Developing Assessment As Learning on Basic Physics Virtual Practicum As An Asessment Instrument of Process And Cognitive Skills on Online-Learning

Didik Setyawarno[*], Eko Widodo, Dadan Rosana
Study Program of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta
[*]Corresponding Author. Email: didiksetyawarno@uny.ac.id

ABSTRACT

This research aimed to i) create and analyze an assessment as learning on basic physics virtual practicum to measure the process and cognitive skills on online-learning, ii) analyze the implementation of the assessment as learning on basic physics virtual practicum to measure the process and cognitive skills on online-learning, and iii) analyze the effectiveness of the implementation of assessment as learning on basic physics virtual practicum to measure the process and cognitive skills on online-learning. This research used Research and Development (R & D) model with 4-D stages consisted of define, design, develop, and disseminate. The result of the research was a product of an assessment as learning, consisting of peer and self-assessment on virtual practicum of basic physic II on online learning. The product was valid based on an analysis of the Aiken formula and empirical study of the Rasch model. The result of the independent t-test sample towards the implementation of the product of assessment as learning, both peer and self-assessment was 0.160, which was higher than 0.5. The result showed that no significant differences occurred in the implementation of assessment as learning, both peer and self-assessment on the practicum of basic physics.

INTRODUCTION

The pandemic conditions have made all education stakeholders around the world switch from face-to-face learning (offline learning) to distance learning (online learning). For this reason, innovation is urgent, which can be realized by developing strategies, models, learning media, as well as assessment system. One of the learning activities that are affected by the covid-19 pandemic is practicum activities, especially science subjects. Practicum is impossible to be separated from experimental activities, both for discovering and verifying concepts through laboratory activities and field practicums. A virtual practicum may be used as the main alternative to overcome this problem.

Virtual practicum learning is one of the main elements that are very essential in the current education system that prioritizes technological advances (Winkelmann et al., 2019). This may become a form of technology implementation in education (Bautista & Boone, 2015). Moreover, this

follows the needs that students are required to use technology in the learning process (Ahmed, 2014). Besides that, teachers are required to improve technological skills in learning and create learning media (McGarr, 2020). Therefore, virtual practicum becomes an effective means to improve the process and cognitive skills. In this case, cognitive ability is about how technology can become a tool or means as a solution to solve problems. Process skills in virtual practicum are a person's ability to work independently or in a group with other students effectively, responsibly, and appropriately using technological instruments to obtain, manage, integrate, evaluate, create, and communicate the information.

Today, various kinds of human needs have been widely applied by the support of the Internet and the digital world as a vehicle for interactions and transactions. The world of education needs to prepare students to face the increasingly complex

challenges of the 21st century. Education is not enough to only teach students with the knowledge and simple thought processes. But, education also needs to prepare students to have and possibly to develop the essential skills of this century. Partnership for the 21st century skills collaborates to develop a 21st-century learning framework for students aiming they could be successful in this digital era. The framework for the 21st century learning is presented in Figure 1.
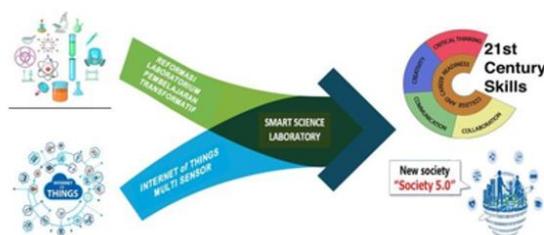
Figure 1. Framework for the 21st Century Learning

As a primary learning medium during this pandemic, the virtual practicum is considered an effective way for improving the process and cognitive abilities of students. As a virtual practicum simulation is identical to the actual practicum, it can increase the speed of students in understanding the material by facilitating students to be creative as freely as possible in the learning process (Herga, Čagran, & Dinevski, 2016; Xie, Zhou, & Yu, 2015). On the other hand, it has also been proven that interactive learning through VIS-LAB can also help students to solve problems regarding concepts of abstract topics, where students are more active in the learning process and have the opportunity to construct and understand difficult concepts easily (Climent-Bellido, Martínez-Jiménez, Pontes-Pedrajas, & Polo, 2003).

In the particular study, science process skills (SPS) are defined as the ability of students to apply scientific methods in understanding, developing science, and discovering knowledge. This definition is in line with the opinion of Rusman (2013) that process skills are a process approach in teaching science based on observations of what is done by a scientist. Afrizon, Ratnawulan, & Fauzi (2012) state that SPS is very important for every student to use scientific methods in developing science. The aim is that students can acquire new knowledge or develop knowledge. This skill is closely related to laboratory activities because the concept of discovery process involves basic skills through scientific experiments that are implemented and improved through laboratory activities (Murniasih, Subagia, & Sudria, 2013).

In a broad definition, cognitive is a psychological domain centered in the brain and is associated with conation (will) and affection (feeling). Susanto (2011) defines cognitive as a thinking process, that is an individual's ability to connect, assess, and consider an event. Rahman (in Wiyani, 2013) states that the term cognitive comes from the word cognition or knowing, which means a broad concept, while inclusion refers to mental activities appearing in the process of acquisition, organization, and knowledge use. Padmonodewo (2003) argues that cognitive is thinking and observing, which is a behavior of people to gain knowledge and solve problems. Based on the previous opinion, cognitive abilities are the development of parts of the brain, used for understanding, reasoning, knowledge, and feeling. The child's mind begins to be active since birth, from day to day throughout his/her growth. The development of the mind is, such as learning about people, learning about something, learning about new abilities, gaining a lot of memories, and adding a lot of experience. Throughout the development of the child's mind, the child becomes more intelligent and smart (Susanto, 2011: 52).

The main problem in this research is that the virtual practicum has not been optimally implemented due to the pandemic conditions, especially how the assessment is carried out from the aspects of the process and results. There is no instrument specifically developed in the implementation of virtual practicum in the basic physics subject, which is in accordance to the rules of assessment as learning with the orientation of an authentic assessment. Hence, this instrument can assess the process and learning outcomes in an integrated manner.

METHOD

The type of this study was Research and Development (R & D). The development model was 4-D, which has been modified by the researchers following the needs of field conditions during the study. The 4-D development model consisted of four main stages, namely define, design, develop, and disseminate (Donald, 1982; Paidi, 2010).

The research location for the empirical test was the Basic Physics Laboratory of Faculty of Mathematics and Natural Science, Universitas Negeri Yogyakarta, which has used the revised MBKM curriculum. The population in the Laboratory of Basic Physics consisted of two classes. 40 students were selected as the research sample through the cluster random sampling technique.

The obtained data consisted of both quantitative and qualitative data. The qualitative data were obtained from inputs or comments from science education experts, which the data were used as the references for the first revisions before the

instrument was implemented in schools. The quantitative data were obtained from the expert assessment sheet and it was used to see the quality of the developed instrument items from the aspects of content, construct, and language aiming to assess the feasibility of the science assessment as a learning assessment instrument. This data were provided by an expert lecturer in the field of science education. Field tests were conducted to see the quality of items empirically conducted at the Science Education Study Program, Universitas Negeri Yogyakarta.

The initial research was carried out in the following ways. First, analyzing the depth of the revised material of the Basic Physics I subject with MKBM, which includes identifyng the science material or concepts that could be developed as an assessment instrument for science assessment as learning. Second, designing an assessment instrument model. Third, implementing or empirical testing in the field. Next, a validation process was conducted to the first revision. Lastly, disseminating the result through international seminars attended by students, teachers, lecturers, and observers of science education.

The obtained data were then analyzed quantitatively and qualitatively. The aspects of content, construct, and language validation analysis from the expert judgment results for each item was analyzed using the Aiken formula (Setyawarno, 2020; Retnawati, 2014). The formula is given as follows:

$$V = \frac{\sum S}{[n(C - 1)]} \tag{1}$$

where $S = R - l_o$; l_o is the lowest assessment score (for example 1); C is the highest assessment score (for example 4); R is the score provided by the expert judgement; and n is the number of expert judgement.

The quantitative data were converted to qualitative scale referring to the criteria listed in Table 1 (Suparwoto, 2003). The data were from the results of expert assessments related to the feasibility of the Science assessment as a learning assessment instrument that has been developed from the aspects of content, construct, and language aspects.

Table 1. Conversion Scale of the Score to Criteria

Score of the Expert Judgement	Criteria
X > Xi + 1.8 Sbi	Excellent
Xi + 0.6 SBi < X ≤ Xi + 1.8 Sbi	Good
Xi – 0.6 SBi < X ≤ Xi + 0.6 Sbi	Enough
Xi – 1.8 SBi < X ≤ Xi – 0.6 Sbi	Poor
X ≤ Xi – 1.8 Sbi	Very Poor

Average of ideal score (Xi) = ½ (ideal maximum score + ideal minimum score); Ideal score of Standard Deviation (SBi) = ½ (ideal maximum score - ideal minimum score); and X = empirical score.

The assumption test in item response theory included unidimensional, local independence, and subgroup invariance. The assumption test was carried out using the SPSS version 25 application for Windows. The unidimensional assumption may be defined as the ability measured by using a set of single questions. The items meet the unidimensional assumption if the test items only measured one of the test takers' abilities. Item fit analysis was analyzed using the Rasch model (model 1 PL) through the QUEST application with the conditions listed in Table 2 (Adams & Kho, 1996).

Table 2. Condition of Infit MNSQ on Rasch Model

Value *INFIT MNSQ*	Description
> 1.30	Not fit with the Rasch model
0.77 – 1.30	Fit with the Rasch model
< 0.77	Not fit with the Rasch model

Descriptive statistical analysis used the MS Excel application that aimed to see an overview of each class from the aspects of process skills and cognitive abilities in online learning and problem solving including the average value, standard deviation, variance, maximum value, and minimum score (Rosana & Setyawarno, 2016). Analysis of prerequisite tests consisted of normality and homogeneity tests and was carried out with the help of SPSS version 25 for Windows (Rosana & Setyawarno, 2016). The purpose of this analysis was to see the distribution of the data and to find out the

next statistical test whether to use parametric or non-parametric statistics. The analysis of the Manova test was conducted when the analysis prerequisite test was met. Otherwise, the Kruskal Wallis expansion test for multivariate data was carried out using the SPSS version 25 application for Windows if the test was not met.

RESULTS AND DISCUSSION

Results

This research is divided into four stages. The first stage was the identification stage. The identification results are obtained in a guideline of assessment as learning instruments that are appropriate for the practicum of Basic Physics II. The second stage was the planning of assessment as learning, which is developed for the practicum of the Basic Physics II. The third stage is the preparation and development of assessment as learning by involving experts and field tests aiming to produce an appropriate instrument to be used as an assessment as learning for the practicum subject of Basic Physics II. The fourth stage is the

dissemination of research results through activities of science teacher training at the Junior High School level in Sleman and Yogyakarta and then presented into international seminars and publications so that the developed instruments can be used on a wider scale by various educators, both at schools and universities.

1. Define Stage

The purpose of this stage is to determine and define the assessment as a learning instrument to be designed. This stage is carried out through literature studies and previous research, including analysis of core competencies and basic competencies from the semester lecture design, analysis of concepts and topics of practicum in the Basic Physics II, and formulation of the indicators of assessment as learning. The results of the analysis at this stage are the guideline of the assessment as learning that is adapted to the field conditions from the assessment report and during the practicum. The guideline of the instruments is used to measure the dimensions of cognitive and process skills from virtual laboratory practicum activities that are presented in Table 3.

Table 3. Component of an assessment as learning on practicum of virtual laboratory

No	Dimension	Component of assessment	Technique of Assessment
1	Cognitive	Title, Purpose, and Theory	Documentation study of practicum report
2	Skills	Tool and Material	Documentation study of screen recorder from practicum of virtual laboratory
3	Skills	Procedure of Experiment	Documentation study of screen recorder from practicum of virtual laboratory
4	Skills	Data Display	Documentation study of screen recorder from practicum of virtual laboratory
5	Cognitive	Data Analysis	Documentation study of practicum report
6	Cognitive	Discussion	Documentation study of practicum report
7	Cognitive	Conclusion	Documentation study of practicum report

2. Design stage

This stage aimed to prepare a prototype of the developed product on a digital platform using Google Form that is set to be an assessment to make it easier for the field trials. This stage consists of preparation of an assessment as a learning instrument in the virtual practicum laboratory of Basic Physics II that aims to measure the dimensions of the process and cognitive skills. The instruments are arranged based on the results of the formulation of the instrument guideline. The format selection stage is carried out by reviewing the available formats and a developed format for the particular research. The product of this planning stage is a guideline of assessment as learning instruments in the virtual practicum laboratory of Basic Physics II that aims to measure the dimensions of process and cognitive skills.

3. Develop stage

The develop stage aims to produce an instrument assessment as learning in the virtual laboratory practicum on Basic Physics II that is used to measure the process skills and cognitive dimensions based on input from experts. This stage includes: (a) drafting, (b) validating the product by experts, and (c) field testing of the instrument. The results of stages (b) and (c) are used as the guideline for the revision. The obtained data are analyzed quantitatively and qualitatively. Details of the data analysis in this study are explained as follows.

a. The validity analysis, which includes the content, construct, and language provided by the expert judgment for each item of the assessment as learning is analyzed using the Aiken formula (Setyawarno, 2020). The validity of the

instrument is estimated through the feasibility test or relevance of the content, namely rational analysis by a competent panel or through expert judgment consisting of the aspects of content, construct, and language. The results of the validity test of 20 items on assessment as learning, which is assessed by five science education experts with four categories. Determination of valid or invalid was based on the Aiken table for 5% or p-value < 0.05, which is 0.87. Moreover, all items are valid.

b. Analysis of the scale conversion from quantitative to qualitative is from the results of

expert judgments related to the feasibility of the assessment as a learning instrument in the virtual laboratory practicum on Basic Physics II. The product aims to measure the dimensions of process skills and cognitive ability from the aspect of content, construct, and language with the criteria for the lowest and highest assessment scores are one (1) and four (4), respectively. The result of the expert judgment after the conversion is presented in Table 4.

Table 4. Result of Expert Judgement

Score of Feasibility (X)	Result	Description
94.3	On interval $86 < X \leq 98$	Good

c. The assumption test in item response theory consisted of unidimensional, local independence, and subgroup invariance with the 1-parameter logistic model (1-PL). The assumption test is carried out using the SPSS version 25 application for Windows.

1) Test of KMO and Bartlett is used to see whether the sample used in the test is sufficient. Based on the results of the factor analysis in the table of KMO and Bartlett's test, the chi-square value in the Bartlett test is 433.224 with a p-value of < 0.01 or a significance of less than 5%. Then, the sample size used in the test of the factor analysis has satisfies the needs of the test sample.

2) The chi-square test is used to test the assumption of local independence. Items that satisfy the assumption of local independence are number items that have a value of sig < 0.05. The results of the analysis show that all items in both peer and self-assessment for the

process skills and cognitive dimensions have satisfied the local independence.

3) The third assumption is the invariance of item parameters and capability parameters. This assumption is proven by estimating the item parameters in different groups of test-takers. The class is divided into two groups from the aspect of item difficulty level through linear regression test with a gradient close to one (Retnowati, 2016).

4) The item fit is analyzed with the Rasch model (1 PL model) using the QUEST application. As a result, all items have been fit with the Rasch model.

5) Descriptive statistical analysis using the SPSS version 25 for Windows application is conducted to see an overview of the aspects of the assessment as learning both in peer assessment (A score) and self-assessment (D score). The result of the analysis is presented in Table 5.

Table 5. Descriptive statistical analysis of the assessment results on assessment as learning

	N	Mean	Std. Deviation
Score A	81	34.0741	2.16089
Score D	81	34.5432	2.06791

6) Prerequisite test analysis consisted of the normality test (one-sample Kolmogorov-Smirnov test) and homogeneity test (test of homogeneity of variances) and analyzed with the help of SPSS version 25 for Windows application. The purpose of this analysis is to see the data distribution in order to know whether the next statistical test uses parametric or non-parametric statistics. The

results of the analysis of the prerequisite test conclude that the data are homogeneous and normally distributed.

7) Analysis of the difference test, namely the independent sample t-test in the analysis prerequisite test is carried out using the SPSS version 25 application for Windows. The analysis of the difference test obtains the value of sig, > 0.05, so it is concluded that

there is no difference between peer assessment and self-assessment in the Basic Physics II practicum.

4. Disseminate Stage

The disseminate stage is the introduction stage of the developed product on a wider scale by presenting it in national and international science education seminars attended by various science education parties, such as teachers, lecturers, and science education students. Moreover, the product is also published in an accredited publication.

Discussion

The type of this study is R & D, which is applied to the assessment as learning. The development model used is 4-D. The 4-D development model consisted of four main stages, namely define, design, develop, and disseminate (Donald, 1982; Paidi, 2010). The objectives of the research are to (1) analyze and create assessment as learning in the virtual practicum of basic physics subject to measure the process and cognitive skills in online learning, (2) analyze and create assessment as learning in virtual practicum of Basic Physics II to measure cognitive ability in online learning, (3) simultaneously analyze and create assessment as learning in the virtual practicum of Basic Physics II to measure the process skills and cognitive abilities in online learning, and (4) analyze and find out the effectiveness of the process skills and cognitive ability assessment instruments in online learning through the test of the assessment as learning in the virtual practicum of Basic Physics II in online learning. The development of the assessment as learning instrument is directed to the assessment model, which includes five components, namely: (1) objectives consisting of learning objectives, indicators, and criteria for success; (2) structured learning tasks; (3) self-assessment, (4) peer assessment; and (5) feedback for learning improvement. These five components are integrated into the 4-D R & D stage.

Analysis and preparation of assessment as learning in the virtual practicum of Basic Physics II is carried out through the stages of depth analysis of the revised material of Basic Physics II and implemented at the Undergraduate level of Science Education, Universitas Negeri Yogyakarta, and identify science materials or concepts of the assessment, namely process skills and cognitive abilities, assessment components of practicum reports and performance during the virtual practicum, and assessment techniques following the characteristics of practicum. The evaluation components of the virtual performance and practicum reports consist of (1) title, objectives, and theoretical basis, (2) tools and materials, (3) experimental procedures, (4) data presentation, (5) data analysis, (6) discussion, and (7) conclusions (Houtz, 2010; Rosana, 2015). The results of the analysis become a guideline for creating assessment indicators of the product following the characteristics of the Basic Physics II practicum. Each component is converted into indicators that becomes an assessment sheet for both peer assessment and self-assessment.

The indicators for the assessment component of the title, objective, and theoretical basis are i) writing the title and objectives correctly, ii) relevance to the concept of the practicum topic, iii) discussing the concept of the practicum topic completely, and iv) writing clearly and coherently. The indicators of the assessment of instruments and materials are i) writing all the instruments and materials, ii) making an experimental design, iii) writing the experimental steps using sentences that are slightly different from the instructions, iv) taking experimental data virtually, and v) being skilled in selecting instruments and materials. The assessment indicators of the experimental procedure are i) assembling the instruments and materials needed correctly, ii) taking practicum data (has successfully taken the data at one time), iii) repeating to obtain data for at least five variations of data, iv) data collecting carried out alternately and in an orderly manner, and v) applying knowledge about work procedures during practicum. The assessment indicators of the presentation of the experimental data are i) presenting in an appropriate tabular format, ii) using the symbol of the quantity being measured, iii) using units, iv) writing the uncertainties, and v) observing all variables and obtaining accurate and appropriate data. The indicators of the data analysis assessment are i) the data analyzed is complete and correct by connecting between the measured quantities, ii) using international units (SI) for the formula and units in the calculation, iii) the graphic image is complete and correct (either manually or using computer application), and iv) coherent and systematic following the rules for writing significant figures and uncertainties. The indicators of the discussion assessment are i) making a relationship between variables in the experiment, for example, directly or inversely proportional, ii) comparing the experimental results with the theory, iii) new findings in the experiment following the theory based on the objectives of the experiment being studied, and iv) describing an explanation of the reasons or chronology when the experimental findings do not follow the theory. The last indicator is the assessment of conclusions, namely i) the appropriateness of the conclusions with the objectives and ii) the conclusions explain the relationship among variables based on the objectives

of the experiment. These are indicators of the assessments, both in terms of process skills and cognitive abilities (Sheeba, 2013; Houtz, 2010; Rezba, 2002). These indicators serve as the basis for the sheets of assessments of process skills and cognitive abilities that are applied to the online practicum of the Basic Physics II.

The preparation of the instrument includes inviting science education experts and implementing the instrument in the field trials. The content validation test is carried out using the Aiken formula. Determination of the validity is based on the Aiken table for 5% or p-value < 0.05, which is 0.87. The result of the V-count states that the developed instrument has fulfilled the content validation. In addition, the instrument feasibility assessment is analyzed using a score conversion scale to the criteria of the feasibility, which is 94.3. This value is in the interval of $86 < X < 98$ with a good category. The empirical test is carried out by applying the assessment as a learning instrument to science education students in the practicum of Basic Physics II. The results of the empirical test are analyzed in several stages, namely fulfilling the assumption test in the item response theory and item suitability test with the Rasch model.

Unidimensional assumption test is performed using KMO and Bartlett's test and total variance explained with the help of SPSS version 25 application for Windows. KMO and Bartlett's test is used to find out whether the sample is sufficient or not. Based on the results of the factor analysis in the KMO and Bartlett's test table, the chi-square value in the Bartlett test is 433.224 with a p-value of < 0.01 or a significance of less than 5%. Then, the sample size used in the factor analysis test has satisfies the needs of the test sample. Next, the assumption test is the total variance explained, which is used to find out the dominant factors in the item set. Based on the table of total variance explained, the highest eigenvalue is determined. The number of factors on the item set from the eigenvalue is > 1. This is further strengthened by the cumulative percentage value of 5 measurement factors on peer assessment of 68.330 and self-assessment of 58.740. The minimum criterion of the cumulative percentage is 50%. Then, it is determined that some factors are appropriate. Thus, the unidimensional assumption on the instrument is proven.

The chi-square test is used to test the assumption of local independence. The test is aimed to ensure that the responses of the test subjects toward the item are always independent. The analysis is carried out with the help of the SPSS version 25 application for Windows. The indicated items satisfy the assumption of local independence with a sig. value < 0.05. The analysis results show that all items in both peer and self-assessments for the process skills and cognitive dimensions have satsified local independence.

The third assumption is the invariance of item and capability parameters. This assumption is proven by estimating the item parameters in different groups of test-takers, which is divided into two groups from the aspect of item difficulty level through linear regression testing with a gradient close to one. The results of the regression test, both peer and self-assessments produce the regression equations of y = 0.9207x + 0.0783 and y = 0.9131x + 0.0852, respectively. This value indicates the gradient is close to 1 so that the invariance assumption of the item parameters has been satisfied.

The item fit is analyzed with the Rasch model (1 PL model) using the QUEST application. The determination of the fit item with the model in the QUEST program is based on the average value of INFIT mean of square (INFIT MNSQ) and its standard deviation or the average value of INFIT MNSQ or INFIT t. Determination of the fit of each item with the model in the QUEST program is based on the INFIT MNSQ value or the INFIT t item value with the conditions following Adams & Kho (1996). The analysis results show that the developed and validated item by the expert empirically has shown suitability with the Rasch model seen from the INFIT MNSQ value in the range of 0.77 - 1.30. The results of the analysis using the INFIT MNSQ QUEST for the peer assessment produces a value of 1.01 with a standard deviation of 0.10, while self-assessment produces a value of 1.01 with a standard deviation of 0.13.

The instrument of assessment as a learning in the virtual practicum has been tested in the practicum of Basic Physics II to measure cognitive abilities in online learning. The results of the assessment implementation are analyzed using descriptive statistics with the average scores for the peer and self-assessments of 34.0741 ± 2.16089 and 34.5432 ± 2.06791, respectively. The analysis results show that these values are close. Then, further simultaneous analysis is conducted to find out the effectiveness of the assessment as a learning by using the different independent sample t-test with the help of SPSS version 25 for Windows. The analysis of the different test of independent sample t-test is carried out as the data are normally distributed and homogeneous. The analysis of the independent sample t-test with a 2-tailed sig. value is 0.16. The analysis shows the results of sig. > 0.05 so it can be concluded that there is no difference between peer and self-assessments in the practicum of Basic Physics II. In addition, the effectiveness of the instrument is determined by comparing the peer and self-assessments. As there is no difference

between peer and self-assessments, the instrument is declared effective for use in practicum assessment.

CONCLUSION

An assessment as a learning instrument has been created, which consists of peer and self-assessments in the practicum of Basic Physics II on online learning with 10 items, completed with indicators for assessing i) titles, objectives, and theoretical basis, ii) tools and materials, iii) experimental procedures, iv) data presentation, v) data analysis, vi) discussion, and vii) conclusions. The instrument is valid based on the Aiken formula and empirically based on the Rasch model. The results of measuring process skills and cognitive abilities with the assessment as a learning instrument in the practicum of Basic Physics II on online learning obtain the average scores of peer and self-assessments of 34.0741 and 34.5432, respectively. The results of the independent sample t-test toward the implementation of assessment as learning, which consist of peer and self-assessments in the practicum of Basic Physics II in online learning is 0.160, which is higher than 0.5. The score indicates that there is no significant difference in the implementation of assessment as learning of peer and self-assessments to be used in the practicum of Basic Physics II.

ACKNOWLEDGEMENTS

REFERENCES

Afrizon, R., Ratnawulan, & Fauzi, A. (2012). Peningkatan Perilaku Berkarakter dan Keterampilan Berpikir Kritis Siswa Kelas IX MTSn Model Padang pada Mata Pelajaran IPA-Fisika Menggunakan Model Problem Based Instruction. *Jurnal Penelitian Pembelajaran Fisika*, *1*, 1– 16.

Anderson, L. W. & Krathwohl. (2001). A Taxonomy for Learning, Teaching and Assessing a Revision of Blooms Taxonomy of Educational Objetives. New York: Longman.

Abungu, O. & Wachanga. (2014). Journal of Educational and Social Research: The Effect of Science Process Skills Teaching Approach on Secondary School Students' Achievement in Chemistry in Nyando District, Kenya. Kenya: Management Egerton University.

Ary Donald, Jacobs, Lucy Cheser, & Razavieh, A. (1982). Introduction to Researt in Education (terjemahan). Surabaya: Usana Offset Printing.

Bybee, R., Mccrae, B., & Laurie, R. (2009). PISA 2006: An Assessment of Scientific Literacy. *Journal of Research in Science Teaching*, *46* (8), 866-867.

Bolat, Y. & Karakus, M. (2017). Design Implementation and Authentic Assessment of a Unit According to Concept-based Interdisciplinary Approach. *International Electronic Journal of Elemtary Education*, *10*(1).

Candra Sayekti, I., Sarwanto, & Suparmi. (2012). Pembelajaran IPA Menggunakan Pendekatan Inkuiri Terbimbing Melalui Metode Eksperimen dan Demonstrasi Ditinjau dari Kemampuan Analisis dan Sikap Ilmiah Siswa. *Jurnal Inkuiri*, *1*(2), 142–153.

Chiappetta, E. L. & Koballa, T. R. (2010). Science Instruction in the Middle and Secondary Schools. New York: Allyn & Bacon.

Diani, R. (2015). Pengembangan Perangkat Pembelajaran Fisika Berbasis Pendidikan Karakter dengan Model Problem Based Instruction. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *4*(2), 241–253. https://doi.org/10.24042/jpifalbiruni.v 4i2.96

Fensham, P. J. (2018). Science Education Policy-Making: Eleven Emerging Issues. Paris: UNESCO, Section for Science, Technical and Vocational Education. Accessed from unesdoc.unesco.org/images/0015/001567/156 700e.pdf.

Holbrook, J. & Rannikmae, M. (2007). The Nature of Science Education for Enhancing Scientific Literacy. *International Journal of Science Education*, *29*(11), 1347-1362.

Houtz, B. (2010). Teaching Science Today. Corinne Burton.

Human Development Report. (2015). Briefing Note for Countries on the 2015 Human Development Report for Indonesia. Accessed on the 3 March 2016 from http://hdr.undp.org/sites/all/themes/hdr_them e/country-notes/IDN.pdf.

Komikesari, H. (2016). Peningkatan Keterampilan Proses Sains dan Hasil Belajar Fisika Siswa pada Model Pembelajaran Kooperatif Tipe Student Team Achievement Division. *Jurnal Keguruan dan Ilmu Tarbiyah*, *1*(1), 15–22.

Kurniawan, D. T. (2014). Model Pembelajaran Berbasis Masalah Berbantuan Website Interaktif pada Konsep Fluida Statis.

Indonesian Journal of Science and Mathematics Education, *01*(1), 49-54.

Murniasih, L., Subagia, I. W., Sudria, I. B. N., Pascasarjana, P., & Ganesha, U. P. (2013). Pengelolaan pembelajaran IPA: Studi Kasus pada Perguruan Tinggi di Daerah Terdepan, Terluar, dan Tertinggal. Program Studi Pendidikan IPA, Program Pascasarjana.

Osborne, J. (2007). Science Education for Twenty First Century. *Eurasia Journal of Mathematics and Science Education*, *3*(3), 173-184.

Paidi. (2011). Diktat Perkuliahan Metodologi Penelitian Pendidikan Biologi. Yogyakarta: FMIPA, UNY.

Raina Vovianti, N. (2011). Kontribusi Pengelolaan Laboratorium dan Motivasi Belajar Siswa Terhadap Efektivitas Proses Pembelajaran. *Jurnal Penelitian Pendidikan*, Special Edition (1), 158– 166.

Retnawati, H. (2014). Teori Respons Butir dan Penerapannya. Parama Publishing.

Retnawati, H. (2016). Validitas Reliabilitas & Karakteristik Butir. Parama Publishing.

Rezba, R. J. (2002). Learning and Assesing Science Process Skill. Kendall/Hunt Publishing Company.

Rosana, D. (2015). Evaluasi Pembelajaran Sains. Yogyakarta: UNY Press.

Rosana, D. (2015). Evaluasi Pembelajaran Sains (1st ed., Vol. 1). Yogyakarta: UNY Press.

Rosana, D., & Setyawarno, D. (2016). Statistik Terapan untuk Penelitian Pendidikan. Yogyakarta: UNY Press.

Rusman. (2013). Model-Model Pembelajaran Mengembangkan Profesionalisme Guru. Jakarta: PT. Raja Grafindo Persada.

Sahlan, M. & Rusilowati. (2012). Literasi Sains Sebagai Kerangka Asesmen Pembelajaran Sains Abad 21. *Prosiding Seminar Nasional IPA IV UNESA Surabaya*.

Setyawarno, D. (2020). Analisis Skor. Yogyakarta: FMIPA Universitas Negeri Yogyakarta.

Shwartz, Y., Ben-Zvi, R., Hofstein, A. (2006). Chemical Literacy: What It Means to Scientists and School Teachers? *Journal of Chemical Education*, *83*, 1557-1561.

Sheeba, M. N. (2013). An Anatomy of Science Process Skills in the Light of the Challenges to Realize Science Instruction Leading To Global Excellence in Education. Educationia Confab.

Subana, M. R., & Sudrajat. (2000). Statistik Pendidikan. Bandung: Pustaka Setia.

Sugiyono. (2010). Metode Penelitian Pendidikan; Pendekatan Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta.

Suryani, A., Siahaan, P., & Samsudin, A. (2015). Proseding Seminar Nasional: Pengembangan Instrumen Tes untuk Mengukur Keterampilan Proses Sains Siswa pada Materi Gerak. Bandung: UPI.

Titik Harsiati, (2018). Karakteristik Soal Literasi Membaca pada program PISA. *Jurnal LITERA*, 17(1).

Yagger, R. E. (1996). Science/Technology/Society as Reform in Science Education. Albany: State University of New York Press.

Zulaeha, Darmadi, I. W., & Werdhiana. (n.d.). Pengaruh Model Pembelajaran Predict, Observe and Explain terhadap Keterampilan Proses Sains Siswa Kelas X SMA Negeri 1 Balaesang. *Jurnal Pendidikan Fisika*, *2*(2), 1– 8.