Development of Mathematical Worksheet for Junior High School Based on Guided Discovery Oriented by PISA

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Abstract

The problem solving ability is one of the most important skills to students. However, in reality these skills do not seem to have been optimally achieved in schools, as students are less involved in the development ofthe concepts learnt and teacher-centered learning. Possible efforts are the development of a guided, discovery-based worksheet based on the PISA model. In which the students are given instructions to understand the concept directly. Students are then asked key questions so that they can think, analyze by themselves, and are confident in dealing with arguments. The purpose of this study is to create a worksheet based on a guided discovery that is PISA-based and valid, practical and effective in improving students' problem solving skills. This research is a bulging research model consisting of four internships. The subjects of this study was the 7th grade students or SMP N 1 Lembang Jaya. The tools used were validation, internship sheets, interview guidelines, observational sheets and questionnaires. The results obtained are valid worksheets and can be well understood by the students.

Keywords: Guided Discovery, PISA, Problem Solving

1. Introduction

The problem-solving ability is an essential capability that students must possess. Furthermore the overall aim of studying mathematics in high school is to enhance this skill (Nasution and Yerizon, 2019). This skill is the ability for students to accurately identify any appropriate data that requires problem-solving, create mathematical models, to choose and implement strategies, to interpret results according to original problems and to verify the truth of results or answers (Susanti, 2017)..

Unfortunately this ability is not yetoptimalfor Indonesian students as seen from the PISAresults(Program for International Student Assessment). An international assessment by the OECD on the skills and competences of 15-year-old students (OECD, 2013; Shiel et al., 2007), the age at which students in most countries end compulsory education (Stacey, 2011).Skills and abilities assessed in PISA include math, reading and science (OECD, 2013; Stacey, 2012), PISA was first implemented in 2000 and then held every 3 years (Stacey and Stephens, 2008). The results of other studies also showed the same results (Kim, 2014; Hunter, 2015; Amir, 2015; Lein, 2016; Widodo, 2017; Yuniwati, 2017; Suastika, 2017).. This is due to students not being used to solving problems which PISA deemed examinable under their problem criteria.

PISA questions are developed and based on content, context and competence (OECD, 2013). The four main forms of content includes: form and space, change and relationship, quantity and uncertainty. While in the context of the PISA question consists of four, namely with regard to the situation / personal context (personal), work (professional), social / general (social) and scientific (scientific). Competencies in PISA are then classified into three groups (clusters), namely reproduction, connection and reflection (OECD, 2013).

For this reason it is most necessary to include the PISA model questions when learning. The student worksheet (SW) is then made with a guided discovery model by entering the PISA question model (Khasanah et al, 2017). The steps of learning with Guided Discovery are as follows: (1) Stimulation, (2) Problem definition, (3) Data collection, (5) Verification (6) Generalization. The guided discovery model gives students the opportunity to learn by involving their minds in thinking, reasoning and solving problems to find the final results (Yerizon et al, 2018)..   Anything obtained in this way will be more meaningful and remembered for longer (Wijayanti, 2016); Yurniwati, 2017).

Some of the benefits of the guided discovery model are (Hosnan, 2014):

a.   Contributes to students' improvementin their cognitive skills and processes.

b.   Can help to improve the ability of students to solve problems.

c.   The knowledge gained through this strategy is very personal and powerful because it strengthens understanding, memory and transfer.

d.   Encourages students to direct their own learning activities by involving their own spirit and motivation

e.   Students will better understand basic concepts and ideas

f.   Encourage students to think and work on their own initiative

g.   Encourage the involvement of student activity

h.   Gives satisfaction to students

i.   Can increase motivation

j.   Train students to learn independently

By applying this discovery model, individual talents and skills can be developed to achieve good results. This result is supported by various previous studies (Akanmu, 2013; Rahmawati, 2016; Adelia, 2017). For this reason it is necessary to make a student worksheet based on guided discovery of the PISA questions (SW-DL-PISA).

2. Methods

This research is based on the Plomp model developed by Tjeerd Plomp that consists of three phases, namely preliminary research, development or prototype phase and assessment phase that has also been used by previous researchers (Plomp, 2013). The development phase refers to formative evaluation (Nievenn, 1999) as Figure 1 .
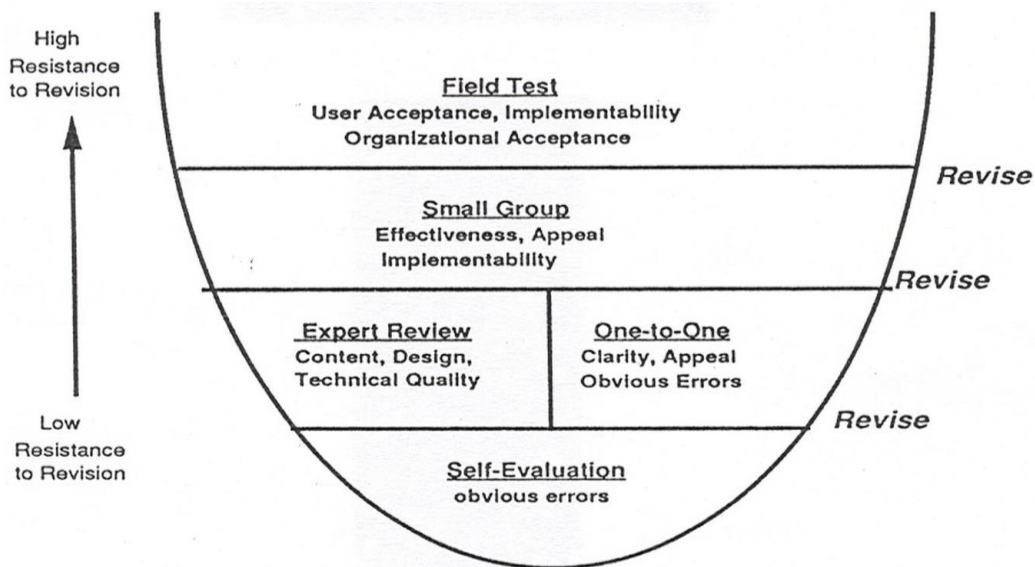
Picture1.   The formative Evaluation Layer of the Plomp Development Model

3. Result and Discussion

PISA questions are developed based on content, context and competence (OECD, 2013),

a. Math content

The mathematical content in PISA is determined on the basis of the results of in-depth studies and on the basis of consensus between OECD countries, so that students' performance can be compared internationally by taking into account the diversity of each participating country. The content is divided into four parts: 1) space and form, 2) change and relationship, 3 quantity and 4) uncertainty.

b. Mathematical competence

PISA does this by looking at the ability to reason, analyze, communicate ideas, formulate and solve problems. Competences in PISA are subdivided into three clusters, namely reproduction, connection and reflection (OECD, 2013).

c. Mathematical context

In PISA, the mathematical context is divided into the following four situations:

1. Personal context directly related to the daily activities of students.

2. Educational and work contexts related to the lives of students at school and / or at the workplace.

3. General context with regard to the use of mathematical knowledge in social life and the wider environment in daily life.

4. Scientific context that is specifically related to scientific activities, that is more abstract in nature and requires understanding and command of theory in solving mathematical problems.

3.1. The result of One to one evaluation

In the previous activity it appeared that SW-DL-PISA was valid in terms of content, construction, graphics and language. The "one on one" evaluation method was then utilized. The "one on one" evaluation was performed on 3 students from class VII of SMP Negeri 1 Lembang Jaya. The three students have different academic skills, 1 student with high level skills, 1 student with an average skills and 1 student

with low skills. Students are asked to read, respond to and work on SW-DL-PISA. Researchers conducted a "one-on-one" evaluation of 6 SW with the following description:

In SW 1 there are typos in the SW instructions. The obstacles that students encounter when working on SW 1 are that students do not fully understand the existing instructions, students often ask questions so that they still need guidance from researchers so that students understand the use of the SW 1 offered. Students do not understand how to conclude the concept material of any given activity. Students have difficulty putting together their own sentences, so they need guidance from the researcher. Subsequently, students in problem 2 ofSW 1 do not understand the assignment sentence in SW 1, namely "note the number line in point 2". Students don't understand the purpose of point 2 in the assignment sentence, so a review of the question phrase is needed to better understand it. In the practice questions on SW 1, students still have difficulty answering, students are not used to working on PISA model problems. So much supervision is needed from researchers so that students understand the purpose of the problem. From the observations of researchers it can be concluded that SW 1 still needs a review of the errors found.

In SW 2, students still have difficulty in concluding the concepts in each activity. But students have come to understand the command questions in SW 2. Students are still confused to conclude the material concept of each activity, so the "conclusions" column is still empty. In addition, students find unclear question assignments in SW 2, so that students are confused in answering and asking researchers questions. Then exercise number 2 on SW 2 is still categorized by students as difficult, so it requires guidance from researchers to understand the problem. From the results of researchers' observations, it can be concluded that SW 2 still needs a review of the errors found. The same results can still be found in SW 3, 4 and 5.

The one-on-one evaluation activities on SW 6 were conducted in the same way as the previous meeting. The subject at meeting 6 was "multiplication and fraction distribution". Based on the results of observations on SW 6, students found no typos. The instructions for using SW are clear enough and can be understood by students. In SW 6 the students did not understand, the PISA questions are in the form of story questions. Students also still have difficulty completing the concept as a whole, so students need guidance from the researchers. It can be concluded from the results of researchers' observations that SW 6 has not been revised.

General results of observations on SW 1 to SW 6 are shown in Table 1.

Table 1. Summary of the results of the observation phase of*One to one Evaluation*

SW	Observation Results
SW 1	There was a review of typing, the instructions on the SW were not fully understood by the students, so they still needed guidance from the teacher.
SW 2	There was a revision in typing, the students began to understand the instructions in SW, but still had difficulty filling in the PISA questions that were asked.
SW 3	There is a revision in typing, students have tried to solve the problem of the PISA model in SW, but still need guidance from the teacher, students still have a lot to ask ..
SW 4	There is a revision in typing, among students have been able to solve the problem of the PISA model in SW, but still need

		guidance from the teacher
	SW 5	There is a revision in typing, students still need guidance from the teacher when working on PISA questions.
	SW 6	There are no mistakes when typing, students still need guidance from teachers when working on PISA questions, because there are still things that students don't understand.

3. 2 The Result of Small group evaluation

After performing one-to-one evaluation activities, improvements were made to SW-DL-PISA. The following activity is an evaluation of a small group. This small group evaluation was performed on 6 students from class VII of SMP Negeri 1 Lembang Jaya with different academic skills. In this activity, students are divided into 2 groups, with 1 group consisting of 3 students consisting of 1 person with high capacity, 1 person with moderate capacity and 1 person with low capacity. Evaluation activities of small groups conducted during 6 meetings on the material numbers.

During the evaluation of the small group, the researcher was assisted by an observer who had to observe the implementation of learning using SW-DL-PISA. Observations were made about the acceptance and enthusiasm of students about the learning process, the implementation of the learning process, the suitability of the time with the allocation of available time, as well as the activities of the teacher and students.

The following are the results of the activities carried out during the evaluation process for small groups.The overall results of the small group evaluation in the form of an observer evaluation from meeting 1 to meeting 6 are shown in Table 2.

Table 2. Summary of the Results of the Observation Phase of Small Group Evaluation

Meeting	Hasil Observasi
1	Students are confused at completing SW and many ask the teacher that the time used is not in accordance with the specified assignment.
2	Students started with enthusiasm in learning, but have not been too active and are also guided by many teachers in solving problems in SW, especially many PISA questions, which are still not understood.
3	Students get used to having discussions, but the time allocation is not suitable. Students have become accustomed to PISA-oriented problems, but they still need guidance.
4	The discussion has already active so that students are enthusiastic and enjoy learning.
5	Time allocation is appropriate and the learning process is in accordance with the lesson plan.
6	Learning is going well, students have become active, but the time used is not in accordance with the specified assignment

The results of the one-to-one review and a small group review were continued with the field test. The assessment phase is performed to determine the usability and effectiveness of the developed SW-DL-PISA. Field tests were performed on 30 students of group 4 of SMP Negeri 1 Lembang Jaya. In practice, students are divided into 5 groups, with each group consisting of 6 students. Field tests were performed 6 times.

The practical data of SW-DL-PISA were obtained from the questionnaire of the teacher, the questionnaire of the students' answers to the SW. The results of the teacher questionnaire analysis are shown in Table 3.

Table 3. General answers from teachers to questionnaire in field tests

No	Aspects	Practicality	Category
1	Ease of use	75%	Practical
2	Attractiveness	75%	Practical
3	Allocation of Time	75%	Practical
4	Ease of Understanding	75%	Practical
5	Advantages of Student Worksheet	100%	Very Practical
The Average Practicality		**80%**	**Practical**

In Table 3 above we can see that the results of the teacher's overall answers to usability have been given a practical value of 80%. The usefulness of SW-DL-PISA is explained on the basis of the established criteria. It can therefore be concluded that the teacher is of the opinion that SW-DL-PISA is practically used in learning mathematics in grade VII of high school.

Answers to questionnaires from students that have been completed after students have learned with SW-DL-PISA. The results of the analysis of the answers to the student's questionnaire are shown in Table 4.

Table 4. The Results of the Analysis of the Answers to the Student's Questionnaire

No	Aspects	Practicality	Category
1	Ease of Use	88,37%	Very Practical
2	Attractiveness	77,56%	Practical
3	Allocation of Time	83,62%	Practical
4	Easeof Understanding	82,25%	Practical
5	Advantages of Student Worksheet	89%	Very Practical
The Average Practicality		**84,16%**	**Practical**

In table 4 above we see the results of the answers to the questionnaire obtained from students with practical values of 84.16%. The SW-DL-PISA is explained on the basis of the established criteria.

Observations of the implementation of learning is focused on seeing if learning has been carried out according to the steps of the guided discovery and identifying the obstacles experienced during the implementation process. Observation of the implementation of learning is intended to see if learning is consistent with what is designed. Observation was performed 6 times.

Based on observations, the teacher explains to students about the instructions for using SW that are not understood. Students are guided by the teacher to find the concept of the material by working on the activities in SW. Students are also trained to conclude the concept of material in each activity in SW 1, but

when implementing learning, students still have difficulty compiling sentences to conclude the concept of each activity, students still have a lot to ask to the teacher.

When answering PISA-oriented problems that exist in SW 1, there are still many people who are confused to answer. So the teacher meets every group experiencing difficulties and tries to guide students in answering questions in SW 1 that they don't understand.

During the 2nd meeting When the students have tried to solve the problem, but there are still questions that they do not understand, the teacher tries to explain the questions that the students do not understand. At the end of the lesson, students are asked to collect the work that SW has done. The teacher invites students to conclude as a whole about the material "sorting and comparing fractions". In the final phase, the teacher informs about learning for the next meeting and ends the learning by saying greetings.

The learning process went very well during the fifth and sixth meetings, students already understood the steps to be taken. After SW 5 and 6 are completed, the teacher appoints a group to present their work to the class. Other groups are asked to compare their work with that of the presenter groups. After the presenter group presents their work, the other groups respond enthusiastically if there are answers that differ from what they get.

Based on these results, it can be said that SW-DL-PISA can help teachers improve students' problem-solving skills. With the PISA model questions, students are trained to develop their skills (Hartono et all, 2017). This is in line with earlier research that has shown that the guided discovery model can improve students' mathematical skills (Marta et al, 2017; Khomsiatun et al, 2015). This way SW-DL-PISA can be used well by teachers and students.

4. Conclusion

Based on the results of the study, it concluded that:

1. SW-DL-PISA can be well understood and used by students.
2. SW-DL-PISA can help students improve their math skills. well used by teachers and students.

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