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Improvement of Science Process Skills Through Sound Variable Intensity Level Tool Kit

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Abstract

Science process skills (SPS) are essential to assist the learning of senior high school students according to the 2013 curriculum, which prioritizes a scientific approach. The learning method that supports SPS is experiment methods. Nevertheless, learning with experimental methods is still rarely applied in schools, especially in the sound intensity level concept. The reason is the limited number and variant of experiment tool kits to support learning in schools. This study aims to develop a sound variable intensity level sound tool kit based on development procedures proposed by Jan van de Akker (2006). Sound variable intensity level kit was developed based on tool kit, which was developed before by Fikri Habibi. Sound variable intensity level experiment kit was evaluated by several learning media and learning material experts before being tested on high school students in several stages, including the one-on-one evaluation stages, small group evaluations, and field tests. The researcher revised the sound variable intensity level kit based on suggestions from the experts and the students. After being revised, the sound variable intensity level kit was tested on summative evaluation. Based on the results of summative evaluations, the sound variable intensity level kit becomes a successful, practical, and effective learning support tool kit for improving the science process skills of the student in the concept of sound intensity level.

Keywords: development experiment tool kit, science process skill, the sound intensity level

INTRODUCTION

Science process skills (SPS) are essential in improving student competency in physics learning. SPS is a fundamental skill to implement scientific methods for discovering and developing a concept (Edie et al. 2018). Students with good SPS are expected to have four competencies (4C abilities) to face the industrial Era 4.0. These include creative thinking, critical thinking, communication, and collaboration (Sutarto 2018). Students' collaboration and communication skills must be improved because an employer in this century looks to hire individuals with soft skills, collaboration, and communication (Sunaryo et al. 2019).

SPS consists of three skills; there are manual skills, intellectual skills, and social skills. Manual skill is the skill of students using media in the learning process, for example, assembling practical tools, or using tools for measurement. Intellectual skill is related to students' cognitive abilities, while social skill is related to students' ability to interact with teachers or other students in the learning process (Rustaman 2005).

Physics learning that involves students will practice science process skills. Science process skills are needed so students can find and develop concepts. Learning that encourages students to find their

knowledge will create meaningful learning (Edie et al. 2018). However, based on our survey of several physics teachers in four senior high schools in South Tangerang City, Banten, stated that students' SPS is still low and poorly trained. This is due to the lack of learning utilizing practical kit so that SPS students are less trained.

Physics learning based on the experiment can be the solution to the low SPS. Practical activities encourage students to be active in the learning process and encourage students to carry out scientific activities (Sagala 2014). Besides, the set of practicums used by students to experiment can support students' intellectual (Alfiyah et al. 2016), psychomotor abilities (Alfiyah et al. 2016), acquisition of skills (Solihan et al. 2018), and increased attitudes (Solihan et al. 2018). Nevertheless, the consideration of the number and variety of experiment tool kits in schools is an obstacle in the implementation of practicum. Especially in learning about the sound intensity level at this time is still being dominated by the use of Microsoft PowerPoint. Even though 60% of the 273 students were surveyed at high school in South Tangerang City, preferred learning with practicum because it was more interesting and easy to understand.

Sound is one of the important topics in physics. The basic concepts of sound that are learned at the senior high school is sound intensity level. The sound intensity level is the representation of sound strongness (Halliday & Resnick 2010). The sound intensity level depends on the power of the sound source. Besides that, it depends on the number of sound sources and the distance between the sound source and the observer. The change sound intensity level to distance and the number of sound sources is in the form of a logarithmic function (Dagdeviren 2018). The character of this material is very suitable to be developed in experiment tool kits. The development of experiment tool kits is seen as a useful tool for providing meaningful learning opportunities with several constructivist learning experiences (Somyurek 2014). Both novel virtual and physical tools such as interactive computer simulations or remote laboratories allow students to observe scientific phenomena, manipulate variables, organize experiments, and collect data (Bumbacher et al. 2017). Therefore it is very interesting if we develop a tool kit about sound intensity level.

Development research of sound intensity level tool kit has previously been carried out and motivated students to learn the concept successfully. However, the instrument developed can only show the influence of distance to sound intensity level, but the variable number of sound sources that also affects the sound intensity level cannot be shown. The study also did not observe an increase in students' scientific process skills through experiment activities (Habibi and Prabowo 2015).

The development of the experiment tool kit in this study provides facilities for students to observe the effect of the number of sound sources and distances on the sound intensity level. Besides, students are directed to convert experimental results from tabular form to graphical form so that sound intensity level changes can be seen in the form of logarithmic functions. Thus, students discover the concept of sound intensity level through direct experiments so that learning is more meaningful and can train students' science process skills.

METHODS

This study uses the development research of Jan van de Akker that consists of four main stages, and there are preliminary research, prototype stage, summative evaluation, and reporting. Research problems were identified based on field surveys and literature studies in preliminary research. Then the prototype experiment kit is made and evaluated at the prototype stage. Sound variable intensity level experiment kit is validated by 12 experts consisting of 6 learning media experts and 6 content experts. After the experiment kit developed was declared feasible by the 12 experts, the experiment kit was tested on one to one evaluation, small group evaluation, field test (Tessmer 1993). The research subjects consisted of 48 students of South Tangerang 6 High School. It divided into several stages, as in FIGURE 1 below.

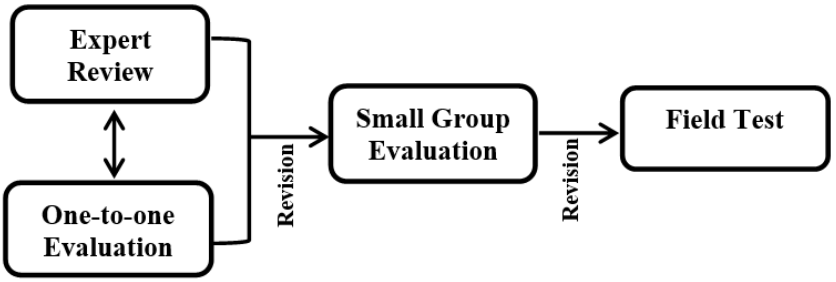

FIGURE 1. Stage of Formative Evaluation

The experiment kit was optimized based on suggestions on formative evaluation. The final evaluation of the experiment kit is carried out on summative evaluation to test its feasibility, practicality, and effectiveness. Summative evaluations were conducted on 15 students at SMAN 9 South Tangerang after the sound intensity level experiment kit was optimized based on suggestions from the previous evaluation (Jan van den Akker 2006).

This research examines the feasibility, practicality, and effectiveness of sound variable intensity level kit. The research instruments in the form of a questionnaire, observation sheets, and science process skills tets (multiple choice). Questionnaires are given to students to obtain student assessments regarding the feasibility of a sound variable intensity level experiment kit based on various aspects, including suitability, efficiency, or the ability of the experiment kit to be implemented. Questionnaires are also given to teachers to find out the practicality of the experiment kit.

The science process skills test aims to find out the improvement of science process skills students after using the sound variable intensity level experiment kit. Besides that, the test aims to measure the effectiveness of the experiment kit (Jan van den Akker, 2006). The test instrument consisted of 10 multiple choices with SPS indicators tested are observing, classifying, interpreting, predicting, asking questions, making hypotheses, planning experiments, preparing equipment/materials, applying concepts, and communicating. Instrument test has been tested using content validation, which is an instrument validity test technique based on expert judgment (Sugiyono, 2018). Observation sheets are also used to assess student SPS during experiment activities. Some SPS indicators observed include observing, making a hypothesis, preparing equipment/materials, doing experiments, interpreting, and communicating.

RESULT AND DISCUSSION

Sound variable intensity levels experiment kit is designed for students to observe changes sound intensity level logarithmically due to change in the number of sound sources and the distance of the sound source to the detector. The sound source used is the SFM-27-I buzzer, which is practical and affordable. The development of the experiment kit should use materials that obtained easily, for example, materials that can be recycled or materials at affordable prices.

The experiment kit is made based on design guidelines. The components used are of good quality and in accordance with needs. The buzzer used has the same frequency and intensity level. The electric current and voltage entering each buzzer also affect the level of sound intensity so that the current and voltage applied to the buzzer must be equal. The sound variable intensity level kit consists of two acrylic boxes with a length of 50 cm. Each box has holes in pairing sound level meter sensors. The design of the sound variable intensity level kit is discussed in FIGURE 2.

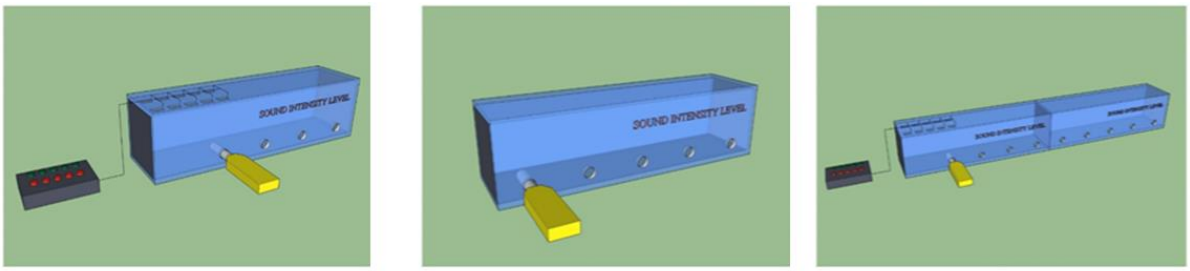

FIGURE 2. Design of the Sound Variable Intensity Level Kit

The sound variable intensity level experiment kit was tested by experts and students at the formative evaluation stage to obtain an assessment and suggestions for optimization of the experiment kit. Some suggestions are applied to optimize the sound variable intensity level kit. Assessment of sound variable intensity level kit at the formative evaluation stage shown in TABLE 1 and TABLE 2.

TABLE 1. Results of Expert Assessments on Formative Evaluations

No.	Aspect	Percentage	Category
1.	Learning Media	93%	Very Good
2.	Learning Materials	100%	Very Good

TABLE 2. Results of Student Assessments on Formative Evaluations

No.	Stage	Percentage	Category
1.	One-to-one Evaluation	71%	Good
2.	Small-Group Evaluation	84%	Good
3.	Field Test	74%	Good
	Average	**76%**	**Good**

The experts stated that the feasibility of the sound variable intensity level experiment kit is very good and can be used in learning. Some suggestions are applied to optimize the sound variable intensity level experiment kit. Suggestions from media experts and content experts that are followed up by researchers include coating the experiment box with the sponge, tidying the cable connection using a string cable, revising students' worksheets by comparison between measurement and calculation results, and giving instructions to illustrate the relationship graph between variables in the experiment.

Students at the stage of one to one evaluation, small group evaluation, and field tests stated that the feasibility of the sound variable intensity level experiment kit was in a good category. Experts and students suggested multiplying the sound variable intensity level experiment kit so that each student has a role in experiment activities. Besides, students were also given ten pre-test and post-test questions in the form of multiple choices to measure the effectiveness of the experiment kit in improving science process skills. The results of the pre-test and post-test are shown in TABLE 3 below.

TABLE 3. Results of Pretest-Posttest on Formative Evaluations

No.	Stage	Exhaustiveness	N-gain
1.	One-to-one Evaluation	100%	-
2.	Small Group Evaluation	79%	0,53
3.	Field Test	93%	0,72
	Average	**91%**	**0,62**

Students are completing the test if the post-test results exceed the minimum standard score, which is 75. The results of the post-test on each stage showed that 91% of students exceeded the minimum standard score so that the sound variable intensity level experiment kit is very effective in improving science process skills. The gained of post-test from pre-test scores were observed in small group

evaluation and field tests with n-gain, respectively 0.53 (medium) and 0.72 (high). The sound variable intensity level is optimized based on suggestions on formative evaluation, then the experiment kit tested at summative evaluation. The results of the summative evaluation can be seen in TABLE 4 below.

TABLE 4. Results of Summative Evaluations

No.	Aspect	Percentage	Category
1.	Practically	92%	Very Good
2.	Effectiveness	87%	Good

Summative evaluation results show the final assessment of the sound variable intensity level experiment kit. The assessment aims to examine practicality and effectiveness. Result of the questionnaire is given to four teachers shows that the experiment kit is practically used in process learning. The experiment kit was also effective based on post-test results, i.e., 13 of 15 students at SMAN 9 South Tangerang exceeded the minimum standard scores. Post-test results improved compared to pre-test results with n-gain of 0.68 (average).

Observing skill, making hypotheses skill, using equipment/materials skills, doing experiments skill, interpreting skill, and communicating skills were observed in this study. The skills of observing, making hypotheses, interpreting, and communicating observed based on the results of student worksheets that have been filled out. While the skills of using equipment/materials and doing experiments were observed directly, student activity when doing experiments, is shown in FIGURE 3 below.

FIGURE 3. Experiment Activities in Summative Evaluation

The result of science process skills observation is shown in TABLE 5.

TABLE 5. Result of SPS Observation in Summative Evaluation

No.	Indicator	Percentage	Category
1.	Observing	97%	Very Good
2.	Making Hypotheses	94%	Very Good
3.	Using Equipment/Materials	67%	Good
4.	Doing an Experiment	92%	Very Good
5.	Interpreting	69%	Good
6.	Communicating	93%	Very Good
	Average	**89%**	**Very Good**

Overall, science process skills students in a very good category (89%). The observing aspect gained the highest percentage. In this aspect, most of the students able to observe the change of sound intensity level in various circumstances of sound source and distance.

The aspect of using equipment/materials gets the lowest percentage. Student ability is very diverse in that aspect. Male students tend to be more skilled in assembling the kit, using the kit, and exploring

the kit. That is because male students have more experience using equipment or materials than female students. This explanation is correspondent to research conducted by Necati Hirça (Hirca 2013).

The aspect of making hypotheses is observed based on the hypotheses was written by the student on the worksheet. Ruys and Aelterman state that a hypothesis is a reasonable estimate for explaining a phenomenon (Edie et al. 2018). Students make a hypothesis after listening to the teacher's explanation of the sound intensity level in everyday life and after reading the basic theory on a worksheet. Therefore, students already have an initial concept about the sound intensity level so that they can estimate the results of the experiment.

The aspect of doing an experiment is observed directly during experiment activities. This aspect shows the ability of students to obtain all data with the given time duration. Besides, behavior of students during experiment activities such as working in a team attitude was observed.

The aspect of interpreting shows the ability to find patterns of data in order to conclude the observations (Zulfiani 2009). Most students did not conclude the experiment result completely. For example, students only conclude that sound intensity level inverse to distance (r), whereas the conclusion precisely is sound intensity level inverse to the square of the distance (r2).

The communicating aspect gained a percentage score of 69%. The aspect shows the ability of students to inform the results of the experiment with other people. This information can be in the direct form of communication, written, graphic, diagram, or picture (Zulfiani, 2009). Most students have been able to communicate the results of the experiment in graphical form so that it is more concise and easy to understand. The graph of observations is shown in FIGURE 4.

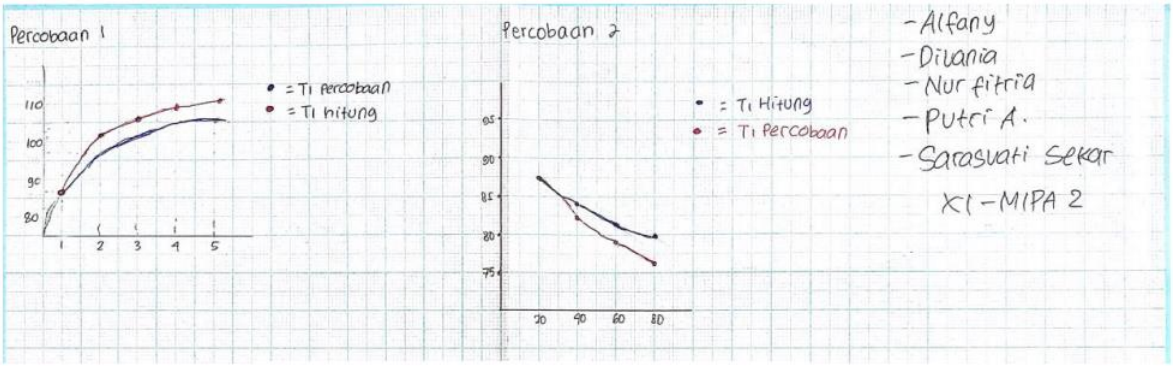

FIGURE 4. Graph of Experiment Results

This research shows that experiment activities can improve science process skills based on the results of the pre-test and post-test that uses a validated science process skills questions. The result of observation also shows that experiments train science process skills. The science process skills of students represent skills needed to face the industrial Era 4.0, including critical thinking skills, communication skills, and cooperating skills. Critical thinking skills are analytical skills or consider a problem based on experience and knowledge through methods science (Chiam et al. 2014). The SPS assessment on interpreting indicators is also based on students' ability to analyze patterns of data then associate with previous knowledge and experience in order to give an interpretation. Communicating skills are also an indicator of SPS that observed in this study. Communicating skills is the ability to communicate a number of data in the table/graph form, which is more effective. While cooperating, skill is also trained during experiment activities through teamwork so students can work together with their classmates to get results of the experiment.

CONCLUSION

A sound variable intensity level experiment kit can be implemented in the learning process based on the results of testing the feasibility, practicality, and effectiveness. Sound variable intensity level experiment kit can improve science process skills with n-gain 0.62 in the formative evaluation and n-gain 0.68 in summative evaluation, and percentage of students who exceeded minimum standard score is 91% in the formative evaluation and 87% in summative evaluation. Sound variable intensity level

experiment kit can be used in learning to observe changes in sound intensity level due to changes in the number of sound sources and the distance between the sound source and the detector. Learning through direct observation becomes more meaningful. Besides, the process of experiment activities, starting from assembling kits to retrieving data can train students' science process skills. Science process skills improved by such an experiment kit is important for students to have as provisions to face the industrial era 4.0.

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