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Development of RME Based Mathematics Learning Tools to Improve Students' Problem-Solving Abilities and Independence

Shahnaz Shafitri Harahap[1,*], Hasratuddin[2], Mangaratua.M.Simanjorang[3]

[1,2,3] *Postgraduate Mathematics Education Study Program, State University of Medan*
Jl. William Iskandar Ps. V, Kenangan Baru, Deli Serdang, Sumatera Utara, Indonesia

[*] Shahnaz.shafitri39@guru.sd.belajar.id

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Abstrak

Penelitian ini bertujuan untuk mendeskripsikan: Validitas, kepraktisan dan efektifitas LKPD berbasis pendekatan pembelajaran matematika realistik yang dikembangkan terhadap peningkatan kemampuan pemecahan masalah siswa dan kemandirian melalui LKPD berbasis pendekatan pembelajaran matematika realistik yang dikembangkan. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model pengembangan Tessmer tipe formative evaluation. Model pengembangan ini terdiri dari 2 tahap pengembangan yaitu preliminary (penentuan) dan prototyping (desain dan evaluasi). Dari hasil uji coba I dan uji coba II diperoleh: LKPD berbasis pendekatan pembelajaran matematika realistik untuk meningkatkan kemampuan pemecahan masalah dan Kemandirian Belajar siswa yang dikembangkan sudah memenuhi kriteria valid, praktis dan efektif; Peningkatan kemampuan pemecahan masalah menggunakan LKPD berbasis pendekatan pembelajaran matematika realistik yang telah dikambangkan dilihat dari nilai N-gain pada uji coba I sebesar 0,35 meningkat menjadi 0,39 pada uji coba II, artinya berada dalam kategori "sedang"; dan Peningkatan self-efficacy siswa dengan pendekatan pembelajaran matematika realistik yang telah dikambangkan dilihat dari nilai N-gain pada uji coba I sebesar 0,31 meningkat menjadi 0,40 pada uji coba II, artinya berada dalam kategori "sedang".

***Kata Kunci**: Pengembangan LKPD, model Tessmer, Pendekatan Pembelajaran Matematika Realistik, Pemecahan Masalah, Kemandirian Belajar.*

Abstract

This study aims to describe: Validity, practicality and effectiveness of LKPD based on realistic mathematics learning approach developed towards improving students' problem solving ability and independence through LKPD based on realistic mathematics learning approach developed.: This study is a development research using Tessmer development model formative evaluation type. This development model consists of 2 stages of development, namely introduction (determination) and prototyping (design and evaluation). From the results of trial I and trial II obtained: LKPD based on realistic mathematics learning approach to improve students' problem solving ability and Learning Independence developed has met the criteria of valid, practical and effective; Improvement of problem solving ability using LKPD based on realistic mathematics learning approach that has been developed seen from the N-gain value in trial I of 0.35 increased to 0.39 in trial II, meaning it is in the "moderate" category; and the increase in students' self-ability with the realistic mathematics learning approach that

has been developed can be seen from the N-gain value in trial I of 0.31 increasing to 0.40 in trial II, meaning it is in the "moderate" category.

Keywords: Worksheet Development, Tessmer model, Realistic Mathematics Learning Approach, Problem Solving, Self-efficacy.

A. Introduction

In general, studying mathematics is inseparable from problems, since problem-solving determines success. Elementary, middle, and high school students need problem-solving abilities (Marsaulina, E., Syaban, M., & Retnaningrum, 2019). Learning maths is about problem-solving. According to (Liljedahl, P., Trigo, M. S., Malaspina, U., & Bruder, 2018) problem-solving skills have an important place among the main objectives of the curriculum". (Minarni, 2017) states that problem-solving is a crucial talent since people have confronted difficult challenges from birth. According to (Sihotang, 2019) mathematical problem solving has long been valued in mathematics, mathematics teaching, and mathematics learning. (Szabo, A., & Andrews, 2017) state that problem-solving activities should reflect mathematical abilities rather than past solutions. (Ząbkowski, T., Gajowniczek, K., Matejko, G., Brożyna, J., Mentel, G., Charytanowicz, M., Jarnicka, J., Olwert, A., & Radziszewska, 2023) state that issue-solving occurs once problem solving yields enough knowledge about the problem space to grasp it.

Problem-solving engages high- and low-level thinking in mathematics, according to (Hoiriyah, 2019). Problem-solving is key to arithmetic. Existing issues need mathematical problem-solving skills. In mathematics education, problem solving may be a goal, a process, or a fundamental ability, according to (Hasratuddin, 2018). (Das, R., & Chandra, 2018) define problem-solving as crucial to mathematics education. Students may enhance their thinking, methods, and conceptual knowledge by solving problems. Problem-solving is crucial to arithmetic learning. Students can think better, apply techniques, and comprehend topics by solving problems. Math problems are difficult and non-routine. Without proper issue depiction, problem resolution is impossible (Sajadi, M., Amiripour, P., & Rostamy-Malkhalifeh, 2019). (Marsigit., 2019) states that problem solving may help students think clearly, consistently, and methodically and establish a documentation/recording system. Problem-solving is crucial to learning arithmetic. Students must be able to answer arithmetic problems.

Problem-solving abilities are crucial to kids' intellectual development, particularly in arithmetic; thus, they should be given considerable emphasis. However, in the field, pupils lack problem-solving abilities and frequently don't grasp the teacher's concerns. Most solutions or mistakes occur in calculation implementation strategy, process verification, and calculation outcomes (Wahyudi, 2019). This supports (Sari, A., Revita, 2022) finding that pupils just care about the answers and not the explaining process. Students also struggle to solve non-routine contextual situations since they are unfamiliar with them. Initial observations of 30 class VIII pupils at SMP Budi Utomo Deli Serdang showed inadequate mathematical problem-solving

abilities, supporting the rationale above. This involves asking problem-solving questions that follow the steps outlined by (Polya, 1973) recognizing the issue, designing the solution, calculating, and verifying.

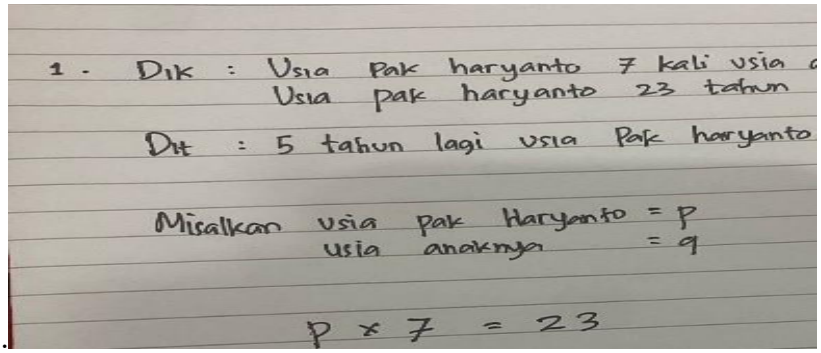


Figure 1. Wrong Student Answers in Solving Problem Solving Questions

Out of 30 students, 23.3% have high abilities, 43.3% have moderate abilities, and 33.3% have very low abilities when answering problem-solving questions. Students' problem-solving planning skills range from 3.3% extremely high, 3.3% intermediate, 33.3% low, and 60% very low. 6.6% of students have very high problem-solving skills, 6.6% have high skills, 10% have moderate skills, 16.6% have low skills, and 60% have very low skills. Overall, pupils' first ability test problem-solving skills are poor. Learning completion was attained by 12 pupils, 40% of 30. Students still struggle to solve contextually and complexly posed questions, as seen by the preceding student answers. This demonstrates that kids' problem-solving skills are still poor

Students haven't understood the questions' issues from the initial problem-solving sign (Roswanti, 2020). Students are still inaccurate in putting issues into mathematical models based on what is known in the inquiry because they cannot write what is known appropriately. The second problem-solving signal shows pupils planning to tackle the issue but not understanding the subject. Students still make mistakes while picking a formula or strategy to tackle an issue. Student solutions for the third problem-solving indication were incorrect. Because pupils erred in step two. Students didn't recheck the fourth problem-solving indication, hence the solution was erroneous. Due to the initial problem-solving indication, pupils cannot write what is known in the problem.

Based on a conversation with a grade 8 mathematics teacher at SMP Budi Utomo Deli Serdang, Mr. Azka on February 7, 2022. Because teachers always try to complete teaching materials on time, teachers control the learning process more so that students are less enthusiastic. Students are accustomed to memorizing formulas and how to answer questions from teachers or textbooks without developing problem-solving skills. As a result, children have difficulty answering arithmetic questions in class. From the explanation above, mathematical

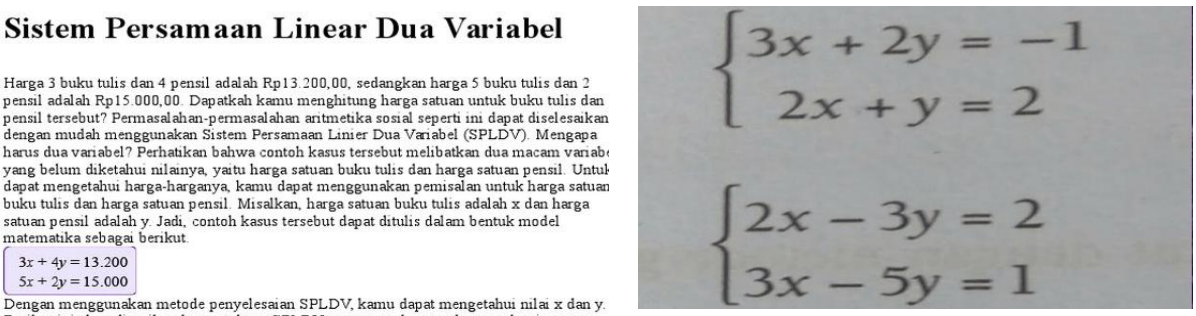
problem-solving is vital and should be improved in learning. Unfortunately, field data shows that kids' problem-solving skills remain inadequate. Student internal factors can contribute to bad mathematics learning results. (Nurullita., Surya, Edy. & Syahputra, 2017) Solving math problems and finding the right solution require high thinking activity and emotional management to create motivation, eliminate pessimism, and create enthusiasm, perseverance, and patience to keep trying until the problem is solved with the right result. In addition to mathematical problem-solving abilities, student learning independence is vital. Psychological factors like student learning independence affect students' assignment and problem-solving performance. Self-confidence may help students complete homework and answer instructor questions, but it can also boost their performance. Student Learning Independence evaluates students' problem-solving skills.

(Purnama Sari, D., Syahputra, E., & Surya, 2018) claimed that Student Learning Independence is a psychological factor that greatly affects students' assignment and question completion. (Agumuharram, F. N., & Soro, 2021) define Student Learning Independence as a person's confidence in their capacity to attain life objectives. (Jatisunda, 2017) defines student learning independence as the notion that a person can discover, organize, and complete a task to attain their objectives. High Student Learning Independence students constantly want to develop and succeed. (Mukhid, 2019) states that people with a strong sense of Learning Independence work harder to complete tasks and overcome obstacles than those with a weak sense of independence.

Thus, students with more Student Learning Independence will have a stronger intention and be more likely to complete tasks despite external constraints. (Schunk, 1995) states that "individuals with high Independence are more likely to participate in assignments or lessons, while individuals with low learning independence are more likely to leave lessons or assignments". Student Learning Independence denotes a person's behaviour or attitude that decreases self-confidence and accomplishment when they face an unfavourable scenario. According to discussions with Budi Utomo Deli Serdang Middle School mathematics instructors about Learning Independence, many pupils moan while working on tough issues and don't want to solve them. Some kids don't desire to study actively. For instance, asking or responding instructor questions. Students' mathematical insecurity drives this hesitation. Due to its positive impact on learning motivation, Student Learning Independence has to be improved. (Dogan, 2018) adds "that students who are confident in their Learning Independence and have a desire to behave academically will be able to motivate themselves to learn and fulfill cognitive activities to be successful".

Cognitive, emotional, and psychomotor abilities are needed to learn. Mathematics aims to teach problem-solving, and Student Learning Independence is affective/psychological. Problem solving and student learning independence are crucial to maths learning. Besides problem-

solving abilities and Student Learning Independence, students' mathematical learning strategy is missing, since instructors still utilize an ordinary or conventional learning technique. The researcher interviewed SMP Budi Utomo Deli Serdang mathematics teacher Mr. Azka, who said that learning activities continued as usual, with the teacher explaining the material and students answering practice questions. Learning activities cannot be done according to the RPP, but the most essential thing is that the instructor explains the subject and the pupils internalize it. (Ulfah, A., Bintari, S. H., & Pamelasari, 2018) state that open resources like student worksheets make teaching and learning dynamic, effective, innovative, engaging, and enjoyable. LKPDs that satisfy validity, practicality, and efficacy are excellent. The interview with Mr. Azka revealed that classroom learning uses LKPD in the form of a summary and regular questions. This suggests that instructors' LKPD employed the wrong learning technique. The current LKPD does not match the one we should offer. The right LKPD is developed by professors based on their expertise and is tailored to meet each student's abilities and traits. LKPD often involves just basic activities that do not enhance student skills.



Sistem Persamaan Linear Dua Variabel

Harga 3 buku tulis dan 4 pensil adalah Rp13.200,00, sedangkan harga 5 buku tulis dan 2 pensil adalah Rp15.000,00. Dapatkah kamu menghitung harga satuan untuk buku tulis dan pensil tersebut? Permasalahan-permasalahan aritmetika sosial seperti ini dapat diselesaikan dengan mudah menggunakan Sistem Persamaan Linier Dua Variabel (SPLDV). Mengapa harus dua variabel? Perhatikan bahwa contoh kasus tersebut melibatkan dua macam variabel yang belum diketahui nilainya, yaitu harga satuan buku tulis dan harga satuan pensil. Untuk dapat mengetahui harga-harganya, kamu dapat menggunakan pemisalan untuk harga satuan buku tulis dan harga satuan pensil. Misalkan, harga satuan buku tulis adalah x dan harga satuan pensil adalah y. Jadi, contoh kasus tersebut dapat ditulis dalam bentuk model matematika sebagai berikut.

$3x + 4y = 13.200$
$5x + 2y = 15.000$

Dengan menggunakan metode penyelesaian SPLDV, kamu dapat mengetahui nilai x dan y. Berikut ini akan diuraikan konsep dasar SPLDV serta metode-metode penyelesaian yang dapat digunakan.

$$\begin{cases} 3x + 2y = -1 \\ 2x + y = 2 \end{cases}$$

$$\begin{cases} 2x - 3y = 2 \\ 3x - 5y = 1 \end{cases}$$

Figure 2 Student Worksheet at Budi Utomo Middle School, Deli Serdang

An effective learning strategy is needed to increase problem-solving abilities and Student Learning Independence via LKPD. The appropriate method also influences pupils' arithmetic learning. Good learning activities are characterized by students' growing skills and instructors' capacity to process learning to motivate pupils. Real-life circumstances increase problem-solving and student learning independence. (Mahayukti, G. A., Suarsana, I. M., & Wijaya, 2016) said "Teach math using student issues. This requires actual and relevant learning". The maths learning style is realistic. The term comes from Teffers' taxonomy of arithmetic learning approaches: mechanistic, empirical, structuralistic, and realistic. Realism shows a more authentic learning strategy based on student realities. The realistic technique is similar to inductive learning, which uses reason to gain information. Realistic thinking allows pupils to build inductive reasoning from real-world events.

Based on test results, (Harahap, S. S., Hasratuddin, & Simamora, 2017) found that the learning device based on the realistic mathematical approach improved students' learning mastery, especially mathematical problem solving. According to (Somakin., 2016), the realistic approach to mathematics improves students' mathematics learning independence better than a conventional mathematical approach, so high-level students have better math learning independence. Additionally, school-level kids do not affect student learning independence math success. Based on the problems above, learning realistically can help students overcome low mathematical problem-solving ability and learning independence, so the researcher feels the need to conduct research on "Development of Student Worksheets Based on a Realistic Mathematics Learning Approach to Improve Problem-Solving Ability and Learning Independence in Budi Utomo Junior High School."

B. Research Method

This research is included in development research (development research) (Azis, 2015). This research uses the Tessmer development model of the formative evaluation type. This development model consists of 2 stages of development, namely introduction (determination) and prototyping (design and evaluation). This research was conducted at SMP Budi Utomo Deli Serdang in the even semester of the 2022/2023 academic year. The reasons for choosing the location of the research were because similar research had never been conducted at the school, the distance between the research location and the place of residence was closer than other schools, making the research process easier, and the school was very open to researchers who could improve learning. The subjects in this study were representatives of class VIII students of SMP Budi Utomo Deli Serdang in the 2022/2023 academic year, while the objects in this study were Student Worksheets (LKPD) developed based on a realistic mathematical approach to the material of data-side spatial shapes. The development of LKPD in this study refers to the modified Tessmer model of the formative evaluation type. This research consists of 2 stages, namely the preliminary stage (determination) and prototyping (design and evaluation) which include expert reviews, one-to-one, and small groups and the field test stage (high resistance in revision). The development model in this study is schematically shown in Figure 3. The stages of LKPD development are detailed as follows:

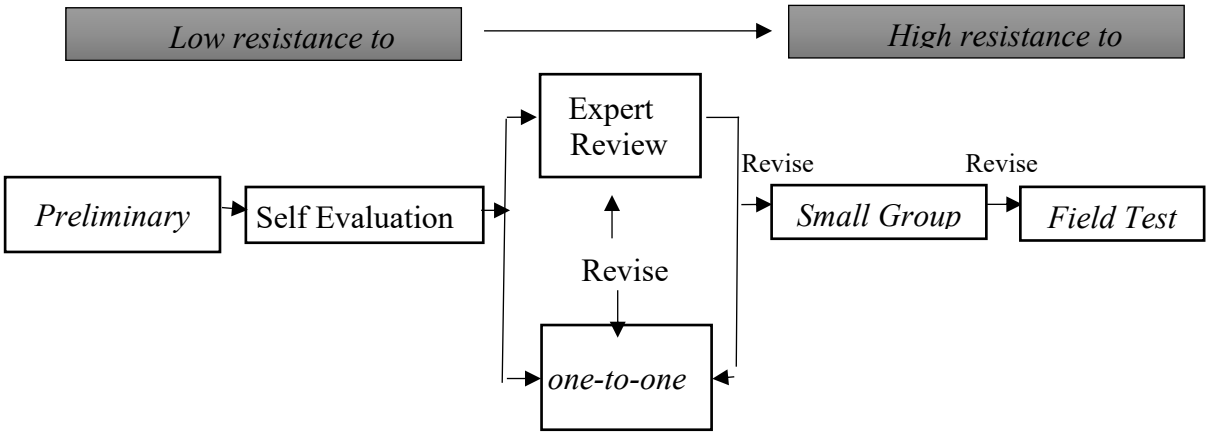


Figure 3.Tessmer 1998 Research Flow (Jurnaidi & Zulkardi, 2013:45)

C. Result and Discussion

To achieve these objectives, development research was conducted using the Tessmer model which includes preliminary stages and prototyping stages using a formative evaluation flow. Data analysis and research results obtained in each stage of development are presented as follows

Preliminary

At this stage, the researcher will conduct an analysis of the students, curriculum analysis and material analysis. This stage is carried out by the researcher before carrying out the design.

Curriculum analysis is conducted in order to adjust the existing curriculum in schools with the developed LKPD. Through the analysis of the material presented in the textbooks used and comparing it with the needs of students and its relevance to the 2013 curriculum, the subject matter used in this study is the material on flat-sided spatial figures for junior high school grade VIII in the even semester. This curriculum analysis is intended to identify, detail, and systematically organize the concepts that students will learn in the material on flat-sided spatial figures into a concept map. This concept map is then adjusted to the LKPD used. Overall, the concept map produced in the study can be seen in Figure 4.

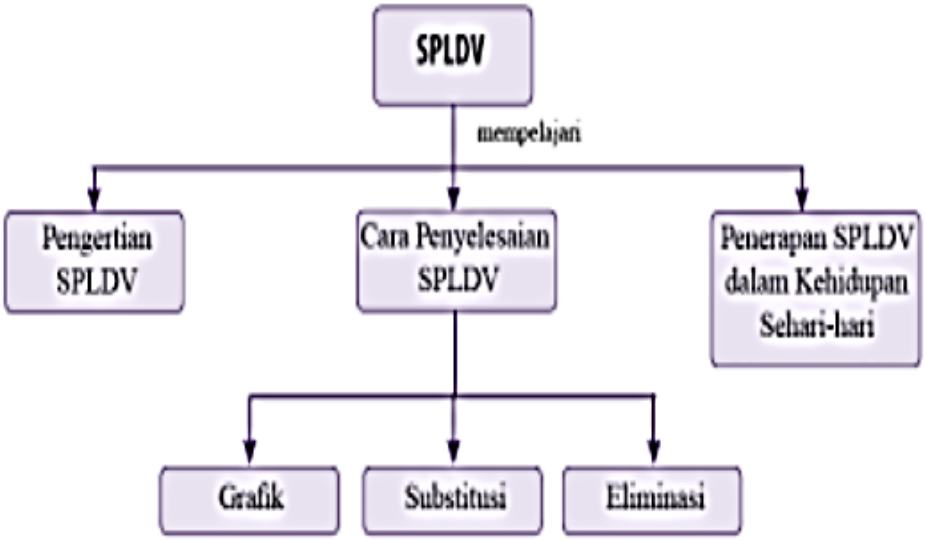


Figure 4. Concept Analysis Results for SPLDV Material

After conducting curriculum analysis, the next step is to conduct material analysis. Material analysis is carried out by analyzing the 2013 curriculum, core competencies, then mapping basic competencies, learning objectives and learning materials. The selection of materials in this activity is carried out by considering various considerations as an effort so that the selected materials can truly support the achievement of core competencies and basic competencies. The materials that will be included in the LKPD to be developed can be seen in Table 1.

Table 1. Learning Objectives for Each Meeting

No	Draft	Learnin Objectives	The 2nd Meeting
1	Definition, elements, properties of cubes and cuboids	1. Students are able to understand the concept of cubes and cuboids 2. Students are able to identify the elements of cubes and cuboids 3. Students are able to identify the properties of cubes and cuboids	1
2	Surface area of a cube	1. Students are able to find the surface area of a cube 2. Students are able to solve problems related to the surface area of a cube	2
3	Surface area of a cuboid	1. Students are able to find the formula for the surface area of a cuboid 2. Students are able to solve problems related to the surface area of a cuboid	3
4	Volume of a cube	1. Students are able to find the formula for the volume of a cube. 2. Students are able to solve problems related to the volume of a cube.	4

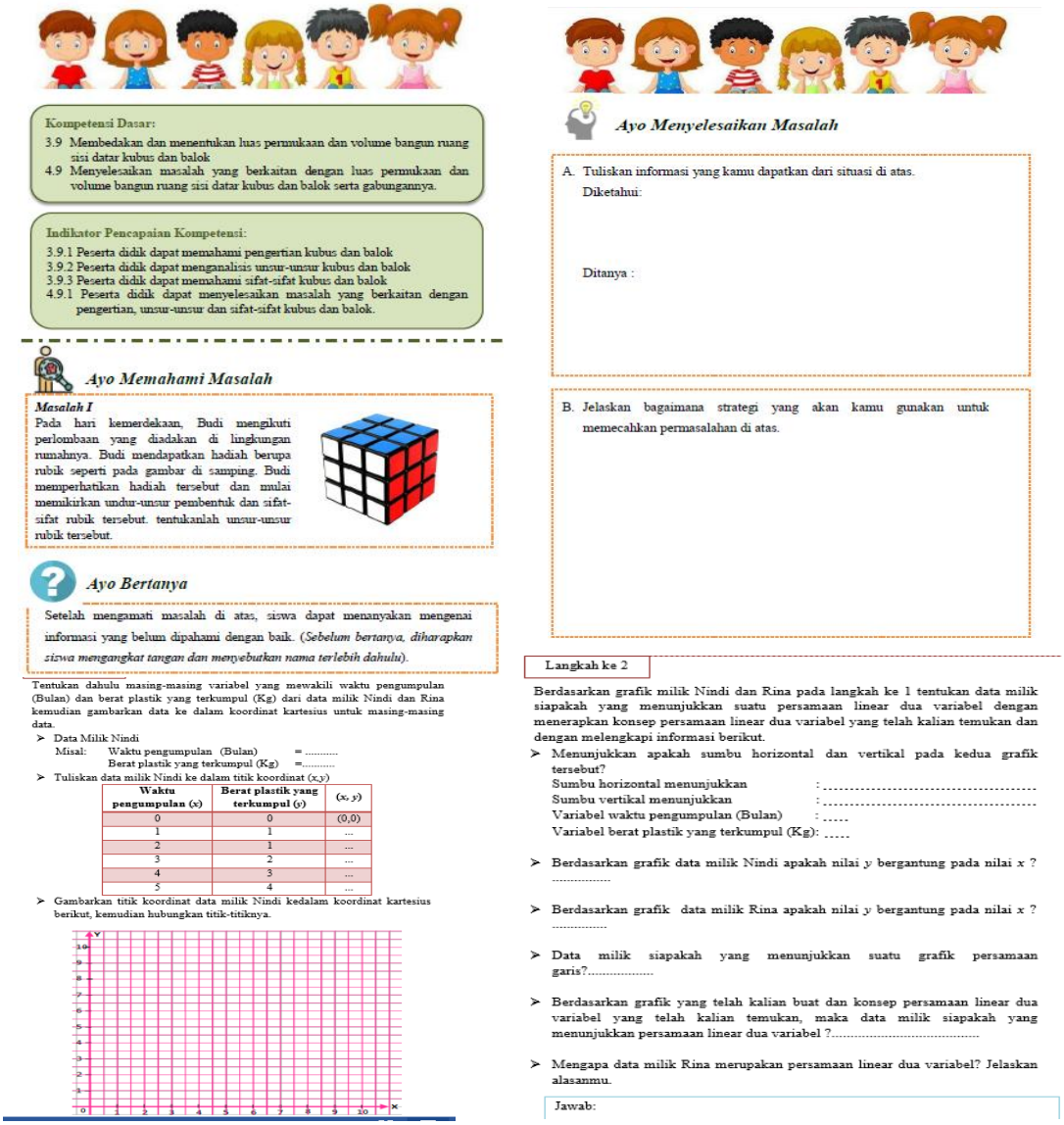
No	Draft	Learnin Objectives	The 2nd Meeting
5	Volume of a cuboid	1. Students are able to find the formula for the volume of a cuboid 2. Students are able to solve problems related to the volume of a cuboid	5

Self Evaluation

The researcher devised the LKPD design at this point. Independent assessment of the original prototype with lecturer/supervisor input. The supervisor validated the researcher's independent judgment. Prototype I from this stage's revisions went to expert assessment. We chose the developed LKPD at this point. LKPD was designed using a realistic mathematics learning paradigm. LKPD based on a realistic mathematics learning method is an issue since it does not yet exist or does not fulfill the learning demands and test instruments to develop students' mathematical problem-solving skills. In this work, LKPD was created using a realistic mathematics learning strategy to scaffold student problem-solving. Realistic mathematics learning helps students develop problem-solving skills and Learning Independence, enabling them to solve problems in informal and formal settings.

Development of the LKPD included 5 meetings. Three experts and two practitioners verified the LKPD. The designed LKPD includes group name, members, work instructions, fundamental competencies and competence achievement indicators, and contextual challenges that students must address with their group. Real-life challenges are offered so students may comprehend and be motivated to solve them. The LKPD questions also address problem-solving skills that should enhance mathematical problem-solving. The display of LKPD

problems based on a realistic mathematics learning approach that is adjusted to the indicators of mathematical problem solving abilities can be seen in the image below



Kompetensi Dasar:
3.9 Membedakan dan menentukan luas permukaan dan volume bangun ruang sisi datar kubus dan balok
4.9 Menyelesaikan masalah yang berkaitan dengan luas permukaan dan volume bangun ruang sisi datar kubus dan balok serta gabungannya.

Indikator Pencapaian Kompetensi:
3.9.1 Peserta didik dapat memahami pengertian kubus dan balok
3.9.2 Peserta didik dapat menganalisis unsur-unsur kubus dan balok
3.9.3 Peserta didik dapat memahami sifat-sifat kubus dan balok
4.9.1 Peserta didik dapat menyelesaikan masalah yang berkaitan dengan pengertian, unsur-unsur dan sifat-sifat kubus dan balok.

Ayo Memahami Masalah

Masalah I
Pada hari kemerdekaan, Budi mengikuti perlombaan yang diadakan di lingkungan rumahnya. Budi mendapatkan hadiah berupa rubik seperti pada gambar di samping. Budi memperhatikan hadiah tersebut dan mulai memikirkan unsur-unsur pembentuk dan sifat-sifat rubik tersebut. tentukanlah unsur-unsur rubik tersebut.

Ayo Bertanya

Setelah mengamati masalah di atas, siswa dapat menanyakan mengenai informasi yang belum dipahami dengan baik. (*Sebelum bertanya, diharapkan siswa mengangkat tangan dan menyebutkan nama terlebih dahulu*).

Tentukan dahulu masing-masing variabel yang mewakili waktu pengumpulan (Bulan) dan berat plastik yang terkumpul (Kg) dari data milik Nindi dan Rina kemudian gambarkan data ke dalam koordinat kartesius untuk masing-masing data.

- Data Milik Nindi
  Misal: Waktu pengumpulan (Bulan) = ...
  Berat plastik yang terkumpul (Kg) = ...
- Tuliskan data milik Nindi ke dalam titik koordinat (x,y)

Waktu pengumpulan (x)	Berat plastik yang terkumpul (y)	(x, y)
0	0	(0,0)
1	1	...
2	1	...
3	2	...
4	3	...
5	4	...

- Gambarkan titik koordinat data milik Nindi kedalam koordinat kartesius berikut, kemudian hubungkan titik-titiknya.

Ayo Menyelesaikan Masalah

A. Tuliskan informasi yang kamu dapatkan dari situasi di atas.
Diketahui:

Ditanya :

B. Jelaskan bagaimana strategi yang akan kamu gunakan untuk memecahkan permasalahan di atas.

Langkah ke 2

Berdasarkan grafik milik Nindi dan Rina pada langkah ke 1 tentukan data milik siapakah yang menunjukkan suatu persamaan linear dua variabel dengan menerapkan konsep persamaan linear dua variabel yang telah kalian temukan dan dengan melengkapi informasi berikut.

- Menunjukkan apakah sumbu horizontal dan vertikal pada kedua grafik tersebut?
  Sumbu horizontal menunjukkan : .....
  Sumbu vertikal menunjukkan : .....
  Variabel waktu pengumpulan (Bulan) : .....
  Variabel berat plastik yang terkumpul (Kg): .....
- Berdasarkan grafik data milik Nindi apakah nilai *y* bergantung pada nilai *x* ? .....
- Berdasarkan grafik data milik Rina apakah nilai *y* bergantung pada nilai *x* ? .....
- Data milik siapakah yang menunjukkan suatu grafik persamaan garis?.....
- Berdasarkan grafik yang telah kalian buat dan konsep persamaan linear dua variabel yang telah kalian temukan, maka data milik siapakah yang menunjukkan persamaan linear dua variabel ?.....
- Mengapa data milik Rina merupakan persamaan linear dua variabel? Jelaskan alasanmu.

Jawab:

Figure 5. Student Worksheet Display

Expert Review

At the evaluation stage, one-on-one LKPD and research instruments are validated by experts in their fields and practitioners. The experts referred to in this case are lecturers in mathematics education at Medan State University and practitioners including mathematics teachers. In general, expert validation includes content validation that contains observation points related to: (1) format, (2) language, and (3) content. The results of expert validation are in the form of validation values, corrections, criticisms, and suggestions that are used as a basis for revising and improving the developed LKPD. The revised LKPD is an LKPD that has met the valid criteria. The results of the validation and revision of the LKPD are based on the assessment and

correction of the validator. The validators selected in this study consisted of three mathematics lecturers at Medan State University and one teacher at Budi Utomo Deli Serdang Middle School. Validation activities are carried out by submitting the LKPD to the validator along with the validation sheet, which is then checked by the validator. The following will describe the results of the validation and revision carried out on the LKPD

The following is a display of the student worksheet that was developed:

Table 2. Validation Results

No	Aspect	Average	Category
1	Student Worksheets	4,32	Valid
2	Problem Solving Ability Test	4,33	Valid
3	Learning Independence	4,20	Valid

Table 2 shows that the RPP, Student Worksheets have a total average of "valid" of 4.5. The data in this study were analyzed using descriptive statistical analysis. According to Sheskin (2004), descriptive statistics as an analysis tool for the purpose of describing data without drawing conclusions and making predictions. The general procedure used in descriptive statistics is in the form of tables, graphs, diagrams and calculations of the magnitude of the center and distribution of data.

One to One Trial

The first prototype results were also tested in a small class (one to one) to determine the level of validity, whether the LKPD was worthy or not to be tested. After being given a one to one test, a validity test was carried out on the LKPD, in addition to that, a revision of the one to one trial was carried out. The results of the revision at this stage produced the second prototype LKPD. This LKPD trial was carried out at the research location, namely SMP Budi Utomo Deli Serdang. At the one to one stage, a trial of the LKPD design that had been developed was carried out on students who were testers. The results of this implementation were used to revise the design that had been made. The LKPD tested in this case was the material on flat-sided spatial structures. The researcher chose students from class VIII-1 with categories of high, medium and low abilities with 2 people each. The results of the one to one trial were used to determine whether the LKPD that was compiled could be understood by students, to avoid ambiguity/double meanings so that they could understand the intent and answer questions correctly. After being tested, validation was carried out on LKPDs that had not been understood by students, both in terms of grammar, or could cause double meanings.

Small Group

The results of the revision of the expert review and the difficulties experienced during the trial on the first prototype were used as the basis for revising the prototype and named the second prototype, the results of which were then tested on a small group. The small group in this case was taken from class IX-2, with categories of high, medium and low ability with each category consisting of 3 people. So that the total number of students who took part in the small group trial was 9 people. The revised LKPD was given on prototype II, whether there were questions that were not understood by the students or whether there were questions that had multiple meanings. The results of this trial were then used for revision before the trial was carried out at the field test stage. The assessment carried out by students on the LKPD included: format, language, and content. In making revisions, the researcher referred to the results of the students' LKPD work by following the students' opinions as validators.

Field Test

This trial was conducted five times in accordance with the RPP that had been developed. During the trial, the researcher acted as the teacher who taught. Learning was designed by conditioning students to sit in groups of 3-4 people in one group. Group members were formed heterogeneously in terms of academic ability so that each student could gain a variety of learning experiences. With heterogeneous grouping, it can be said that the characteristics and average abilities of each group are relatively the same.

The practicality of the learning device in the trial can be seen through the results of the observation of the implementation of learning. The results of the observation of the implementation of learning in the trial showed that the average observation of the implementation of learning in the first meeting of trial II was 3.67; the second meeting was 3.67; the third meeting was 3.73; the fourth meeting was 3.80 and the fifth meeting was 3.87. Furthermore, the average value of the five meetings was 3.74, which is in the category of being implemented well (3≤O_k<4). This score has met the criteria for achieving the practicality of LKPD in terms of the implementation of learning

Furthermore, the description of the results of students' mathematical problem-solving abilities in trial II as a whole is shown in Table 3 below.

Table 3. Pre-test and Post-test Achievement Level of Students' Mathematical Problem Solving Ability in Trial

Category	*Pretest*		*Posttest*	
	Number of Students	Number of Students	Number of Students	Number of Students
Completed	8	26,67 %	26	86,67%
Not Completed	22	73,33%	4	13,33%
Total	30	100%	30	100%
Average Class	59,69		75,52	

From table 3, it can be seen that the percentage of students' classical achievement of mathematical problem solving ability in the pre-test of trial II was 73.33% (not complete) and 26.67% (complete) while the percentage of students' mathematical problem solving ability completion in the post-test of trial II was 13.33% (not complete) and 86.67% (complete). In accordance with the criteria for classical student achievement, namely at least 85% of students who took the mathematical critical thinking ability test were able to achieve ≥70. So, the results of the pre-test and post-test of mathematical problem solving ability have met the criteria for classical achievement. So it can be concluded that, in trial II, the application of LKPD based on the realistic mathematics learning approach that was developed has met the criteria for classical achievement.

Description of the Results of the Student Learning Independence Questionnaire in the Trial

In this study, the data of the Student Learning Independence questionnaire were obtained from data before and after being given treatment, namely the realistic mathematics learning approach. The Student Learning Independence Questionnaire was conducted once at the beginning before the learning activity began and once at the end of the learning process, which aimed to determine the increase in Student Learning Independence obtained by students after being given learning treatment using learning based on the realistic mathematics learning approach on the material of the Two Variable Linear Equation System. The description of the results of Student Learning Independence in trial as a whole is shown in the following table

Table 4. Description of Student Learning Independence Questionnaire Data in the Trial

Category	Before Treatment	Student Self-Efficacy Achievement	After Treatment	Student Self-Efficacy Achievement
	Number of Students		Number of Students	
Very Low	1	3,33%	0	0 %
Low	3	10,00 %	2	6,67 %
Medium	14	46,67 %	10	33,33 %
High	12	40,00 %	11	36,67 %
Very High	0	0 %	7	23,33 %
Total	30	100 %	30	100 %
Average Class	73,76		91,30	

Based on the table, it can be seen that the Learning Independence of Students in trial shows data on the number of students before being given treatment in the very low, low, medium, high categories and in sequence, namely: 1 student, 3 students, 14 students, and 12 students. While

in the data after treatment, the number of students in the low, medium, high and very high categories in sequence are: 2 students, 10 students, 11 students and 7 students.

Discussion

Valid LKPD is acquired for numerous reasons, including: First, realistic mathematics learning approach-based LKPD has content validity. The curriculum criteria were met when LKPD was developed using a realistic mathematics learning method. This curriculum requires students to develop core skills and fundamental competencies via learning activities that match the course topic and actual mathematical learning procedures. According to (Arikunto, 2012) strong content validity is when a learning device can assess specified goals that match the classes' content. Many call this content validity curricular validity. Second, construct validity was achieved using LKPD and a realistic mathematics learning model. This means that LKPD based on a realistic mathematics learning approach was developed using indicators of mathematical problem-solving abilities and Student Learning Independence. The created LKPD complements RPP and LKPD, which are suited to RME-based learning techniques, to assess students' mathematical problem-solving and Student Learning Independence. (Akbar, 2013) highlighted that learning device validation tests provide good validity.

Then, through the observation sheet of the implementation of learning using LKPD based on the realistic mathematics learning approach given to an observer at each trial meeting I and II, the results obtained were that the observation score of the implementation of learning in trial I had not met the criteria of practicality, namely with an average observation at the first meeting of 2.87; the second meeting of 2.93; the third meeting of 3.00; the fourth meeting of 3.00 and; the fifth meeting of 3.07, with an average of 2.97 (category "implemented poorly"). While in trial II the first meeting was 3.67; the second meeting of 3.67; the third meeting of 3.73; the fourth meeting of 3.80 and; the fifth meeting of 3.87. The average result of the observation of the implementation of learning in trial II was 3.74 with the category "implemented well". Therefore, it can be concluded that the LKPD based on the RME approach that was developed has met the indicators of practicality of LKPD The post-test results of trial I showed a 66.67% classical achievement, while trial II showed an 86.67% achievement, meeting the criteria of 85% students achieving a minimum score of ≥ 70. Thus, students' post-test mathematical problem-solving outcomes met traditional accomplishment in Two-Variable Linear Equation Systems. The analysis of trial I data showed that the average percentage of the questionnaire on students' mathematical learning independence before treatment was 77.90 and the average class after treatment was 89.93. In trial II data analysis, the average percentage of the questionnaire on students' mathematics learning independence before treatment was 73.76, and the average class after treatment was 91.30. Chapter III study indicates that the average score of students' math learning independence before and after utilizing LKPD based on RME technique is

"moderate" (50-75). In trial I and trial II, LKPD based on the RME method satisfied the efficacy criterion as shown by students' math learning independence.

The pre-test and post-test analysis indicated that trial I's average mathematical problem-solving skill was 54.84 and increased to 70.89. Students' mathematical problem-solving skills improved from 59.69 to 75.52 in trial II. Mathematical problem-solving skills increased in trial I, with a "moderate" score of 0.34 (0.30 <n-gain ≤ 0.70). Trial II showed a "moderate" rise with a score of 0.35 (0.30 <n-gain ≤ 0.70). This suggests that LKPD based on the RME technique improves students' mathematical problem-solving. (Ulandari, L., Amry, Z., & Saragih, 2019) found that Realistic Mathematics Education (RME) that meets successful criteria improves students' mathematical problem-solving and Learning Independence.

Through improving LKPD and reflecting on learning practices, students' mathematical learning independence increases to a better category according to the criteria set. LKPD with an RME-based learning strategy increases student math learning independence. Students' arithmetic interest may grow with RME learning. Based on the discussion above, LKPD based on a realistic mathematics learning approach has been valid (as shown by LKPD validation and research instruments), practical (as shown by observations of learning implementation), and effective (as shown by mathematical problem-solving abilities, Student Mathematical Learning Independence, and positive student responses).

D. Conclusion

LKPD berbasis metode pembelajaran matematika realistik memenuhi syarat kepraktisan berdasarkan data observasi keterlaksanaan pembelajaran. LKPD berbasis metode pembelajaran matematika realistik memenuhi syarat kepraktisan berdasarkan (1) kemampuan pemecahan masalah matematika siswa, (2) kemandirian belajar, dan (3) jawaban siswa. Kemampuan pemecahan masalah matematika siswa mengalami peningkatan pada semua aspek. Uji coba I dan II menunjukkan adanya peningkatan kemampuan pemecahan masalah matematika berdasarkan indeks gain ternormalisasi. Hal ini menunjukkan bahwa LKPD teknik pembelajaran matematika realistik dapat meningkatkan kemampuan pemecahan masalah matematika siswa. Setiap aspek Kemandirian Belajar Matematika meningkatkan Kemandirian Belajar siswa. Indeks gain ternormalisasi menunjukkan bahwa skor angket Kemandirian Belajar siswa mengalami peningkatan pada uji coba I dan II. Hal ini menunjukkan bahwa LKPD metode pembelajaran matematika realistik dapat meningkatkan kemandirian belajar siswa.

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