

Development of science practicum instructions on the discovery-based human respiratory system

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Article information	ABSTRAK
Article history Received: August 24, 2022 Revised : August 26, 2022 Accepted : Dec 7, 2022	Petunjuk praktikum sangat penting dalam proses pelaksanaan praktikum. Adanya kegiatan praktikum mempermudah peserta didik untuk mengembangkan potensi keterampilan dan menjadikan peserta didik aktif dalam berfikir. Tujuan penelitian ini adalah untuk mengetahui kualitas petunjuk praktikum IPA SMP pada materi sistem pernapasan manusia berdasarkan kriteria terhadap ahli materi, media, guru IPA dan mengetahui respon peserta didik pada uji coba skala kecil terhadap petunjuk praktikum IPA SMP materi sistem pernapasan manusia yang sudah dikembangkan. Metode yang digunakan dalam penelitian ini adalah research and development (R&D) dengan desain model pengembangan yaitu pada model 4-D dengan tahapan pendefinisian (<i>define</i>), perancangan (<i>design</i>), pengembangan (<i>develop</i>), dan penyebaran (<i>disseminate</i>). Instrumen pengumpulan data ini berupa lembar angket, pedoman wawancara. Analisis data dalam penelitian ini menggunakan analisis data kualitatif dan analisis data kuantitatif. Uji coba kelas kecil terdiri dari 9 peserta didik. Hasil penilaian petunjuk praktikum yang dikembangkan memperoleh skor 95,83% oleh ahli materi dengan kategori sangat baik, 75% oleh ahli media dengan kategori baik, 81,90% oleh guru dengan kategori sangat baik dan 100% hasil respon peserta didik pada uji coba skala kecil. Berdasarkan hasil penilaian petunjuk praktikum sistem pernapasan berbasis discovery untuk kelas VIII SMP layak untuk digunakan uji coba skala besar.
Kata kunci: Discovery learning petunjuk praktikum R&D IPA	ABSTRACT Practical instructions are very important in the process of implementing practicum. The existence of practicum activities makes it easier for students to develop their potential skills and makes students active in thinking. The purpose of this study was to determine the quality of the junior high school science practicum instructions on human respiratory system material based on criteria for material experts, media, and science teachers and to find out the responses of students in small-scale trials to junior high school natural science practicum instructions on human respiratory system material that had been developed. The method used in this study is research and development (R&D) with a development model design, namely the 4-D model with the stages of defining, designing, developing, and disseminating.
Keywords: Discovery learning practical instruction R&D Natural science	

The data collection instrument was in the form of a questionnaire, and an interview guide. Data analysis in this study used qualitative data analysis and quantitative data analysis. The small class trial consisted of 9 students. The results of the evaluation of the practicum instructions developed obtained a score of 95.83% by material experts in the very good category, 75% by media experts in the good category, 81.90% by the teacher in the very good category, and 100% of the results of the responses of students in the scale trial small. Based on the results of the assessment of discovery-based respiratory system practicum instructions for class VIII SMP, it is feasible to use large-scale trials.

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INTRODUCTION

Biology learning is related to learning that uses practical methods. Practical learning is very important in biology learning. The existence of practicum-based learning activities can increase understanding of concepts (Baeti, et al. 2014) as well as improve students' process skills and work skills (Candra & Hidayati, 2020). Before carrying out the practicum, there are various things that need to be prepared including laboratories, tools and materials for practicum, practicum instructions. Students are expected during the practicum to know the stages of the experiment that will be carried out. For students to understand the delivery of the practicum that will be tried out, the teacher needs to provide practicum instructions to help students during the practicum.

Practical instructions are very important in the process of implementing practicum. The existence of practicum activities makes it easier for students to develop their potential skills and makes students active in thinking. The purpose of this study was to determine the quality of the junior high school science practicum instructions on human respiratory system material based on criteria for material experts, media, and science teachers and to find out the responses of students in small-scale trials to junior high school natural science practicum instructions on human respiratory system materials that have been developed. The method used in this study is research and development (R&D) with a development model design, namely the 4-D model with the stages of defining, designing, developing, and disseminating. The data collection instrument was in the form of a questionnaire, and an interview guide. Data analysis in this study used qualitative data analysis and quantitative data analysis. The small class trial consists of 9 students. The results of the evaluation of the practicum instructions developed obtained a score of 95.83% by material experts in the very good category, 75% by media experts in the good category, 81.90% by the teacher in the very good category, and 100% of the results of the responses of students in the small scale trial. Based on the results of the assessment of discovery-based respiratory system practicum instructions for class VIII SMP, it is feasible to use large-scale trials. Practical activities carried out in schools can train students to do scientific work during practicum (Anggraini, 2016). Practicum is a group activity that requires a lot of time, so there needs to be a special way so that the activity can run smoothly. Efforts are made so that there is a special way in the learning process, namely the selection of effective and efficient learning models that can develop active learning (Umah and Sudarmin, 2014). Practicum activities are not only oriented toward the final results obtained but how the process is to find existing scientific facts. The practicum process requires practicum instructions that are used to guide students in doing practicum (Budiarti & Oka, 2017). Practicum Instructions are supporting books in practicum activities that contain material and procedures that will be carried out during practicum. Practicum instructions affect success in learning in the laboratory because they serve as a reference for students in carrying out practicum (Bago, 2018). The importance of practicum instructions, namely practicum instructions can be used as a learning resource to support the

learning process during experiments, increasing students' interest in practicum activities, students can find out how to do practicum and students can know the systematics in making a practicum report (Waluyo & Parmin, 2014).

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The development of practicum instructions has been carried out a lot. However, most of the development of biology practicum instructions is at the high school or college level. The development of practical instructions for biology material at the junior high school level is still quite small. Based on a literature search on Google Scholar which was published in 2010-2020 with the keyword "development of biology practicum instructions" there were only 39 articles. Of the 39 articles, only 3 developed guidelines for biology practicum for junior high school level. These studies include the development of guided inquiry-based practical instructions (Aprilia, Lestariningsih, Ayatusa'adah, 2020) and the development of practical instructions based on the results of research on the effect of basic ingredients and types of sugar on layer thickness and organoleptic tests of nata (Effendi & Utami, 2013). In addition, there has been no development of practicum instructions aimed at carrying out practicums independently by students.

Based on the results of interviews conducted with science teachers at SMP Negeri 9 Yogyakarta, it is known that the material on the respiratory system is quite easy to understand, but with so much material on the respiratory system, it is easy for students to forget about the material. One method that can be applied to help students remember the material being studied is the practicum method. Based on the results of the interviews it was also known that at SMP Negeri 9 Yogyakarta there were no practical instructions. Even though students became more active in asking the teacher in practicum activities because of high curiosity. The absence of practicum instructions can cause students to be less focused in carrying out practicum activities and there are students who only see other friends doing practicum. Therefore, it is necessary to develop practicum instructions as a work guide in the laboratory.

Instructions for biology practicum can not only be developed based on inquiry but can also be developed based on discovery. Discovery is finding a concept from a series of information obtained from observations and experiments. Discovery learning is a cognitive learning method that requires teachers to be more creative to create students who are active in discovering their knowledge (Sani, 2017). Discovery stages include Stimulation, Problem statement, Data collecting, Data processing, Verification, and Generalization (Yusniawati, Sajidan, and Sugiyarto, 2015).

Selection of the discovery learning model because this model has advantages. The discovery learning model provides opportunities for students to be actively involved in discovering concepts, developing process skills through practical activities and being able to train students' thinking activities (Rachayuni, 2016). Therefore, this learning model can be applied in learning that applies the practicum method. Preparation of practicum instructions can include the syntax of the discovery learning model, so that the practicum activity steps can be more focused following the discovery learning model.

Because of the limited development of biology practicum instructions for junior high school level and there is still a lack of developing independent practicum instructions that allow students to utilize simple tools and materials at home. So, it is necessary to develop practical instructions, especially for the human respiratory system based on the discovery of class VIII SMP. This study aimed to determine the quality of junior high school science practicum instructions on human

breathing student material based on the results of the assessment of material experts, media, and science teachers and to find out the responses of students in small-scale trials.

METHOD

This research is a research and development (R&D) study. Development research can expand existing knowledge, development research is used when developing a product (Hanafi, 2017). The development model used in this study is the 4-D model proposed by Thiagarajan and modified by Trianto (2010). The 4-D model has four stages of development, namely define, design, develop, and disseminate. The define stage discusses needs analysis such as student analysis, concept analysis, and analysis of specific instructional objectives, the design stage discusses the design of product designs that have been designed by researchers, and the development stage discusses the stages in the development of practicum instruction products. At this stage, assessment tests were carried out by material experts, media experts, teachers, and small-scale and large-scale tests. The dissemination stage discusses the dissemination that will be carried out after the practicum instruction product is at the final production stage by disseminating it to other schools.

The test subjects in the research on developing practical instructions consisted of material experts, media experts, biology teachers at SMP Negeri 9 Yogyakarta, and students in small-scale tests. The small class trial was conducted on 9 class VIII students at SMP Negeri 9 Yogyakarta. Due to the Covid-19 pandemic, the trial was carried out on a small scale. The data collection instrument used was a questionnaire sheet for assessing practicum instructions filled in by material experts, media experts, teachers, and students. Interview guidelines to determine the character and needs of students and teachers.

The research procedure was carried out through 4 stages, namely definition (define) carried out by student analysis, concept analysis, and Analysis of Special Instructional Objectives. The design stage is carried out by product design, systematic preparation, and practicum method design. The development stage (develop) carried out product validation tests on material experts, media experts, and teachers and small class tests on students with a limited test carried out on 9 class VIII students of SMP 9 Negeri Yogyakarta. The dissemination stage is carried out by giving practical instructions to teachers to be used in large classes or learning.

The data analysis technique was carried out descriptively. Assessment of the quality of the practicum instructions included:

- a. Data analysis for the assessment of material experts, media experts, science teachers and small-scale trial responses to students, the data obtained through a questionnaire in this study were the results of an assessment by the validator that had been given. The rules for giving a Likert scale are presented in Table 1.

Table 1. Rules for Giving a Scale Using a Likert Scale

Assessment Score	Category
4	Strongly agree
3	Agree
2	Disagree
1	Strongly disagree

- b. The data has been obtained through questionnaires from experts, science teachers, and the responses of small-scale trials on students. Data is collected to calculate the average value obtained using the formula:

$$NP=R/SM\times 100$$

Information: NP: Product value (desired or expected percent value)

R: indicator scores obtained

SM: Ideal maximum score

100: constant

(Purwanto, 2006)

- c. Determination of product quality is determined based on the assessment classification category. The product is declared feasible if it meets the assessment classifications of material experts, media and biology teachers and is included in the good category and the responses of students in small-scale trials receive a good category rating classification. The assessment criteria and the criteria for giving the scale are presented in table 2.

Table 2. Rating Classification Guidelines

Percentage	Category
76% - 100%	Very good
51% - 75%	Good
26% - 50%	Not Good
0% - 25%	Very Not Good

RESULTS AND DISCUSSION

Define stage

The defining stage in this study consisted of student analysis, concept analysis, and objective analysis. The characteristics of students can be known based on interviews with students. Concept analysis by analyzing the practicum guidance materials adapted to KI and KD. Concept analysis by conducting an analysis of practical guidance material adapted to KI and KD, practicum instructions focus on KD 3.9 because KD 3.9 can increase students' understanding through practicum activities and are skilled in using simple tools and materials. Analysis of specific instructional objectives by analyzing the objectives of the practicum. The purpose of the adjusted practicum from KD 3.9 is to know the concept of respiratory volume, identify respiratory volume, analyze in measuring respiratory volume, and know that each air volume capacity of each child is different.

Design Stage

The Design phase is carried out by compiling practicum instruction products. The design stage begins with the preparation of a practicum guide framework and writing systematics. The composition of the practicum guide framework, namely the logo, the author's name, the title, the title of the material, the practicum title, the picture of the lungs, and the university description. The parts of the writing systematics include the title page, table of contents, preface, instructions for use, discovery syntax instructions, activities (KI and KD, objectives, material summaries, questions, pictures of tools and materials, work methods, observation tables, questions, conclusions), bibliography. Product display at the design stage is presented in Figure 1.

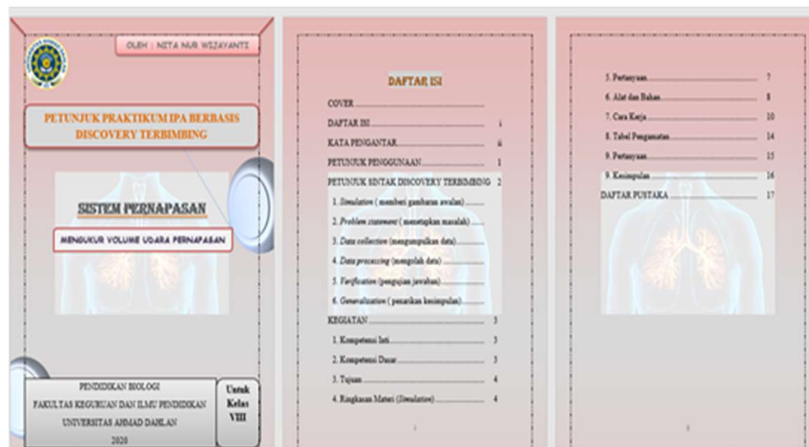


Figure 1. Preliminary design

At the development stage, a product assessment is carried out based on the assessment of material experts, media experts, and science teachers as well as student responses. Assessment is carried out by compiling assessments and providing suggestions and comments on the practicum instructions developed. The results of the assessment related to the assessment score by material experts (Table 3) obtained an assessment score of 95.83% (very good). The results of the media expert's assessment (Table 4) of the product get an assessment score of 75% (good). The results of the science teacher's assessment (Table 5) obtained an assessment score of 81.90% (good criterion).

Table 3. Material expert assessment results

No	Assessment Aspect	Score	Percentage	Keterangan
1.	Content eligibility	850	94,44 %	Very good
2.	Appearance	875	97,22 %	Very good
Average percentage			95,83 %	Very good

Assessment by material experts includes aspects of the feasibility of the content and presentation of the product. In the product assessment based on material experts, there were several revisions including the lack of appropriateness of the working method at the inspiratory reserve volume stage in the material of the human respiratory system with the topic of measuring the volume of breathing air. The revisions that have been made are presented in Figure 2.

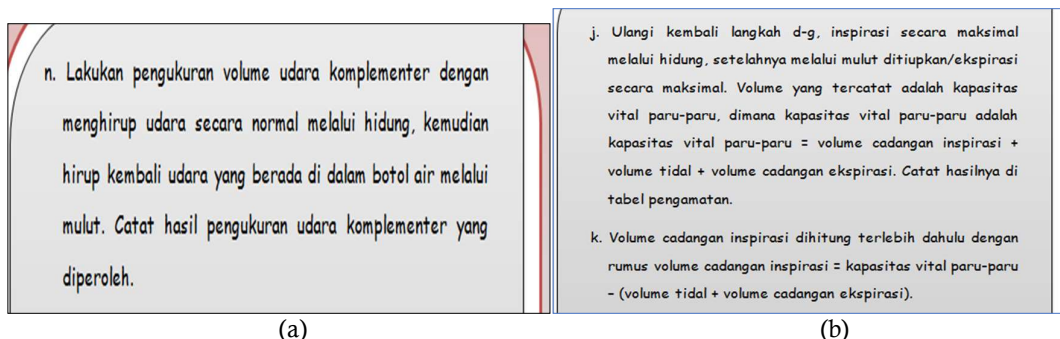


Figure 2. Product revision, (a) before revision; (b) after revision

Media experts assess the practicum guide product at 75% (good). In the assessment by media experts, there were several revisions, such as in the section on images of tools and materials that lacked contrast with the background, so the product was revised so that images of tools and materials could contrast according to the background. According to (Sanaky,

2013), images have the advantage of overcoming space and time so that images are created so that they do not require a lot of space and are easy to obtain. The cover design and display presentation are less attractive so the authors revise the cover so that the practicum instructions look attractive so that students are interested in reading the contents of the practicum instructions. According to (Rohmatillah & Oemar, 2019), the cover is the first glance for every reader so it influences the reader's interest. The improvements made based on the results of the media expert's assessment are presented in figure 3 and figure 4.

Table 4. The results of the media expert's assessment

No	Assessment aspect	Score	Percentage	Category
1.	Graphics	175	87,5 %	Very good
2.	Appearance	650	72,2 %	Good
Average percentage			75 %	Good

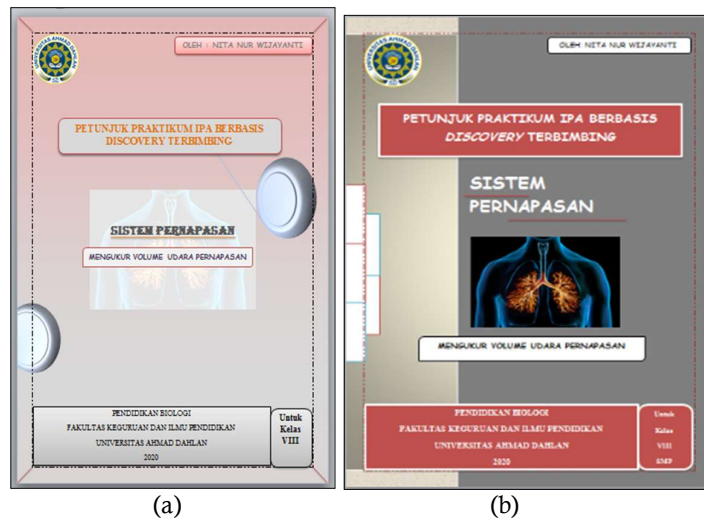


Figure 3. Cover revision, (a) before revision; (b) after revision

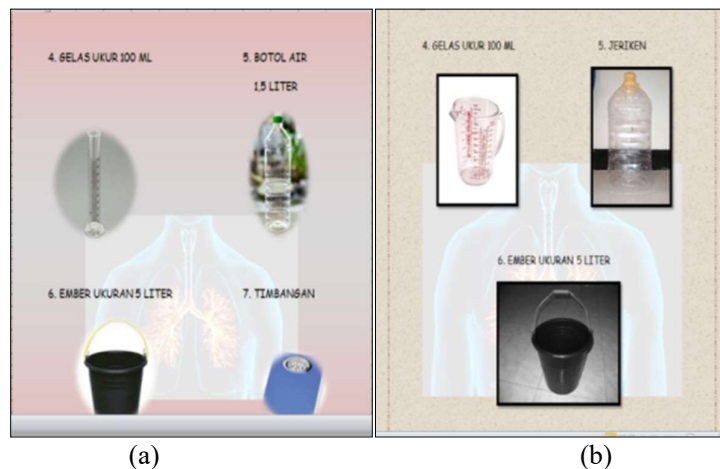


Figure 4. Product revision, (a) before revision; (b) after revision

Based on the Science Teacher's assessment of product quality, a score of 81.90% (very good) was obtained. In the feasibility aspect of the content, presentation, and appearance, the criteria are very good, while the graphic aspect is good. There is a revision of the science

teacher's assessment, namely a change in the picture of the jerry can contain in the tools and materials section.

Table 5. The results of the science teacher's assessment

No	Assessment component	Score	Percentage	Category
1.	Content eligibility	725	80,55 %	Very good
2.	Course	750	83,33 %	Very good
3.	Graphics	150	75 %	Good
4.	Appearance	750	83,33 %	Very Good
Average percentage			81,90 %	Very Good

Products that have been revised from the results of the assessment of material experts, media experts and teachers are then tested on a small scale. The results of student responses in small-scale trials (Table 6) obtained an assessment score of 100% (very good).

Table 6. Student responses to small-scale tests

No	Assessment component	Score	Criteria
1.	Material suitability	100 %	Very good
2.	The language used	100 %	Very good
3.	Execution	100 %	Very good
4.	Practical instructions display	100 %	Very good
5.	Interested in practical instructions	100 %	Very good
Average percentage		100%	Very good

The results of student responses in small-scale trials obtained a percentage of 100% (very good). Responses include aspects of material suitability, language, implementation, appearance, and interest in using practicum instructions. After the students used the practicum manual and tried to carry out their practicum activities, they stated that the practicum instructions were very interesting and the learning was easy to understand. The small class trial was carried out in 2 sessions, the first session consisted of 6 students and the second session consisted of 3 students. The distribution was due to the Covid-19 pandemic, so 2 sessions were held to keep following the health protocols set by the government, so as not to take too many students.

Small-scale trials were conducted on students. The trial results show that practicum instructions can develop the independence of students in assembling the tools and materials listed in the workings of the practicum instructions. Discovery model-based practicum instructions make it easier for students to be actively involved in doing practicum and developing the potential science process skills.

Practicum product instructions are based on discovery learning. The advantage is that students can be directly involved in real examples so that students become more active in participating in learning activities, discovery activities provide many opportunities for students to be directly involved during learning. The weakness of discovery is cultural and habitual factors, discovery learning is demanded in its independence. The demands of discovery learning adjust to the habits of students so that it can make them compulsion to carry out ordinary activities in the learning process (Ilahi, 2012).

The practicum method applies the discovery learning model with the topic of respiratory system material measuring the volume of breathing air. The discovery model has syntax in the form of stimulation, problem statement, data collection, data processing, verification, and generalization (Yusniawati, Sajidan, and Sugiyarto, 2015). The application of basic discovery learning is found at each stage that students must do as written in the practicum instructions developed. The stimulation stage includes the objectives of the practicum to be carried out. There is a summary of the material in the form of measuring the volume of breathing air. Before starting the practicum, it will be conveyed in advance about the objectives of the practicum and a

summary of the material to increase students' knowledge regarding the practicum to be carried out.

The problem statement stage is the problem-solving stage. After carrying out the stimulation stage, students are given a question to answer with their group. The questions given are useful for measuring student understanding and solving a problem related to the question.

In the data collection stage (data collection), students begin to carry out experimental activities measuring the volume of breathing air. Tools and materials and how to work for each practicum process are provided as stated in the practicum instructions, then students carry out experimental activities with their groups.

At the data processing stage, students write the results of the experiment in the observation table provided. Students after carrying out experimental activities get data on the results of the activities that have been carried out then these results are written in the observation table to find out the results of each child. Verification stage (verification) Verification stage, students compare the results of the data from the hypotheses that have been formulated with their respective groups according to the references used.

In the generalization stage, students conclude the results of discussions and questions that have been discussed with the group. Students after carrying out experimental activities from start to finish, then conclude what has been done and discuss the questions that have been discussed by the group.

Disseminate

Based on the results of the entire discovery-based human respiratory system practicum product for class VIII SMP, it is feasible to distribute because it meets the criteria for distribution. The dissemination stage does not reach the direct use of the product widely in schools but is only given to teachers. This is done because the school still establishes an online learning process so that students learn from home. The dissemination was carried out at SMP Negeri 9 Yogyakarta and MTS Muhammadiyah Gedongtengen Yogyakarta, by submitting practical instructional products to science teachers.

CONCLUSION

The quality of the discovery learning-based practicum product on human respiratory system material based on the assessment of material experts and teachers gets a very good category. Based on the assessment of media experts, it gets a good category. Student responses in small-scale trials also obtained very good categories. Practicum guide products are feasible to used as teaching material.

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