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Students' Worksheets Based on Problem Based Learning In Composition and Inverse Functions to Enhance Conceptual Understanding

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ABSTRACT

This research aims to design student worksheets based on problem-based learning in composition and inverse functions to facilitate conceptual understanding is valid. This research uses a PPE model by Richey and Klein; there are three parts: planning, production, and evaluation. The planning stage is a product planning process that will be developed for a specific purpose. The production stage is the process of making a product according to a previously made design. The evaluation stage is the process of testing and assessing the product that has been developed. The data obtained from the expert validator is then processed using a Likert scale and calculated using Aiken's formula to conclude the validity of the product developed. The Student Worksheets based on Problem Based Learning to aid students' understanding of mathematical ideas on composition functions and inverse functions were valid, have a 0.84 average validity value, and were classified as high. The PBL model familiarizes students with understanding concepts through problem-solving processes. On the other hand, learning mathematics using PBL effectively improves students' understanding and abilities because students apply mathematical concepts in everyday life.

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INTRODUCTION

Conceptual understanding is part of learning mathematics that students must master because it has a role in determining learning success. Students who understand the concept well will easily recall, apply the ideas learned, and handle existing problems (Hadi & Kasum, 2015). According to Novitasari (2016), conceptual understanding is a process of absorbing meaning from a material being studied. Conceptual understanding is the ability of students to understand mathematical concepts so that they can restate mathematical concepts, classify objects based on certain properties, provide examples and non-examples of a concept, present concepts in mathematical representations, use procedures, and apply the concept to

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problem-solving (Mawaddah & Maryanti, 2016). According to Pratiwi (2016), conceptual understanding is not just memorizing but is the ability of students to find and explain, translate, interpret, and conclude a mathematical concept based on the formation of their knowledge. It can be concluded that conceptual understanding is the ability of students to absorb ideas, explain, translate, and conclude a material based on the formation of their knowledge. Conceptual understanding plays a role in developing other mathematical skills, including critical thinking skills, creative thinking, problem-solving, reasoning, connection, communication, and representation. Therefore, students must have a conceptual understanding (Utami & Sukoriyanto, 2021).

According to the Regulation of the Director-General of Education at the Ministry of National Education No 506/C/Kep/PP/2004 it is explained that indicators of students' conceptual understanding can: 1) restate a concept, 2) classify objects according to certain properties according to with the concept, 3) give examples and not examples of a concept, 4) presenting concepts in various forms of mathematical representation, 5) develop the necessary or sufficient conditions of a concept, 6) using and utilizing and selecting procedures or certain operations, and 7) apply concepts or algorithms in problem-solving (Astuti et al., 2018). However, some research (Kholilah, 2019) states students still have difficulty in conceptual understanding. Even according to some research (Kamin et al, 2021), students who still have difficulty understanding the material of composition and inverse functions are classified as high. Students have difficulties in solving the problem of function composition and inverse functions including difficulties in understanding concepts, difficulties in skills, and difficulties in solving problems (Susanti & Lestari, 2019). Based on research from Kholilah (2019) related to conceptual understanding, most students still get scores below the KKM with an average of 54. It shows that the student has difficulty in conceptual understanding of composition and inverse functions and needs to improve.

Conceptual understanding is not easily achieved by itself without the efforts and facilities specifically designed for learning (Fitriani et al., 2016). One of the efforts that can be done is by designing teaching materials in the form of a worksheet that can facilitate conceptual understanding, that is a worksheet that used problem-based learning. Some research (Yulianti & Gunawan, 2019; Suhendar & Ekayanti, 2018; Halim, Suriana, & Mursal, 2017; Ejin, 2016; Rahmadari & Acesta, 2017; Fariana, 2017) show that Problem Based Learning can improve conceptual understanding. Problem Based Learning (PBL) is a learning model that utilizes real problems as material for students to solve these problems to

gain knowledge and learn to make decisions (Amin, 2017). Problems must be adapted to challenge students' interests to solve them, connect them with previous experiences and learning, and require collaboration and various strategies to solve them (Maryati, 2018). As a learning model, PBL also has advantages over other learning models. Among them are, that problem-solving in PBL is good enough for students to understand the content of the material, helps students to understand problems in the real world, can increase learning activities in class, assists students in developing knowledge, and building exciting learning and discussion environment for students (Wulandari & Surjono, 2013). The advantages possessed by PBL will also help students to be able to improve their conceptual understanding.

Student worksheets are teaching materials routinely used in schools (Mukti et al., 2018), but according to Sarah et al. (2019), teaching materials in worksheet contained in schools still have shortcomings, like the worksheet used is not problem-based and does not suit the needs of students (Fitriani et al., 2016) and the worksheet used is not problem-based and does not suit the needs of students and most of the worksheets contain explanations of concepts equipped with examples and practice questions related to the concept (Fannie & Rohi, 2014). It makes students feel they don't need to understand mathematical concepts to work on issues correctly, and they only need to memorize the steps that the teacher has taught. In addition, the worksheets used have not helped students construct their knowledge because of a lack of meaningfulness in the learning process for students (Fannie & Rohi, 2014).

Several studies (Fitriani et al., 2016; Wijayanti et al., 2019; Afridiani et al., 2020; Basri et al., 2020; Apriani et al., 2021) show that developing PBL worksheets can improve conceptual understanding. One of the reasons is the students' worksheets, students' understanding of concepts can be increased through students' worksheets in the learning process (Wijayanti et al., 2019). Students' worksheet that contains guidelines for implementing learning activities, learning materials, and practice questions to make students active in learning activities both in class and outside the classroom can improve the quality of learning outcomes. Through the use of students' worksheets, students are given the responsibility to solve problems; this is expected to increase the role of students in the learning process to develop their knowledge (Wahyuni & Efuansyah, 2019). In addition, Mukti et al. (2018) revealed that the students' worksheet was felt to attract students' attention in the learning process, equipped with exciting, and up-to-date pictures of the studied material. Thus, to facilitate conceptual understanding, students' worksheet must be designed

with a suitable learning model, considering that the students' worksheet used in schools has not been equipped with a series of activities that can help students build their knowledge, one of which is using the PBL model. The stages in the PBL model, namely 1) problem orientation to students, 2) organizing students to learn; 3) support the group to conduct investigations, 4) design and deliver the results of the work, and 5) analyzing and evaluating the process and results of problem-solving (Warsono & Hariyanto, 2012). Several studies (Fitriani et al., 2016; Wijayanti et al., 2019; Afridiani et al., 2020; Basri et al., 2020; Apriani et al., 2021) show that developing PBL worksheets can improve concept understanding, but there is no development of worksheets using PBL on composition and inverse functions. Because of that and the urgency of students' understanding of these materials, it is necessary to develop worksheets based on PBL in composition and inverse functions. Thus, this study aims to design students' worksheets based on PBL in composition and inverse functions to facilitate conceptual understanding that is valid.

RESEARCH METHOD

The research is classified as research and development (R&D). This research is to design students' worksheets based on PBL in composition and inverse functions to facilitate conceptual understanding that is valid for grade XI senior high school. In this study, there was no limited trial, so the subject was only an expert validator. The subjects of this study were 2 expert validators. The validators in this study were two expert validators with the research instrument used in a product assessment sheet. The expert validator is two mathematics education lecturers from UIN Sunan Kalijaga Yogyakarta and it is being done in June 2021.

This study uses the PPE development model developed by Richey and Klein with three stages of development, namely planning, production, and evaluation. At the planning stage, there are six steps carried out by researchers, namely 1) analysis of student characteristics, 2) material analysis, 3) curriculum analysis, 4) preparing the structure of the students' worksheet, 5) planning learning content, and 6) compiling research instruments. Furthermore, at the production stage, there are two steps taken by the researcher, namely the development of materials and practice questions as well as developing the students' worksheet design. In the last stage of evaluation (evaluation), an assessment is carried out by experts on the validity of the students' worksheet that the researcher developed. The data obtained from the expert validator is then processed using a Likert scale and calculated using

Aiken's formula to conclude the validity of the product developed. Qualitative data obtained from the assessment of experts is in Likert scale converted into quantitative with the following provisions in Table 1.

Table 1. Category of Scoring Assessment Sheet

Category Research	Score
Very Good	4
Good	3
Less	2
Very Poor	1

Data from the validator's assessment is calculated using the formula Aiken's, where each aspect is calculated content validity index with calculation as follows (Retnawati, 2016).

$$v = \frac{(\sum s)}{n(c-1)}$$

$s = r - lo$

lo = lowest validity rating score

c = highest validity rating score

r = number given by rater

To interpret the value of V that has been obtained from the calculations above, the benchmarks are in Table 2. A student worksheet is said to be valid if the average validity score interval is at a high criterion

Table 2. Validity Criteria

Category Research	Score
Very Good	4
Good	3
Less	2
Very Poor	1

RESULT AND DISCUSSION

Developing the students' worksheet begins at the first stage, namely planning or planning. At this stage, it is further divided into several stages. The first is an analysis of the characteristics of students through a literature review, where the results show that students in the SMA/MA class X are in the formal operational stage. Students begin to think about concrete experiences and think abstractly, ideally, and logically. Therefore, students can think abstractly when faced with a problem. In addition to having abstraction skills, students can also develop deductive hypotheses about solving a problem and systematically draw conclusions. Furthermore, a study was conducted on the learning resources commonly used

by students, namely the 2013 curriculum mathematics textbooks for class X, to analyze the material for composition functions and inverse functions. From here, four main materials will be presented in the students' worksheet, namely functions, algebraic operations of functions, composition functions, and inverse functions. The third stage in planning is curriculum analysis by analyzing the 2013 Revised Edition Curriculum. The parts analyzed are Core Competencies and Basic Competencies. From the basic competence on compositional and inverse functions, twelve Competency Achievement Indicators were developed. Four points are related to compositional function material, four are related to inverse functions, and four are related to function material.

The next stage is to develop the structure of the students' worksheets. The students' worksheet structure is an overall picture of the components contained in the students' worksheet. The components of the students' worksheet developed are divided into the initial, core, and final sections. The initial section includes the title page, introduction, table of contents, concept map, instructions for using students' worksheets, a description of the PBL model, Core Competencies, Basic Competencies, and Competency Achievement Indicators, and lesson plan. The core section contains material packaged in the PBL model and practice questions. The end includes a bibliography.

The learning content will be planned by finding and collecting appropriate references to develop students' worksheets. The references used in this study are 1) BUPENA Mathematics for SMA/MA Class X Compulsory Group, 2) Mathematics for Class X, and 3) Mathematics 2: for SMA/MA Class XI Social Science Programs. The materials and questions that have been collected are then adapted and modified to be included in the students' worksheets. The material for composition and inverse functions in the students' worksheet that will be developed is divided into four sub-students'] worksheets, namely students' worksheet 1 contains material on functions, students' worksheet 2 contains material on algebraic operations of functions, students' worksheet 3 contains material on composition functions, and students' worksheet 4 contains material on inverse functions. Finally, the research instrument is compiled in the planning or planning process. The assessment instrument is a product assessment sheet adapted and modified from previous research by Khasanah (2016) and Basri (2019). The assessment aspects contained in the product assessment sheet are aspects of the feasibility of content, language, presentation, and graphics. This assessment sheet is a checklist using a Likert scale and is equipped with comments and suggestions for the validator.

The second stage in the development of this student's worksheet is production. Researchers will develop students' worksheets for students and students' worksheets for teachers at this production stage. The difference between the two students' worksheets lies in the lesson plans, answer keys, and teacher activity instructions contained in the teacher handbook students' worksheet. At the same time, there is no difference between the two in terms of material and practice. The steps for this production activity are developing materials, practicing questions, and creating product designs.

In the first step, the material and practice questions presented in the students' worksheet are arranged based on the Problem Based Learning (PBL) learning model stages. The material is shown in real problems that students must solve. The material presented in each sub-student worksheet is further elaborated into several sub-materials by the Basic Competencies, and Competency Achievement Indicators made previously. The problems in each sub-student worksheet are related to the real world. Problems like this are chosen to be more relevant to the situation of students so that it is easier to understand, the closer to the real world, the better for students' understanding. For example, in students' worksheet 1, students at the beginning of learning will be faced with problems related to test scores obtained by several students, then they are asked to classify which ones are functions and which are not. In students' worksheet 2, one of the problems presented relates to the use of PDAM water for daily activities, where students are asked to calculate how much they have to pay in a particular month. Likewise, students' worksheet 3 and students' worksheet 4 also contain problems related to the real world.

Furthermore, product design development is carried out in the second step using Microsoft Word 2013 and pictures and illustrations from several references with free licenses. The students' worksheet components designed include the students' worksheet cover, introduction, table of contents, concept map, instructions for using students' worksheet, description of the Problem Based Learning (PBL) model, Core Competencies (KI), Basic Competencies (KD), and Competency Achievement Indicators., materials, practice questions, and bibliography. One of the designs of the students' worksheet components is presented in Figure 1.

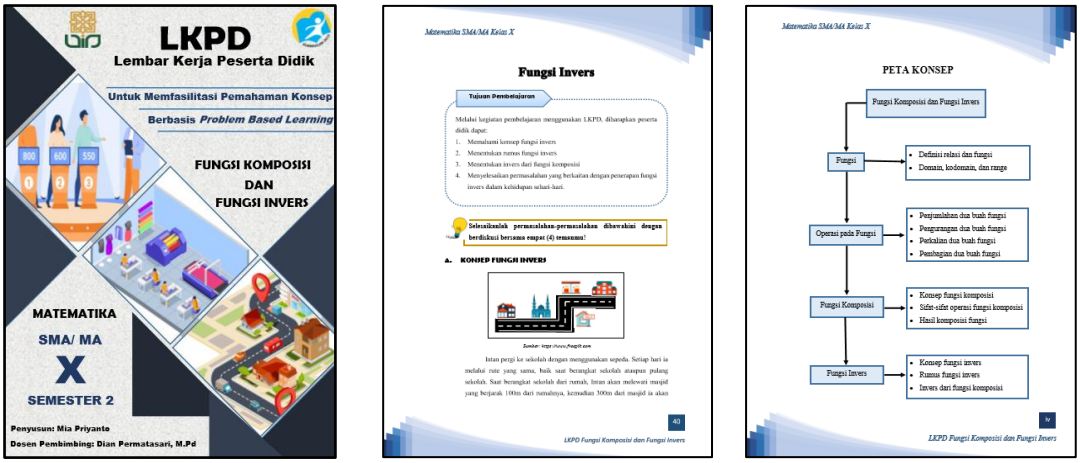


Figure 1. Design of students' worksheet Components

The third stage of developing this student's worksheet is the evaluation stage. Two expert validators validate the product development results at this stage. Furthermore, criticism and suggestions are obtained from the validator, which will improve the developed students' worksheets. Some of the complaints and directions given by the validator include the following: 1) the students' worksheet cover illustration does not yet describe the content or material in the students' worksheet; 2) some writing errors occurred; 3) lack of consistency in using symbols; 4) has not included the source of the image used in the students' worksheet, and 5) using too many typefaces.

The validity of this student's worksheet can be seen from the results of the assessment or product validation by expert validators. The results of the expert validator assessment can be seen in Table 3.

Table 3. Product Assessment Results

No	Aspect assessment	Indicator	Score	Average of the Aspect	Category
1	Content eligibility component	Scope of materials	0,89	0,89	High
		Material accuracy	0,92		
		Component of problem-based learning	0,92		
		Facilitate concept understanding	0,85		
2	linguistic component	Communicative	0,67	0,75	Medium
		Straightforward	0,75		
		Coherence and coherence of thoughts	1,00		
		Compatibility with Indonesian rules	0,67		
		Use of terms, symbols, and symbols	0,67		
3	Components of serving material	Presentation techniques	0,92	0,94	High
		Presentation support	0,96		
4	Graphic component	Worksheet size	0,83	0,80	Medium
		Worksheet 's design and skin	0,78		
		Worksheet contents design	0,79		
Total				**0,85**	**High**

Based on Table 1, an assessment of the validity of the students' worksheet with Problem Based Learning (PBL) was obtained on the material of composition and inverse functions. The highest average value is in the presentation aspect, which is 0.91, and the lowest average value is in the linguistic element, which is 0.75. Overall, the validity value of students' worksheet with Problem Based Learning (PBL) on the material of composition and inverse functions is included in the high category with an overall average value of 0.85, so it can be concluded that the product developed is students' worksheet with Problem Based Learning (PBL) on the material composition and inverse functions meet the valid criteria.

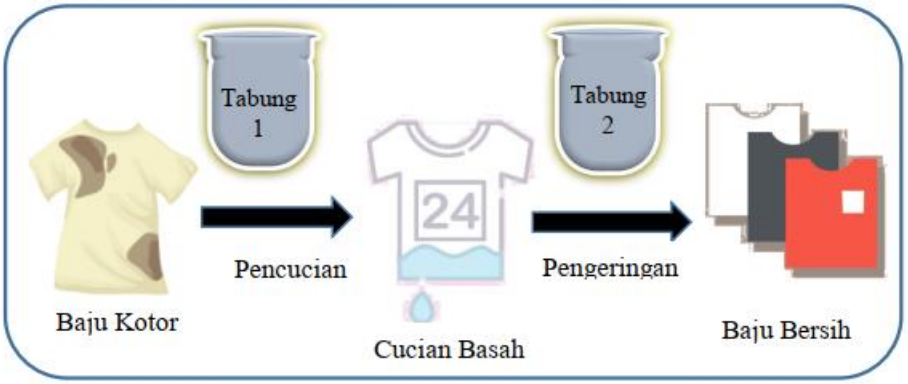
Based on Table 1, shows that this worksheet fulfills the Problem Based Learning Component. The detail of the item and the score is shown in Table 4.

Table 4. The Item and Score from the Expert for Problem-Based Learning Component

No.	Item Evaluation	Score	Category
1.	The problems and practice questions have allowed give students the opportunity to understand the concepts they have acquired	1,00	High
2.	There are activities in the worksheet that can orient students to problems	1,00	High
3.	There are activities in the worksheet that can organize students to learn	1,00	High
4.	There are activities in the worksheet that can facilitate the investigation of groups of students	0,83	High
5.	There are activities in the worksheet that can facilitate students to present their work	0,83	High
6.	There are activities in the worksheet that can be used to evaluate the results of problem-solving	0,83	High

According to Table 2, all of the components are in the high category. It means all of the components of Problem Based Learning are fulfilled. The students' worksheet with Problem Based Learning approach starts with presenting the problem situation. Examples of problems used in students' worksheets are shown in Figure 2.

Perhatikan ilustrasi berikut!



Sumber: vecteezy.com

Nina membantu Ibunya untuk mencuci pakaian kotor menggunakan mesin cuci di rumahnya. Mesin cuci tersebut merupakan mesin cuci dengan dua tabung, dimana untuk mencuci baju harus melalui dua tahap seperti ilustrasi di atas. Berdasarkan ilustrasi tersebut, bagaimana tahapan/ proses mencuci baju dengan mesin cuci dua tabung? Agar tidak memakan banyak waktu, bisakah proses mencuci hanya melalui satu tahap saja? Adakah mesin yang dapat melakukan hal tersebut? Jika ya, buatlah ilustrasi yang menggambarkannya!

Translate:

Nina helps her mother to wash dirty clothes using the washing machine at home. The washing machine is a washing machine with two tubes, where to wash clothes you have to go through two stages as illustrated above. Based on the illustration, what are the steps/process of washing clothes with a two-tube washing machine? In order not to take a lot of time, can the washing process only go through one stage? Is there a machine that can do that? If so, make an illustration that illustrates it!

Figure 2. Examples of Problems in students' worksheets

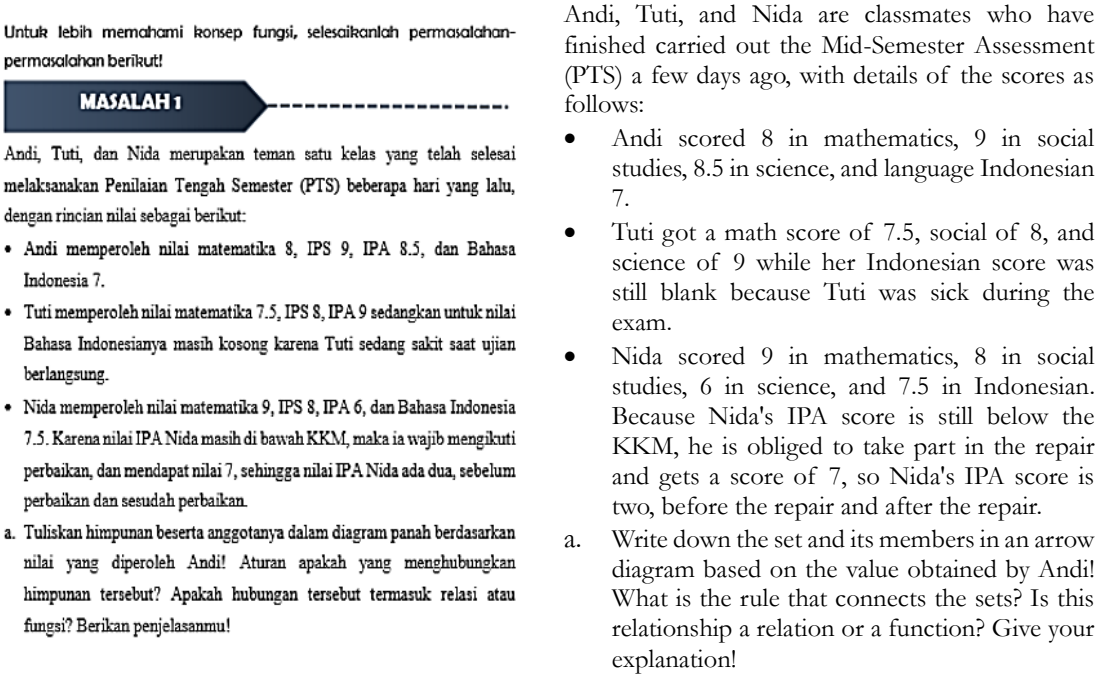
After presenting the problem, it is continued by organizing students into study groups. Groups of students are then asked to design and carry out their investigations, searching for possible solutions. The teacher and the students themselves monitor student progress while the questions are open. Finally, the group demonstrates their learning and engages in reflection and debriefing (Arend & Kilcher, 2010). PBL in mathematics learning is expected to facilitate students to learn actively to construct their knowledge related to mathematics (Masitoh & Fitriyani, 2018).

On the other hand, based on Table 1, according to the expert, the worksheet can facilitate conceptual understanding ability with 0,85, which is in the high category. The detail of the item and the score is shown in Table 5.

Table 5. The Item and Score from the Expert for Aspect Facilitate Concept Understanding

No	Item Evaluation	Score	Category
1.	The problems and practice questions allowed give students the opportunity to understand the concepts they have acquired	0,83	High
2.	Some questions classify objects according to certain properties	0,83	High
3.	There is a concept discovery step through giving examples and not examples of concepts	0,83	High
4.	Some questions classify that present concept in various mathematical representations	0,83	High
5.	Some questions classify that present the development of necessary or sufficient conditions for a concept	0,83	High
6.	Some questions classify that present the use and utilization and selection of certain procedures or operations	0,83	High
7.	Some questions classify that present the use and utilization and selection of certain procedures or operations	1,00	High

In the students' worksheet developed, there are aspects of conceptual understanding ability that classify objects according to specific properties and present concepts in various forms of mathematical representation, for example, in problem 1 material functions, wherein this problem three students are presented with the values obtained, then given the task of describing the problem in arrow diagrams, then classify which ones are relations and which ones are functions. It is shown in Figure 3.


Untuk lebih memahami konsep fungsi, selesaikanlah permasalahan-permasalahan berikut!

MASALAH 1

Andi, Tuti, dan Nida merupakan teman satu kelas yang telah selesai melaksanakan Penilaian Tengah Semester (PTS) beberapa hari yang lalu, dengan rincian nilai sebagai berikut:

- Andi memperoleh nilai matematika 8, IPS 9, IPA 8.5, dan Bahasa Indonesia 7.
- Tuti memperoleh nilai matematika 7.5, IPS 8, IPA 9 sedangkan untuk nilai Bahasa Indonesianya masih kosong karena Tuti sedang sakit saat ujian berlangsung.
- Nida memperoleh nilai matematika 9, IPS 8, IPA 6, dan Bahasa Indonesia 7.5. Karena nilai IPA Nida masih di bawah KKM, maka ia wajib mengikuti perbaikan, dan mendapat nilai 7, sehingga nilai IPA Nida ada dua, sebelum perbaikan dan sesudah perbaikan.

a. Tuliskan himpunan beserta anggotanya dalam diagram panah berdasarkan nilai yang diperoleh Andi! Aturan apakah yang menghubungkan himpunan tersebut? Apakah hubungan tersebut termasuk relasi atau fungsi? Berikan penjelasanmu!

Andi, Tuti, and Nida are classmates who have finished carried out the Mid-Semester Assessment (PTS) a few days ago, with details of the scores as follows:

- Andi scored 8 in mathematics, 9 in social studies, 8.5 in science, and language Indonesian 7.
- Tuti got a math score of 7.5, social of 8, and science of 9 while her Indonesian score was still blank because Tuti was sick during the exam.
- Nida scored 9 in mathematics, 8 in social studies, 6 in science, and 7.5 in Indonesian. Because Nida's IPA score is still below the KKM, he is obliged to take part in the repair and gets a score of 7, so Nida's IPA score is two, before the repair and after the repair.

a. Write down the set and its members in an arrow diagram based on the value obtained by Andi! What is the rule that connects the sets? Is this relationship a relation or a function? Give your explanation!

Figure 3. The application of indicators classifies objects according to specific properties and presents concepts in various forms of mathematical representation

Indicators provide examples of concepts, one of which is found in problem 2 in the function material and shown in Figure 4. In this indicator, students are asked to give

examples of the application of functions in everyday life.

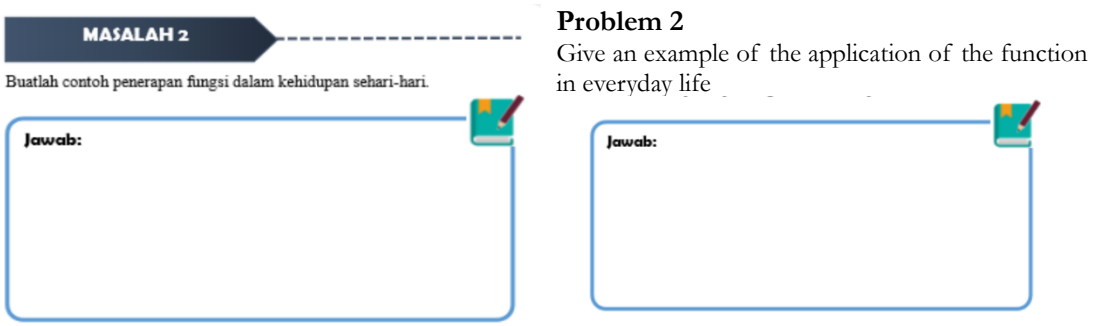


Figure 4. Application of indicators provides examples and not examples

Indicators develop necessary or sufficient conditions, use and select specific procedures or operations, and apply concepts to problem-solving, one of which is in problem 5 in the function material. Problems related to functions in real life are presented, in the form of the costs required to take a taxi, then students are asked to determine the difference in costs between two passengers. The problem is shown in Figure 5.

Figure 5. The application of indicators develops the necessary or sufficient conditions of a concept, uses and utilizes and selects specific procedures or operations, and applies the concept to problem-solving

Indicators restate a concept found in the function material conclusion column, where students are asked to conclude the problems they have worked on. The application of indication restates a concept as shown in Figure 6.

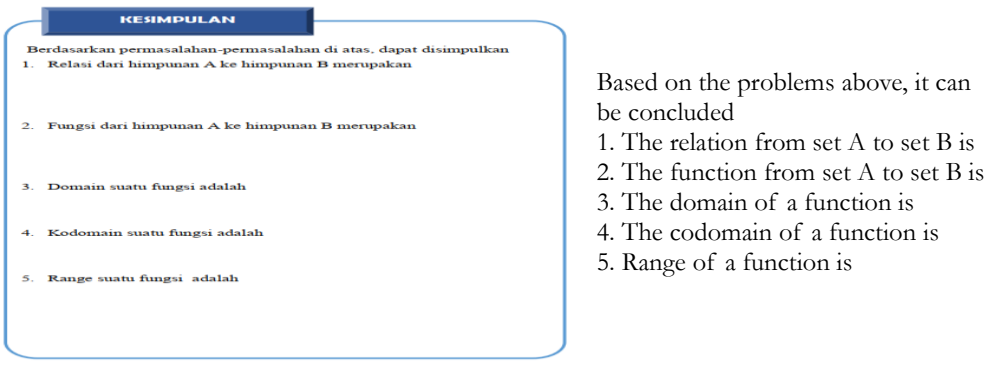


Figure 6. Application of indicators restates a concept

Several studies (Tristanti, 2017; Fariana, 2017; Nurzazili et al., 2018; Basri, 2019) developed students' work with Problem Based Learning (PBL). According to Basri (2019), problem-based worksheets can improve understanding of concepts. The research results reinforce this by Afridiani et al., (2020). It shows that understanding students' concepts has changed significantly with applying the PBL model in the learning process. Furthermore, Napiah et al. (2019) revealed that Problem Based Learning (PBL) is one solution to improve students' understanding of concepts because the PBL model stages focus on understanding mathematical concepts. The PBL model familiarizes students with understanding concepts through problem-solving processes (Suhendar & Ekayanti, 2018). On the other hand, Padmavathy & Mareesh (2013) also stated that learning mathematics using PBL effectively improves students' understanding and abilities because students apply mathematical concepts in everyday life.

CONCLUSION AND SUGGESTION

The development of students' worksheets (Student Worksheet) PBL facilitates the ability to understand concepts in the composition material and to understand the PPE development model. Based on the results of the expert validator's assessment, this development research has succeeded in developing the students' worksheet of compositional and inverse functions based on Problem Based Learning (PBL) to facilitate the ability to understand concepts belonging to the valid criteria with an average value of product validity of 0.84 which is included in the high category.

The suggestions for further product development include the development of this student's worksheet, which is expected to add other material because this student's worksheet only contains material on composition functions and inverse functions. It is hoped that there will be further development related to variables, approaches, and mathematical ability.

REFERENCES

Afridiani, T., Soro, S., & Faradillah, A. (2020). Pengaruh Model Problem Based Learning (PBL) Berbasis Lembar Kerja Peserta Didik (LKPD) Terhadap Kemampuan Pemahaman Konsep Matematis. *Euclid*, 7(1), 12-21.

Apriani, F. N., Novaliyosi, N., & Jaenudin, J. (2021). Pengembangan Lembar Kerja Peserta Didik (LKPD) dengan problem based learning terhadap kemampuan pemahaman konsep matematis. *Wilangan: Jurnal Inovasi dan Riset Pendidikan Matematika*, 2(2), 88-96.

Amin, S. (2017). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Dan Hasil Belajar Geografi. *Jurnal Pendidikan Geografi*,

4(3), 25–36.

Arends & Kilcher, A. (2010). *Teaching for student learning: Becoming an accomplished teacher*. New York, NY: Taylor & Francis Group.

Astuti, T. P., Masykur, R., & Pratiwi, D. D. (2018). Pengaruh Model Pembelajaran Tandur Terhadap Kemampuan Pemahaman Konsep dan Penalaran Matematis Peserta Didik. *Jurnal Pendidikan Matematika FKIP Univ. Muhammadiyah Metro*, 7(2), 201–209.

Basri, B., Tayeb, T., Abrar, A. I. P., Nur, F., & Angriani, A. D. (2020). Pengembangan Lembar Kerja Peserta Didik Berbasis Masalah dalam Meningkatkan Pemahaman Konsep Aljabar. *Al-Khwarizmi: Jurnal Pendidikan Matematika dan Ilmu Pengetahuan Alam*, 8(2), 173-182.

Ejin, S. (2016). Pengaruh Model Problem Based Learning (PBL Terhadap Pemahaman Konsep dan Keterampilan Berpikir Kritis Siswa Kelas IV SDN Jambu Hilir Baluti 2 Pada Mata Pelajaran Ilmu Pengetahuan Alam. *JP (Jurnal Pendidikan): Teori dan Praktik*, 1(1), 66-72.

Fannie, R. D., & Rohati. (2014). Pengembangan Lembar Kerja Siswa (LKS) Berbasis POE (Predict, Observe, Explain) pada Materi Program Linear Kelas XII SMA. *Jurnal Sainmatika*, *8*(1), 96–109.

Fariana, M. 2017. Implementasi Model Problem Based Learning untuk meningkatkan pemahaman konsep dan aktivitas siswa. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, 1 (1), 25-33. http://e-journal.ivet.ac.id/index.php/matematika/article/view/454

Fitriani, F., Hasan, M. H. M., & Musri, M. (2016). Pengembangan lembar kegiatan peserta didik (LKPD) berbasis masalah untuk meningkatkan pemahaman konsep dan aktivitas belajar peserta didik pada materi larutan penyangga. *Jurnal Pendidikan Sains Indonesia*, 4(1), 26-42.

Hadi, S., & Kasum, M. U. (2015). Pemahaman Konsep Matematika Siswa SMP Melalui Penerapan Model Pembelajaran Kooperatif Tipe Memeriksa Berpasangan (Pair Checks). *EDU-MAT: Jurnal Pendidikan Matematika*, *3*(1), 59–66. https://doi.org/10.20527/edumat.v3i1.630

Halim, A., Suriana, S., & Mursal, M. (2017). Dampak problem based learning terhadap pemahaman konsep ditinjau dari gaya berpikir siswa pada mata pelajaran Fisika. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 3(1), 1-10.

Kamin, V. A., Andinny, Y., & Ramadani, I. (2021). Analisis Pemahaman Konsep Matematika Materi Fungsi Komposisi dan Invers Kelas X. *Prosiding Diskusi Panel Nasional Pendidikan Matematika*. Seminar Nasional dan Diskusi Panel Pendidikan Matematika 2022, Universitas Indraprasta PGRI, 189-200.

Khasanah, N. (2016). Pengembangan Lembar Kerja Siswa (LKS) Matematika dengan Pendekatan Saintifik untuk Memfasilitasi Pemahaman Konsep Siswa SMA/MA Kelas X pada Pokok Bahasan Statistika. Skripsi. Universitas Islam Negeri Sunan Kalijaga. Yogyakarta.

Kholilah, A. (2019). *Analisis Kemampuan Pemahaman Konsep Mateatis pada Materi Fungsi Ditinjau dari MUultiple Intelligences Sesuai Teori Gardner Siswa Kelas X SMAN 1 Kendal Tahun Pelajaran 2018/2019*. Skripsi (tidak dipublikasika). Universitas Islam Negeri Walisongo.

Maryati, I. (2018). Penerapan Model Pembelajaran Berbasis Masalah pada Materi Pola Bilangan di Kelas VII Sekolah Menengah Pertama. *Jurnal Mosharafa*, *7*(1), 63–74.

Masitoh, L. F. & Fitriyani, H. 2018. Improving students' mathematics self-efficacy through problem based learning. *Malikussaleh Journal of Mathematics Learning (MJML)*, 1(1), 26-30. https://doi.org/10.29103/mjml.v1i1.679

Mawaddah, S., & Maryanti, R. (2016). Kemampuan Pemahaman Konsep Matematis Siswa SMP dalam Pembelajaran Menggunakan Model Penemuan Terbimbing (Discovery Learning). *EDU-MAT: Jurnal Pendidikan Matematika*, 4(1), 76–85. https://doi.org/10.20527/edumat.v4i1.2292

Mukti, F., Connie, C., & Medriati, R. (2018). Pengembangan Lembar Kerja Peserta Didik (LKPD) Pembelajaran Fisika untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa SMA Sint Carolus Kota Bengkulu. *Jurnal Kumparan Fisika*, *1*(3), 57–63. https://doi.org/10.33369/jkf.1.3.57-63

Napiah, N., Kurniawati, I., & Fitriana, L. (2019). Upaya Peningkatan Pemahaman Konsep Matematika Siswa pada Materi Himpunan Melalui Penerapan Model Pembelajaran Problem Based Learning (PBL) (Penelitian dilakukan di Kelas VII F SMP Negeri 13 Surakarta Tahun Pelajaran 2017/2018). *Jurnal Pendidikan Matematika Dan Matematika (JPMM) Solusi*, *3*(5), 535–547.

Novitasari, D. (2016). Pengaruh Penggunaan Multimedia Interaktif Terhadap Kemampuan Pemahaman Konsep Matematis Siswa. *FIBONACCI: Jurnal Pendidikan Matematika dan Matematika*, 2(2), 8–18. https://doi.org/10.24853/fbc.2.2.8-18

Nurzazili, N., Irma, A., & Rahmi, D. (2018). Pengembangan Lembar Kegiatan Siswa (LKS) Berbasis Problem Based Learning (PBL) Untuk Memfasilitasi Kemampuan Pemecahan Masalah Matematis Siswa di SMA Negeri 10 Pekanbaru. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 2(1), 172179. https://doi.org/10.31004/cendekia.v2i1.43

Padmavathy, R. D., & Mareesh, K. (2013). Effectiveness of problem based learning in mathematics. *International Multidisciplinary e-Journal*, 2(1), 45-51.

Pratiwi, D. D. (2016). Pembelajaran Learning Cycle 5E berbantuan Geogebra terhadap Kemampuan Pemahaman Konsep Matematis. *Al-Jabar : Jurnal Pendidikan Matematika*, 7(2), 191–202. https://doi.org/10.24042/ajpm.v7i2.34

Rahmadani, H., & Acesta, A. (2017). Pengaruh Penerapan Model Pembelajaran Problem Based Learning Terhadap Pemahaman Konsep Siswa. *Jurnal Sekolah Dasar*, 2(1), 1-9.

Retnawati, H. (2016). *Analisis Kuantitatif Instrumen Penelitian (Panduan Peneliti, Mahasiswa, dan Psikometrian)*. Yogyakarta: Parama Publishing.

Sarah, D., Risnawati, R., & Amir, Z. (2019). Pengembangan Modul Berbasis Pendekatan Konstruktivisme untuk Memfasilitasi Pemahaman Konsep Matematis Siswa Sekolah Menengah Atas di Pekanbaru. *JURING (Journal for Research in Mathematics Learning)*, 1(3), 199–206. https://doi.org/10.24014/juring.v1i3.4760

Suhendar, U., & Arta Ekayanti. 2018. Problem based learning sebagai upaya peningkatan pemahaman konsep mahasiswa. *Jurnal Dimensi Pendidikan dan Pembelajaran*, 6 (1), 15-19.

Susanti, B., & Lestari, Y. (2019). Analisis Kesulitan Siswa Kelas XI Dalam Menyelesaikan Soal

Fungsi Komposisi dan Fungsi Invers di SMK Al–Ikhsan Batujajar. *Journal on Education*, 1(3), 446-459. https://doi.org/10.31004/joe.v1i3.189

Tristanti, L. B. 2017. Pengaruh Model Pembelajaran Kooperatif Tipe TAI Dan Problem Based Learning (PBL) Terhadap Pemahaman Konsep Bangun Ruang Siswa. *Jurnal Pendidikan Matematika FKIP Univ. Muhammadiyah Metro*, 6(3), 338-349.

Utami, N. I., & Sukoriyanto. (2021). Analisis Kemampuan Pemahaman Konsep Matematis Siswa Pada Materi Komposisi Fungsi. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, 10(1), 1–13. https://doi.org/10.25273/jipm.v10i1.8268

Wahyuni, R., & Efuansyah. (2019). Pengembangan Lembar Kerja Siswa Untuk Memfasilitasi Pencapaian Penguasaan Konsep Matematika. *Numerical: Jurnal Matematika Dan Pendidikan Matematika*, *3*(2), 105–118. https://doi.org/10.25217/numerical.v3i2.485

Warsono, & Hariyanto. (2012). *Pembelajaran Aktif*. Bandung: PT Remaja Rosdakarya.

Wijayanti, A. T., Caswita, C., & Sutiarso, S. (2019). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Masalah pada Pemecahan Konsep Matematis Siswa. *ARITHMETIC: Academic Journal of Math*, *1*(1), 83–92. https://doi.org/10.29240/ja.v1i1.812

Wulandari, B., & Surjono, H. D. (2013). Pengaruh problem-based learning terhadap hasil belajar ditinjau dari motivasi belajar PLC di SMK. *Jurnal Pendidikan Vokasi*, *3*(2), 178–191. https://doi.org/10.21831/jpv.v3i2.1600

Yulianti, E., & Gunawan, I. (2019). Model Pembelajaran Problem Based Learning (PBL): Efeknya Terhadap Pemahaman Konsep dan Berpikir Kritis. *Indonesian Journal of Science and Mathematics Education*, 2(3), 399-408.