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Development of Guided Inquiry Oriented Book of Biology Experiments for Junior High School Students

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Abstract

The purpose of this research to produce a guided inquiry oriented book of biology experiments for junior high school students that valid and practice. This research used Plomp model with preliminary research, development or prototyping, and assessment phases. Data analyzed through descriptive. The instruments used in this study were validation and practicality questionnaires. The product validated by 2 biology lecturers and a science teacher, while for practicality was done by a science teacher and 30 junior high school students at one junior highschool in Padang, Indonesia. Based on the results of the study obtained the validity of 3.40 with very valid, experiment by teachers 3.35 very practical and the practicality by students 3.73 with very practical.

Keywords: Guided Inquiry Oriented Book of Biology Experiments, Junior High School, Expertiment

INTRODUCTION

The essence of learning science is not only remembering and understanding the concepts discovered by scientists, but the habitual behavior of scientists in discovering concepts carried out through experiments and scientific research (El Islami, Nuangchalerm, & Sjaifuddin, 2018; Nuangchalerm & El Islami, 2018; Parmin, Nuangchalerm, & El Islami, 2019; Parmin et al 2020; El Islami & Nuangchalerm, 2020; Mnguni et al 2020; Jampel et al, 2018; Fahrunnisa et al, 2020; Milama, Bahriah and Mahmudah, 2017; Marianingsih et al, 2021; Listianingsih et al, 2021; Hasanah and Shimizu, 2020).

The process of finding concepts that involve fundamental skills through scientific experiments can be carried out and improved through laboratory activities (Subagyo, *et al*., 2008; Rakhmawan, *et al*., 2015; Rosnita, 2016; Gunawan, *et al*., 2017; Malik & Ubaidillah, 2021; Fatmaryanti, *et al*., 2022;Fung & Watts, 2019; Hakim et al, 2016; Irby et al, 2018; Latimer et al, 2018; Monga et al, 2018; Moozeh et al, 2019; Qadar et al, 2018).

One vital practical facility is a practical guide. Book of experiments are experiment facilities that have been used for a long time (Kilinc, 2007). Experiment book is intended to help and guide students so that they can work continuously and directed (Susantini, *et al*., 2012; Suyanti, 2013; Aldilla, *et al*., 2016; Redhana, 2017).

Based on observations on August 3 and 24, 2017 at one of junior high schools in Padang Indonesia through the distribution of student response questionnaires on book of biology experiments in grade 7 at the 1st semester and questionnaire analysis of student needs for the book of biology experiments for grade 7 at the 1st semester found several problems regarding the implementation of biology experiments. The first problem is the absence of a specific book in carrying out biological science experiment materials. The experiments carried out by the teacher is only based on the activities of "Come, We Do" in the revised 2017 IPA student book. The activity contains what is needed, what needs to be done, what needs to be discussed, and what can be concluded. Students have not been able to formulate problems, compile hypotheses, collect data, and analyze the experiment data, so that experiment activities carried out have not been able to develop students' scientific learning abilities, because these activities only guide students to do experiment by following existing procedures.

The second problem, the practical instructions contained in the "Come, We Do" activity in the 2017 revised IPA student book is still conventional with a *cookery book type*, because it contains tools, materials, work steps, questions, and conclusions (Ministry of Educaton and Culture, 2017). One of the advantages of conventional experiment instructions is that they are easy to understand. But because it is still simple, so that it cannot fully develop students' scientific work, such as students have not been able to formulate problems at the time of practicing. In accordance with the questionnaire responses of students regarding the book of biology experiments, namely as many as 93.33% of students have not been able to formulate problems; 73.33% have not been able to analyze data; 53.33% have not been able to form a hypothesis; and 90% have not been able to make a report on lab results in accordance with the steps of the scientific method.

The third problem is the absence of a summary of special material on practical activities in the "Come, We Do!" Activity in the 2017 revised IPA student book, so that students do not have prior knowledge before doing an experiment. Therefore students want a practical guide that contains a summary of the material, according to the results of the questionnaire analysis of student needs for book of biology experiments, namely 93.33% of students agree with a summary of the material as the students' initial thinking/ knowledge. In addition 96.67% of students also want a practical guide with supporting images that can facilitate students in understanding the material. Ginarsih (2015) has conducted research on the development of book of biology experiment accompanied by guided inquiry-based images. The results of the study show that the biology experiment accompanied by the developed picture is easy to use, useful, and the learning time becomes more efficient.

Based on the results of student needs analysis of the practical guide, the approach that fits these criteria is guided inquiry. Guided inquiry have several steps, there are formulating a problem, making a hypothesis, designing an experiment, conducting experiments to obtain information, collecting data, and making conclusions accordingly with student needs (Yunus, *et al.*, 2013; Kurniawan, 2013; Juhji, 2016; Abdurrohim, *et. al*., 2016; Setiawan *et al.*, 2016; Putra, *et al.*, 2016; Suryani, 2017; Langitasari, *et al.*, 2018; Muhlisin, *et al*., 2019; Pursitasari, *et al*., 2020; Defista, *et al*., 2022).

Based on the results of research that has been carried out by several researchers, the guided inquiry learning

model is effective in improving the scientific attitude, critical thinking skills (Niana, *et al.,* 2016; Nisa, *et al.,* 2017; Misbah, *et al.,* 2018; Supriyatno *et al.*, 2020; Rambe, *et al*., 2020; Rasyid, *et al.,* 2022; Afridah, *et al*., 2022), effective to improve students' science literacy skills in science learning in the classroom (Arifin & Sunarti, 2017; Aulia, *et al*., 2018; Mulyana *et al.*, 2018, Saefullah et al, 2017), and can improve the students' learning achievement (Siyenti, *et al.*, 2017; Mulyana, *et al*., 2018; Sarwi, et al., 2018; Amir & Marisda, 2021; Jannah *et al.,* 2020). Therefore, researchers have carried out research to develop a guided inquiry oriented book of biology experiments for junior high school students.

METHOD

This research is a development research using the development model of Plomp. The development phase using the Plomp model has 3 phases, namely the preliminary research phase, development or prototyping phase and assessment phase (Plomp, 2013). The details of the development procedure include the following steps.

1. Preliminary Research Phase

Activities carried out at this stage are curriculum analysis, student analysis and practical guide analysis.

2. Development or Prototyping Phase

The results of the prototype design at the initial stage are called prototypes I, which are evaluated by self-evaluation. Prototype II is a development stage by asking for opinions and suggestions from experts (validators), namely 2 Biology lecturers and one Science teacher. The criteria to be obtained at this stage are experiment book that have fulfilled didactic requirements, construction requirements, technical requirements, and language requirements. Products that have been valid from the revised prototype II, then conducted one-to-one evaluation. At this stage three students with different levels of ability (low, medium and high abilities) were carried out. The next step is small group evaluation. At this stage an evaluation of 6 students with low, moderate, and each consisting of 2 students was evaluated. The revision of prototype IV was based on small group evaluations and proceed to the assessment phase by conducting field trials.

3. Assessment Phase

This assessment phase is carried out by field trials to see the practicality of the products that have been designed. The effectiveness test was not carried out at this stage because of limited time, energy and costs in the study. The practicality test was carried out by product testing to one teacher and thirty

students of grade 7 in a junior high school in Padang, Indonesia.

The data analysis technique used is qualitative analysis in descriptive form that describes the validity and practicality of the developed biology experiment book. Questionnaire for validity test and practicality test uses a Likert scale modified with 4 alternative answers, that is, strongly agree (weight 4), agree (weight 3), disagree (weight 2), and strongly disagree (weight 1). The value of the validity and practicality of the product developed is determined by descriptive statistics in the form of a mean assessment using a modified formula from Lufri, *et al*. (2017) as follows.

a. Validity assessment criteria:
   - 3,25-4,00 = very valid
   - 2,50-3,24 = valid
   - 1,75-2,49 = invalid
   - 1,00-1,74 = very invalid

b. Practicality assessment criteria:
   - 3,25-4,00 = very practical
   - 2,50-3,24 = practical
   - 1,75-2,49 = impractical
   - 1,00-1,74 = very impractical

RESULTS AND DISCUSSION

1. Preliminary Research

This phase begins by conducting curriculum analysis, student analysis, and experiment book analysis.

a. Curriculum Analysis.

Curriculum analysis is carried out so that the experiment guides produced refer to the applicable curriculum. The curriculum used as a reference is the 2013 Curriculum. Based on the analysis conducted, it is known that the 2013 Curriculum emphasizes student involvement in the learning process. The design of this practical guide is focused on biological science material in Core Competencies 3 and 4, as well as Basic Competencies 3.1, 3.4, 3.5, 4.1, 4.4, and 4.5. The basic competencies that are analyzed are basic competencies about biological science that occur in the first semester. The results obtained are, there is still no practical guide on these basic competencies. Existing books have not been able to fully develop students' scientific work, such as students who have not been able to formulate problems during experiment.

b. Student Analysis.

The results of the analysis of students are students want a practical guide that has a summary of the material accompanied by supporting images in order to help students in understanding the practical material. Students also agree if the guideline developed has a guided inquiry approach that can help students to develop scientific attitudes in practicing.

c. Practical Guidance Analysis

The results of the practical guideline analysis are simple practical instructions that are still simple and have

not been able to develop students' scientific attitudes in the experiment. So it is necessary to develop a guided inquiry oriented practice guide that has stages that are able to develop students' scientific attitudes, namely formulating problems, formulating hypotheses, designing and conducting experiments, collecting and analyzing data, and concluding.

2. Development or Prototyping Phase

The development of guided inquiry oriented practice guides can be described as follows.

a. Prototype I

This practical guide was created using applications *Microsoft Office Publisher* 2007 with the help of *Microsoft Office Word 2007* and *Microsoft Office Power Point 2007*. Components in this guided inquiry oriented practice guide include cover's book, introductory words, table of contents, table lists, image lists, introduction to guided inquiry oriented practice guides, experiment rules, instructions for using book of experiment, competency reviews, experiment objectives, theoretical basis, guided inquiry stages, and questions.

b. Prototype II

Prototype II development is a stage by asking for opinions and suggestions from experts (validators). The suggestions are as follows.

1) Didactic requirements

Add competency reviews, remove the dividing lines for each icon so that the inquiry syntax is clearly visible.

2) Constructive requirements

Improve the experiment rules, adjust the title of experiment rules with experiment titles on the cover, thicken colored writing on the basis of theory,

3) Technical requirements

Add the Curriculum 2013 symbol and Tut Wuri Handayani on the cover, add images that represent guided inquiry syntax or experiment on cover, fix the type of writing on the cover, fix the location of the inscription on the cover, fix a table of contents, fix the location of the picture on the cover,replace the picture is less clear statement, correct the color combination on the cover, jthe title experiment enlarged, and the identity of the owner put it in the middle.

4) Language requirements

Correct writing errors and errors in the use of punctuation. The validity test results filled in by the validator can be seen in Table 1.

Table 1. Validity Test Results of Guided Inquiry Oriented Book of Biology Experiments for Junior High School Students

No	The Aspects	Validity Value	Criteria
1	Didactic requirements	3.48	Very valid
2	Constructive requirements	3 , 70	Very valid

3	Technical requirements	3.20	Valid
4	Language requirements	3.22	Valid
	Average	3.40	Very valid

The validity in Table 1 shows an average value of 3.40 with very valid criteria. This shows that the developed book of biology experiments is valid from didactic, construct, technical and language requirements and can and is worthy of being used as a material for biology subject in grade 7.

c. Prototype III

The book of biology experiments have been revised according to the advice of the validator, it is named as prototype III. Then, the prototype III is conducted one-to-one evaluation and small group evaluation.

The results of students' responses to one-to-one evaluation, namely the appearance of the cover is interesting and the image is also interesting, the appearance or design of the practical guide is interesting so students are interested in reading it, the language in the material is easy to understand so students understand the material there, guided inquiry steps are clear and easy to understand and can improve students' thinking skills, formulation of problems can make students think scientifically, and images can make it easier for students to understand the material that is practiced. The results of the student's response are maintained by the researcher.

The results of a small group evaluation filled in by students can be seen in Table 2.

Table 2. Small Groups Evaluation Results of Guided Inquiry Oriented Book of Biology Experiments

No.	Indicators that are rated	Score Average	Category
1.	Ease of use of book of experiments	3.95	Very Practical
2.	Allocation of experiment time	3.67	Very Practical
3.	Ease of interpreting	3.50	Very Practical
4.	Having equivalence	3.67	Very Practical
	Average	3,70	Very Practical

Based on Table 2, it is known that the practicality test results through small group evaluations have very practical value which means that from the ease of use of book of biology experiments, experiment time allocation, ease of interpretation and having practical equivalents are used for large group trials.

3. Assessment Phase

In the assessment phase, to test the practicalities of guided inquiry oriented book of biology experiments by teachers and students.

a. Practicality of Book of Biology Experiments by Teachers

Practical tests are carried out with a science teacher. The results of the

practicality test analysis filled out by the teacher can be seen in Table 3.

Table 3. Practicality Test Analysis Results of Guided Inquiry Oriented Book of Biology Experiments by Teacher

No	Indicators assessed	Score Average	Category
1.	Ease of use book of experiments	3.40	Very Practical
2.	Allocation of experiment time	3.00	Practical
3.	Ease of interpretation	4.00	Very Practical
4.	Has equivalence	3.00	Practical
	Average	3,35	Very Practical

Based on Table 3, it is known that the practicality of guided inquiry oriented book of biology experiments by teachers is 3.35 with very practical criteria. This shows that the book of biology experiments is very practical to be used by the teacher as an ingredient to carry out the biology experiment in grade 7.

b. Practicality of Practical Guidance by Students

The next stage of practicality test is practicality test for 30 students. The results of the practicality test analysis which are filled in can be seen in Table 4.

Table 4. Practicality Test Analysis Results of Guided Inquiry Oriented Book of Biology Experiments by Teacher

No	Indicators assessed	Score Average	Category
1.	Ease of use book of experiments	3.80	Very Practical
2.	Allocation of expertiment time	3.60	Very Practical
3.	Ease of interpreting	3.70	Very Practical
4.	Has equivalence	3.83	Very Practical
	Average	3.73	Very Practical

Based on Table 4 it is known that the practicality value of the guided inquiry oriented book of biology experiments by 31 students is 3.73 with very practical criteria which means from the aspect of ease of use of books of biology experiments, experiment time allocation, ease of interpretation and having practical equivalence used by students in the experiment.

This study produced a guided inquiry oriented book of biology experiments which valid and practical. Development of book of biology experiments carried out using the development of the model *Plomp*.

1. Validation of Guided Inquiry Oriented Book of Biology Experiments

Before the book of biology experiments is piloted to students, the book of biology experiments is first assessed by experts (validators). Based on the description by two validator lecturers and one science teacher, it is known that the developed guided inquiry oriented book of biology

experiments has met very valid criteria. An instrument is said to be valid if the instrument actually measures something to be measured. This is in accordance with the opinion of Sugiyono (2011) that the ability of an instrument (measuring instrument) to measure what must be measured. Validation carried out in this study emphasizes four aspects, namely didactic requirements, construction requirements, technical requirements and language requirements.

Judging from the didactic aspects, it is stated to be very valid by the validator, meaning that the material in the practical guide is in accordance with the curriculum 2013 and in accordance with Core Competencies and Basic Competencies. These are supported by the Ministry of National Education (2008) stating that the teaching materials developed must be in accordance with the applicable curriculum. Very valid criteria on didactic aspects also show that the material presented has been able to provide information relating to experiment activities, as well as practical guides already have guided inquiry syntax.

Judging from the construct aspect, it is stated to be very valid by the validator because the guideline developed has been presented clearly and directed including experiment book already have clear experiment rules, have clear instructions for use for teachers and students. This is in accordance with Nasution (2008) that one of the advantages of learning is presented clearly and specifically so that student learning becomes directed. In addition, the material on the practical guide has supported the experiment activities carried out and the topics in the experiment activities are presented systematically, experiment activities presented in accordance with guided inquiry and guided inquiry oriented guides can motivate students to work scientifically.

Judging from the technical aspects, it was declared valid by the validator because the guideline developed had fulfilled the requirements for good experiment book, including the sub-aspects of writing that had clearly read the type and size of the letters, and questionnaires on the practical guide had punctuation. In the sub-aspect of the image, the image contained on the *cover* has illustrated the contents of the practical guide, the symbol of the image can distinguish the procedures from the activities to be carried out, the image on the guide in accordance with the concept and description of the image on the guide clearly.

In the graphic sub-aspect, the guiding color design on the *cover* can make students interested in knowing the

guiding contents, the colors of each symbol used has been varied and interesting, and an attractive guide page. This statement is supported by Kusrianto (2009) that visually, color has the power that can influence the image of the person who sees it, each color is able to respond psychologically. The researcher used blue and green as the dominant colors in the practical guide. According to Zein (2013) this blue color is able to describe perfect calm, because it has a calming impression and emphasis on each step of inquiry work.

Judging from the aspect of the language declared valid by the validator. This shows that the developed experiment book has met the requirements of good practical guiding preparation, including the language is communicative, is a good and correct language according to the rules of Indonesian language, and the sentence in the experiment book uses terms that are in accordance with the main concepts.

Valid assessment of the experiment book that has been developed indicates that the experiment book can be used as one of the learning resources in practical activities. This is in accordance with the opinion of Fitri, et al. (2014) which states that valid teaching materials are good and can be used as learning resources for students in the learning process. Thus, the experiment book has been able to enter the evaluation phase of one-to-one evaluation and continued with the small group evaluation.

Based on the evaluation sheet of one-to-one evaluation, note that the guidance developed has been able to attract the attention of students to read. After the improvements/ revisions to the practical guidance that has been developed, further evaluation of small group evaluation.

Based on the evaluation sheet of small group evaluation note that students have been able to understand step-by-step guided inquiry. However, there are some inputs from students, including the supporting image information that is less clearly replaced so that students are able to understand the material by looking at the picture. The procedure in the small group evaluation is inaccordance with Plomp's explanation (2013) which states that small group evaluation aims to find consideration in developing an experiment book before entering the field test. .

2. Practicality of the Guided Inquiry Oriented Book of Biology Experiments

Practical test aims to determine the use of the guided inquiry oriented book of biology experiments by teachers and students. This practicality test was carried out to teachers and 30 students in

grade 7. From the results of the practicality test analysis of the guided inquiry oriented book of biology experiments by teachers and students it is known that the experiment book is categorized as very practical. This practical value is the average of the 4 aspects in the practical test, namely the ease of use of experiment book, the time required in the implementation, easy to interpret, and have equivalence.

In terms of the ease of use of experiment book by teachers and students, guided inquiry oriented book of biology experiments are categorized as very practical. This shows that the guided inquiry oriented book of biology experiments make it easier for teachers to be able to guide students more actively in practical activities, making it easier for teachers to manage practical activities, improve student activities in practical activities, develop students' scientific abilities and facilitate students in understanding the practiced material. This is supported by Plomp (2013) that a developed media is said to be practical if the media can be used easily by users (teachers and students) in learning.

In terms of aspects of experiment time allocation, guided inquiry oriented book of biology experiments proved to be efficient when used in the experiment. This can be seen from the results of the practical test by the teacher stating the practical criteria and by the students who stated it was very practical. This means that the use of experiment book can help teachers allocate time so that students can run and complete all guided inquiry syntax at the time of experiment.

In terms of easily interpreted aspects, it is obtained very practical criteria by teachers and students. This is obtained because the developed experiment book is very easy to understand by teachers and students so that it does not raise doubts about the material and guided inquiry syntax found in the experiment book. This statement is supported by the opinion of Zainudin, et al. (2012) which states that practicality of experiment book can be seen from interesting content, attractive appearance, easy to understand explanations, easy to understand sentences, and easy to understand images.

Judging from the aspect of having equivalence obtained practical criteria by the teacher and very practical by students. This is obtained because the developed experiment book has conformity and relevance to the material provided in the learning process. This is in accordance with the opinion of Sukardi (2011), that one consideration of practicality can be seen in aspects

having the same equivalence, so that it can be used as a substitute or variation.

Furthermore, based on the analysis of the practicality test results of experiment book by students, which were tested on 30 students, the overall results were obtained with very practical criteria. That means the experiment book can be used by teachers and students in practical activities.

Based on the results of the validity test and the practicality tests that have been carried out, this guided inquiry oriented practice guide is declared valid and practical. This practical guide is expected to be used as one of the teaching materials used by teachers and students in practical activities. The constraints faced in carrying out this guiding practicality test are the students' inaction in using lab materials so that one of the materials is broken, but it has been overcome by the researcher.

CONCLUSION

Based on the research that has been done, it can be concluded that the guided inquiry oriented book of biology experiments for junior high school students has been produced for students in grade 7 with a validity value of 3.40 (very valid) that meets the didactic requirements, construction requirements, technical requirements, and language requirements. The practical value of the guided inquiry oriented book of biology experiments by the teacher is 3.35 (very practical) and the practical value by students 3.73 (very practical) in terms of the ease of use of book of biology experiments, experiment time allocation, ease of interpretation and equivalence with material of biology subject in grade 7 at the 1st semester. It can be stated that the developed guided inquiry oriented book of biology experiments for junior high school students is very valid and very practical through development research using the development model *Plomp* which includes the initial investigation phase, development phase, and assessment stage.

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