



## Development of E-Module Guideline on Basic Physics Practicum for Science Process Skills in a Pandemic Period

Aprina Defianti<sup>1\*</sup>, Desy Hanisa Putri<sup>2</sup>, Siti Rohayati<sup>3</sup>, Asmida Herawati<sup>4</sup>, Li Yi Chen<sup>5</sup>

<sup>1,2,3</sup> Physics Education Study Program, Faculty of Teaching and Education of Universitas Bengkulu, Indonesia

<sup>4,5</sup> Applied Physics Department of Tunghai University, Taiwan

\*Correspondence Author: [aprina.defianti@unib.ac.id](mailto:aprina.defianti@unib.ac.id)

Received: 29 December 2021 Accepted: 26 April 2022 Published: 30 April

### ABSTRACT

The present study was carried out to produce a product in the form of e-module guidelines of basic physics practicum developed using the SIGIL application to practice students' science process skills during the covid-19 pandemic. This research-based paper was conducted through ADDIE model, which consisted of analysis, design, development, implementation, and evaluation stages. In the analysis phase, a needs analysis of questionnaire was conducted to determine the need for e-modules for practitioners and practicum assistants. During the design stage, a preliminary design is made in the form of the structure or content of the e-module, practicum titles, and their layout. Furthermore, in the development stage, the e-module has been developed using the SIGIL application by inserting a practical tutorial video based on a scientific approach and has been assessed with an average score of 3.82 considered Very Good. The implementation was carried out by giving the developed e-module to 20 students who took the basic physics practicum course. After using e-modules for 4 practicum titles, students are given a posttest of science process skills. Based on the posttest results, students received an average score of science process skills of 83.94 considered Skilled category. In addition to data on the score of science process skills, at this stage data on student responses to e-modules were also obtained using responses from questionnaires. The results disclosed that the developed e-module addressed a positive perception with an average response score of 89 considered Very Good. In the last evaluation stage, it was therefore argued that the e-module of basic physics practicum using SIGIL application was concluded appropriate to use on practicing students' science process skills during the Covid-19 pandemic.

**Keywords:** e-module guidelines, basic physics practicum, science process skills.

### INTRODUCTION

Physics is a part of natural science which has the essence of score, product, and process. Physics learning shall be addressed in such a way that these three properties can be fulfilled. Physics learning shall bring students closer to the events of everyday life through a series of practicum activities that can assist students understand the natural surroundings (Erwin, Permana and Hayat, 2018). Practicum is carried out to fulfill the nature of processes and scores developed through the application of scientific methods and scientific attitudes to kindly understand and master the concepts, laws, policies, principles, and theories of physics (Sirait and Lubis, 2020).

Basic physics practicum has a weight of 1 credit. This seems incredibly valuable thus students have experimental skills which include planning experiments, formulating hypotheses, identifying variables, using tools and materials, conducting practicum activities in accordance with planned procedures and making reports in the form of basic physics practicum journals

(Suprianto, Kholida and Andi, 2017). Experts call these formulated skills as science process skills. Students' science process skills are necessary to be practiced as a provision to use scientific methods in developing science and are expected to acquire new knowledge or develop the knowledge they have (Darmaji *et al.*, 2018). As well, science process skills can be practiced through empirical activities (Misbah *et al.*, 2018; Darmaji *et al.*, 2019).

Basic physics practicum activities can run well if they are supported by basic physics practicum guidelines (Misbah *et al.*, 2018; Darmaji *et al.*, 2019; Sirait and Lubis, 2020). Practical instruction has a strategic function for the teaching and learning process, where it can assist both lecturers and students during the learning activities (Murniati, M.S and Muslim, 2018). However, at the same time, basic physics practicum activities cannot be carried out properly. This is because Indonesia is experiencing a period of the Covid-19 pandemic which requires the learning process to be carried out distance learning activities through web applications and internet networks. Such obvious condition hinders practicum activities from being carried out in the laboratory, hence it is necessary to renew practicum activities such as virtual and independent practicum (Hendriyani and Novi, 2020) in order to continue to practice students' science process skills. Moreover, the provision of practical tutorial video in the laboratory also needs to be performed, hence students can figure out the common tools and materials used in practicum, the procedure for working on an experiment, what happens during the experiment, and concepts that need to be understood from the results of the experiment (Saraswati and Mertayasa, 2020).

In connection with actual practicum, virtual and independent practicums require practicum guidelines that can practice students' science process skills. In actual practicum, the guidebook that is commonly used is a printed module. The printed practicum guidebook has the advantage that students can easily operate directly on the sheet provided and can make notes on the module page. Beside the advantages, the print module also possesses disadvantages, such as unable to display videos, animations, and music, not interactive which makes students feel bored, and requires large printing costs if there are many pictures (Puspitasari, 2019). These weaknesses can be overcome by using modules in electronic form that can utilize smartphone or laptop technology. These two technologies significantly support learning activities, especially during the pandemic. Therefore, the guideline of basic physics practicum needs to be delivered in the form of an electronic module.

An electronic module (e-module) is a form of presenting self-study materials that are systematically arranged into certain learning units presented in electronic format (Direktorat Pembinaan SMA, Direktorat Jenderal Pendidikan Dasar dan Menengah and Kementerian Pendidikan dan Kebudayaan, 2017). E-modules can be created in Portable Document Format (PDF) and Electronic publication (Epub). Based on such observation, the basic physics practicum guidelines used in the odd semester of the 2020/2021 academic year has been made in PDF yet it has not been designed to practice students' science process skills. The e-module does not provide opportunities for students to formulate hypotheses and identify variables and thus students have difficulty in making conclusion regardless variables that affect a quantity in the practicum report. Moreover, from the independent practicum videos made by students, there are still errors in the practicum procedures. Such obvious issue demonstrates that practical video tutorial is necessary to be included in the e-module guidelines on practicum to overcome these obvious problems.

Videos can be embedded in both PDF and Epub. However, the e-module with the Epub format can adjust the appearance of the e-module if it is read through any electronic devices (user friendly) such as computers, laptops, and smartphones (Wirasasmita and Uska, 2017) compared to PDF which adjusts to paper size. Epub (electronic publication) is a digital format which is a form standardization format introduced by the International Digital Publishing Forum (IDPF) in 2011. E-modules in Epub format can be created using the SIGIL application. This is an open source software for creating epub and ebook (Malik, 2021).

In an effort to address such situation, the results of the literature study indicated that research on the development of an e-module for basic physics practicum guidelines in the form of Epub has not been carried out. Research conducted by Darmaji, dkk (2019), the guidelines on basic physics practicum developed is made in the form of mobile learning. Whereas (Siahaan, Medriati and Risdianto, 2019) the guidelines are designed with augmented reality techniques.

Based on the above description, the current research was conducted on “Development of E-Module Guidelines of Basic Physics Practicum to Practice Students' Science Process Skills in a Pandemic Period”. The objectives of this study were to determine: (1) the feasibility of the e-module of basic physics practicum developed using the SIGIL application and (2) students' science process skills after using the e-module.

## METHODOLOGY

This is a type of a research and development method with the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). The ADDIE model is considered relevant to use in the development of teaching materials (Cahyadi, 2019). The ADDIE model is programmed with systematic sequences of activities (Wibawa *et al.*, 2017).

The research procedures were carried out in five stages. The following is the procedures for each stage:

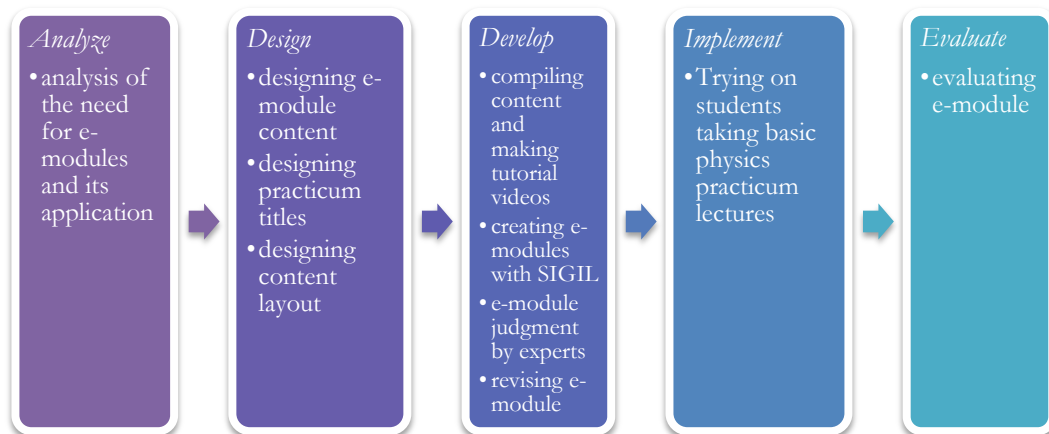


Figure 1. Procedures of E-module development

After going through the evaluation stage, the e-module of the basic physics practicum using the SIGIL application can be concluded as a feasible product to use on practicing students' science process skills.

The primary subject in the current research is the e-module on basic physics practicum using the SIGIL application to practice students' science process skills. In other words, other research subjects, at the test stage, were students of the Chemical Education Study Program, FKIP Bengkulu University, who took basic physics practicum lectures during the odd semester of 2021/2022.

The research instrument used in this study consisted of an expert judgment sheet, a science process skills test, and a student response questionnaire to the e-module of the basic physics practicum guide developed using the SIGIL application. The expert judgment sheet consists of 20 questions with judgment aspects in terms of presentation, content, language, and practicality. The science process skills test consists of 9 questions according to each indicator, (1) asking questions related to experimental hypotheses, (2) determining the tools and materials used and their functions and how to use them, (3) determining work steps, (4) drawing graphs and

compiling tables, (5) interpreting influential variables in an experiment, (6) linking experimental results with theory, (7) making conclusions from the experiments carried out, (8) stating observations that might occur if the variables are changed, and (9) use the correct concept to explain what happened. The student responses on questionnaire sheet consists of 20 questions with judgment aspects in terms of presentation, content, practicality, and benefits. The whole three types of instruments are filled in online.

The data analysis techniques based on the data collected are described as follow:

1. Data of expert judgment

Expert judgment data were analyzed descriptively and quantitatively by averaging the expert judgment scores and then categorized. The categories of expert judgment results are as follows

**Table 1. Category average score expert judgment results**

Number	Interval	Category
1	$\bar{x} > 3,25$	Very Good
2	$2,5 < \bar{x} \leq 3,25$	Good
3	$1,75 < \bar{x} \leq 2,5$	Fair
4	$\bar{x} \leq 1,75$	Poor

(Misbah *et al.*, 2018)

2. Data of students' science process skills

The posttest score of students' science process skills was obtained through the formula:

$$Score = \frac{acquisition\ score}{maximum\ score} \times 100 \tag{1}$$

The score of students' science process skills is further categorized according to the authentic judgment guidelines:

**Table 2. Category of Students' Science Process Skills Score**

Number	Score	Category
1	91 – 100	Very Skilled
2	81 – 90	Skilled
3	71 – 80	Semi-Skilled
4	< 71	Unskilled

(Adopted from (Esomar, Nirahua and Akyuwen, 2020))

3. Students' Responses to Questionnaire

Student responses to the questionnaires used a Likert scale with five ratings, namely 1 (very bad), 2 (not good), 3 (average), 4 (good), and 5 (very good). The results of the student response to the questionnaires were averaged and then categorized. The following are the categories of responses from 20 question items:

**Table 3. Category of Students' Responses to the Questionnaire**

Number	Interval	Category
1	20,0 – 36,0	Very Poor
2	36,1 – 52,0	Poor
3	52,1 – 68,0	Fair
4	68,1 – 84,0	Good
5	84,1 – 100	Very Good

(Adopted from (Darmaji, dkk, 2019))

The indicators of success in this development research are the e-module guidelines on basic physics practicum which considered Good in expert judgment, students' science process skills in the Skilled category, and student responses in the Good category.

## **FINDINGS AND DISCUSSION**

### **FINDINGS**

The present study developed an e-module of basic physics practicum using the SIGIL application to practice students' science process skills during the Covid-19 pandemic. This study uses the ADDIE model, called as analysis, design, development, implementation, and evaluation. The following is a description of stages in research process.

#### *1. Analyze*

At this stage, a needs analysis of the e-module on basic physics practicum was carried out as well as a literature study on the manufacture of e-modules using the SIGIL application. To capture the need for e-module, a needs analysis questionnaire was prepared. The questionnaire was intended for practitioners and practicum assistants who took part in basic physics practicum activities in 2020. Each questionnaire consisted of 10 questions.

The results of the needs analysis showed that (1) as many as 87.5% of assistants and 75% of practitioners opened a practicum guide using cellphones and laptops, (2) 87.5% of assistants and 95% of practitioners agreed to insert video tutorials and (3) all assistants and practitioners agreed to use a scientific approach. Thus, the module needs to be made electronically and hence it can be opened through smartphones and laptops. In addition, electronic modules (e-modules) are necessary to be inserted tutorial videos. Both of these things can be fulfilled by creating an e-module using the SIGIL application according to the results of a literature study. The development of e-modules also needs to use a scientific approach thus the objective of practicing science process skills can be achieved.

#### *2. Design*

Such formulated stage was conducted by designing the structure or content of the e-module. It started from the components of practicum activities to complements that need to be included in an e-module. The initial structure of the e-module consisted of the beginning, A user guide, introduction, content and closing. The initial section consisted of a cover, table of contents, and introduction. The introductory part consisted of an explanation of the practicum, the theory of errors, and how to draw graphs. The core part was a worksheet based on a science approach with the aim of practicum according to science process skills. The closing section consisted of a bibliography, author bios, and video contributor bios.

In addition to designing the structure of the content, at the design stage, the practicum titles would be chosen by the practitioner. The selection was based on the material studied in basic physics, the availability of tools in the laboratory, and the ease of obtaining tools and materials. The title of the practicum carried out in a limited practicum consisted of measuring and determining the density of an object, the force on an inclined plane, Hooke's law, and simple pendulum. Meanwhile, the experiment at home only consisted of circular motion, momentum, Torricelli's theorem on a leaking tank, and viscosity.

#### *3. Develop*

At this stage, e-module development was carried out which consists of making tutorial videos, making e-modules with the SIGIL application, making expert judgment to the



questionnaires, and evaluating e-modules by experts. The e-module on basic physics practicum was created using the SIGIL application version 1.7.0 with the epub 2.0 extension which can be opened using the Moon+reader application on a smartphone and Radium on a laptop or computer. Here is how it looks using smartphones and laptops.



Figure 2a. E-module display with *smartphone*

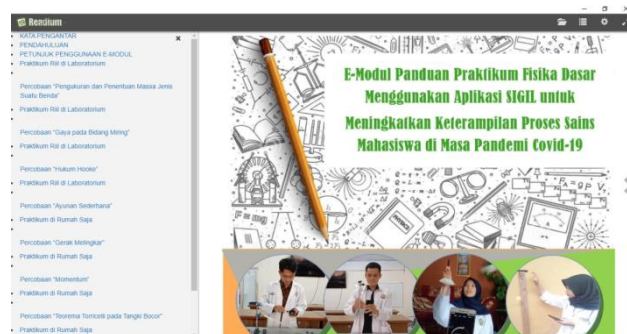


Figure 2b. E-module display with *Laptop*

Figure 2a shows the display of the e-module that was opened using the Moon+Reader smartphone application. The application allows setting the screen to be portrait and landscape. In addition, there are blue-light filter settings, night mode and day mode that can provide convenience in reading e-modules. While Figure 2b is the display of the e-module which is opened using a laptop with the Radium application embedded in Google Chrome. Radium also offers several settings such as one page or two pages on screen and full screen for watching videos in e-module.

The e-module development was continued with expert judgment. The expert judgment was carried out by two experts lecturers in science process skills and basic physics practicum. One expert came from the Islamic University of North Sumatra and another from the University of Bengkulu. Those two experts assessed the e-module on basic physics practicum using online questionnaires, e-module files, and e-module user guide. The results of the judgment of the two experts are described as follows.

Table 4. Expert Judgment Results

Number		Presentation	Content	Language	Practicality	Total
1	Expert 1	3,5	3,75	4	4	3,75
2	Expert 2	3,83	4	4	3,67	3,9
3	Average	3,66	3,88	4	3,84	3,82
4	Category of average	Very Good	Very Good	Very Good	Very Good	Very Good

Based on table 4, the e-module presentation aspect obtained an average score of 3.5 from the first expert and 3.83 from the second expert. In the aspect of content, the first expert gave an average rating of 3.75. The other expert gave an average score of the content aspect of 4. In the language aspect, the e-module received an average score of 4 from the two experts. Furthermore, in terms of practicality, the average score of e-modules from the two experts is 4 and 3.67, respectively. While the overall are 3.75 and 3.9.

Table 4 also shows that the average expert judgment from the presentation aspect is 3.66 considered very good, the content aspect is 3.88 considered very good, the language aspect is

considered very good and the practical aspect is 3.84 considered very good. Based on overall result, the e-module on basic physics practicum using the SIGIL application to practice science process skills during the Covid-19 pandemic obtained an average score of 3.82 considered very good.

The results of the expert judgment disclosed that the e-module guideline of the basic physics practicum is very good, but requires a little revision thus it can be checked. Several considerable things are necessary to revise (1) the e-module user guide needs to be added to the e-module installation' instructions, (2) the guide section needs to add information related to scientific approaches and science process skills, and (3) images of experimental series that are manually not clear, it shall be replaced with a screenshot from the video tutorial in the e-module.

#### 4. *Implementation*

At the implementation stage, a revised e-module was tested according to expert advice. The test was carried out in 1 class taking basic physics course in the odd semester of the 2021/2022 academic year. The basic physics practicum arranged in this e-module is in the form of practicum in the laboratory and practicum at home. Practicum in the test process is carried out offline in the laboratory by observing health protocols. The data taken in this test are students' science process skills and student responses to e-modules.

Science process skills data was obtained through a science process skills posttest which was given after students used the e-module. The average posttest result of students' science process skills was 83.94 considered Skilled category. The following are the details of the categories based on the results of the posttest.

**Table 5. Category of students' science process skills based on posttest**

Number	Category of Students' Science Process Skills	Percentage
1.	Very Skilled	20%
2.	Skilled	45%
3.	Semi-Skilled	30%
4.	Unskilled	5%

Table 5 shows the science process skills possessed by students after using the basic physics practicum e-module using the sigil application with the .epub format. Based on the table, a total of 65% of students or about 13 out of 20 people have achieved the indicator of research success, which is at least in Skilled category. Meanwhile, 35% of students have not reached Skilled category.

Student responses to the e-module were obtained from giving a questionnaire to the class via google form. The average student response was 89 considered Very Good. The details of the student response categories are described in the following table 6.

**Table 6. Category of student response about e-module**

Number	Category of Student Response	Percentage
1.	Very Good	65%
2.	Good	35%

Based on table 6, 65% responses of students considered very good and 35% responses of considered good. Thus, student responses to e-modules have met the minimum indicator (Good).

#### 5. *Evaluation*

At this stage, an evaluation of the e-module on basic physics practicum was carried out using the SIGIL application that has been developed. Based on the results of the development, the e-module is considered Very Good, the science process skills of students using the e-module are in

the Skilled category and student responses to the e-module are in the Very Good category. These results indicate that the basic physics practicum e-module is appropriate to use to practice students' science process skills.

## DISCUSSION

Basic physics practicum activities during the Covid-19 pandemic was carried out online since 2020. Online basic physics practicum in 2020 consists of practicum with PhET simulation and practicum at home. Although basic physics practicum is conducted online, students are still necessary to practice the science process skills. The implementation of basic physics practicum, especially practicum activities at home, can practice students' science process skills if students are given a basic its e-module guideline that guides activities towards achieving scientific process skill indicators.

The results of the needs analysis of the e-module guideline on basic physics practicum indicate that students feel the need for e-module to be prepared based on a scientific approach in order to practice students' science process skills. This is because the stages of the scientific approach are able to direct practical activities in order to achieve the indicators of student science process skills. The following is a matrix of scientific approaches and indicators of student science process skills used to design e-modules at the design stage.

**Table 7. Matrix of scientific approach and science process skills indicators**

Num	Stages of Scientific Approach	Science Process Skills Indicators
1	Observing	-
2	Questioning	Asking questions related to the experimental hypothesis
3	Collecting data/experimenting	<ol style="list-style-type: none"> <li>1) Determining the tools and materials used</li> <li>2) Knowing the function and how to use tools and materials</li> <li>3) Determining work steps</li> <li>4) Drawing graphs and compiling tables</li> </ol>
4	Associating	<ol style="list-style-type: none"> <li>1) Interpreting influential variables in an experiment</li> <li>2) Relating experimental results to theory</li> <li>3) Drawing conclusions from the experiments carried out</li> <li>4) Presenting observations that may occur if the variable is changed</li> <li>5) Using the correct concept to explain what happened</li> </ol>
5	Communicating	-

Each worksheet for practicum activities in the e-module is arranged based on the matrix in Table 7. There are 8 practical activities in the developed e-module. Each practicum aims to achieve the indicators of students' science process skills in accordance with the basic physics material related to the practicum.

In addition to developing e-modules with a scientific approach, e-module development is also carried out by inserting video tutorials. E-modules equipped with video tutorials can enrich the learning experience (Direktorat Pembinaan SMA, Direktorat Jenderal Pendidikan Dasar dan Menengah and Kementerian Pendidikan dan Kebudayaan, 2017). Based on the needs analysis, students feel that the basic physics practicum e-module needs to be equipped with a video tutorial that shows the real possibilities of what tools and materials are used and how the practicum is carried out. However, in the development process, the video tutorial editing process was carried out to practice the ability to determine tools and materials, know the functions and how to use tools and materials and determine work steps.

The development of e-modules uses a sigil application that can include images, sounds, and videos, making it easier to package material in an e-module learning media (Aisy, Farida and Andriani, 2020). E-modules developed with the sigil application are made in .epub (electronic publication) format. This format allows users to conveniently access e-modules via smartphones



and laptops. This is because the .epub format can adjust the size of the e-module to the screen of the device used. In addition, the sigil application is easy to use and can be obtained for free from the provider's website.

The basic physics practicum e-module is composed of a cover, table of contents, introduction, the e-module using instructions, introduction, practicum worksheet, bibliography, author bio and video contributor profile. The number of practicum worksheets is adjusted to the number of practicums, which are 8 pieces. The practicum worksheet contains the title of the practicum, practicum objectives according to the indicators of science process skills, and practicum activities according to the scientific approach.

After creating the e-module using the sigil application, an expert judgment process is carried out. The process was carried out by 2 experts who were given a questionnaire, e-module, and e-module installation instructions. Based on expert judgment, the e-module of basic physics practicum guide that has been developed is in the Very Good category for every aspect and as a whole. Nevertheless, the expert suggested several things that needed to be revised including (1) the e-module instructions need to be added to the e-module installation' instructions, (2) the guide section needs to be added with information related to scientific approaches and science process skills, and (3) circuit drawings. the obscure experiment in the e-module is replaced with a screenshot from the tutorial video.

The implementation stage begins after the revision of the basic physics practical guide e-module has been carried out. At this stage, students are given e-modules and e-module installation instructions. Students who have obtained the e-module are asked to copy the practicum worksheet as stated in the e-module on a paper for only 1 practicum title. Each time practicum, before starting the practicum, students are required to fill out the worksheet to questions about determining work steps. Students can correct the answers on the worksheets and continue to fill them in until they are complete during the practicum. After practicum, students are asked to collect worksheets and practicum reports.

The implementation or test stage ends with the provision of a posttest of science process skills and a response questionnaire. Based on the posttest results, students' science process skills reached an average of 83.94 in the Skilled category. This shows that the use of the basic physics practicum guide e-module using the sigil application and a scientific approach can practice students' science process skills.

The acquisition of a high score of science process skills is because the e-module used is structured with a scientific approach which consists of observing, asking questions, conducting experiments, associating, and communicating. Each stage of the scientific approach is designed to achieve the indicators of science process skills. In addition, at the observing stage, the experimental group was given a short video tutorial instead of a complete tutorial with the aim of students being able to analyze the tools and materials used as well as the work steps, then evaluate during the practicum to find out the correct tools, materials, and work steps. It also practices students' thinking skills.

Based on such obvious description, the use of the e-module of basic physics practicum using the SIGIL application with a scientific approach can practice students' science process skills. This is in accordance with research that examines the effectiveness of a scientific approach in the study of animal physiology. The results of the study stated that the scientific approach was considered effective to enhance students' science process skills (Siregar and Nursafiah, 2019). Other research on physics learning also states that there is an increase in science process skills after the application of a scientific approach, especially on vibration and wave materials (Sholihah and Sudiby, 2019). This research is also in line with research on the development of physics modules based on a scientific approach which states that the use of these modules is effective in improving students' science process skills (Sumiati, Septian and Faizah, 2018).

The use of the basic physics practicum guide e-module using the sigil application in .epub format got a positive perception from the experimental group students. It is proven that the average score of the response questionnaire to the e-module is 89 in the Very Good category. These results can be caused by the user-friendly characteristics of the e-module, which can be opened using any electronic device such as smartphones and laptops. The use of e-modules or modules in electronics makes it easier for students to study anywhere and anytime, especially if e-modules can be opened with smartphones which are currently mobile phones that almost everyone has. This is in accordance with research on mobile learning-based basic physics practicum guides which revealed that students stated that using smartphones in learning was a good idea because they were easy to carry anywhere and practical to use (Darmaji *et al.*, 2019).

The final stage in this research is the evaluation stage. At this stage, it was concluded that the basic physics practicum guide e-module using the sigil application to practice students' science process skills during the covid-19 pandemic was in the Very Good category, the acquisition of student process skills scores in the skilled category, and responses in the Very Good category. Thus, research on the development of this practical guide e-module is useful in carrying out basic physics practicum not only offline but also online because the e-module also guides practical activities at home. This is in line with research on online practicum development which states that it is necessary to adjust practicum activities and practicum guidelines during the pandemic (Hendriyani and Novi, 2020).

## CONCLUSION

Based on results obtained in this line of research, research on the development of an e-module guidelines on basic physics practicum using the SIGIL application to practice students' science process skills during the Covid-19 pandemic has resulted in e-module considered Very Good, the acquisition of process skills scores students in the skilled category, and the response in the Very Good category. And therefore, it can be concluded that the basic physics practicum guidelines using the SIGIL application is appropriate for practicing students' science process skills during the Covid-19 pandemic.

The suggestions delivered to further researchers are the need for large-scale tests for larger classes and more number of practicum titles thus the results of such development research are more valuable and can be generalized. Most importantly, it is necessary to produce a detailed guideline on how to read e-module using the Moon+reader application on smartphones and Radium on laptops according to what the various readers expected.

## ACKNOWLEDGE

The researchers would like to thank mostly to LPPM of Universitas Bengkulu for funding this research with contract number 1827/UN30.15/PG/2021, validators/expert assessors of research instruments, and other parties who have given such valuable assistance on this project.

## REFERENCE

- Aisy, D. R., Farida and Andriani, S. (2020). Pengembangan E-Modul Berbantuan Sigil Software dengan Pendekatan Saitifik pada Materi Sistem Persamaan Linier Dua Variabel ( SPLDV ), *EduSains*, 8(1), 61–71.
- Cahyadi, R. A. H. (2019). Pengembangan Bahan Ajar Berbasis ADDIE Model, *HALAQA: Islamic Education Journal*, 3(1), 35–43.
- Darmaji *et al.* (2018). Pengembangan Penuntun Praktikum Fisika Dasar I Materi Gesekan

- Berbasis Keterampilan Proses Sains menggunakan Model Problem Solving, *EDUSAINS*, 10(1), 83–96.
- Darmaji *et al.* (2019). Persepsi Mahasiswa pada Penuntun Praktikum Fisika Dasar II Berbasis Mobile Learning, *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 4(4), pp. 516–523.
- Direktorat Pembinaan SMA, Direktorat Jenderal Pendidikan Dasar dan Menengah dan Kementerian Pendidikan dan Kebudayaan. (2017). *Panduan Praktis Penyusunan E-Modul*. Jakarta.
- Erwin, Permana, I. and Hayat, M. S. (2018). Strategi Evaluasi Program Praktikum Fisika Dasar, *Jurnal Penelitian Pembelajaran Fisika*, 9(1), 12–20.
- Esomar, K., Nirahua, J. and Akyuwen, F. (2020). Pengembangan Bahan Ajar Keterampilan Proses Sains yang menggunakan Model Discovery Learning dalam Perkuliahan Eksperimen Fisika, *Jambura Physics Journal*, 2(1), 1–10.
- Hendriyani, M. E. and Novi, R. (2020). Laporan Praktikum Mandiri dalam Bentuk Video Presentasi untuk Mengembangkan Kreativitas dan Komunikasi Lisan di Masa Pandemi Covid-19, *Prosiding Seminar Nasional Pendidikan FKIP Untirta*, 328–338.
- Malik, A. S. (2021). Pengembangan E-Modul Berbantuan Sigil Software dan Analisis Kemampuan Berpikir Kritis Siswa, *Pasundan Journal of Mathematics Education (PJME)*, 11(1), 18–35.
- Misbah *et al.* (2018). Pengembangan Petunjuk Praktikum Fisika Dasar I Berbasis 5M untuk Melatih Keterampilan Proses Sains dan Karakter Wasaka, *Jurnal Fisika FLUX*, 15(1), 26–30.
- Murniati, M.S, S. and Muslim, M. (2018). Pengembangan Petunjuk Praktikum Fisika Sekolah I Berbasis Keterampilan Proses Sains Mahasiswa Calon Guru, *Jurnal Inovasi dan Pembelajaran Fisika*, 5(1), 15–25.
- Puspitasari, A. D. (2019). Penerapan Media Pembelajaran Fisika menggunakan Modul Cetak dan Modul Elektronik pada Siswa SMA, *Jurnal Pendidikan Fisika*, 7(1), 17–25.
- Saraswati, N. L. P. A. and Mertayasa, I. N. E. (2020). Pembelajaran Praktikum Kimia pada Masa Pandemi Covid-19: Qualitative Content Analysis, *Wahana Matematika dan Sains: Jurnal Matematika, Sains, dan Pembelajarannya*, 14(2), 144–161.
- Sholihah, R. M. and Sudiby, E. (2019). Penerapan Pendekatan Saintifik untuk Melatihkan Keterampilan Proses Sains Materi Getaran dan Gelombang, *PENSA E-JURNAL: Pendidikan Sains*, 7(3), 296–301.
- Siahaan, A. D., Medriati, R. and Risdianto, E. (2019). Pengembangan Penuntun Praktikum Fisika Dasar II menggunakan Teknologi Augmented Reality pada Materi Rangkaian Listrik dan Optik Geometris, *Jurnal Kumbaran Fisika*, 2(2), 91–98.
- Sirait, R. and Lubis, N. A. (2020). Analisis Buku Panduan Praktikum Fisika Dasar di Fakultas Sains dan Teknologi UIN Sumatera Utara Medan, *JISTech (Journal of Islamic Science and Technology)*, 5(1), 71–79.
- Siregar, S. and Nursafiah (2019). Implementasi Pendekatan Saintifik untuk Meningkatkan Kemampuan Berpikir Kreatif, Keterampilan Proses Sains dan Penguasaan Konsep pada Pembelajaran Fisiologi Hewan, *JESBIO*, VIII(2), 53–57.
- Sumiati, E., Septian, D. and Faizah, F. (2018). Pengembangan Modul Fisika Berbasis Scientific Approach untuk Meningkatkan Keterampilan Proses Sains Siswa, *Jurnal Pendidikan Fisika dan Keilmuan (JPFK)*, 4(2), 75–88.

- Suprianto, Kholida, S. I. and Andi, H. J. (2017). Pengembangan Panduan Praktikum Fisika Dasar 1 Berbasis Guided Inquiry untuk Meningkatkan Kemampuan Hard Skill dan Soft Skill Mahasiswa (Calon Guru Fisika), *Seminar Nasional Hasil Penelitian Universitas Kanjuruhan Malang*, 487–494.
- Wibawa, S. C. *et al.* (2017). The Design and Implementation of an Educational Multimedia Interactive Operation System Using Lectora Inspire, *ELINVO*, 2(1), 74–79.
- Wirasasmita, R. H. and Uska, M. Z. (2017). Pengembangan Media Pembelajaran Berbasis Buku Digital Elektronik Publication (EPUB) menggunakan Software Sigil pada Mata Kuliah Pemrograman Dasar, *EDUMATIC : Jurnal Pendidikan Informatika*, 1(1), 11–16.