

# Work Sheet Development based on Laboratory Investigation-Scientific Safety to Improve Practical Skills on Secondary School

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**Abstract**—Natural Science learning in the 21st century is closely related to the scaling of scientific skills. Students practical skills is one of scientific skills which must be mastered. Applying practical skills in the laboratory need an ability to scientific safety. This research was aimed to produce the students work sheet based on Laboratory Investigation-Scientific Safety that feasible and effective to improve the student's practical skills of Secondary School. This research and development (R & D) used Borg & Gall model with modification of eight steps; (1) preliminary study, (2) planning, (3) product development, (4) limited trial, (5) product revision, (6) field test, (7) product revision final product improvement) and, (8) limited dissemination. The data were collected by non-test techniques which included using product validation instrument, student questionnaire to response work sheet, practical skills observation sheet. Field trials were conducted using Pre-test-Post-test control group design with 35 subjects in the experimental and control classes. The data were analyzed using normality test, homogeneity test, and t test. The results were: (1) the students work sheet based on laboratory investigation scientific safety was considered good and proper by lecturer of media expert, material expert, science teacher, and colleague with mean value 89,5%, (2) the students practical skills improved to be 89.5 after using students work sheet. Practical skills improvement was evidenced by the acquisition of a t test significance value of 0.000 less than 0.05. Overall, it can be concluded that student's product based on laboratory investigation scientific safety focused theme of human digestive system was feasible to be used in learning and effective to improve students' practical skills of secondary school.

**Keywords**—students work sheet, laboratory investigation-scientific safety, practical skills

## I. INTRODUCTION

Nowadays, the efforts to improve quality of Indonesian education are very interesting to do, especially by the government. It can be seen through innovative curriculum development from basic education to higher education that has resulted in the product of curriculum 2013. Curriculum 2013 is applied to prapare the students to facing the 21st century. The 21st century is marked by development of technology and science fastly, so that the students need to be equipped with the ability of the 21st century.

Natural Science learning in the 21st century is closely related to the scaling of scientific skills. Scientific skills include science process skills, thinking skills, and psychomotor skills (practical skills). One of the 21st century skills-based learning is learning with psychomotor skills (practical skills).

Psychomotor skills can be divided into categories of procedural and manipulative skills (P & M), observation skills (O), drawing skills (D), reporting and interpreting skills. According to one of the objectives of science teaching is to teach students to gain experience through the application of scientific method (experiment), so they are trained to become a scientist. Students are always confronted with various problems of natural phenomena, and in order to deal with this problem, not only do they need theoretical knowledge, but also do they need a scientific attitude as a benchmark of their level of understanding.

To improve practical skills, innovation is needed in the learning process, so that students learn effectively and learning objectives can be achieved completely. Process of learning will success if students interact with learning resources seriously and continuously, do exercises for control of competence, get feedback immediately after learning process, apply ability in real context, and interaction in acquiring knowledge and skill [1].

To realize a successful learning and in accordance with the objectives of learning, it required an appropriate teaching materials. Students work sheet is One of the teaching materials which accordance [2]. Students work sheet is one of the teaching materials that aims to trigger and help students to do learning activities in order to master an understanding, skill and or attitude. Students work sheet contain of steps were taken by students in investigation activities in order to solve problems and aims to trigger and help students to learn activities in order to master a knowledge, skills and attitude.

Based on observations in State Islamic Secondary School 1 Yogyakarta showed that teachers use teaching materials in the form of book packages and students work sheet. The existing students work sheet contains only material summaries, practicum activities and practice questions. For practical activities students are still not skilled at using practicum tools and do not understand about the safety (scientific safety) what is needed when conducting

investigations in the laboratory. Laboratory investigations should be consider scientific safety to avoid laboratory accidents. Workplace safety in the laboratory is an obligation of every individual who aware of the health, safety and security interests work comfortability.

Scientific safety equipments which needed during practicum are gloves, masks, glasses and lab coats. The ability of students when doing practice indicate their practical skills. Therefore, it is necessary to develop students work sheet that can facilitate practical skills in investigative activities in the laboratory. Practical learning skills most often use laboratory activities, especially with regard to tools and materials with small class sizes and require a long time [3]. According to Hackling, the abilities possessed by students in the investigation are identifying variables for testing in the investigation, writing hypotheses, planning experiments with control of disturbing variables and with adequate sample size, evaluating experiments that identify the lack of variable control or insufficiency in sample size, draw tentative conclusions from the experimental results. Based on the explanation above, it is necessary to use students work sheet based on laboratory investigation-scientific safety to improve practical skills.

The rest of this paper is organized as follow: Section II describes the proposed research method. Finally, Section III describes the obtained results and following by discussion. Finally, Section IV concludes this work.

**II. RESEARCH METHOD**

This research is a research development with the development model from Borg & Gall in [4], which modified into eight steps: preliminary study, planning, product development, limited trial, product revision, field test, product revision (final product refinement) and limited dissemination. The product is validated and rated by 2 experts, 2 teachers and 2 peer reviewers. A limited product trial using a small class with several students as much as 9. Empirical testing conducted at State Islamic Secondary School 1 Yogyakarta by using Pre-test-Post-test control group design as described in Table I [5].

TABLE I. RESEARCH DESIGN

Class	Pre-test	Treatment	Post-test
Control	O <sub>1</sub>	X <sub>1</sub>	O <sub>2</sub>
Experiment	O <sub>3</sub>	X <sub>2</sub>	O <sub>4</sub>

Where:

- O1: the early mean value of student’s practical skills of control class.
- O2: the final mean value of student’s practical skills of control class.
- O3: the early mean value of student’s practical skills of experiment class.
- O4: the final mean value of student’s practical skills of experiment class.
- X1: learning using students work sheet from school
- X2: learning using students work sheet-based laboratory investigation-scientific safety

The subjects of this research amounted to 35 students in both control and experimental class. The instrument to collect the data are form of product validation sheet and

practical skills observation sheet. The product validation sheet covers aspects of content assessment, presentation components, language and key graphics using a Likert scale of 1-5 as described in Table II. The product validation sheet refers to the rules of the Ministry of National Education 2016. The practical skills observation sheet is adapted from Khendra in [6] which includes aspects of skills assessment; (a) manipulative and procedural, (b) observing, (c) drawing, (d) reporting and concluding.

Product validation score data is calculated using the formula:

$$mean\ score = \frac{Total\ score}{Number\ of\ appraisers}$$

TABLE II. IDEAL ASSESSMENT CATEGORY CRITERIA

Score Range	Category
$\bar{X} > M_i + 1,80 SB_i$	Very Good
$M_i + 0,60 SB_i < \bar{X} \leq M_i + 1,80 SB_i$	Good
$M_i - 0,60 SB_i < \bar{X} \leq M_i + 0,60 SB_i$	Enough
$M_i - 1,80 SB_i < \bar{X} \leq M_i - 0,60 SB_i$	Bad
$\bar{X} \leq M_i - 1,80 SB_i$	Very Bad

Where:

- Mi = Mean ideal
- Mi = 1/2 × (ideal high score + ideal lowest score)
- SBI = Ideal Standard deviation, i.e.
- SBI = (1/2) × (1/3) × (ideal high score - ideal lowest score)
- Ideal highest score = Σ item criteria × highest score
- Ideal lowest score = Σ item criterion × lowest score

The data value of practical skills is calculated using the formula:

$$Value = \frac{Score\ obtained}{Maximum\ score}$$

Improved practical skills are calculated based on the gain score obtained using the formula:

$$Gain = \frac{end\ -\ score\ initial\ score}{Score\ maximum\ -\ initial\ score}$$

The next magnitude category is determined using the following standard gain criteria as described in Table III [7]:

TABLE III. STANDARD GAIN CRITERIA

Gain score	Category
$g \geq 0.7$	High
$0.3 < g < 0.7$	Medium
$g < 0.3$	low

**III. RESULTS AND DISCUSSION**

Students work sheet based on the investigation-scientific safety laboratory developed is said to be feasible and effective to be used in learning in the laboratory determined by the assessment of the validator. Validators who will assess the students work sheet developed are two expert lecturers, two science teachers, colleagues, and nine students. Expert lecturers who become validators are material experts and media experts who can assess the feasibility of the students work sheet developed. Science teachers were also asked to assess whether the students work sheet that was developed was feasible and effective to

use in learning in the laboratory. Students are also asked to assess how the Natural Sciences students work sheet is based on the laboratory investigation-scientific safety developed. Students work sheet is assessed using the validation assessment sheet that researchers have prepared.

Data is analyzed by changing the qualitative data obtained from the reviewer's assessment into the form of quantitative data with the calculation. The quantitative data is tabulated and analyzed in each aspect of assessment. The final score obtained is converted into qualitative data based on the criteria of the ideal assessment category. The following are laboratory-based students work sheet quality investigation-scientific safety based on the assessment of material experts, media experts, teachers, peers and student responses

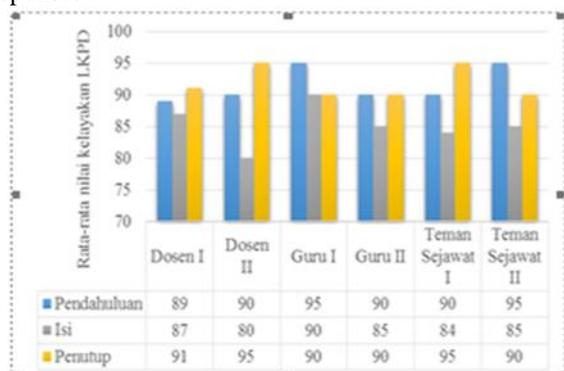


Fig. 1. Quality of Integrated Students Work Sheet Results of Assessment of Media Experts, Material Experts, Peer Reviewers and Teachers

Based on Figure 1 above that the assessment of each aspect based on the accumulation of overall assessments from media experts, material experts, peer reviewers, and Natural Sciences Teachers shows that the quality of students work sheet is included in both categories stated with an average value of 89.5 so that the overall quality of students work sheet is good.

The results of the trial are limited to small classes with 9 research subjects are described in Table IV as follows:

TABLE IV. SCORE OF STUDENTS WORK SHEET

score of content aspect	score of presentation aspect	score of linguistic aspect	Total score	value	Category
22.22	21.33	8.88	52.44	87.33	Very Good

The mean number of scoring scores in all aspects is 52.44. When compared with the ideal assessment category criteria table, the average number of scores is 52.44 more than 50.4. This shows that descriptively the students work sheet based on the laboratory investigation-scientific safety that was developed received a very good and feasible assessment to be used in empirical / field trials.

Based on the Table V below, it is known that there is an increase in the average value of practical skills in the experimental class and control class. The experimental class practical skills gain value is 0.712 (high category), in the control class is 0.199 (low category).

TABLE V. THE AVERAGE VALUE OF PRACTICAL SKILLS

Tendensi sentral	Nilai awal		Nilai akhir		Gain			
	Eksp-	Kon-	Eksp-	Kon-	Eksperimen		Kontrol	
					Angka	Keterangan	Angka	Keterangan
Rata-rata	70	67	92	81	0,712	Tinggi	0,199	Rendah
Minimum	60	60	85	78	0,5	Sedang	0,000	Rendah
Maksimum	80	73	100	87	1	Tinggi	0,5	Sedang

TABLE VI. NORMALITY TEST

Class	Kolmogorov-Smirnov Z	Sig. (2-tailed)
Control	1.207	0.109
Experiment	1.221	0.101

TABLE VII. HOMOGENITY TEST

Variable	Levene Statistic	df1	df2	Sig.	conclusion
Practical	1.207	1	68	0.312	H0 is accepted

From Tables VI and III, the significance value for the practical skills variable is more than 0.05. Since the value of  $\text{sig} > \alpha$  then  $H_0$  is accepted. It shows that there is no variant difference in the variables in the experimental class or control class. It can also be said that before being treated, the practical skills of control and experiment classes are equal

The results of the gain score analysis for improving practical skills with  $t$  test are described in Table VIII as follows:

TABLE VIII. INDEPENDENT SAMPLE T TEST

F	T	df	Sig.
0.652	-12.085	68	0.000

The significance value for each  $t$  test is  $0.000 < 0.05$ . It shows that learning variables using students work sheet-based laboratory investigation-scientific safety and students work sheet learning in schools that are given about research together (simultaneously) affect the variable tied practical skills. The test results show that  $H_0$  is rejected.

The product of students works sheet-based laboratory investigation-scientific safety that has been developed is considered feasible as a specific teaching material. Students work sheet eligibility becomes an important factor in determining the success of a natural science lesson. The product has a category B (good) value and is feasible to be implemented in science-based science laboratory investigation-scientific safety that is material of the human digestive system. Referring to Sarwono in [8] regarding the assessment standard, the product is feasible to be implemented when obtaining category B (good). Setyosari in [9], suggests that the development of a learning device at least refers to 3 aspects: (1) the content component, (2) the presentation component, and (3) the language component. These results indicate that the experimental class using the laboratory-based laboratory investigation-based students work sheet has better practical skills compared to the control class that does not use laboratory investigation-developed laboratory-based students work sheet safety.

Learning practical skills is closely related to work in the laboratory. Therefore, the practical skills of learners can be developed by inviting learners to perform laboratory work. The use of laboratory-based students work sheet can certainly facilitate the implementation of learning activities. This is because the method according to Hertz-Lazarowitz in [10] laboratory activities or laboratory work is a form of practical work located within an environment tailored to the purpose for learners to engage in a planned learning experience and interact with equipment to observe and understand the phenomenon.

Learning natural science to develop practical skills must be very different when compared with learning to develop a science that is limited to theories and concepts. Suggests that practical skills learning most often uses laboratory activities, particularly about tools and materials of small, long-term sizes. Hayward, in [11] says, "the learning of practical skills is most often associated with your workshops laboratories". The emphasis of the statement is that in learning practical skills is closely related to laboratory work (laboratory investigation) or lab work. Therefore, to develop practical skills required activities such as laboratory work (laboratory investigation) or lab work.

Laboratory work is very effective to help learners develop practical skills. Students still rarely do the assessment in the form of practical tests so that practical skills cannot be measured properly [12]. It is expected that in these activities learners learn to be good scientists, such as conducting inquiry planning, selecting methods of investigation and appropriate tools and materials, making measurements or observations carefully, recording data of experimental results or observations with precise and clear, and draw reliable conclusions from the results of experiments or observations that have been made. In addition to developing practical skills learners, learning by inviting students to do laboratory work can also make the phenomenon becomes more real, and make learners engaged more actively in learning [11].

#### IV. CONCLUSION

This paper has developed students work sheet based on laboratory investigation-scientific safety to improve students practical skills on secondary school. It can be concluded that student's product based on laboratory investigation scientific safety focused theme of human digestive system was feasible to be used in learning and effective to improve students' practical skills of secondary school.

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