International Conference on Character and Sustainable Education (ICoCSE) Proceedings
Vol.1, 2024, pp. 38-45

Development of Laboratory Guidelines for Science Learning at Junior High School Based on Guided Inquiry on Subtopic Mixtures

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Abstract

Currently, teachers at SMP Negeri 2 Lamongan use lab worksheets from textbooks for lab-based science learning activities. In addition, the implementation of laboratory activities is not ideal because students do not play an active role and rely more on teacher explanations. The purpose of this study was to provide a guided inquiry-based autonomous curriculum laboratory guide on the mixture subtopic to help students improve their scientific performance skills. The design of this research is based on the 4D model, which includes the steps of defining, designing, developing, and disseminating. The sample method used was simple random sampling. In order to ascertain the laboratory guide's viability, this study employed data analytic methodologies such as laboratory guide validation and practicality. This study used surveys, observations, and literature reviews as data collection methods. The results revealed that the validation of the laboratory guide met extremely high requirements and was deemed very valid with a V value of 0.94. The results of the practicality of the laboratory guide received very high criteria and were rated as very practical with a value of 92. Scientific performance skills can be developed by using guided inquiry-based laboratory guides on mixtures subtopic, as evidenced by the percentage of student's scientific performance scores from three experiments at the beginning stage of development with a percentage of 55%, 61% and 48%, while at the advanced stage obtaining a percentage of 35%, 29% and 42%, respectively. It can be concluded that overall students have achieved the Learning Objective Achievement Criteria as a standart.

Keywords: mixtures subtopic, kktp, laboratory guidelines, scientific performance skills, guided inquiry.

INTRODUCTION

The rapid development of Science and Technology (Science and Technology) in the era of Society 5.0 does require significant changes in the world of education (Muhtadin & Santoso, 2022). Society 5.0 it self refers to the concept of a society that incorporates advanced technologies, such as artificial intelligence (AI), internet of things (IoT), and big data, with the aim of improving the quality of human life. In the context of education, this means not only students need to master basic literacies such as reading, writing, and arithmetic, but also more complex skills, including critical thinking, creativity, collaboration, and digital literacy, particularly in Science learning, innovative approaches are needed to respond to these changes.

The main objective of science learning is to help students understand scientific concepts related to natural phenomena and apply them in everyday life with a scientific attitude (Farida & Khosiah, 2022). Science learning also provides direct learning experiences through activities such as investigations, experiments, and practicums (Ekantini, 2020).

Practicum is a learning activity in the laboratory that allows students to gain hands-on experience through real activities. Practicum guidelines are very important to maintain the direction of activities and help students measure their scientific skills and attitudes (Agustina & Juliar, 2021). The practice manual serves as a guide during the practicum, from preparation to final reporting (Rianti, 2022). Practicum-based learning requires the right learning model, such as the guided inquiry model, which is effective in training students' scientific performance during science practicum.

The guided inquiry learning model is suitable for practicum-based learning because it encourages students to think critically, be skillful in presentation, answer questions, and

actively ask questions (Indawati *et al.*, 2021). This model trains students' scientific performance which includes scientific methods, scientific attitudes, and scientific communication skills, both oral and written. Scientific performance plays an important role in supporting practicum learning with the guided inquiry model.

The achievement of science skills in Indonesia is still relatively low, especially in practicum activities. Based on the results of the 2018 PISA study, Indonesian students scored 396, far below the global average of 489, so that Indonesia was ranked 74 out of 79 countries (Samsudin *et al.*, 2023).

Based on interviews with two 8th grade science teachers at SMP Negeri 2 Lamongan, on Tuesday, 14 November 2023, it is known that practicum-based science learning still uses simple guidelines from package books. During practicum activities, students tend to focus more on the teacher's explanation, so they are less actively involved. Whereas the Merdeka Curriculum expects students to play an active role, while the teacher functions as a facilitator. In conclusion, practicum activities in class VIII are still dominated by simple LKS and do not involve students' scientific performance skills, which are only used to measure learning outcomes.

Based on research by Mufidah *et al.* (2018) entitled "Development of Guided Inquiry-Based Water Pollution Practicum Instructions to Improve Learning Outcomes of Junior High School Students," the results of validation by media experts and material experts show that guided inquiry-based practicum instructions meet the criteria of valid, practical, and can be implemented in practicum-based learning.

Based on the description above, it is necessary to design a practicum guide that can train students' scientific performance skills. This design is in the form of developing a guided inquiry-based practicum guide on mixed sub-topics for class VIII junior high school. By using the guided inquiry model, it is expected that students can be more actively involved in practicum activities, so as to train scientific performance skills effectively.

METHOD

The type of research used is development research. The development model used in this research is 4D (Define, Design, Development, Disseminate). The location used as a research site is SMP Negeri 2 Lamongan which is located at Jalan Veteran No.3 Banjar Anyar Banjarmendalan, Lamongan Regency, East Java 62212. This study uses random sampling techniques because all members of the population have the same characteristics. The number of samples in this study were 90 students of class VIII SMP Negeri 2 Lamongan. Data collection techniques in this study were surveys, observations, and literature studies. The research instruments used were product validation sheets and research instruments, practicality sheets, student scientific performance observation sheets. Data analysis techniques include:

Feasibility test of the practicum guide

The learning media will be tested using validation test and practicality test to assess the quality or feasibility of learning media. Learning media and research instruments will be tested for validation using Aiken's V test which is formulated as follows:

$$V = \frac{\sum s}{[n(c-1)]}$$

After the results are obtained, then the validity of the product is determined based on the following criteria table:

Table 1. validity criteria

No.	Presentase	Criteria
1	0,81 – 1,00	Very valid
2	0,61 – 0,80	valid
3	0,41 – 0,60	sugar valid
4	0,21 – 0,40	less valid
5	0,20 – 0,00	very invalid

Furthermore, the product practicality test will be calculated using the formula equation (Kwuta *et al.*, 2022) as follows:

$$P = \frac{score\ obtained}{maximum\ score}\ X\ 100\%$$

After the results are obtained, then the practicality of the product is determined based on the following criteria table:

Table 2: Criteria for practicality

No.	Presentase	Criteria
1	81,25 < x ≤ 100	Very practical
2	62,50 < x ≤ 81,25	Practical
3	43,75 < x ≤ 62,50	Less practical
4	25,00 < x ≤ 43,25	Not practical

The validity test of the practicum guide. practicum guide practicality test. student scientific performance assessment sheet.

Assessment of students' scientific performance skills

The ability of students ' scientific performance can be measured from the values obtained during practical activities in accordance with the weight of each indicator used in the assessment. The category of scientific performance assessment consists of 4 categories, namely undeveloped, developing, developing and advanced. The stages in calculating the average percentage score for each scientific performance indicator using the formula equation as follows:

$$\% = \frac{n}{N}\ X\ 100\%$$

Keterangan :

% : percentage of student scores

n : total score obtained by students

N : maximum score

Table 3: Interpretation of scientific performance skills based on KKTP

Process	Stage	Criteria
0 – 40%	Undeveloped	Not yet reached KKTP needs improvement in all parts.
41 – 65%	Early developing	Not yet reached KKTP needs improvement in certain areas.

Process	Stage	Criteria
66 – 85%	Beginning to develop	Have reached KKTP no need for remedial.
86 – 100%	Proficient	Already achieved KKTP needs more enrichment or challenge.

(Direktorat KSKK Madrasah, 2022)

RESULTS AND DISCUSSION

The product developed is a practical guide designed using 4D models. Practicum guide developed based on inquiry guided on mixed sub topics for Class VIII junior high school. The purpose of developing practicum guide is to train students ' scientific performance in practicum activities using practicum guide. The stages of the 4D model as follows:

The first stage is the defining stage, at this stage includes the initial final analysis to determine the problems that occur or obstacles experienced by teachers during practicum-based learning activities, through this activity can help researchers in designing products to be developed.

Analysis of the characteristics of students in order to determine the readiness of students in practicum-based learning activities. At this stage can be seen from the background of the knowledge of students, academic ability, level of knowledge and interest of students, it can help researchers in developing products to be made.

Concept analysis aims to identify concepts related to relevant aspects of scientific performance skills in the practicum guide to be developed. In the analysis of this concept researchers can identify learning outcomes and learning objectives to be used.

The second stage is the design stage, at this stage contains the activities that need to be done by researchers in designing the product being developed. At this stage there are several steps that need to be done, among others: the preparation of scientific performance assessment instruments that have been adapted to the indicators and learning objectives to be used in the practicum guide, the selection of media that will be used in designing the practicum guide has been adapted to the learning objectives and characteristics of students, the initial design consisting of cover design, title, content and cover. The following is the design of the practicum guide that will be developed.

Figure 1. Initial design, cover, contents and cover or cover

The developed practicum guide has several parts starting from the introduction which includes the cover, title, foreword, learning outcomes, learning objectives, concept maps, table of contents. The contents section consists of theoretical basis, tools and materials, experimental steps and scientific performance indicators that have been adjusted to the learning objectives used, while the closing section contains the bibliography and the final cover.

The third stage is the development stage, at this stage the aim is to produce a product in the form of a valid and practical practicum guide based on input from expert validators. After conducting validity and practicality tests, the next step will be to conduct a development test with a one-shot cast study design. The development stage starts from the expert validation test to see the feasibility of the practicum guide that has been made, where the practicum guide is said to be feasible if it meets the valid and practical criteria. Validation of the practicum guide consists of aspects that are assessed, including media/presentation format aspects, material aspects and language aspects. Table 4 is the validation results.

Table 4. Results of validation of practical guide

No	Aspects	Value V	Criteria
1	Media	1,00	Very high
2	Language	0,90	Very high
3	Material	0,91	Very high
Average		**0,94**	**Very high**

After the assessment was carried out by the expert validators, the calculation of the number of values given by the validators was carried out with the Aikens test and a total value of 0.94 was obtained and was in the very high category. The results of the study by (Rz *et al.*, 2022) stated that learning devices that had been validated by the validator and obtained a very high value were said to be worthy of being tested on students.

The second test is a practicality test by 2 science teachers at the school in terms of practicality/ease of use during learning. Table 5 is the practicality result.

Table 5. Practical results of the practical guide

No	Teacher	Validator assessment	Criteria
1.	Science teacher 1	93	Very practical
2.	Science teacher 2	91	Very practical
Average percentage		**92**	**Very practical**

The results of the practicality of the practical guide got a score of 92 with very practical criteria. Furthermore, the practical guide will be revised according to suggestions for improvement by experts. The results of research by (Samsu *et al.*, 2020), showed that learning devices that had been tested for practicality by practicality experts and received a score of 80%, then the learning device was declared practical and could be tested on students.

The fourth stage is the disseminate stage. In this study, the disseminate stage was not carried out due to the researcher's time constraints, so this study only reached the development stage.

Results of student scientific performance assessment

Students' scientific performance skills can be trained by using a one-shot case study design in the form of student grades after conducting practicums using a practicum guide. The practicum guide contains 6 indicators of scientific performance, namely formulating problems, stating hypotheses, designing experiments, collecting and analyzing data, conveying experimental results, concluding experimental results. The results of student grades from all indicators for each practicum will be accumulated into one data and will be tested for prerequisites, namely normality and homogeneity tests to determine whether the data is normal and homogeneous. Furthermore, the data will be tested using a one-tail test, namely a one-sided right or left test depending on the areas of acceptance and rejection of Ho and Ha. Here are the results of the one-tail test:

One-Sample Test

	Test Value = 66					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference Lower	Upper
SCIENTIFIC PERFORMANCE	23.938	89	.000	16.80411	15.4093	18.1989

Based on the one tail test table above, it shows a sig value of 0.000 or sig one tail test < 0.05, the t-count result is 23.938 ≥ t table 1.662, so Ho is accepted and Ha is rejected, so it can be said that the developed practical guide can train students' scientific performance in practical activities, this can also be proven from the results of the scores of all students who have reached the KKTP set, which is above 66

Results of observations of students' scientific performance assessment

The results of the scientific performance assessment analysis were obtained from the value of 3 x practicums using the practicum guide. The value is based on the assessment of 2 observers which will be accumulated into 1 value. The following is a diagram of the results of the 1st, 2nd and 3rd practicum values:

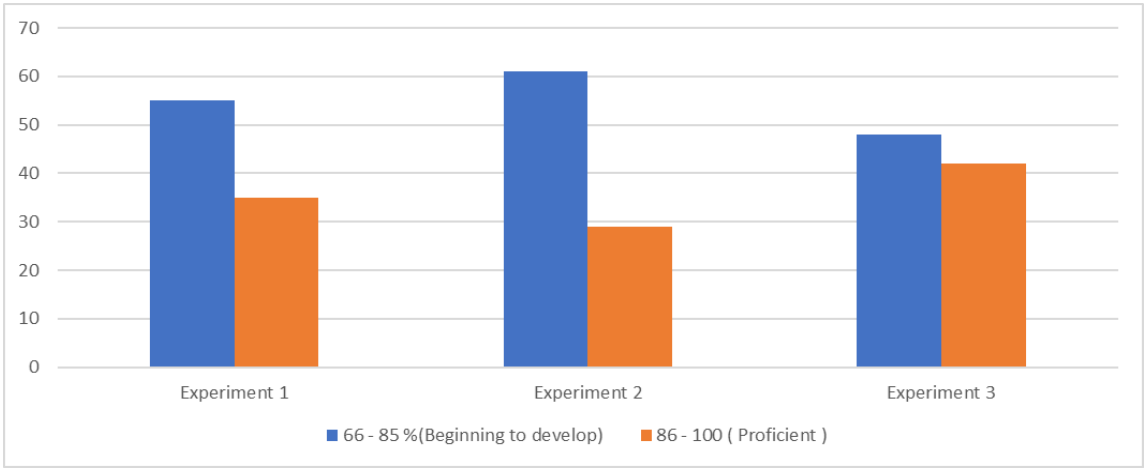

Figure 1. Percentage of students' scientific achievements

The percentage value above is the average value of 3 trials for all scientific performance indicators. Based on Figure 2 above, the average value of students' scientific performance in trial 1 is at the beginning of development stage 55% and the advanced stage 35%, in trial 2 it is at the beginning of development stage 61% and the advanced stage 29% while in trial 3 it is at the beginning of development stage 48% and the advanced stage 42%, it can be concluded that

in 3 trials all students are at the beginning of development and advanced stages and have met the criteria for achieving learning objectives (KKTP).

CONCLUSION

Based on the results and discussions that have been described above, the following conclusions are obtained: The practical guide is declared feasible based on the assessment of validation and practicality experts and the results are in the very valid and very practical categories. Students' scientific performance after using the practical guide, when viewed from the Learning Objective Achievement Criteria (KKTP), is at the stage of starting to develop and become proficient. This can be seen from the percentage of students' scientific performance in experiments 1, 2 and 3. So overall, students' scientific performance has reached the Learning Objective Achievement Criteria (KKTP).

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