# Higher Order Thinking Skills Oriented Student Worksheet of E-learning Model in Electric Circuit Topic

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***Abstract*** **– This study is aimed to develop Higher Order Thinking Skills (HOTS)-Oriented Student Worksheet in basic physics courses of electric circuit topic through e-learning model. The model used in this study was the ADDIE model. The instruments used were the validity assessment sheet and students' responses to assess the effectiveness and practicality of the developed product. The validity assessment was carried out by seven validators, which consisted of experts and practitioners. Effectiveness and practicality were assessed using object test responses involving 13 students at the Department of Physics of Universitas Papua who enrolled in basic physics subject. This study reveals that developed student worksheet is valid. Effectiveness and practicality assessment obtained good results. This result showed that the developed HOTS-oriented e-learning in electric circuit topic was appropriate to be used. Students can analyze, evaluate and create various physics concepts through the available facilities.**

***Keywords*** **– e-learning, electric circuit, HOTS, student worksheet.**

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## 1. Introduction

Advances in technology have an important role in various fields of life, one of them is education. The presence of technology has an important role in learning. The integration of technology, pedagogy and content in the form of Technology, Pedagogy and Content Knowledge (TPACK) based learning device has begun to be implemented in various countries. TPACK is an integration of technology, pedagogy, and interacting material to produce virtual based learning [1], [2]. Advances in technology have made it possible for new techniques of teaching and learning, such as online classes, where students take part in online learning using their own computer or tablet equipment [3]. The use of online learning is one of the efforts to increase students' independence, who are able to learn easily wherever and whenever. One online application in learning is in the form of e-learning utilization. E-learning as an electronic media brings the changes impact in the learning process. Learning through e-learning is one of the means of transforming conventional learning into digital form. The use of e-learning can eliminate the limitations of space and time that have occurred in the education world.

Information and communication technology have been rapidly advancing. Industrial Revolution 4.0 has been often discussed; it utilizes technology in various aspects of lives and strongly influences human lives. Education, as one of the important aspects of human lives, also needs to keep up with this technological development by making the learners as the actors in the currently developing technology [4]. High-quality education is one of the success keys to produce learners as the actors of technological development. Concept of education needs to be changed from teaching and learning or teacher-centered to student-centered. The educator is no longer transferring the knowledge as much as possible, rather facilitating learners, which enables them to develop their knowledge by utilizing currently available technology [5]. Learners are expected to develop their knowledge by utilizing available technology.

The development of technology, especially the internet technology, has broadened the coverage of information, such as access to digital learning sources and both interactions with the lecturers and among learners [6]. Utilization of internet technology in learning and e-learning facilitate learners and teachers without any time and space limitations [7]. Through e-learning media, a teacher presents various learning facilities to support online learning.

Learning facilities could be the provision of qualified teaching materials that can be easily accessed by learners [8]. One of the efforts to help learners in learning is the provision of the worksheet to guide them in learning [9]. The worksheet is integrated into online learning or e-learning; thus, learners could access them anytime, anywhere. The designed worksheet is expected to train learners' ability to solve presented problems. Problem-solving ability is very important for students, especially students of higher education institutions, to prepare them for the job market. Problem-solving skills can be developed through higher order thinking skills (HOTS). HOTS is the highest level of thinking within the cognitive ability hierarchy [10]. The level of cognitive ability hierarchy is generally modeled after Bloom taxonomy from the level of knowing to creating [11]. The first three levels are categorized as Lower Order Thinking Skills (LOTS), while the next three levels are categorized as Higher Order Thinking Skills (HOTS) as shown in Figure 1. [12].

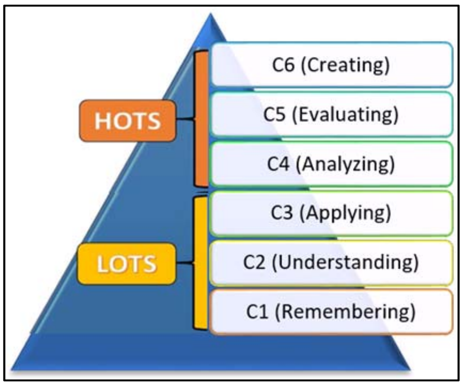



*Figure 1. Revised Bloom Taxonomy Pyramid*

The problem experienced today is the low ability of students' HOTS. Students still find it difficult to develop their ability to apply, evaluate and create. The limited facilities and infrastructure available is one of the inhibiting factors in increasing the capacity of the HOTS. Therefore, innovation in learning is needed so that students' HOTS abilities can be improved. Low HOTS ability of the students could be developed through the presentation of problems related to daily lives, which encompasses analyzing ability, evaluating ability, and creating ability [10], [13]. Through the HOTS ability, it is expected that learners could accomplish various learning problems. To realize the HOTS, students need to be more active in learning [11]. Each teacher is expected to be able to train HOTS ability to the learners in each subject.

Physics is a difficult subject. Physics learning is considered as the highest level of thinking [14]. It needs innovation and creativity to teach physics to be easily understood by students. Availability of sufficient learning resources is one of the supporting factors that enable the students to understand the materials properly. Presentation of learning materials such as student worksheet integrated with HOTS is expected to help them in solving problems. The currently available worksheet is yet able to make students think in HOTS level. Most of the worksheets are presented in the form of work procedure. The currently available worksheet provides fewer chances for students to think creatively in designing their experiments. Student worksheets can be presented interactively which emphasizes problem solving and conceptual understanding. The results showed that 68% of students preferred interactive worksheets to textbooks (29%) and homework (32%) [15]. Similarly, the experimental and control group students' post-test scores demonstrated that the experimental group students who were taught using problem-solving-based worksheets were more effective than the control group students who were taught using standard assignments ($t=23,23$; $p<0,05$) [16]. Student worksheets need to be made attractively so that students' thinking skills can be developed. Presentation of the appropriate worksheet can help students to become creative and develop their HOTS ability. Utilization of HOTS-oriented e-learning model worksheet provided the students with the opportunity to access the learning materials and carry out experiment anytime anywhere. It is expected that through the utilization of such worksheet, students' HOTS could be developed. This study is aimed to develop HOTS-Oriented Student Worksheet in basic physics courses of electric circuit topic through e-learning model. The worksheets developed are expected to be effective and practical to be used by students who can ultimately develop their HOTS abilities.

## 2. Methodology

This study was an ADDIE development model consisting of Analyze, Design, Development, Implementation, and Evaluation stages [17]. The ADDIE model was used to describe the systematic approach to development. Because the product being produced was a learning medium rather than a software engineering project, the ADDIE technique was appropriate for the product development process.

The ADDIE model with its components can be illustrated in Figure 2.

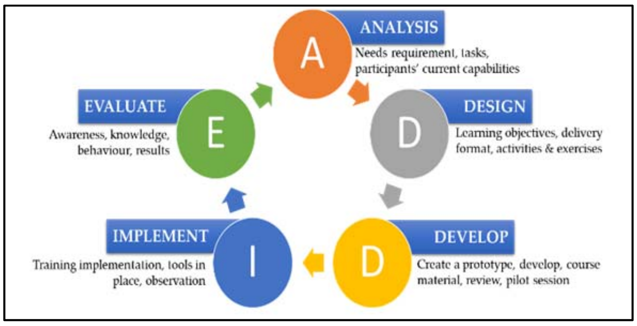



*Figure 2. ADDIE stages in designing Higher Order Thinking Skills (HOTS)-oriented student worksheets*

### Analysis

The analysis stage is a needs analysis process in the form of determining the goal of developing student worksheets, identifying problems, analyzing assignments and determining the format of student worksheets to be applied. The results obtained are in the form of problem identification related to the design needs of student worksheets that are presented in the previously developed e-learning. In the development and implementation of e-learning in basic physics courses, there are several needs that must be met. These needs include the availability of good e-learning facilities. The resource used to support e-learning is Moodle LMS.

### Design

The design of the student worksheet will be established at this point. At this point, the display styles for student worksheets are organized based on the findings of the needs analysis. Students' worksheets are created by presenting a variety of challenges that need them to use their HOTS skills. The student worksheets are then given in an e-learning format so that they may be accessed online by students.

### Develop

Everything needed for creating or organising student worksheets has been created at this point. Student worksheets and validation are also done at this point, with the help of measurement experts, physics education experts, physicists, and practitioners. Instruments used in this study were the validation sheets. The validation sheet was used to assess the validity of the content from the developed students' worksheet. The validation involved seven validators consisted of experts' validators from the Universitas Negeri Yogyakarta and practitioners' validators from the Universitas Papua. Validators assessment consisted of an assessment on the content appropriateness aspect, presentation aspect, language aspect, and graphic aspect [18]. Aiken' V formula was used to analyze the data [19]. This formula was also used to assess whether the developed students' worksheet (SW) fulfilled the validity criteria.

$$V = \frac{\Sigma s}{n(c-1)}$$

V is the validator agreement index regarding the validity of the items, s is the score of the validator's assessment minus the lowest score of the assessment, while n is the number of validators, and c is the number of categories that can be selected by the validator. The entire statement is valid if the V Aiken index value is in the range of 0.37 to 1 [20]. The V Aiken value of each statement is calculated based on the item assessed by each validator. At this stage, evaluation is also carried out, namely revising student worksheets based on suggestions for improvement from each validator. The validator provides input directly on the student worksheets and provides an assessment on the observation sheet based on the aspects and assessment statements presented in Table 1.

*Table 1. Aspects and statements assessed by the validator*

| No. | Aspects | Statements |
|---|---|---|
| 1 | Aspect of content feasibility | a. The suitability of the student worksheet with the experiments<br>b. Encourage students' curiosity<br>c. Develop students' HOTS<br>d. Able to guide students in understanding the virtual experiment<br>e. Suitability of the students' worksheet with the media used |
| 2 | Presentation aspect | a. Student worksheet presentation technique attracts attention<br>b. Able to support the implementation of a virtual experiment |
| 3 | Language aspects | a. Language grammar<br>b. Correct spelling<br>c. Appropriate terms<br>d. Appropriate punctuation |
| 4 | Integrity aspect | a. Text clarity<br>b. Illustration clarity (figure/table) |

### Implementation

At this stage, the application of student worksheets that had been developed was carried out on the trial subject, namely students of the Department of Physics Education, Universitas Papua, who programmed a total of 13 Basic Physics Courses. The students who programmed the general physics course as the sample in this study were 13 people consisting of 6 men and 7 women. Students learn by using developed worksheets. The student's HOTS ability is measured after the application of learning using a worksheet. Students respond to the worksheets used after learning activities.

### *Evaluation*

Evaluation is a process to see whether the worksheet developed is successful in accordance with initial expectations or not. The evaluation stage is carried out at each stage and is referred to as formative evaluation, the purpose of which is for revision needs [21]. For example, at the design stage, expert reviews are needed to provide input to the design that is being made. The evaluation stage is carried out after implementation, namely measuring student responses through giving a questionnaire. Students' responses questionnaire was used to measure the effectiveness and practicality of the developed worksheet. The statement on the students' responses assessment based on the effectiveness and practicality aspects is presented in Table 2. [22]. The description of the students' responses used the Rasch Model analysis [23].

*Table 2. Aspects and statements student responses to the worksheet*

| Aspect | Code | Statement |
|---|---|---|
| Effectiveness | +P1 | a. Utilization of students' worksheet (hereinafter will be referred to as SW) can increase students' willingness to learn. |
| | +P2 | b. SW functions to gain information related to physics learning |
| | +P3 | c. SW also assists in the implementation of virtual experiments |
| | +P4 | d. Stimulates students' curiosity |
| | +P5 | e. It can promote independent learning |
| | +P6 | f. Help students to develop analytical skills |
| | +P7 | g. Help students to develop evaluate skills |
| | +P8 | h. Help students to develop invention skills |
| Practicality | +P9 | a. Presentation of experiment activities within the SW draws the attention of the students |
| | -P10 | b. The text within the SW is hard to be read |
| | +P11 | c. Figures, illustration, or graphic within the SW are attractive |
| | +P12 | d. The content within the SW is presented in sequence |

The research data were analyzed and described qualitatively. The data obtained are related to each other so that corroborating findings are produced. At the evaluation stage, a student's HOTS ability measurement was also carried out after the implementation of learning. The analysis was carried out through the categorization of students' HOTS abilities based on Table 3. [24].

*Table 3. Category of student ability assessment*

| Interval | Category |
|---|---|
| 76-100 | Very Good |
| 51-75 | Good |
| 26-50 | Less |
| 0-25 | Very Less |

## 3. Results

In the early stages, the LMS was developed using the Moodle Application. The development of the LMS was carried out through the previous systematic stages. The LMS is an initial display for the development of various further learning content, including student worksheets that will be developed. The initial display of e-learning used is shown in Figure 3.

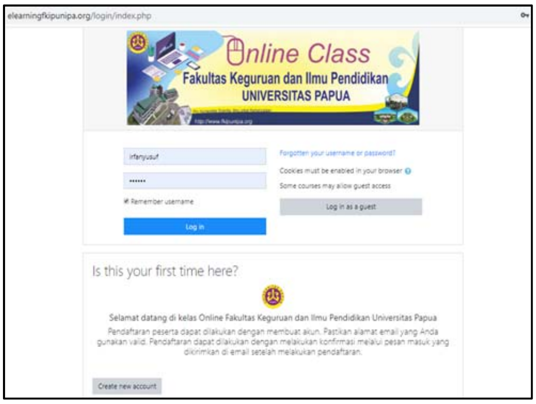



*Figure 3. The initial display of e-learning at the Faculty of Teacher Training and Education, Universitas Papua*

Moodle provides facilities that allow educators to enter a variety of media and learning resources for students. The media and learning resources in basic physics courses include learning materials in the form of videos, animations, simulations and virtual laboratories that allow students to conduct experiments directly through e-learning. The appearance of virtual laboratory media that is packaged in e-leaning is displayed in Figure 4.

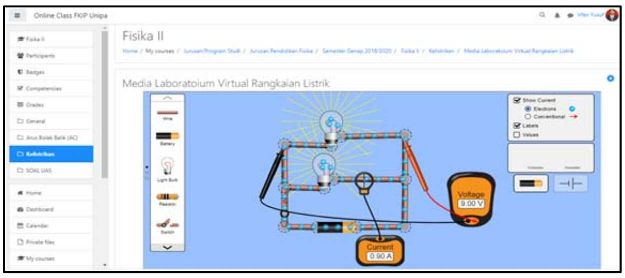



*Figure 4. Facility of Virtual Laboratory Media in e-learning of basic physics class*

The initial stage in the development of HOTS-oriented e-learning model of students' worksheet is an analysis stage. The analysis was carried out on students' initial ability who enrolled in basic physics subject at the Department of Physics of Universitas Papua. Students' initial abilities were different as they came from different secondary school. Some students came from the science department or social department and the others were from a vocational school. These background differences become obstacles in learning. Some students can easily understand the material, but there are also some who need more explanation. The results of the analysis of student learning outcomes before using the worksheet are in Table 4.

*Table 4. Student learning outcomes before using the worksheet*

| Learning Outcome Interval | Number of Students | Category |
|---|---|---|
| 76-100 | 1 | Very Good |
| 51-75 | 1 | Good |
| 26-50 | 1 | Less |
| 0-25 | 10 | Very Less |
| Total of Students | 13 | |
| Average Value | 32.99 | |
| Maximum Value | 79.17 | |
| Minimum Value | 12.50 | |
| Standard Deviation | 22.15 | |

Students' learning outcomes before employing worksheets in learning revealed that just a handful of them received high marks. In addition, students' attitudes towards e-learning are also found. The students are not accustomed to learning online so that each feature and step to use it need to be introduced. Learning through e-learning using Moodle LMS is still difficult in its application. This is due to a number of factors, including: lecturers' adaptability is still in its early stages, students are not used to having real-time and forum-based discussions, and the material presented is still incomplete without video explanations or other supporting media, requiring students to study independently, resulting in the lecturer's answers not satisfying them. Therefore, it is very important to introduce the use of e-learning media as an initial step in this research.

Another problem currently is that during the Covid-19 pandemic learning is directed online so that innovation is needed to be able to convey learning properly. Students are expected to be active and develop their abilities even though learning is conducted online. Therefore, student worksheets are needed that include various content that can increase their creativity in learning, one of which is to develop the HOTS abilities.

The next analysis was learning achievement analysis. The basic physics topic studied in student worksheet learning is an electric circuit. The topic regarding electric circuit consists of the electric battery, electric current, Ohm law, series and parallel circuits of a resistor and capacitor, electric power, electromotive force, Kirchoff law, and Resistor-Capacitor (RC) circuit.

In the initial stages of the research, it was found that students were not accustomed to use e-learning. All this time, learning is always limited to face-to-face class, so it needs adjustments for students. Therefore, it is very important for lecturers to introduce the use of various e-learning features before they are implemented. Guidelines for using e-learning need to be provided both for lecturers and students so that various online learning activities can be optimized.

The course model of Moodle-based e-learning consists of 2 types, namely, weekly display model and material topic display model [25]. The application of e-learning in basic physics course is designed using the display of material topic. In each topic of the material are also presented the learning media in the form of modules, simulations and virtual experiments through virtual laboratory media.

The next step is design. In this design stage, the student worksheet model is designed. The developed worksheet consists of basic physics topic of an electric circuit. An electric circuit is one of the most difficult and abstract physics topics to be directly described in a real-life laboratory. At this stage, the design of the developed worksheet format is carried out.

The format of the worksheet is dynamic, meaning that students can directly access and fill out various findings that they have obtained during the learning activities carried out. The next in this study is a development study. This stage involves the creation of a worksheet that is connected with the e-learning. In this e-learning, virtual experiments on electric circuits are provided. Students are encouraged to do their virtual experiments based on the provided worksheet. There are four units of experiment on the developed student worksheet. Those are an experiment in Ohm law, series and parallel circuits, Kirchoff law, Superposition theory, and Loop current theory shown in Figure 5.

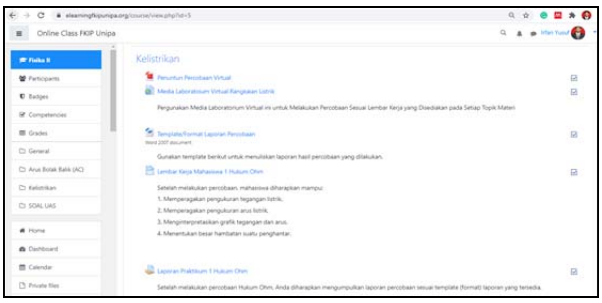
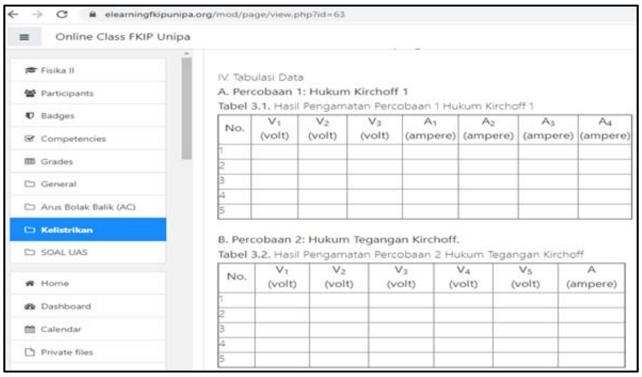



*Figure 5. The feature of student worksheet with e-learning model*

The feature of student worksheet with e-learning model and the feature of one of the worksheet content with HOTS orientation are shown in Figure 6. The worksheet is interactive. Students can control various facilities, namely data collection and direct input of observed values. The problems presented are related to the HOTS problems, so it is hoped that students can develop their HOTS abilities, especially when filling out the worksheets.


*(a)*




*(b)*

*Figure 6. The feature of one of the worksheet content with HOTS orientation; (a) introduction and virtual experimental procedure; (b) table of observations that can be input directly by students*

Validation of the developed worksheet was also carried out in the development stage. Validation involved seven validators, which consisted of expert validators from the Universitas Negeri Yogyakarta and practitioner validators from the Universitas Papua. The validators' assessment showed a valid result for each assessed aspects as shown in Table 2. The calculated V Aiken was higher than the V Aiken table value. The value was 0.76 for the seven validators with 4-item assessments.

The validation was carried out directly through the discussion process with validators. There was various input from validators. The validators suggested revising the content as there was some material description that was less appropriate with the experiment objectives. Meanwhile, for the graphics aspect, validators recommended that the worksheet be equipped with better resolution pictures. Thus, it would be easy for students to read. Another recommendation was from the language aspect, where it was recommended that each formula be numbered and clear and consistent unit were used, such as in the strength of electric current unit; it should be written A (not Ampere). Further, the recommendation and input from the validators were considered to revise the worksheet. The result of validators' assessment on the developed student worksheet is shown in Table 5.

*Table 5. Results of validator assessment*

| No. | Aspects | Statements | Aiken'V | Category |
|---|---|---|---|---|
| 1 | Aspect of content feasibility | a. The suitability of the student worksheet with the experiments | 0,86 | Valid |
| | | b. Encourage students' curiosity | 0,86 | Valid |
| | | c. Develop students' HOTS | 0,86 | Valid |
| | | d. Able to guide students in understanding the virtual experiment | 0,90 | Valid |
| | | e. Suitability of the students' worksheet with the media used | 0,81 | Valid |
| 2 | Presentation aspect | a. Student worksheet presentation technique attracts attention | 0,86 | Valid |
| | | b. Able to support the implementation of a virtual experiment | 0,81 | Valid |
| 3 | Language aspects | a. Language grammar | 0,90 | Valid |
| | | b. Correct spelling | 0,81 | Valid |
| | | c. Appropriate terms | 0,81 | Valid |
| | | d. Appropriate punctuation | 0,81 | Valid |
| 4 | Integrity aspect | a. Text clarity | 0,81 | Valid |
| | | b. Illustration clarity (figure/table) | 0,76 | Valid |

The final stage in this study was evaluation. It was carried out to find the effectiveness and practicality of the developed media. Effectiveness and practicality were obtained through a questionnaire distributed to obtain students responses. The result of the students' responses is presented in Figure 7. Figure 7. shows that in general, students' responses mostly agree with the developed learning media.

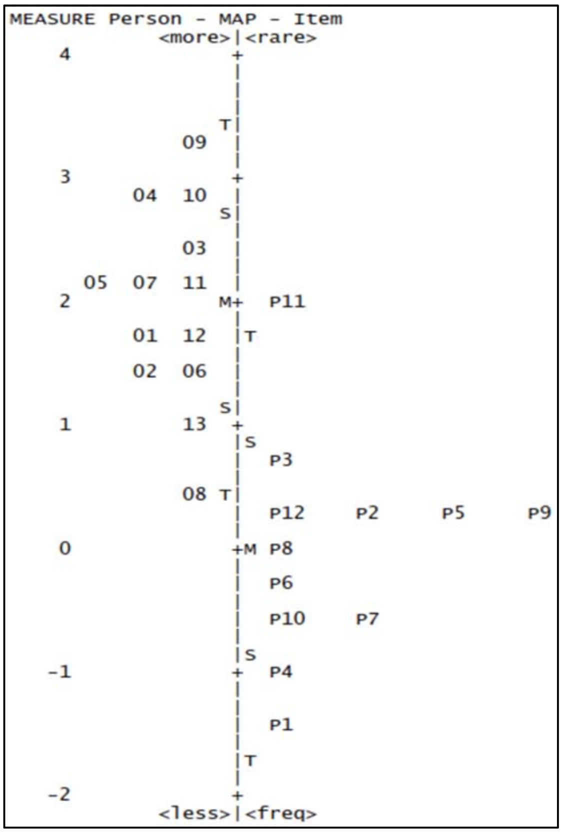



*Figure 7. Students' responses in using HOTS-oriented worksheet*

The left side of Figure 7. showed that students with highest logit value or those who said they highly agree with the statements provided in the questionnaire were students number 09, 04, 10, 03, 05, 07, and 11. On the bottom left, it is seen that only one student who had low logit value is student number 08. On the right side of the picture, it is seen that there is one statement with the lowest agreement level, statement number P11. Statement P11 is related to the pictures, illustration, or graphics in the student worksheet. Because the e-learning media utilized featured varied information, such as virtual laboratory media, which was used to support the worksheets employed, student responses were low in this area compared to others. It is vital to be cautious in noting any changes in physical quantities that occur when running a virtual experiment medium [26]. The quality of the content display depends on the resolution of the computer or android phone used. If the computer or cellphone used to have a good resolution to show good quality pictures, then the quality of the pictures would be better. The wider the computer screen, the easier to carry out a virtual experiment. Hence, it is recommended to carry out a virtual experiment through the computer, and it is not recommended to carry out a virtual experiment through the android phone with a small screen display.

At the evaluation stage, an analysis of student learning outcomes was also carried out after learning. Student learning outcomes are related to their HOTS abilities after learning. The results of the student's HOTS ability assessment after learning are as shown in Table 6.

*Table 6. Student learning outcomes after using the worksheet*

| Learning Outcome Interval | Number of Students | Category |
|---|---|---|
| 76-100 | 7 | Very Good |
| 51-75 | 3 | Good |
| 26-50 | 2 | Less |
| 0-25 | 1 | Very Less |
| Total of Students | 13 | |
| Average Value | 81.50 | |
| Maximum Value | 92.50 | |
| Minimum Value | 23.50 | |
| Standard Deviation | 13.14 | |

Table 6. shows that students tend to have high HOTS abilities after learning. There are 7 out of 13 people who have scores in the 76-100 range, while only 1 person has low scores in the 0-25 range. Students' HOTS abilities have increased when compared to their abilities before learning. This shows that students can develop their HOTS skills through learning activities carried out using developed worksheets.

## 4. Discussion

Students need to be equipped with a good basic understanding of basic physics courses, especially in abstract concepts, one of which is in the material of electrical circuits. Basic physics subject becomes very important, as this subject is basic for several advanced subjects, which are related to physics science. Therefore, students' understanding of Basic Physics becomes crucial. Thus, learning media that can ease students to understand physics are needed [27].

Student worksheets that are presented through e-learning are equipped with various facilities supporting the implementation of online learning that allows students to learn independently [28]. Various kinds of learning resources can be integrated directly through e-learning such as animation and simulation as well as interactive multimedia that makes it easy for students to understand the subject matter [29]. Learning through e-learning can train learning independence to develop their various abilities, one of which is the HOTS. This can be seen based on the acquisition of HOTS scores that have increased in each material topic given. The use of e-learning media in learning can train the students' HOTS ability because the subject matter contained can be accessed anytime and anywhere. Various learning resources that are packaged in e-learning are animation, simulation, interactive multimedia and virtual laboratory media that are HOTS-oriented, enabling students to develop their HOTS abilities.

The use of virtual laboratory media that is packaged with student worksheets through e-learning is one of the right solutions to make it easier for students to understand the subject matter. The lecturer provides a worksheet that demands students to carry out their own experience by utilizing the virtual laboratory that can be accessed through their accounts in e-learning media. Utilization of e-learning student worksheet is an effective solution to develop students' skills, including the HOTS. Students HOTS can be developed through various problems presented within the worksheet. The problems include the ability to analyze, evaluate, and create, all of which are HOTS aspects. Students' ability in analyzing is shown through their ability in differentiating, sequencing, and giving specific characteristics based on the experiment that they have carried out. Evaluation skill is evident from their ability to check and to criticize the result of their experiment. Meanwhile, creation ability is evident from their ability in discovering ideas or planning the experiment that would be carried out [12]. The e-learning student worksheet contains various problems presented in the form of questions to train students' HOTS.

The result of measurement using Rasch modeling obtained the person measure of +1.95 logit, which was larger than 0.00, which showed that the student agreed with the HOTS-oriented e-learning student worksheet. Students are more encouraged to learn using online-based worksheet due to its various facilities and the easiness to understand the presented materials [30]. Utilization of the HOTS-oriented e-learning student worksheet could encourage positive responses from students toward physics learning.

The students considered that the use of student worksheets consisting of various learning resources such as animation, simulation, multimedia or virtual laboratories in e-learning should be further improved. The use of these media can increase their understanding and can create a more interesting learning atmosphere. In addition to using these media, problems in the form of HOTS questions play an important role in increasing students' HOTS. Therefore, the lecturer designs each meeting with HOTS problems which is expected to provide understanding material for the students in order to create a meaningful learning atmosphere.

The use of student worksheets through e-learning makes it easy for students to learn because it can be accessed whenever and wherever they are. Students are required to do more activities in learning. Through e-learning, lecturers are no longer the only source of learning, but students can obtain various kinds of reading resources by utilizing digital search facilities provided either on e-learning or free access on the internet [31].

In general, students approve learning through the use of student worksheets that are presented on e-learning. Students have more time to learn compared to conventional learning because they can access subject matter whenever and wherever they are [32]. The use of e-learning media can also foster student learning independence. Learning by utilizing Moodle media has an impact on students' attitudes, such as they are more likely to be trained to learn and discover a concept independently [33]. Students are seen actively learning through the use of e-learning media. Lecturers as facilitators provide a variety of reading resources that can be freely accessed by students so that they can develop their thinking skills especially the HOTS abilities. The HOTS ability can be developed through a training process by getting students to learn solving their HOTS problems. The e-learning media used are equipped with a variety of subject matter that requires them to think in HOTS. Based on the results of the assessment on the effectivity and practicality of e-learning media by students, it can be concluded that learning through e-learning is effective and has a good impact on their HOTS abilities, so that they can be further applied in learning.

In terms of lecture activities through e-learning, students prefer the task of conducting virtual experiments over the virtual laboratory media provided on e-learning. Virtual laboratory media are effectively integrated in e-learning because students can practice their ability to find concepts without any limitation of time and place [34]. Through virtual experiments on e-learning, students can directly simulate the online material learned [35]. The worksheets provided can be used to guide them through virtual experiments.

Students believe that worksheets allow them to study at their own speed rather than being confined to being physically present in class. Although it has advantages, student worksheets through e-learning also have disadvantages such as lack of involving the social aspects of students because there is no direct interaction between students and lecturers or among students themselves. Another obstacle is the lack of availability of supporting facilities for the implementation of learning through e-learning such as internet facilities (maybe this is related to the problem of the availability of electricity, cellular networks, or computers). This is also an obstacle especially at the Universitas Papua, in which the lack of internet facilities provided by the campus to students.

## 5. Conclusion and Implications

In general, the development of HOTS-oriented e-learning student worksheet was valid from all aspects including, content appropriateness, presentation aspect, language aspect, and graphics aspect. Utilization of this e-learning model through try-out on students at the department of physics at the Universitas Papua who enrolled in basic physics subject reveal effective and practical results. Most of the students responded that they highly agree with the utilization of this HOTS-oriented e-learning student worksheet in Electric Circuit. The use of student worksheets has implications for increasing their HOTS abilities in learning. Students can analyze, evaluate and create various physics concepts through the available facilities. Students can find concepts and experience the process directly through the worksheets provided on e-learning. This shows that the developed student worksheet is appropriate to be used. It is recommended that further trials with wider and larger test subjects and its utilization for various subjects be carried out.

### References

[1]. Malik, S., Rohendi, D., & Widiaty, I. (2019, February). Technological pedagogical content knowledge (TPACK) with information and communication technology (ICT) integration: A literature review. In *5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018)* (pp. 498-503). Atlantis Press. https://doi.org/10.2991/ictvet-18.2019.114

[2]. Elas, N., Majid, F., & Narasuman, S. (2019). Development of technological pedagogical content knowledge (TPACK) for english teachers: The validity and reliability. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(20), 18-33.

[3]. Syynimaa, N. (2018). Teaching on Hybrid Courses: Insights from Commercial Online ICT-Training. In *International Conference on Computer Supported Education*. SCITEPRESS Science and Technology Publications.

[4]. Suryani, A. (2017). "I am an Old Car, My Engine is not Powerful Anymore," A Senior Teacher's Voice on his ICT Learning, Obstacles and Its' Implications for Teachers' Development. *International Journal of Pedagogy and Teacher Education*, *1*(2), 177-191.

[5]. Heggart, K., & Yoo, J. (2018). Getting the most from Google Classroom: A pedagogical framework for tertiary educators. *Australian Journal of Teacher Education*, *43*(3), 140-153. https://doi.org/10.14221/ajte.2018v43n3.9

[6]. Martín-Blas, T., & Serrano-Fernández, A. (2009). The role of new technologies in the learning process: Moodle as a teaching tool in Physics. *Computers & Education*, *52*(1), 35-44. https://doi.org/10.1016/J.COMPEDU.2008.06.005

[7]. Culliton, S. E., Bryant, D. M., MacDonald, S. J., Hibbert, K. M., & Chesworth, B. M. (2018). Effect of an e-learning tool on expectations and satisfaction following total knee arthroplasty: a randomized controlled trial. *The Journal of Arthroplasty*, *33*(7), 2153-2158.https://doi.org/10.1016/j.arth.2018.02.040.

[8]. Sartika, D., Arsyad, A. A., & Mutmainna, M. (2018). Validity of Physics Lesson book Oriented Metacognitive Strategies for Problem Solving Skills of Teacher Candidates. *American Journal of Educational Research*, *6*(12), 1605-1608. https://doi.org/10.12691/education-6-12-3

[9]. Astra, I., Wahyuni, C., & Nasbey, H. (2015). Improvement of Learning Process and Learning Outcomes in Physics Learning by Using Collaborative Learning Model of Group Investigation at High School (Grade X, SMAN 14 Jakarta). *Journal of Education and Practice*, *6*(11), 75-79.

[10]. Tanujaya, B., Mumu, J., & Margono, G. (2017). The Relationship between Higher Order Thinking Skills and Academic Performance of Student in Mathematics Instruction. *International Education Studies*, *10*(11), 78-85.

[11]. Winarti, C., Sunarno, W., & Istiyono, E. (2015). Analysis of higher order thinking skills content of physics examinations in madrasah aliyah. In *International Conference on Mathematics, Science, and Education 2015 (ICMSE 2015)* (Vol. 2015, pp. 32-38).

[12]. Istiyono, E. (2018, September). IT-based HOTS assessment on physics learning as the 21st century demand at senior high schools: Expectation and reality. In *AIP Conference Proceedings* (Vol. 2014, No. 1, p. 020014). AIP Publishing LLC.

[13]. Yusuf, I., & Widyaningsih, S. W. (2019, February). HOTS profile of physics education students in STEM-based classes using PhET media. In *Journal of Physics: Conference Series* (Vol. 1157, No. 3, p. 032021). IOP Publishing.

[14]. Hakim, A., Liliasari, L., Setiawan, A., & Amir, M. (2019, February). Thermodynamics interactive multimedia to improve physics prospective teacher's generic science skills. In *Journal of Physics: Conference Series* (Vol. 1157, No. 3, p. 032026). IOP Publishing.

[15]. Podolak, K., & Plattsburgh, S. (2013). Interactive Modern Physics Worksheets Methodology and Assessment by Students. *European Journal of Physics Education*, *4*(2), 27–31.

[16]. Celikler, D. (2010). The effect of worksheets developed for the subject of chemical compounds on student achievement and permanent learning. *The International Journal of Research in Teacher Education*, *1*(1), 42-51.

[17]. Aldoobie, N. (2015). ADDIE model. *American International Journal of Contemporary Research*, *5*(6), 68-72.

[18]. Muljono, P. (2007). Kegiatan penilaian buku teks pelajaran pendidikan dasar dan menengah. *Buletin BNSP 2*(1), 14-23.

[19]. Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and psychological measurement*, *45*(1), 131-142.

[20]. Kowsalya, D. N., Venkat Lakshmi, H., & Suresh, K. P. (2012). Development and Validation of a Scale to assess Self-Concept in Mild Intellectually Disabled Children. *International Journal of Social Sciences & Education*, *2*(4).

[21]. Lee, M. F., & Zainal, N. A. (2017, December). Development of needham model based E-module for electromagnetic field & wave. In *2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* (pp. 120-124). IEEE. https://doi.org/10.1109/IEEM.2017.8289863

[22]. Lee, J., & Martin, L. (2017). Investigating students' perceptions of motivating factors of online class discussions. *International Review of Research in Open and Distributed Learning: IRRODL*, *18*(5), 148-172.

[23]. Alagumalai, S., Curtis, D. D., & Hungi, N. (2005). *Applied Rasch measurement: A book of exemplars* (pp. 1-15). Dordrecht, The Netherlands:: Springer.

[24]. Riduwan. (2011). *Skala Pengukuran Variabel-Variabel Penelitian*. Alfabeta.

[25]. Becerra-Romero, A., Díaz-Rodríguez, M., & González-Estrada, O. A. (2019). Development of a virtual learning environment for the subject Numerical Methods under Moodle. In *Journal of Physics: Conference Series* (Vol. 1161, No. 1, p. 012010). IOP Publishing. https://doi.org/10.1088/1742-6596/1161/1/012010

[26]. Leslie-Pelecky, D. L. (2000). Interactive worksheets in large introductory physics courses. *The Physics Teacher*, *38*(3), 165-167. https://doi.org/10.1119/1.880485

[27]. Agung, A., Amin, B. D., Yani, A., & Swandi, A. (2018). Pengembangan Bahan Ajar Berbasis E-Learning Mata Kuliah Fisika Dasar pada Jurusan Biologi FMIPA UNM. *Indonesian Journal of Educational Studies Vol*, *21*(2).

[28]. Yildiz, E. P., Tezer, M., & Uzunboylu, H. (2018). Student Opinion Scale Related to Moodle LMS in an Online Learning Environment: Validity and Reliability Study. *iJIM*, *12*(4), 97.

[29]. Mursid, R. M. (2017, October). The Effectiveness of Higher Order Thinking Skill (HOTS) Based Learning Model Through Using E-Learning and Interactive Multimedia on ICT Learning. In *2nd Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2017)* (pp. 218-223). Atlantis Press. https://doi.org/10.2991/aisteel-17.2017.46

[30]. Chandra, V., & Fisher, D. L. (2009). Students' perceptions of a blended web-based learning environment. *Learning Environments Research*, *12*(1), 31-44. https://doi.org/10.1007/s10984-008-9051-6

[31]. Shamsuddin, N., & Kaur, J. (2020). Students' Learning Style and Its Effect on Blended Learning, Does It Matter?. *International Journal of Evaluation and Research in Education*, *9*(1), 195-202. https://doi.org/10.11591/ijere.v9i1.20422

[32]. Horvat, A., Dobrota, M., Krsmanovic, M., & Cudanov, M. (2015). Student perception of Moodle learning management system: a satisfaction and significance analysis. *Interactive Learning Environments*, *23*(4), 515-527. https://doi.org/10.1080/10494820.2013.788033

[33]. Costa, C., Alvelos, H., & Teixeira, L. (2012). The use of Moodle e-learning platform: a study in a Portuguese University. *Procedia Technology*, *5*, 334-343.

[34]. Liu, D., Valdiviezo-Díaz, P., Riofrio, G., Sun, Y. M., & Barba, R. (2015). Integration of virtual labs into science e-learning. *Procedia Computer Science*, *75*, 95-102. https://doi.org/10.1016/j.procs.2015.12.224

[35]. Oubahssi, L., & Piau-Toffolon, C. (2018, March). Virtual Learning Environment Design in the Context of Orientation Skills Acquisition for LUSI Class. In *CSEDU (1)* (pp. 47-58). https://doi.org/10.5220/0006673800470058