability to submit conjectures, 2) assess the validity or validity of a statement, 3) provide evidence or reasons for a statement, 4) draw conclusions from a statement, 5) determine patterns or properties of mathematical phenomena to make generalizations. Lift is used to obtain data related to student responses to the application of the problem-based learning model assisted by student worksheets that have been applied during learning activities.

The results of the pretest and posttest were analyzed using the N-gain test. Normalized gain analysis is used to determine how much the results have increased between the pretest and posttest.

Table 1. N-Gain Criteria

N-Gain range	N-Gain Criteria
$g > 0,70$	High
$0,30 < g \leq 0,70$	Medium
$g \leq 0,30$	Low

Observation sheets are used to analyze student responses during learning activities by implementing a problem-based learning model assisted by student worksheets. In this study, responses were analyzed using a Likert scale. In the response answers there are 5 categories, namely Strongly Disagree (STS), Disagree (TS), Undecided (RR), Agree (S), and Strongly Agree (SS). Scoring of responses starts from 1 to 5 based on the check mark (☑) given by students on the questionnaire sheet. Response data is analyzed by determining the total score of student responses for each statement. Total response score = (number of students answering SS x 5) + (number of students answering S x 4) + (number of students answering RR x 3) + (number of students answering TS x 2) + (number of students answering STS x 1). Student responses are categorized based on the following Likert scale range obtained from the ideal score if all students' answers are Strongly Agree (SS):

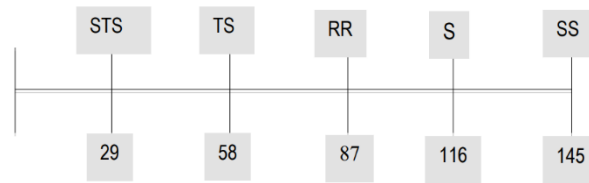


Figure 2. Likert Scale.

RESULTS AND DISCUSSION

This research was conducted in the 2022-2023 academic year, odd semester, in 1 class for 8 meetings. The implementation of learning by applying the problem-based learning model assisted by student worksheets on the material of two-variable linear equation systems has been carried out very well.

The results of the increase in pretest and posttest scores were analyzed using N-gain to measure the increase in students' mathematical reasoning skill, which can be seen in the diagram below.

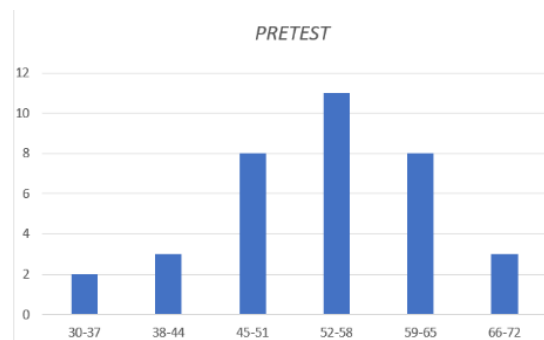


Figure 3. Pretest Results

Based on Figure 3. It can be seen that the pretest scores of students after being given descriptive questions that indicate reasoning ability show low results. This can be seen from the student score diagram that there are only 3 students who get scores in the range of 66-72, while the majority of students get scores in the range of 52-58 with a total of 11 students. Furthermore, there are also 2 students who get scores in the range of 20-37. Then a posttest was conducted to analyze whether there was an increase in reasoning ability or not. The results of the posttest are presented in Figure 4.

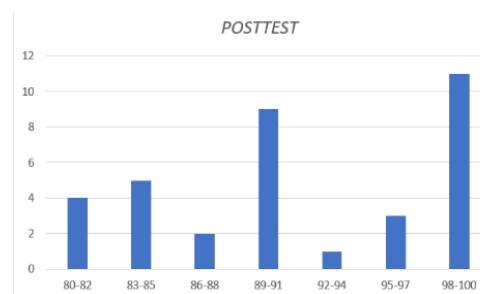


Figure 4. Posttest Results

Based on Figure 4. After students were given treatment by implementing the problem based learning model, it can be seen that student learning outcomes or grades have

increased. This is indicated by the quantity of students who got grades in the range of 98-100 as many as 11 students and only 4 students got grades in the range of 80-82.

Table 2. Pretest and Posttest Results

Category	Pretest	Posttest
Minimum	35	80
Maximum	80	100
Mean	60,9	91,7

Based on Table 3, it is known that the average value of students during the pretest and posttest increased by 30.8 with the highest and lowest values during the pretest being 35 and 80, while during the posttest the students with the lowest and highest values were at 80 and 100.

Table 3. N-Gain Results

N-Gain Average	N-Gain Average %
0,78	0,78%

Based on Table 3. it is known that the average N-Gain value of students is $0.78 > 0.70$. Based on the N-Gain value, it can be concluded that there is a high influence of the application of the problem-based learning model assisted by student worksheets to improve the mathematical reasoning skill of Grade X SMK students. Furthermore, the N-Gain Category for each student is presented in Figure 5.

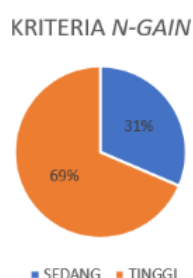


Figure 5. N-Gain Criteria

Based on Figure 5, it is known that the percentage of students' N-Gain values in the medium category is 31% or 11 students, while the percentage of N-Gain values in the high category is 69% or 24 students.

Table 4. Students' Response

No	Question	Number of Respondents' Answers					Total Score	Remarks
		SA	A	N	D	SD		
1	I really like mathematics	20	11	4			156	Strongly Agree
2	Mathematics is very useful in daily life	27	8				167	Strongly Agree
3	Learning mathematics with problem-based learning model	18	14	3			167	Strongly Agree

4	assisted by student worksheets makes me more active in learning	18	10	7	151	Strongly Agree
5	Learning mathematics with problem-based learning model assisted by student worksheets makes me enthusiastic about learning	16	11	8	148	Strongly Agree
6	This learning activity makes it easier for me to socialize with my friends	27	6	2	165	Strongly Agree
7	Learning mathematics in this way makes me more confident in expressing my opinions	28	6	1	167	Strongly Agree
8	The teacher makes the atmosphere more interesting during mathematics lessons with the problem-based learning model assisted by student worksheets	15	11	9	146	Strongly Agree
9	Learning mathematics with the problem-based learning model assisted by student worksheets makes it easier for me to understand the material being studied`	30	5		165	Strongly Agree
10	I prefer learning mathematics with the problem-based learning model assisted by student worksheets	35			175	Strongly Agree

Based on Table 4, the results show a very positive response from the students. This is evident from the average response score of 160,7, indicating strong agreement with the implementation of the problem-based learning model assisted by student worksheets. This model makes students more enthusiastic, more active, and makes learning activities more enjoyable, thereby enhancing students' mathematical reasoning skill.

This research was conducted in the odd semester of the 2022-2023 academic year and was successfully implemented. According to Syahrir & Susilawati (2015), learning activities are considered successful if students show positive changes. These changes include knowledge (cognitive), attitude (affective), and skills (psychomotor). Mulyasa, as cited in Desyandri & Maulani (2019), also stated that learning activities are deemed successful and of high quality if all or most (80%) students are actively involved and show high learning enthusiasm. This can be seen from the interaction between the teacher and

students, and among students, ensuring that the learning activities align with the syntax of the problem-based learning model. Based on the syntax of the problem-based learning model, students are expected to actively participate in group activities, solve problems presented in the student worksheets (LKS), and use real-world problems as a learning context to reason and solve issues while understanding the core concepts of a subject. This aligns with the research by Kotto et al. (2022) that the problem-based learning model can be used to enhance students' mathematical reasoning skill. This is because the problem-based learning model provides stimuli in the form of real-world problems to be investigated and solved as presented in the LKS.

The results of this study, consisting of pretest and posttest analyses using the N-Gain test, are presented in graphs and tables. The data show an increase in students' scores from pretest to posttest. The lowest student score in the pretest was 35, which increased to 80 in the posttest. Another increase is seen in the average student score, which rose from 61,9 in the pretest to 91,7 in the posttest. Analysis of the improvement in students' mathematical reasoning skill using the N-Gain score can be seen in the diagram. The data show that students achieved a high N-Gain criterion of 0,78 or 78%, with 69% (24 students) in the high N-Gain criterion and 31% (11 students) in the moderate N-Gain criterion. The analysis results indicate that the implementation of the problem-based learning model assisted by student worksheets has a very high impact on enhancing students' mathematical reasoning skill. This is in line with the study by Suryani et al. (2023), which demonstrated an increase in students' reasoning skill after being taught using the problem-based learning model assisted by student worksheets (LKS).

Students' mathematical reasoning skill can be developed through various means, one of which is implementing an appropriate learning system. One way is by providing opportunities for students to demonstrate their mathematical ideas. This is also supported by Syahlan et al. (2022) regarding problem-based learning, where the teacher acts as a facilitator and provides questions to stimulate students to use their reasoning skill and experiences to solve the given problems. The increase in mathematical reasoning ability arises because the problem-based learning model uses contextual problems as teaching material, requiring students to think metacognitively and use their reasoning skills independently to solve problems. The more students develop their reasoning skills, the sharper their thinking skill will become.

Students' responses to the implementation of the problem-based learning model assisted by student worksheets received a score of 160,7, which, according to the Likert scale, falls into the strongly agree category. Analysis of student responses shows that learning activities implementing the problem-based learning model are very effective in enhancing students' mathematical reasoning skill. During the learning process with the problem-based learning model assisted by student worksheets, students felt they liked mathematics more, became more active during learning activities, felt more enthusiastic and motivated to participate well in the learning activities, found the atmosphere more interesting and enjoyable, and found it easier to understand the concepts being taught.

CONCLUSION

Based on the research conducted at one of the state vocational high schools (SMK) in the Cimahi area, the application of the problem-based learning model assisted by student worksheets has improved students' mathematical reasoning skill on the topic of two-

variable linear systems. Further research can be developed with broader subjects so that it can be implemented more widely.

ACKNOWLEDGMENTS

The author would like to thank the leadership of IKIP Siliwangi, Mr. Harry Dwi Putra, as the lecturer of the course on strategies for the preparation and publication of scientific papers, and Mr. Habibullah, as the practitioner lecturer of the course on strategies for the preparation and publication of scientific papers, for their assistance in helping the author compile this article.

REFERENCES

- Agoestanto, A., & Shinta, M. (2023). Analisis kemampuan koneksi matematis siswa pada pembelajaran project based learning dengan pendekatan realistics mathematics education. *PRISMA, Prosiding Seminar Nasional Matematika*, 6, 204–208. <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/66617>
- Anggraini, A., Syofiana, M., & Ramadianti, W. (2023). Analisis kemampuan penalaran matematis siswa berbasis masalah pada materi bilangan pecahan. *RANGE: Jurnal Pendidikan Matematika*, 4(2), 267–277. <https://doi.org/10.32938/jpm.v4i2.3156>
- Arida, S. F., & Ikhsan, M. F. (2023). Analisis kemampuan penalaran matematis siswa kelas v sekolah dasar di desa sukolilo pati terhadap pengerjaan soal berbasis pembuktian. *Jurnal Pendidikan, Bahasa, Sastra, Seni, Dan Budaya*, 3(2).
- Cahyani, N. D., & Sritresna, T. (2023). Kemampuan penalaran matematis siswa dalam menyelesaikan soal cerita. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu (PME)*, 02(01), 103–112.
- Desyandri, D., & Maulani, P. (2019). Penerapan model project based learning untuk meningkatkan hasil belajar seni musik pada pembelajaran tematik terpadu di sekolah dasar. *Jurnal Inovasi Pendidikan Dan Pembelajaran Sekolah Dasar*, 3(2), 58–67. <http://e-journal.unp.ac.id/index.php/jippsd58>
- Indah, P., & Nuraeni, R. (2021). Perbandingan kemampuan penalaran deduktif matematis melalui model PBL dan IBL berdasarkan KAM. *Jurnal Pendidikan Matematika*, 10(1). <http://journal.institutpendidikan.ac.id/index.php/mosharafa>
- Kotto, M. A., Babys, U., & Gella, N. J. M. (2022). Meningkatkan kemampuan penalaran matematika siswa melalui model PBL (Problem Based Learning). *Jurnal Sains Dan Edukasi Sains*, 5(1), 24–27. <https://doi.org/10.24246/juses.v5i1p24-27>
- Laily, E. N., & Adirakasiwi, A. G. (2021). Prosiding seminar nasional matematika dan pendidikan matematika analisis kemampuan penalaran matematis siswa SMP dalam menyelesaikan soal materi aritmatika sosial. *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika*, 278–287. <http://conference.unsika.ac.id/index.php/sesiomadika/Sesiomadika2021>
- Marfu, S. (2022). Model pembelajaran matematika untuk meningkatkan kemampuan penalaran matematis siswa. *Prosiding Seminar Nasional Matematika*, 5, 50–54. <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/54339>

- Nababan, S. A. (2020). Analisis kemampuan penalaran matematis siswa MTs dalam menyelesaikan soal-soal geometri. *Genta Mulia: Jurnal Ilmiah Pendidikan*, 11(1), 6–12. <https://doi.org/10.36312/jisip.v4i3.1239>
- Pramudita, M. D., Ambarwati, L., Hidajat, F. A., Timur, J., & Dki, J. (2023). Penerapan model pembelajaran problem based learning (PBL) untuk meningkatkan kemampuan pemecahan masalah matematis siswa kelas X SMA kristen kasih kemuliaan pada materi SPLTV. *Journal on Education*, 05(04), 13783–13788. <https://doi.org/jonedu.org/index.php/joe>
- Sugiarti, I. Y., & Hayati, A. A. (2021). Pengembangan lembar kerja siswa dengan metode survey, question, read, recite, dan review (SQ3R) berbasis higher order thinking skills (HOTS) pada dimensi pengetahuan. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, 4(2), 55–61. <https://doi.org/10.33603/caruban.v4i2.5197>
- Sukmawati, S., Amrullah, A., Hikmah, N., & Soepriyanto, H. (2023). Analisis kemampuan penalaran siswa ditinjau dari gaya belajar. *Journal of Classroom Action Research*, 5(2), 106–110. <https://doi.org/https://doi.org/10.29303/jcar.v5i2.3207>
- Suryani, N. E., Utami, C., & Husna, N. (2023). Model problem based learning (PBL) berbantuan lembar kerja siswa (LKS) untuk meningkatkan kemampuan penalaran dan pemecahan masalah matematis siswa. *JUMLAHKU: Jurnal Matematika Ilmiah STKIP Muhammadiyah Kuningan*, 9, 21–39. <https://doi.org/https://doi.org/10.33222/jumlahku.v9i1.2820>
- Syahlan, S., Irvan Malay, & Asnawati Matondang. (2022). Perbedaan model problem based learning dan model kooperatif ditinjau dari kemampuan penalaran matematis siswa. *Jurnal Pendidikan MIPA*, 12(2), 306–314. <https://doi.org/10.37630/jpm.v12i2.555>
- Syahrir, S., & Susilawati, S. (2015). Pengembangan modul pembelajaran matematika siswa SMP. *Jurnal Ilmiah Mandala Education*, 1(2), 162. <https://doi.org/10.58258/jime.v1i2.235>
- Tanjung, W. M., & Panjaitan, M. (2022). Penerapan model pembelajaran probem based learning untuk meningkatkan kemampuan penalaran matematik siswa kelas VII SMPN Tebing inggi T.A 2021/2022. *Jurnal Ilmiah Multi Disiplin Indonesia*, 1(9), 1278–1285. <https://doi.org/https://doi.org/10.32670/ht.v2i1.2640>