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The Digital Module to Improve Students' SEP Skills during the COVID-19 Pandemic

Wirdiyatusyifa*, Widha Sunarno, Agus Supriyanto

Department of Master Physics Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract: The COVID-19 pandemic has resulted in learning activities that were originally carried out face-to-face in schools to turn into online learning. The implementation of online learning has several challenges, one of which is the development of student skills in the 21st century, especially SEP skills. SEP skills of students are needed in learning physics. Students' SEP skills are currently still in the low category. To support the improvement of students' SEP skills, teaching materials in the form of digital modules are applied. This study aimed to examine the role of digital modules in improving students' SEP skills during the COVID-19 pandemic. This study uses a quantitative descriptive method with a questionnaire technique using 38 items based on eight aspects of SEP skills. The participants in this study were 23 students in a high school in Karanganyar Regency, Indonesia. The results showed that the average SEP skill score after using the digital module was higher (102.34) than before using the digital module (90.58). Based on the value of N gain, the improvement of students' SEP skills in the initial three aspects is in the medium category and the other five aspects are in the low category. The digital module was proved to affect improving SEP skills, although the increase was not very significant. This is because the digital module is equipped with various novelties such as virtual laboratory activities, physics animations, and interactive videos that can help improve students' SEP skills.

Keywords: 21st century student abilities, physics learning, online learning.

在新冠肺炎大流行期间提高学生九月技能的数字模块

摘要：新冠肺炎大流行导致原本在学校面对面进行的学习活动变成了在线学习。在线学习的实施有几个挑战，其中之一是 21 世纪学生技能的发展，特别是九月技能。学习物理需要学生的九月技能。学生的九月技能目前仍处于低水平。为了支持学生九月技能的提高，应用了数字模块形式的教材。本研究旨在检验数字模块在新冠肺炎 大流行期间提高学生九月技能的作用。本研究采用定量描述方法和问卷技术，基于九月技能的 8 个方面使用 38 个项目。这项研究的参与者是印度尼西亚卡兰甘雅县一所高中的 23 名学生。结果表明，使用数字模块后的平均九月技能得分（102.34）高于使用数字模块前（90.58）。基于氮增益的值，学生九月技能的提升在前三个方面属于中等类别，其他五个方面属于低类别。数字模块被证明会影响九月技能的提高，尽管增加不是很显着。这是因为数字模块配备了各种新奇事物，例如虚拟实验室活动、物理动画和交互式视频，可以帮助提高学生的九月技能。

关键词：21 世纪学生能力、物理学习、在线学习。

1. Introduction

Coronavirus has become a global pandemic since March 11, 2020, and has spread to various countries in the world [2]. The coronavirus was first discovered in Wuhan, China in December 2019 [3]. The coronavirus is categorized as a dangerous virus because it can cause mild disorders of the respiratory system, severe lung infections, and even death [4]. This virus spreads very

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About the authors: Wirdiyatusyifa, Widha Sunarno, Agus Supriyanto, Department of Master Physics Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia

Corresponding author Wirdiyatusyifa, wirdiyatusyifa@student.uns.ac.id

quickly between humans. The number of COVID-19 cases in Indonesia continues to increase every day, as of March 30, 2021, the number of COVID-19 cases reached 1,505,775 cases with a death rate of 40,754 cases [5]. As a precautionary measure, the government in Indonesia provides policies to limit activities outside the home and to stay at home [6]. The government imposed the Large-Scale Social Restriction (PSBB) policy to reduce the spread of the coronavirus so that all activities carried out outside the home had to be stopped until the COVID-19 pandemic subsided [7]. As a result, the process of learning activities must be carried out online from their respective homes to minimize the spread of COVID-19 [8, 9].

The implementation of online learning during the COVID-19 pandemic has several challenges, one of which is the development of student skills in the 21st century [10]. One of the 21st-century student skills needed today is SEPs (Science, Engineering, and Practices) skills. SEP skills are the development of science process skills that involve students being active in scientific inquiry activities such as asking questions, designing experiments, analyzing data, and submitting opinions [11]. SEP skills are needed in learning, especially in learning physics. In learning physics, students not only memorize physics formulas and theories but are also faced with physics problems that require skills to solve problems [12]. Additionally, SEP skills are important to apply in physics learning because they can train students to think at higher levels and to be active during the learning process so that they can have higher learning outcomes than just memorizing [13]. However, the SEP skills of students in one of the senior high schools in the Karanganyar district have not been developed optimally. This is evidenced by the results of a pre-research questionnaire that 52% of students stated that SEP skill activities such as analyzing a physics problem, formulating problems, determining experimental variables, determining the relationship between experimental variables, analyzing experimental data, and providing conclusions were rarely performed. These activities can be carried out through laboratory activities. However, limited learning time causes laboratory activities to be rarely carried out [14]. This causes students' SEP skills to be still in the low category with the average pre-test results of SEP skills, namely the highest score only reaching a value of 70 with the average pretest score on the eight SEP skill indicators still low: 2.39, 2.32, 2.52, 2.51, 2.46, 2.51, 2.41, and 2.05. Low SEP skills lead students' physics learning outcomes to also be below [15, 16].

SEP skills are needed in physics learning because, in physics learning, students not only memorize physics formulas and theories but students are also faced with physics problems that require skills to solve problems [12]. If students have mastered SEP skills, then they have mastered the skills needed in high-level learning, namely conducting research and solving problems [17]. Additionally, SEP skills are important to teach because they can train students to think at higher levels and behave actively in the learning process so that they can have higher quality and quantity of learning outcomes than just memorizing. Quality is defined as the level of understanding while quantity is the number of learning outcomes achieved.

Efforts to improve SEP skills have so far been carried out by applying a student-centered learning model [18, 19], implementing virtual laboratory activities [20] and application of modules as supporting teaching materials to improve SEP skills [21, 22]. In this study, digital modules were used as supporting teaching materials in physics learning to improve students' SEP skills. The digital module was chosen as supporting teaching material in physics learning because it is a technology-based learning medium that is practical, interactive, and systematic. Students can easily access learning through digital modules anytime and anywhere through electronic devices (smartphones, tablets, and computers) so that students can gain learning experiences both in the classroom and outside the classroom [23, 24].

2. Literature Review

2.1. Science, Engineering, and Practices (SEPs)

Science, Engineering, and Practices (SEPs) is one of the dimensions of NGSS (Next Generation Science Standard) that students must possess within the framework of K-12 science education [25]. SEPs are also the development of science process skills that are used to build students' knowledge and solve problems [26]. SEP skills of students include eight aspects: asking questions and identifying a problem [sep-1], developing and using models [sep-2], planning and conducting investigations [sep-3], analyzing and interpreting data [sep-4], using mathematics and computational thinking [sep-5], constructing explanations and designing solutions [sep-6], engaging in argument from the evidence [sep-7], and obtaining, evaluating, and communicating information [sep-8] [27].

2.2. Digital Module

Digital or electronic modules are modules in digital form, consisting of text, images, or both containing digital electronic material accompanied by simulations that can and are suitable for use in learning [28]. The electronic module functions as a student self-study tool at home and as a teacher's tool in teaching in the classroom [29]. The digital module is considered very suitable to be a source of student physics learning during online learning during the COVID-19 pandemic [30, 31, 55]. The characteristics of digital modules are practical, easy to carry, can be used offline and online, and can be accessed anytime and anywhere using

electronic devices such as computers, smartphones, and tablets [24, 32]. The digital module is also equipped with animations and practicum simulations, and students can determine the completeness of learning through interactive self-evaluations [30]. The use of electronic modules can make learning more interesting and interactive so that the quality of learning increases [32, 33].

2.3. Online Learning during the Coronavirus Pandemic

Online learning, according to Belawati [34], is learning that is carried out through the internet network. Online learning in Indonesian is translated as online learning or online learning. Online learning, according to Henderson [35], allows students to learn without having to go to the classroom, and learning can be scheduled according to an agreement between the teacher and students, or students can determine their own time desired learning. Online learning systems require supporting technology that can process various application requests given by users [36]. One of the online education service technologies is carried out with various applications such as Zoom, Google Classroom, and Microsoft Teams [37, 54]. Online learning is a learning method used during the COVID-19 pandemic [38]. Online learning that occurs in schools in Indonesia can be in the form of asynchronous and synchronous online learning [39, 40]. In asynchronous online learning, there is an indirect learning process so that students can access online materials at any time. Synchronous online learning means that the learning process is carried out in the direct interaction between teachers and students through learning management systems (LMS) such as e-learning, learning houses, Edmodo, EdLink, Moodle, and Google Classroom, online Schoology classes [37, 41]. In supporting online learning during the COVID-19 pandemic, teachers also use learning resources such as e-books and digital modules as tools to explain learning materials [30, 31].

3. Methods

3.1. Sample

The type of research used was quantitative with a descriptive method. This research was conducted in the 2020/2021 academic year in one of the high schools in the Karanganyar Regency. The research subjects were 32 students of class X SMA.

3.2. Instruments

Students' SEP skills were measured using a 38-item questionnaire based on eight aspects of SEP skills according to the NGSS: asking questions and identifying a problem [sep-1], developing and using models [sep-2], planning and conducting investigations [sep-3], analyzing and interpreting data [sep-4], using mathematics and computational thinking [sep-5], constructing explanations and designing solutions [sep-6], engaging in argument from the evidence [sep-7], and obtaining, evaluating, and communicating information [sep-8].

3.3. Data Analysis

Data were analyzed using N-gain and paired t-test. The normalized N-gain <g> was used to determine the effectiveness of the application of digital modules in improving students' SEP skills. Improving students' SEP skills is done by comparing the average results of the pre-test and post-test of SEP skills. The SEPs skill pre-test was conducted before applying the digital module in physics learning. The SEPs skill post-test was conducted after applying the digital module in physics learning. The formula for the normalized N-gain score is shown in the equation below:

Table 1 Interpretation of the mean N-gain values [1]

Value <g>	Classification
<g> ≥ 0,7	High
0,7< <g> ≤ 0,3	Medium
<g> < 0,3	Low

A paired t-test was used to determine the significance of the application of digital modules in improving students' SEP skill. This analysis used the SPSS 18 program. Several conditions must be met before performing a paired t-test; that is, the data must be normal and homogeneous so that the normality test can be carried out using the Shapiro-Wilk test, and the homogeneity test using the Levene test. The provisions for concluding the paired t-test are as follows:

1) *Ha:* There is a significant average difference between SEP skills before and after using the digital module;
2) *H0:* There is no significant average difference between SEP skills before and after using the digital module.

4. Result

4.1. Significance of SEP Improvement

The results of the descriptive analysis of the scores of each student's SEP skills are shown in Table 2. The average pre-test score of students' SEP skills before using the module was 90.58. After applying the digital module in physics learning, the average post-test of students' SEP skills was 102.34. The results showed that the post-test average of students' SEP skills was higher than the average pre-test.

Table 2 Student SEP skill score

Test	Mean	Max.	Min.
Pre-test	90,58	112	70
Post-test	102,34	130	75

Table 3 Normality test results

Shapiro-Wilk			
Test	**Statistic**	**Df**	**Sig.**
Pre-test	.960	32	.081
Post-test	.941	32	.272

Table 4 Homogenity test results

	Levene Statistics	**df1**	**df2**	**Sig.**
Based on Mean	.039	1	62	0,53

Based on the data in Table 3, the significance value of the Shapiro-Wilk normality test is ($p > 0.05$) so the student SEP skill data is said to be normally distributed. Homogeneity test (Table 4) shows the results of the significance value ($p > 0.05$) so that the students' SEP skill data is homogeneous. After the prerequisite tests are met, then a paired t-test is carried out using SPSS 18. The results of the paired t-test are shown in Table 5.

Table 5 Paired test results

	Mean	**df1**	**Sig. 2-tailed**
Pre-test – Post-test	-14.969	31	.000

Paired t-test results show that the application of digital modules in learning has a significant effect on improving students' SEP skills. This is evidenced by the significance value of the analytical ability of 0.000 (Table 5). This significance is smaller than 0.05 ($p < 0.05$) so that the research hypothesis is accepted, namely that there is a significant difference between students' SEP skills before and after using digital modules in physics learning. The results showed that the post-test scores for the SEP skills were higher than the post-test scores (Table 2). The difference between the post-test and pre-test scores of SEP skills was significantly influenced by the application of digital module in physics learning.

4.2. SEP Improvement Categories

The results showed that the average post-test scores of students in each aspect of SEP skills were higher than the average pre-test scores for each indicator. Aspects of planning and conducting investigations have the highest average score of 2.52 for pre-test and 2.96 for post-test. The aspect of SEP skills that has the smallest average value is obtaining, evaluating, and communicating information with an average score of 2.05 for pre-test and 2.20 for post-test (Table 6).

Table 6 The improvement of students' engineering practices (SEPs)

Aspects of Science Engineering Practices (SEPs)	**Average Pre-test**	**Average Post-test**	**Average N-Gain**	**Category**
Asking questions and identifying problems	2,39	2,92	0,33	Medium
Developing and using models	2,32	2,84	0,31	Medium
Planning and conducting investigations	2,52	2,96	0,30	Medium
Analyzing and interpreting data	2,51	2,59	0,19	Low
Using mathematics and computational thinking	2,46	2,48	0,15	Low
Constructing explanations and designing solutions	2,51	2,63	0,15	Low
Engaging in argument from the evidence	2,41	2,55	0,09	Low
Obtaining, evaluating, and communicating information	2,05	2,20	0,08	Low

The improvement of students' SEP skills is evidenced by the average N-gain of pre-test and post-test scores on each indicator of students' analytical abilities (Table 3). The distribution of improvement in SEP skills of students is divided into three categories, less, low, and high. Based on Table 6, the SEP skills have been mastered by the students. This is evidenced by the increase in the average SEP skills for each aspect from pre-test to post-test. The prediction is an indicator that is mastered by students with a percentage of 58.24%. The aspect of asking questions and identifying a problem is the aspect that is most mastered by the students with the highest average N-gain score of 0.33. The average N-gain score of students' SEP skills in this aspect is greater than 0.3 (> 0.3) so they are classified in the medium category [1]. The aspect of obtaining, evaluating, and communicating information is the lowest aspect mastered by students with the highest average N-gain value of 0.08. The average N-gain score of students' SEP skills is 0.3 (< 0.3) belonging to the low category [1]. This proves that the physics learning process using digital modules has a positive effect on improving the SEP skills of high school class X students, although the increase in students' SEP skills is not too large.

5. Discussion

The use of digital modules is effective in improving students' SEP skills in online physics learning. This is evidenced by the increase in the average post-test of students' SEP skills which is higher than the results of the pre-test (Table 2). This condition agrees with the results of research by [42, 43] that students who learn to use the integrated module of the SEP skill aspect have higher SEP skills than students who learn to use conventional modules. The use of digital modules in physics learning is proven to improve students' SEP skills (Table 2). This is because the digital module contains activities that can improve students' SEP skills, such as exploration activities, formulating problems and hypotheses, virtual laboratories, data processing, and analysis activities, and discussions. This activity has been proven to improve students' science process skills [44]. SEP skills can also be called science process skills based on the NGSS standard [25].

Fig. 1 Exploration activities in digital modules

At the beginning of physics learning, students observe video shows and pictures of Newton's law phenomena in everyday life on Newton's law materials in digital modules, such as the phenomenon of a bus driving and braking, rowing a boat, traditional games of marbles, and the event of someone pushing a sand cart. The presentation of Newton's law phenomena in digital modules contextually based on real-life can make it easier for students to collect information, analyze, ask questions, and propose hypotheses from the questions they have asked. Through this activity, students become more active because they are given direct opportunities so that students' SEP skills can develop rapidly [22]. The improvement of students' SEP skills is also supported by the implementation of virtual laboratory activities in digital modules. According to Siahaan et al. [45] and Mulyeni et al. [46], the implementation of virtual laboratory activities has a significant effect on increasing students' science process skills. Students who study physics in a virtual laboratory have higher science process skills than students who do not study in a virtual laboratory [20, 43]. Through virtual laboratory activities, students are allowed to experience or conduct experiments directly, observe, analyze, prove, plan experimental activities and draw their conclusions about a physics concept so that students' process skills and student learning motivation increase [20, 44].

Fig. 2 Virtual laboratory activities in digital modules

Another factor that supports the improvement of SEP skills is the better quality of learning, which is supported by the application of learning modules. The better the quality of learning in the classroom, the better the quality of students [47]. This is in line with the research results of Harahap et al. [48] that improving the quality of learning supported by the application of learning modules results in a higher score of each aspect of SEP skills. SEP skills of students after using the module proved to be higher than the skills of students' SEPs before using the module (Table 2). The results of the research by Serevina et al. [49] that the post-test scores of students' SEP skills after using the module.

Improvements also occurred in each aspect of students' SEP skills. Of the eight skill aspects of SEPs, only 3 aspects of SEP skills have an N-gain score in the medium category and the other 5 aspects of SEP skills have a low N-gain score (Table 6). SEP skills of students before and after using it proved to have increased in every aspect, but the increase was still not too significant and still relatively low. The highest increase in the SEP skills is in the aspect of asking questions and defining problems, while the lowest increase is in the aspects of obtaining, evaluating, and communicating (Table 6). Asking questions and defining problems is a student's ability to ask questions and make temporary answers to the questions made [27]. The aspect of asking questions and defining the problem had the greatest improvement in aspects compared with other aspects (Table 6). This is because, at the beginning of learning, students are trained to observe physical phenomena which are presented in the form of video or image shows. These physical phenomena are often encountered by students in real life so that students can more easily analyze them, ask scientific questions about the phenomena presented, and propose hypotheses [50, 51]. This agrees with the results of research by Choirunnisa et al. [18] and Gunawan et al. [20] that the highest increase in SEP skills is in the aspects of asking questions and defining problems. In this aspect, students can analyze a physical phenomenon in real life then students can formulate questions according to the phenomenon and make temporary answers to the questions formulated.

The lowest aspect of SEP skill improvement occurred in the aspects of obtaining, evaluating, and communicating (Table 6). This is because, in the learning process, students are not used to explaining physics concepts through pictures, graphs, and tables. Students are also still confused in concluding the results of the investigations carried out. This condition agrees with the results of research by [45, 52, 53] that the aspects of obtaining, evaluating, and communicating are the aspects of SEP skills with the lowest increase. A low ability to acquire, evaluate, and communicate will cause students to have difficulty concluding a physics concept. Based on the results of the study, SEP skills in the aspects of obtaining, evaluating, and communicating after using digital modules have increased, but the increase is still low compared with other aspects of SEP skills.

Digital modules can be used as a source of learning physics during the COVID-19 pandemic, which can

effectively improve students' SEP skills. Students can access the digital modules repeatedly, anywhere, and anytime without time restrictions. The use of digital modules is expected to provide convenience for students in studying physics subject matter.

6. Conclusion

The digital module can effectively improve students' SEP skills in learning physics by increasing the average pre-test and post-test scores. The results prove that students who study with digital modules in online learning during the Covid 19 pandemic have an average SEP skill score that is higher than the average pretest score before using digital modules. The N-gain values in each aspect of SEP skills are 0.33, 0.31, 0.30, 0.19, 0.15, 0.15, 0.09, and 0.08. This proves that the use of digital modules as supporting teaching materials in physics learning during the COVID-19 pandemic can improve students' SEP skills even though the improvement category is still relatively low.

The increase in students' SEP skills was due to the digital modules used in this study, which were presented in the form of learning applications that could be accessed via android smartphones. This is done to make it easier for students to access physics learning that can be done anywhere and anytime. The digital module used in this study was developed with several updates and complements the shortcomings of previous research. The modules are presented digitally in the form of learning applications that can be accessed via android smartphones. The module is also equipped with virtual laboratory activities, physics animations, and interactive videos that can help improve students' SEP skills. The addition of this content is done so that students become more active during the learning process and can better understand physics concepts so that students' SEP skills increase.

7. Limitations and Future Studies

Based on the research results, students' SEP skills can still be improved in every aspect. This improvement can be done through the application of more innovative learning models and the application of digital modules that are made by the SEP skill aspects. The application of the learning model followed by the application of digital modules in physics learning is expected to further improve students' SEP skills, especially in the aspects of obtaining, evaluating, and communicating.

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