



# Virtual Physics Laboratory with Real World Problem Based on Ngada Local Wisdom in Basic Physics Practicum

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## ABSTRAK

Penelitian ini didasari oleh adanya permasalahan di mana kegiatan praktikum pada mata kuliah Praktikum Fisika Dasar tidak dapat lagi dilaksanakan secara optimal karena terjadinya perubahan model pembelajaran dari tatap muka (luring) menjadi dalam jaringan (daring) pada masa pandemi COVID-19. Tujuan penelitian ini adalah untuk mengembangkan virtual physics laboratory sebagai media dalam pelaksanaan kegiatan praktikum dan menganalisis kelayakan produk tersebut melalui hasil validasi para ahli dan hasil uji coba produk pada calon pengguna. Jenis penelitian ini adalah Research & Development dengan model pengembangan ADDIE. Subjek penelitian ini adalah 12 dosen dan 47 mahasiswa program studi pendidikan IPA STKIP Citra Bakti. Teknik pengumpulan data menggunakan lembar validasi dan angket. Instrumen pengumpulan data berupa lembar penilaian validasi dan angket respon calon pengguna. Data hasil penelitian ini dianalisis secara deskriptif kualitatif untuk memutuskan kelayakan produk yang dikembangkan. Hasil penelitian menunjukkan bahwa rerata skor validasi dari ahli materi sebesar 4,63, ahli media sebesar 4,41, ahli desain pembelajaran sebesar 4,30, dan ahli bahasa sebesar 4,51. Hasil validasi dari keempat validator tersebut berada pada kategori sangat baik. Sementara itu, hasil uji coba produk kepada dosen dan mahasiswa sebagai calon pengguna berada pada kategori sangat baik dengan rerata skor masing-masing sebesar 4,53 dan 4,57. Berdasarkan data tersebut, produk virtual physics laboratory dengan real world problem berbasis kearifan lokal Ngada ini direkomendasikan untuk diterapkan pada mata kuliah Praktikum Fisika Dasar dan membantu mahasiswa dalam kegiatan praktikum secara mandiri.

## ABSTRACT

This research is based on the problem where practical activities in the Basic Physics Practicum course can no longer be carried out optimally due to changes in the learning model from face-to-face (offline) to online (online) during the COVID-19 pandemic. The purpose of this study was to develop a virtual physics laboratory as a medium in carrying out practical activities and to analyze the feasibility of the product through the validation results of experts and the results of product trials on prospective users. This type of research is Research & Development with ADDIE development model. The subjects of this study were 12 lecturers and 47 students of the STKIP Citra Bakti science education study program. Data collection techniques using validation sheets and questionnaires. The data collection instruments are in the form of validation assessment sheets and response questionnaires of prospective users. The data from this study were analyzed qualitatively descriptive to decide the feasibility of the product being developed. The results of the research showed that the average validation score of the material expert was 4.63, the media expert was 4.41, the learning design expert was 4.30, and the linguist was 4.51. The validation results of the four validators are in the very good category. Meanwhile, the results of product trials to lecturers and students as potential users are in the very good category with an average score of 4.53 and 4.57, respectively. Based on these data, this virtual physics laboratory product with real world problems based on Ngada local wisdom is recommended to be applied to the Basic Physics Practicum course and to help students in their independent practicum activities.

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## 1. INTRODUCTION

The world now is faced with a delicate problem regarding the spreading of CoronaVirus Disease-19 or COVID-19. The virus infection was first found in Wuhan City, China in late December 2019 (Wen et al., 2020; Zhang et al., 2020; Calvo et al., 2020). Eventually, On 30<sup>th</sup> January 2020, WHO declared COVID-19 as Public

*Health Emergency of International Concern* (PHEIC) (Nathavitharana et al., 2020; Djalante et al., 2020; Sohrabi et al., 2020). This virus spreads rapidly and has infected to almost every countries in the world including Indonesia. The outbreak of the virus has its effects on all over the aspects of human life including the educational activities in Universities, especially with the implementation of Work From Home (WFH) policy for lecturers and employees and the policy of Study From Home (SFH) for the students (Bervell & Arkorful, 2020; Abad-Segura et al., 2020; Maulana & Hamidi, 2020; Satyawan et al., 2020). The change in the learning model from face-to-face to online is a demand that must be implemented as part of the adjustment to the spread of COVID-19 (Khachfe et al., 2020; Laksana, 2020; Durnali, 2020; Abidah et al., 2020). Digital transformation is no longer only a discourse but has to be applied in the learning process in order that the quality of the learning process can still be achieved albeit the online program (Ogunmokun et al., 2020; Adedoyin & Soykan, 2020). Especially, in the middle of this pandemy, the educator can no longer be bound to the old teaching techniques such as taking the class and teaching with the old method, old books, and limited learning sources (Leszczyński et al., 2018; Sadikin & Hakim, 2019). The educators are demanded to create innovations in carrying out learning process by using technology as its medium (Sadikin & Hamidah, 2020; Kumari et al., 2020). Lacking of learning sources is no longer a problem in this era of sophisticated technology (Neppala et al., 2018; Hamidaturrohmah & Mulyani, 2020). The educators are encouraged to be able to establish online learning that gives students opportunities to access all the information needed flexibly anytime, anywhere (Muhaimin et al., 2019a; Hwang et al., 2020).

The implementation of Basic Physics Practicum lectures in the STKIP Citra Bakti Science Education study program during the pandemic cannot run effectively. Lectures that cannot be carried out in real laboratories and the lack of practical tools are the main obstacles in their implementation. The lectures given are in the form of independent assignments and the implementation of practicum is limited to simple activities that do not require laboratory equipment and are carried out independently in their respective homes. This of course has an impact on the mastery of the material and student performance skills. Therefore, digital learning media, that can help overcome this problem, is needed. The implementation of learning activities, especially practicum activities in the field of science that require practical tools and materials, demands the role of the media so that practicum activities can still be carried out effectively even though they are not carried out directly in real laboratories (Hidayah & Priscylio, 2019; Jang et al., 2021).

Learning media itself is defined as a set of learning tools that contain teaching materials, methods and strategies in the implementation of learning, as well as evaluations that are arranged systematically to achieve learning objectives (Istuningsih et al., 2018; Neppala et al., 2018). The industrial revolution 4.0 currently offers many new things in the world of education, including learning media innovations such as the implementation of virtual practicum activities. A virtual laboratory is an interactive situation with the help of applications on a computer in the form of experimental simulations of practical activities (Vysakh et al., 2020; Yusuf & Widyaningsih, 2018). This type of laboratory can be used to increase students' understanding of study matters and is suitable to anticipate problems related to the unpreparedness of the use of real laboratories (Husnaini & Chen, 2019; Tycho et al., 2020). A virtual laboratory is an interactive experience where students can observe and manipulate system objects that are generated to meet learning objectives (Achuthan et al., 2018; Ristina et al., 2020). Students can explore virtual laboratories according to their speed and needs in understanding the material and practicum activities (Alatas & Sakina, 2019; Diana et al., 2020).

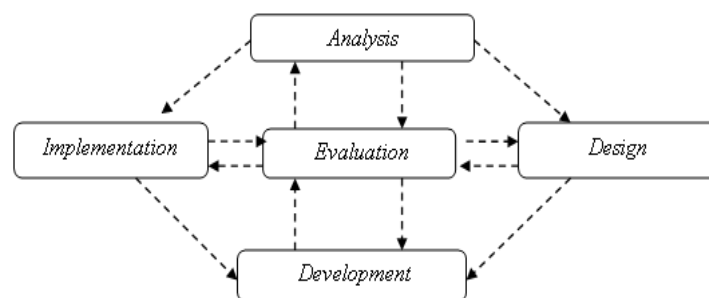
The advantages of this virtual laboratory are that practicum activities can be carried out anywhere and anytime without being bound by time, not requiring real tools and materials, and being able to observe molecular aspects more clearly (Dyrberg et al., 2017; Murugan & Kamisah, 2018). Virtual physics practicum activities will help students in the lecture process during the COVID-19 pandemic. Students do not have to prepare tools and materials, but can still carry out quality practicum activities (Jones, 2018; Ristina et al., 2020). However, virtual laboratories also have a weakness, namely the lack of experience to solve problems and assemble tools (Su & Cheng, 2019; Goudsouzian et al., 2018). Virtual laboratories cannot provide real experience in the field and have no effect on the performance skills of high school or university students in practical activities. Therefore, an educator is required to be able to prepare well the strategies used in the implementation of virtual practicum activities in order to minimize these weaknesses. (Zulimah et al., 2018; Wilde & Hsu, 2019). One alternative that can be used to increase the effectiveness of using virtual laboratories is to present real world problems in practical activities. The learning process by presenting real problems will help students develop and apply important skills, namely problem solving based on self-study skills or group work and gain broad knowledge (McCormick et al., 2015; Kua et al., 2019). Regarding the concept of real world problem, the understanding of the students upon study matters learned getting better when real world problem applied and students are more actively involved if matters learned are in their daily life. (Killen, 2009; Kua, 2018).

Learning activities designed using media based on indigenous culture will give opportunities for the students to learn from their own environment. Local wisdom is the way of life, knowledge and strategies of life in the form of activities done by local society in answering the daily needs (Zafi, 2017; Samri et al., 2020). Culture must be learned, understood, and internalized because culture gives benefit for more meaningful life of

human survival in the days to come (Baka et al., 2018; Lidi et al., 2020). The most effective way of preserving culture is through education (Sebo et al., 2017; Laksana et al., 2019). Culture needs to be integrated in the world of education, both in the form of models and learning media which can later be used by students to learn so that they can achieve learning goals while at the same time achieving national education goals. The local potentials of Ngada district include building traditional houses, using alternative energy sources, making traditional drinks (moke), using natural materials as natural dyes, using certain plants as medicine, weaving, weaving, traditional dances, carvings, and traditional rituals. This local knowledge can be used to explain a number of concepts in physics such as Newton's law of force and law (weaving process), temperature and heat (making traditional drinks and traditional houses), heat and pressure (weaving activities), force and pressure (carving). This research was conducted to produce learning media in the form of a virtual physics laboratory by integrating elements of Ngada culture in the presentation of practical activities. This media can be used to carry out quality practicum activities independently without a real laboratory. Physics practice activities designed using media that put forward real problems in everyday life can improve student performance skills. The virtual laboratory developed will provide a practicum atmosphere based on the experiences experienced by students in everyday life.

## 2. METHOD

This research is a Research & Development with ADDIE model. The product developed in this research is a virtual physics laboratory with real world problems based on Ngada local wisdom. This model consists of five steps: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The selection of this model was based on the consideration that this model was developed systematically and based on the theoretical foundation of learning design. This model is programmed with systematic sequences of activities. The product development procedure is presented in Figure 1 below:



**Figure 1** ADDIE Model (Kurt, 2019)

This research was conducted at STKIP Citra Bakti, Golewa District, Ngada Regency, East Nusa Tenggara Province. The subjects in this study were 12 lecturers and 47 students at STKIP Citra Bakti. While the object under study is a virtual physics laboratory. Data collection techniques using validation sheets and questionnaires. The instruments used in the study were in the form of an assessment sheet on the results of the validation and response questionnaires of prospective users. This instrument has been declared valid and reliable. Validity testing was carried out using the SPSS for Windows version 17.0 program. Decision making is based on

values  $r_{count}$  (Corrected Item-Total Correlation)  $>$   $r_{table}$  amount 0,378 for  $df = 20 - 2 = 18$ , and  $\alpha = 0,05$  then all statements for each assessment have a valid status. Furthermore, the instrument reliability test used the Alpha Cronbach formula using the SPSS program. Each instrument has *Alpha Cronbach*  $>$  of 0,600 that makes all the instruments reliable. The data collected in this study were analyzed using descriptive and inferential statistics as follows: (1) Qualitative data regarding the quality of the virtual physics laboratory product as validated by experts were analyzed descriptively. The analysis technique is done by grouping the information obtained in the form of input, criticism, and suggestions to produce quality products. (2) Quantitative data regarding product quality in the form of test results to lecturers and students in the use of a virtual physics laboratory compiled in a number of questionnaires related to content presentation, media design, learning design, and language as well as the impact and usability of the product were analyzed through score conversion using a Likert scale. The response questionnaire grille of lecturers and students are presented in the Table 1.

**Table 1.** Lecturers Response Questionnaire Grille

No	Assessment Aspect	Number
1	Material Presentation	8
2	Learning Design	6
3	Media Design	7
4	Using of Indonesian and Ngadanese Language	6
<b>Total</b>		<b>27</b>

**Table 2.** Students Response Questionnaire Grille

No	Assessment Aspect	Number
1	Material Presentation	5
2	Product Design	5
3	Language Using	4
4	Product Using Impact	4
5	Usability	4
<b>Total</b>		<b>22</b>

The development of the virtual physics laboratory begins with the analysis stage. In the analysis phase, the activities carried out include (a) analyzing the needs of students in Basic Physics Practicum lectures during the COVID-19 pandemic which requires students to study from home; (b) analyzing the lecture material for the Basic Physics Practicum within the framework of the Science Education study program curriculum at STKIP Citra Bakti. At the design stage, the activities carried out are in the form of compiling a conceptual and theoretical framework based on the results of needs analysis and material analysis so that an overview of the product to be developed includes elements that make it easier for students to carry out practical activities in the Basic Physics Practicum course independently with audio-visual assistance in virtual physics laboratory classes. At the development stage, it is done by creating a virtual physics laboratory with real world problems based on the local culture of the Ngada people. At the implementation stage, the activities carried out were in the form of product validation by material experts, learning design experts, learning media experts, and linguists as well as testing the use of a virtual physics laboratory with real world problems based on the local culture of the Ngada community to lecturers and students. Furthermore, at the evaluation stage, an evaluation is carried out in the form of revisions to the results of product trials until the final product of the study is obtained. The reference for converting scores to qualitative values based on the 5 scale assessment criteria is presented in the table below (Widoyoko, 2014).

**Table 3.** Guideline of 5 Scale Scoring Conversion

Interval Score	Criteria
$\bar{x} > 4,2$	Very Good
$3,4 < \bar{x} \leq 4,2$	Good
$2,6 < \bar{x} \leq 3,4$	Enough
$1,8 < \bar{x} \leq 2,6$	Less

### 3. RESULT AND DISCUSSION

#### Result

This development research begins with analyzing (analyze) the needs of students in the online learning process in the Basic Physics Practicum course. In the curriculum of the Science Education Study Program at the Citra Bakti School of Teacher Training and Education, the Basic Physics Practicum Course is intended to introduce and train students in science practicum related to Basic Physics course material. Basic Physics Practicum material is correlated with Basic Physics course material. In this course, students will study uncertainty in measurement, Atwood plane, centripetal force, physical pendulum and free fall motion, resonance of sound waves, coefficient of long expansion, temperature and heat. Giving practice is expected to strengthen students' understanding of physical phenomena related to kinematics, dynamics, and waves. The material given in the Basic Physics Practicum lecture through a virtual physics laboratory is the material for temperature and heat. The subject matter of temperature and heat includes temperature and thermometers, expansion, heat, changes of state, and heat transfer. The results of the material analysis show that temperature and heat are one of the physical materials that are closely related to the daily environment. However, the reality on the ground shows

that there are still many students who make conceptual errors so that they have difficulty solving problems related to the material. Physics concepts that are taught often do not directly touch everyday experience. For this reason, through practical activities on temperature and heat material with real world problems based on local wisdom of the Ngada community, misconceptions that occur when understanding the concepts of temperature and heat can be overcome.

At the design stage, it begins with compiling a draft of a virtual physics laboratory. The software product used in this research is Adobe Flash CS6, while the hardware is an Intel Pentium 200 Mhz computer unit and a CDROM drive. The design of the virtual physics laboratory consists of the Title of Practical Materials, Using Instructions of Virtual Physics Laboratory, Introduction of Working Actions in Laboratory, Experimental Objectives, Theoretical Foundations, Practical Activities, Discussion Activities, and Competency Tests. The product is equipped with a number of case examples, simulations, videos, and animations that emphasize elements of local wisdom of the Ngada community. The product also provides navigation buttons such as a home button that directs students to virtual physics laboratory menus, a developer profile button, and an exit button. Next, is compiling research instruments in the form of expert validation sheets and questionnaires for responses from prospective users and testing the validity and reliability of the instrument. This instrument has been declared valid and reliable. The test was conducted on 20 respondents and the results were analyzed using the SPSS for Windows version 17.0 program.

At the development stage, the research product was realized so as to produce a virtual physics laboratory with real world problems based on the local wisdom of the Ngada community that could answer the needs of students and provide a quality lecture experience even though it was conducted online. The characteristics of the virtual physics laboratory learning media that were developed are that this product combines the delivery method, the way to do the practicum, and the learning style that provides the opportunity for participants to build active interactions in practical activities that occur online. Practical activities carried out through the virtual physics laboratory provide opportunities for students to get a quality lecture process independently without being limited by space and time. A number of case examples, pictures, simulations, videos and animations provided in this virtual physics laboratory contain elements of local wisdom of the Ngada community so as to provide an interesting and fun practicum atmosphere without reducing the value of quality learning. Virtual physics laboratory products are shown in Figures 2 below:



Figure 2. Display of Virtual Physics Laboratory Materials

The Learning Media of the virtual physics laboratory is then being validated by 4 experts consisting of material experts, learning design experts, learning media experts, and linguists. Validation result is in the category of Very Good. The average validation score from all fourth validators is shown in the graphic below.

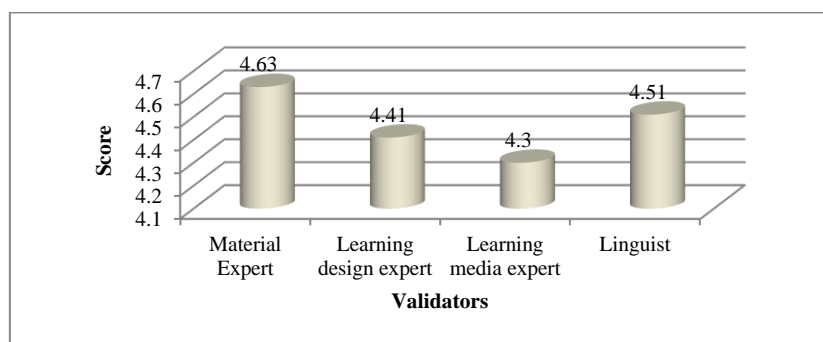


Figure 3. Average Product Validation Score



This learning media was then tested on 12 lecturers and 47 students of the science education study program. The data from the test results of lecturers' responses to the use of virtual physics laboratory learning media with real world problems based on Ngada local wisdom can be seen in Table 4. Based on the data in Table 4, information is obtained that the responses of 12 lecturers to the use of media from aspects of material presentation, learning design, media learning, and language use are in the very good category with the average score obtained is 4.53. Meanwhile, the data from the test results of student responses to the use of virtual physics laboratory learning media with real world problems based on Ngada local wisdom are shown in Table 5. The data in Table 5 shows that the responses of 47 students to the use of media in the Basic Physics Practicum lecture are in the very category. good with an average score of 4.57. This shows that the existence of this digital learning media has a positive impact on both lecturers and students, including encouraging student motivation in participating in Basic Physics practicum activities which are carried out online.

**Table 4.** Product Test Result to 47 Students

No	Assessment Aspect	Average score	Category
1	Material Presentation	4,65	Very Good
2	Product Design	4,58	Very Good
3	Language Using	4,50	Very Good
4	Product Using Impact	4,61	Very Good
5	Usability	4,52	Very Good
<b>Total</b>		<b>4,57</b>	<b>Very Good</b>

## Discussion

Online learning activities are currently a demand that must receive attention from educators as an effort to break the chain of COVID-19 spread (Bahasoan et al., 2020; Ferri et al., 2020). One of them is the implementation of practicum activities in science education study programs which basically require laboratories and assistance in their implementation. The development of a virtual physics laboratory with real world problems based on Ngada's local wisdom was carried out to provide easy access to learning for students in the midst of the COVID-19 pandemic. The development of this learning media is based on the results of the analysis of the needs of students and lecturers in Basic Physics Practicum lectures. The era of education which is influenced by the industrial revolution 4.0 supports the use of digital technology in the learning process (Joshi et al., 2020; Omotayo & Haliru, 2020; Vlachopoulos, 2020). This allows change on face to face learning becomes virtual learning including virtual laboratory (Bortnik et al., 2017; Nolen & Koretsky, 2018; Gambari et al., 2018).

Based on the validation results from the experts, it is known that the ability of researchers in presenting learning material for the Basic Physics Practicum is in the very good category. The aspects assessed by the material expert consist of several parts, namely learning, the scope of practicum activities, the substance of the material, the suitability of the material with real world problems, clarity of material with real world problems based on Ngada local wisdom, presentation techniques, and presentation support. The clarity of the media will make it easier for students to understand the learning material (Churchill et al., 2013; Fonda & Sumargiyani, 2018; Komikesari et al., 2020). The assessment of the learning design expert is in the very good category. The assessment is related to the completeness of the virtual physics laboratory components, the case examples presented are based on Ngada local wisdom, the compatibility of the presentation of the virtual physics laboratory with real world problems, the suitability of image placement, and the compatibility of the contents of the virtual physics laboratory with the characteristics of real world problems based on Ngada local wisdom. The assessment from digital learning media experts in the form of a virtual physics laboratory is also in the very good category. Assessment includes cover, typography, display, visual communication components, and software engineering. Meanwhile, the assessment of linguists regarding the use of Indonesian and the Ngada regional language in relation to the presentation of material/information in the media is in the very good category. The media developed has included the elements needed in online learning, namely interactivity, independence, accessibility, and enrichment (Sriyanto et al., 2019; Anandari et al., 2019; Nisa et al., 2020).

The results of the questionnaire of prospective users consisting of lecturers and students of the STKIP Citra Bakti science education study program also showed a positive response to the use of the product. This is evidenced by the achievement of scores with very good categories in each aspect of the assessment, namely material presentation, learning design, product design, use of Indonesian and Ngada regional languages, impact of product use, and usability. This means that the virtual physics laboratory product with real world problems based on Ngada's local wisdom that was developed has a positive influence on the implementation of practicum activities and supports the implementation of online learning activities. The development of learning media is

basically done to help educators carry out complete learning activities without being limited by space and time (Cloonan & Fingeret, 2020; Lage-Cala et al., 2020; Li, 2020). Students are able to access learning materials easily anytime and anyplace according to their needs and speed of each one in receiving information (Silalahi, 2020; Mastroleo et al., 2020; Ningsih & Mahyuddin, 2021).

The changing from face to face learning into virtual one, demands an adequate learning strategy so that learning activity could be carried out effectively and efficiently for an optimal study result. The quality of a learning process is also determined by the ability of teachers to develop learning activities such as formulating learning objectives, designing learning materials, determining learning strategies, learning media, and evaluating learning (Han & Ellis, 2019; Purnomo & Wilujeng, 2016). Therefore, it is important for a teacher to know exactly what students need for a good learning process. Previous research has shown that the development of digital learning media equipped with good audio-visual media will help students receive messages/information including the material provided clearly so as to minimize the occurrence of misconceptions (Thuneberg et al., 2018; Dinatha & Kua, 2019; Setiyani et al., 2020). Another research also shows that the use of simulation and animation in virtual physics laboratories can increase students' visual and kinesthetic ability and process and conceptual understanding upon practicum material given (Alatas & Sakina, 2019; Vysakh et al., 2020).

The advantage of the virtual physics laboratory product is the integration of Ngada's local wisdom in the presentation of practicum material so as to further improve the quality of the product because learning activities that are based on real everyday experiences in the context of local culture will encourage students to transfer this knowledge or information into their own related studied material (Kua et al., 2019; Laksana et al., 2019; Lidi et al., 2020). Product trials that have been carried out on lecturers and students of STKIP Citra Bakti have shown a positive influence on the implementation of independent practicum activities. This shows that the virtual physics laboratory is recommended to be used in online lecture activities and can help educators to face the challenges of learning during the pandemic where the implementation of practicum activities can be carried out independently by students without experiencing quality differences with the implementation of practicums directly in real laboratories. However, the use of this research product is still limited to the material of Temperature and Heat and users in the local area in Ngada Regency, East Nusa Tenggara Province. Therefore, this research can be used as a reference for other researchers in developing a virtual laboratory that suits their needs by integrating the local cultural wisdom of each researcher.

#### 4. CONCLUSION

The development result of a virtual physics laboratory with real world problems based on Ngada local wisdom in the subject of Basic Physics Practicum gets the category of Very Good from 4 validators consisting of material experts, media experts, learning design experts, and linguists. The results of the trial to prospective users, namely lecturers and students from aspects of content presentation, product design, design of practicum activities, language use, impact of use, and ease of use are also included in the very good category. Based on these data, this virtual physics laboratory product with real world problems based on Ngada local wisdom is recommended to be applied to the Basic Physics Practicum course and can help students in practicum activities independently.

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