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The Use of Smartphone Applications in Laboratory Activities in Developing Scientific Communication Skills of Students

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Abstract. Smartphone applications have been widely used in everyday life, not least in the world of education. The use of smartphone applications in improving the quality of learning has become a trend and is widely used by educators. The use of smartphones in learning is dominated by the implementation of regular learning and is still lacking in the laboratory's implementation. This study aimed to determine the use of smartphone applications in laboratory activities in developing students' scientific communication skills. The research method used was the quantitative descriptive method. The research sample was a fifth-semester physics education study program student who contracted the school physics laboratory course. The smartphone application used in laboratory activities in this study consists of a physics toolbox and tracker. Physics toolbox is an application whose working principle is based on sensors. Students use the tracker to make graphs from videos that illustrate activities laboratory. The research instrument used was a performance assessment in the form of a scientific communication skill observation sheet. The data analysis technique was done by calculating the percentage of achievement of students' scientific communication skills. The results showed that smartphone applications could develop students' scientific communication skills in a good category. Thus, smartphone applications in laboratory activities can develop one of the skills needed by students in facing the era of industrial revolution 4.0.

Keywords: Smartphone, laboratory activities, scientific communication

Introduction

The smartphone application has been widely used in everyday life, with no exception in the educational process. The use of smartphone applications in improving learning quality has become a trend and is widely used by teachers. The use of smartphones in the educational process is in the part of learning media. Smartphone functions are optimized to support and bring learning materials. Some forms of smartphone conversion in the learning process are learning media based on multimedia (Arista & Kuswanto, 2018; Fradika & Surjono, 2018; Saputra & Kuswanto, 2019), learning media based on the digital pocketbook (Astuti, et al., 2018a; Astuti, et al., 2018b; Ferdianto, et al., 2019), supporting facilities of practicum activities (Monteiro, et al., 2015; Septiando, et al., 2017; Staacks et al., 2018), online class (Coca & Slisko, 2017; Oswald, et al., 2018; Wang, et al., 2019), online conferences (Chuntala, 2019; Mueller, et al., 2017) and learning evaluation (Huang & Chiu, 2015; Nayak, 2016; Shi, et al., 2016).

Several advantages of using smartphones in learning activities are a) easy to use, b) easy to duplicate, c) easy dissemination, d) almost on every individual, and e) close to students (Chusni, et al., 2017; Nazar, et al., 2020; Mustaqim, 2017; Sulisworo, et al., 2017). However, some obstacles of using smartphones in Learning media are: a) able to interfere with concentration if unfamiliar, b) requiring habituation and more controlling by teachers to keep students in focus on learning, and c) for some cases, special specifications of smartphones for use as a learning function (Anshari, et al., 2017; Aripin, 2018; Nasution, 2018). The use of smartphones in learning, in general, still focuses on regular classroom learning. Whereas in physics learning, or science learning in general, there are other learning spaces, namely laboratories, where students do exploration through experimental activities. As a learning innovation, the use of smartphones in laboratory activities is considered to be very helpful for teachers and students during learning, provided that adjustments to learning activities are needed.

Activities laboratory-based learning is a learning model that can develop students' cognitive, psychomotor, and affective aspects (Rusu & Tudose, 2018). Laboratory activities designed to help the student to gain their knowledge and understanding of the subject. Generally, there is difficulty in implementing practice-based learning activities such as verification, inquiry laboratory, problem-solving laboratory, and Higher Order Thinking Laboratory. Each laboratory activities model has criteria and focuses on its implementation (Fajarianingtyas, & Hidayat, 2020; Lepiller, et al., 2017; Ubaidillah, 2016; Wardani, et al., 2017).

The implementation of learning becomes one of the signs of success of the learning process in creating learning outcomes from the learning activities. Learning activities with a good implementation level will produce good output, and learning activities with low reliability will produce a low output. It is based on the basic concept that "reliability" refers to a teacher's success in creating students' learning atmosphere and participation in designed learning activities (Pedaste, et al., 2015).

This research aims to determine the implementation of learning in practical activities using a smartphone application in developing students' scientific communication skills. The aspect reviewed as a success for learning refers to improving students' scientific communication skills after following learning activities. This study's novelty included a review of improved scientific communication skills through laboratory-based learning approaches from the various laboratory models. It aims to see how the contributions were given by each model of the laboratory in training and developing students' scientific communication skills. Scientific communication is one of the capabilities expected in 21st-century learning that is contained in the ability of 4C (Manora, et al., 2017). Scientific communication skills become a basic requirement in communicating and conveying ideas. This is due to one of the ethics in scientific communication that presents and discusses facts (Hatala, et al., 2015).

Methods

This research used experimental research methods, which consisted of 23 students of the fifth-semester in Physics Education Department that contracted Advanced School Physics Laboratory courses as the subject. Subjects were selected using a random sampling method consisting of three males and 20 females. The application of smartphones used in laboratory activities in the study consisted of Physics Toolbox and Tracker. The use of the Physics Toolbox application aimed to retrieve the browsing data through the use of sensors found on smartphones. The Video Analysis Tracker in this study served as an analysis of the data that was the movement of the object.

Students' scientific communication skills are trained and developed by applying three laboratory models consisting of inquiry laboratory (inquiry lab), problem-solving laboratory (PSL), and higher order Thinking laboratory (HOT lab) for three meetings. Implementation of the three laboratory models is a gradation; the higher the model's level, the more difficult laboratory activities must be carried out by students. It aims to train and develop students' scientific communication skills. Each meeting conducted laboratory activities related to physics topics, including mechanics, waves, and electricity taught at senior high school.

The research instruments used are performance assessments in an observation sheet filled with a Likert scale from 1-3. The data analysis technique is done by calculating the percentage of the achievement of students' scientific communication skills. Aspect students ' scientific communication skills consist of scientific writing, information representation, and knowledge presentation includes 17 question indicators as Table 1. A scientific communication indicator is developed and adopted of the scientific communication indicators expressed by Levy (Spektor-Levy, et al., 2009) consisting of several aspects: 1) information retrieval, 2) scientific reading, 3) listening and are scientific writing, 4) information representation, and 5) knowledge representation.

Table 1. Aspects and indicators of scientific communication skills

No	Aspect	Indicator
1	Scientific writing	Skilled in choosing quality library sources (journals/scientific papers/reference books)
2		Skilled in using quality library resources (journals/scientific papers/reference books)
3		Proficient in displaying the library review clearly and systematically
4		Fluent in explaining theories for drafting experimental design
5		Fluent in giving opinions to solve problems
6		Fluent in the answer to questions in writing
7		Skilled in writing the bibliography in reports
8		Skilled in systematically reporting practicum activities
9	Information representation	Skilled in creating schemes or networks that represent problem-solving solutions
10		Skilled in the translation of experimental data into graphic form
11		Skilled in interpreting the test result data graphs
12		Fluent in discussing experiment results accompanied by relevant concepts
13		Fluent in concluding relationships between variables through graphic representations or tables
14	Knowledge representation	Skilled in presenting material with systematically display quality
15		Fluent in the raw language and clearly
16		Fluent in written arguments
17		Skilled in analyzing experiment results correctly

(Spektor-Levy, et al., 2009)

Results and Discussion

The research results of students' scientific communication skills include aspects of scientific writing, information representation, and presentation of knowledge. Data on students' scientific communication skills are presented in Table 2. Data on scientific communication skills were measured after using laboratory models in three meetings.

Table 2. Communication skills of each student in each laboratory model

	Model of experiments		
	Inquiri Lab	PSL	HOT Lab
Value of min	64.81	72.55	66.67
Value of max	98.15	94.12	89.96
Average	85.43	84.06	80.10

The highest score of learning performance is in the inquiry lab model with an average of 85.43. As for the average model problem solving 84.06 and the average of the HOT Lab model of 80.10. The reason why student's scores decrease in PSL and HOT Lab has been explained by several researchers. According to Fitrian et al. (2017), the activities at the PSL model are more difficult than the inquiry lab. However, the score for each student's scientific communication skills in each laboratory model still shows a high number in which indicated by the average score of all, in three laboratory models, showing 83.19 which indicates that the achievement aspects of communication skills are at a good level (Malik, et al., 2018).

Specifically, in the inquiry lab model, students' communication skills reached the maximum and minimum scores sequentially of 98.15 and 64.81, 94.12 and 72.55 for the PSL model, 89.96 and 66.67 in the HOT Lab model. Based on the Kruskal-Wallis statistical test results, students' scientific communication skills in terms of the activities laboratory model obtained Asymp. Sig. 0.013, where the result is less than 0.05. These statistics show that there are significant differences in students' scientific communication skills in terms of the activities laboratory model. Kruskal-Wallis' further test was carried out with pairwise comparisons to see the three activities laboratory models' significance. The results of further test statistics obtained the value of Adj. Sig. 0.012 less than 0.05 for HOT Lab-Inquiry Lab comparison. The follow-up test shows that the HOT Lab-Inquiry Lab is significantly different, meaning that the HOT Lab and Inquiry Laboratory models are the most significant in developing science communication skills. Thus, regarding the finding by Barnett, et al. (2006) it indicates that students already have a fairly good understanding of scientific communication principles.

Table 3 shows the average score of student's communication skills reviewed from the aspect of competencies. The highest score is found in the scientific writing aspect with 86.90, and the lowest aspect is the information representation with 77.87. Overall, this result indicates that the students already have good communication skills; it is demonstrated by the average of all aspects with a value of 82.29 with good interpretation (Burns, et al., 2003).

Table 3. Student's communication skills in every aspect of each laboratory model

No	Aspect	Model of experiments			Average
		Inquiry Lab	PSL	HOT Lab	
1	Scientific writing	88.22	85.33	87.14	86.90
2	Information representation	78.55	84.35	70.72	77.87
3	Knowledge presentation	87.83	81.88	76.60	82.10

Based on the data in Table 3, students already have the basic knowledge, and writing scientific papers follows the applicable provisions. The aspect of delivering information, including the lowest aspect indicates a lack of students' ability to explore the data obtained (Laprise & Winrich, 2010).

Table 4. Students' scientific communication skills for each indicator in laboratory model

No	Aspect	Number of indicators	Model of experiments			Average
			Inquiry Lab	PSL	HOT Lab	
1	Scientific writing	1	100	100	100	100
2		2	100	100	100	100
3		3	88.41	82.61	92.75	87.92
4		4	78.26	79.71	73.91	77.29
5		5	78.26	66.67	66.67	70.53
6		6	85.51	65.22	68.12	72.95
7		7	86.96	100	95.65	94.20
8		8	88.41	88.41	100	92.27
9	Information representation	9	82.61	89.86	85.51	85.99
10		10	71.01	73.91	66.67	70.53
11		11	75.36	79.71	62.32	72.46
12		12	81.16	89.86	69.57	80.20
13		13	82.61	88.41	69.57	80.20
14	Knowledge representation	14	98.55	100	68.12	88.89
15		15	69.57	97.12	100	88.90
16		16	84.06	64.30	65.22	71.20
17		17	88.41	97.13	71.01	85.52

Table 4 show the results of scientific communication skills analyzed from indicators where some indicators have been achieved by students optimally, including 1) the ability to process sources of literature, 2) skills in describing literature reviews, 3) skills in describing laboratory activities in detail, and 4) skills in using language that is good and right. These skills are basic skills related to guidance in communication. This shows that students already have the basic ability to communicate scientifically, as evidenced by the description of the achievement of scientific communication skills (Yuliskurniawati, et al., 2019).

Table 4 also shows that there are several indicators of student communication skills that are still low in achievement. These indicators include a) skills in giving opinions, b) skills in answering research questions, c) skills in presenting graphical forms, d) skills in interpreting research results, and e) skills in scientific argumentation. Achievements that are still low refer to advanced abilities in scientific communication skills. These advanced skills require more analytical skills and a strong foundation. In some cases, researcher's/novice students will tend to have lower-level abilities. This can be trained through habituation in arguing, processing, and explaining data (Hardin, et al., 2015).

Conclussion

The results showed that the activities laboratory model using a smartphone could develop students' scientific communication skills. The implementation of laboratory activities, in general, has a major contribution to the development of scientific communication skills of students. The more difficult the activities carried out in the implementation stage, the higher level of the laboratory model, the more difficult scientific communication skills developed. Scientific communication skills in scientific writing reach the highest average after applying the three laboratory models. Aspects of information and knowledge representation become a weak point in this study's results, which indicate that students still have fundamental abilities related to scientific communication. This can be overcome by making structured habituation and repetition to improve information and knowledge representation capabilities through monitoring learning activities or providing workshops related to strengthening scientific communication skills.

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