THE DEVELOPMENT OF STUDENT WORKSHEETS WITH A SCIENTIFIC APPROACH BASED ON THE VIRTUAL LABORATORY

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Abstract: This study aims to develop student worksheets with a scientific approach based on a feasible PhET virtual laboratory and to find student responses. With the Scientific Approach, students will be directly involved or have experience with objects and stimuli in the learning environment. This study uses three virtual, namely pHet, Maya Laboratory and Olabs Amrita.The research was conducted at the Department of Physics, State University of Medan.

This type of research uses the Research and Development (R&D) Borg and Gall model. The resulting product is a Student Worksheet that will be applied to partners, namely class D 2022 students who take the General Physics course. The data analysis technique used qualitative and quantitative data analysis techniques by describing the feasibility, response, and effectiveness of student worksheets on a scientific approach. Data collection tools in this study were a questionnaire, observation, and documentation.

The results of this study indicate that: 1) This student worksheet is very feasible to use based on the results of the percentage score of the material expert assessment of 88.3% and the percentage score of the media expert 86.67 % (2) a very good response, based on the percentage results the response score of the small group student reviewers was 89.65% and the percentage of the response scores from the large group student reviewers was 90.01% (3 The student test results with an average score of 45.56 for the pretest results, and the total average score for the posttest results were 85.31.Then obtained an N-gain score of 0.75 with a high category and an N-gain score (%) 75% with an effective interpretation .Then obtained from the assessment questionnaire and responses, it can be concluded that the student worksheets with the virtual laboratory-based Scientific approach are very feasible to use and develop.

Keywords: General Phyiscs, worksheet, virtual laboratory

Introduction

Physics is a science that studies natural phenomena or natural phenomena, energy-matter, both macroscopic and microscopic. According to Setyaningrum and Wiyatmo, physics is a subject that requires more understanding because of the many illustrations and symbols, as well as the equations used. With physics, humans can get scientific truth from existing natural phenomena. Learning physics is not always about learning facts, concepts, theories, principles, and laws of physics in the classroom but also about learning to develop scientific skills. Scientific skills can be implemented in the classroom using learning methods that facilitate process learning, but they can also be implemented through practical work in the laboratory (Saparini *et al*: 2019). One of the learning methods used in the laboratory is the experimental method. The experiment is an experimental activity to examine an event or symptom that appears under certain conditions using careful observation and control so that a causal relationship can be known from the emergence of these symptoms.

The digital era encourages innovations where technology has opened up the possibility of new science learning processes in the form of virtual laboratories. Virtual laboratories can be used as a solution for conducting

experimental activities whenever and wherever students are. A virtual laboratory is an IT-based learning media. Learning media can clarify the presentation of messages and information, lead to learning motivation, and overcome the limitations of the senses, space, and time (Sukiman: 2012).

Problems related to learning physics are experienced at the middle and university levels at this time. Based on interviews with Physics teachers at SMA Dharma Pancasila, in the current learning, face-to-face is limited, and the time spent studying at school is reduced compared to 100% face-to-face learning. Students have also not done practicum in the laboratory for two years. So far, teachers only provide practical videos on youtube and simple applications on the Android play store because teachers cannot use virtual laboratories. The same happened in the Department of Physics, State University of Medan. It's been two years since students did practicum in the Physics Laboratory. Based on a survey with students in the Department of Physics, namely: (a) for 2020 stamp, class Dik A and Dik B have done Virtual laboratory practicum on electrical and optical materials, while class Dik C has done direct practicum for students who live in the city of Medan only and Dik D does not use a virtual laboratory, (b) for the 2021 stamp for classes A and B, the lecturer has given a virtual laboratory assisted by laboratory assistants, for class C and Dik D have never done virtual laboratories, students are given youtube videos, or use applications simple because educators have limitations in using the Virtual Laboratory.

A virtual laboratory is a learning experience that simulates an authentic laboratory. The laboratory is simulated and visualized digitally so students can explore concepts and theories. The virtual laboratory can be defined as multisensory software that has interactivity to simulate certain practicums by replicating conventional laboratories. Virtual laboratories allow students to learn through a case study approach, interact with laboratory equipment, conduct experiments and analyze and evaluate processes (Wibawanto: 2020). Virtual laboratory applications can be used by students, such as Maya Laboratory, PhET, Amrita Laboratory, and Simbuket, but many students who cannot use it, have to upload materials and practicum guides, but not all applications with practical guides can be opened. According to Saparini, *et al*., (2018), in addition to appropriate learning models and teaching methods, the success of using media in learning is also influenced by one of them, namely the use of worksheets. The worksheets must be arranged according to the characteristics of the multimedia that will be used.

Based on the problems above, a virtual laboratory-based student worksheet is needed. Worksheets as a tool and a guide for students in conducting experimental activities. Saparini *et al*., (2018) research that the student activity sheet based on guided inquiry is to carry out a virtual laboratory practicum on valid dynamic electrical materials with a value of 84.25% with valid criteria. A guided inquiry-based student activity sheet has been successfully developed to carry out a virtual laboratory practicum on suitable dynamic electrical materials with a score of 81.47% in the one-to-one evaluation stage with very practical criteria and 84.10% in the small group evaluation stage with very good criteria. Practical.

The virtual laboratory applications are PhET simulation, Maya Laboratorium, and Olabs Amrita,etc . PhET is a site that provides physics and chemistry learning simulations provided for free by the University of Colorado The PhET Team (2015). To help students understand visual concepts, PhET simulations animate quantities using graphics and intuitive controls such as click-and-drag, rulers, and buttons. The scientific approach is learner-centered and can directly experience objects and stimuli in the learning environment. Research by Sari., et al. (2015) shows that worksheets are very interesting, easy, and very useful, as well as effective products as learning media, with a percentage of student learning outcomes more than 80% who have achieved graduation in cognitive and affective aspects. Student worksheets are intended to provide understanding for students to know, understand, and practice what is being studied scientifically. Based on the description above, the author will conduct a study entitled "Development of Student Worksheets with a Scientific Approach based on a virtual laboratory".

Method

This study use the Research and Development (R&D) method. The stages of research and development of the Brog & Gall R&D (Research and Development) model. The stages to be carried out during this research are as follows:

This study instrument or data collection tool was a questionnaires, observation, and documentation. Questionnaires were given to media experts; material experts, teachers' response, and response were given to students taking General Physics courses. The data analysis technique was carried out using analytical methods. After all the data had been obtained and collected, the data needed to be analyzed. Researchers in this development used qualitative and

quantitative data analysis techniques. Qualitative data were obtained from the survey results in interviews before researching the 2018 B stamp of the Physics Department at State University of Medan. Criticisms and suggestions for products developed. Quantitative data consists of assessment scores by material experts, media experts, and students for student worksheets.

$$P = \frac{X}{Xi}\ x\,100\%$$

Description:

P = percentage of each criteria.
X = score of each cirteria.
X_i = maximal score of each criteria.

For Eligibility Percentage

Table 1. Percentage Scale

Achievement Percentage	Scale	Interpretation Value
76% ≤ score ≤ 100%	4	Very worth
51% ≤ score ≤ 75%	3	Worth
26% ≤ score ≤ 50%	2	Enough worth
0% ≤ score ≤ 25% 1	1	Not worth

Analysis of student assesment questionnaire data on the developed learning mediausing the likert scale method (Sugiyono, 2015)

Table 2. Student assessment Score Guidelines

Evaluation	Scale	Score
SS	Agree completely	5
S	Agree	4
KS	Disagree	3
TS	Nor disagree	2
STS	Strongly disagree	1

Futhermore,all data from student assesment questionnaires were recapitulated and calculated for each statement item using the following formula:

$$P = \frac{Total\ scores\ of\ data\ collection\ results}{Total\ score\ of\ criteria\ maam}\ x\,100\%$$

Based on the calculation that has been carried out, the interpretation of the numerical scores is carried out into a category.

Table 3. Score interpretation criteria

no	Score interval (%)	Category
1	81-100	Very good
2	61-80	Good
3	41-60	Adequate

4	21-40	less
5	0-20	Very less

It is obtained in the following way to test the effectiveness of student worksheets based on a scientific approach.

P=Raw scoreMaximum Score x 100%

Table 4.Media effectiveness assessment criteria

Criteria	Percentage
Very good	80%<X<100%
Good	60%<X<80%
Currently	40%<X<60%
Not good	20%<X<40%
Very not good	0% <X<20%

According to Hake, Gain value can be calculated using the following formula:

N-gain (g) =Posttest Score-Pretest ScoreMaximum Score-Pretest Score x 100%

Table 5. Gain Classification by Hake

Criteria	Percentage
High	0,70<g<1.00
Medium	0,3 <g< 0,7
Low	0,00<g< 0,3
Equal	g = 0,00
Decrease	-1,00 < g <0,00

Results of Discussion

The results showed that the Student Worksheet was very feasible to use and effective.

Research Result

1. Research and data collection,

a. Needs analysis

Researchers found problems faced by lecturers and students. Practicum can be done face-to-face for students in Medan, while students in areas can do the online practicum. Educators have limitations in using Virtual Laboratorie using several applications such as PhET, Amrita labs, and Maya laboratories. So we need a practical guide such as Student Worksheets so students can do online practicums.

b. Literature study

Conducting literature studies in the form of books and journals. The literature study was conducted to strengthen the Student Worksheet STEM-based.

c. Small-scale research

Researchers conducted field studies by interviewing lecturers and students via WhatsApp regarding the use of virtual laboratories.

2. Planning

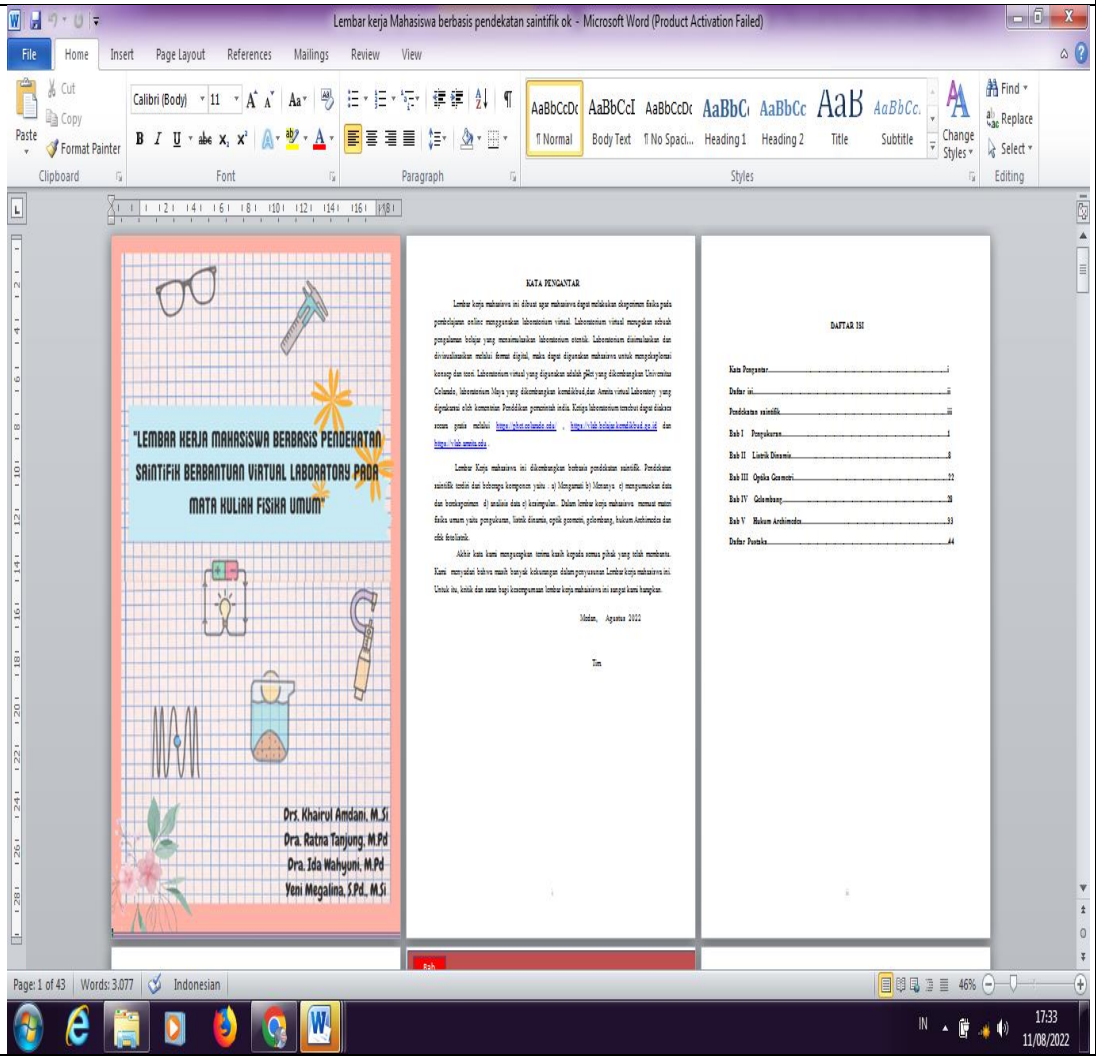
The Student Worksheet media design is developed so that:

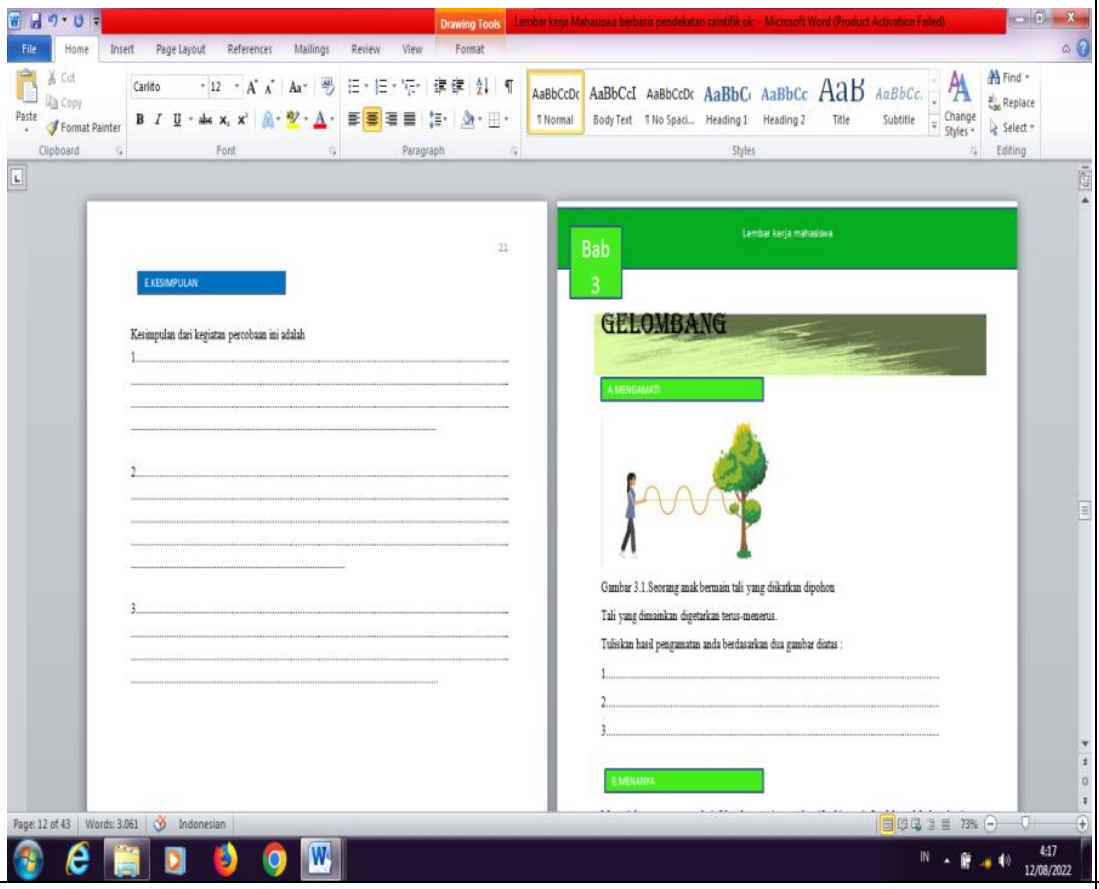
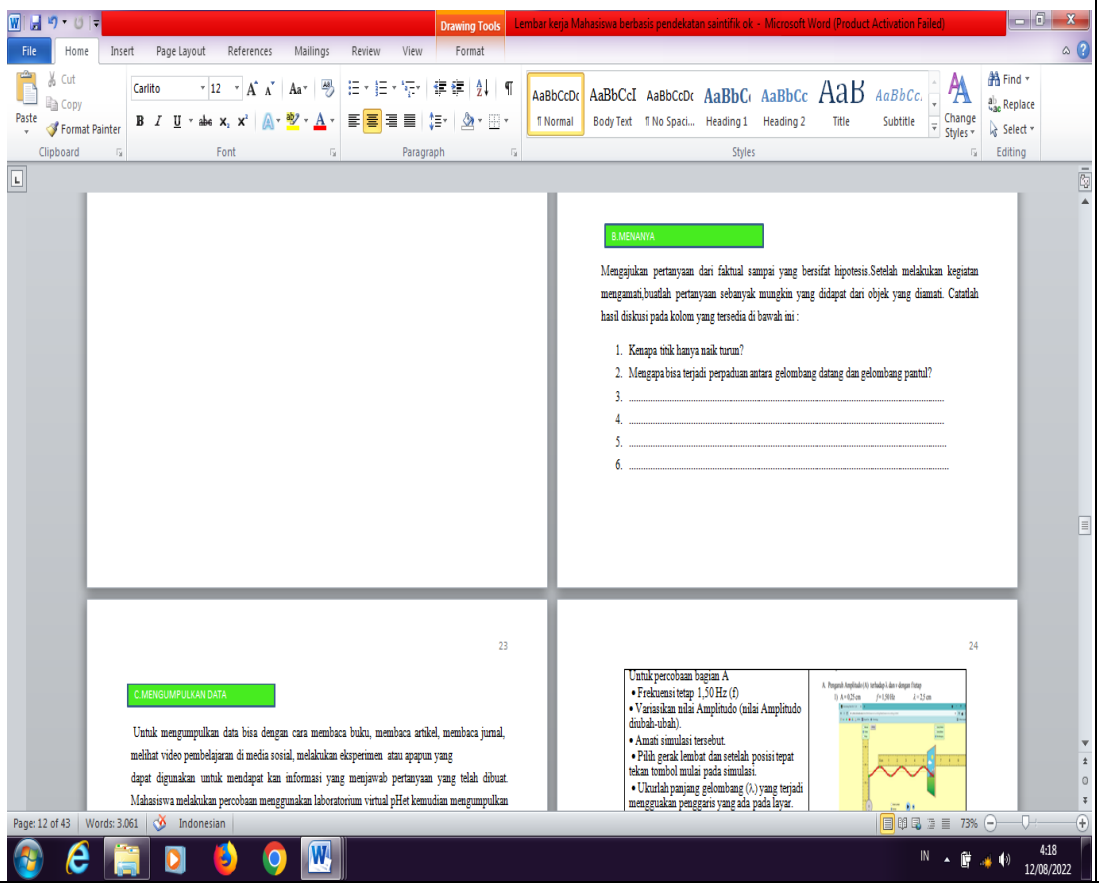
a. Students can do general physics practicum online.
b. The product's target users are students who take general physics courses, namely Class D majoring in Physics 2022.
c. The media for student worksheets that are made can achieve CPL learning, namely so that students can do general physics practicums even though they are online.

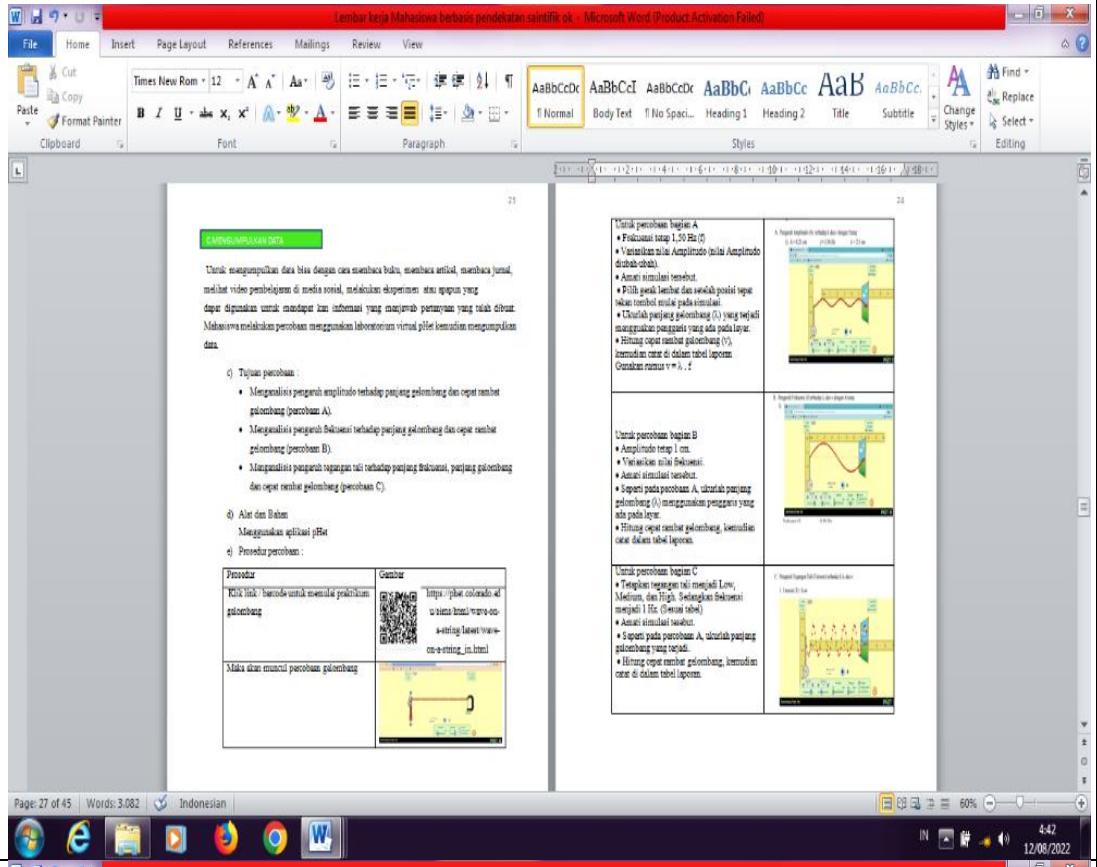
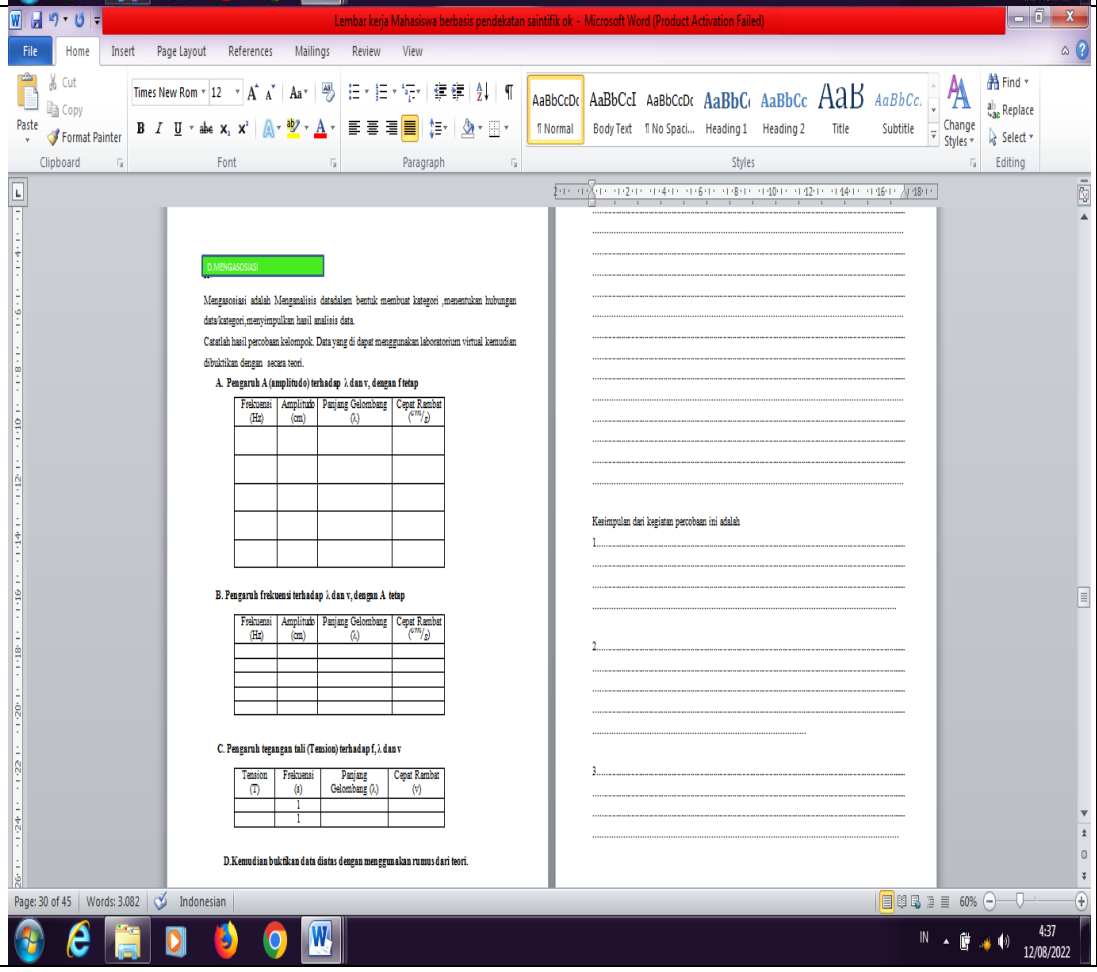
3. Initial product development

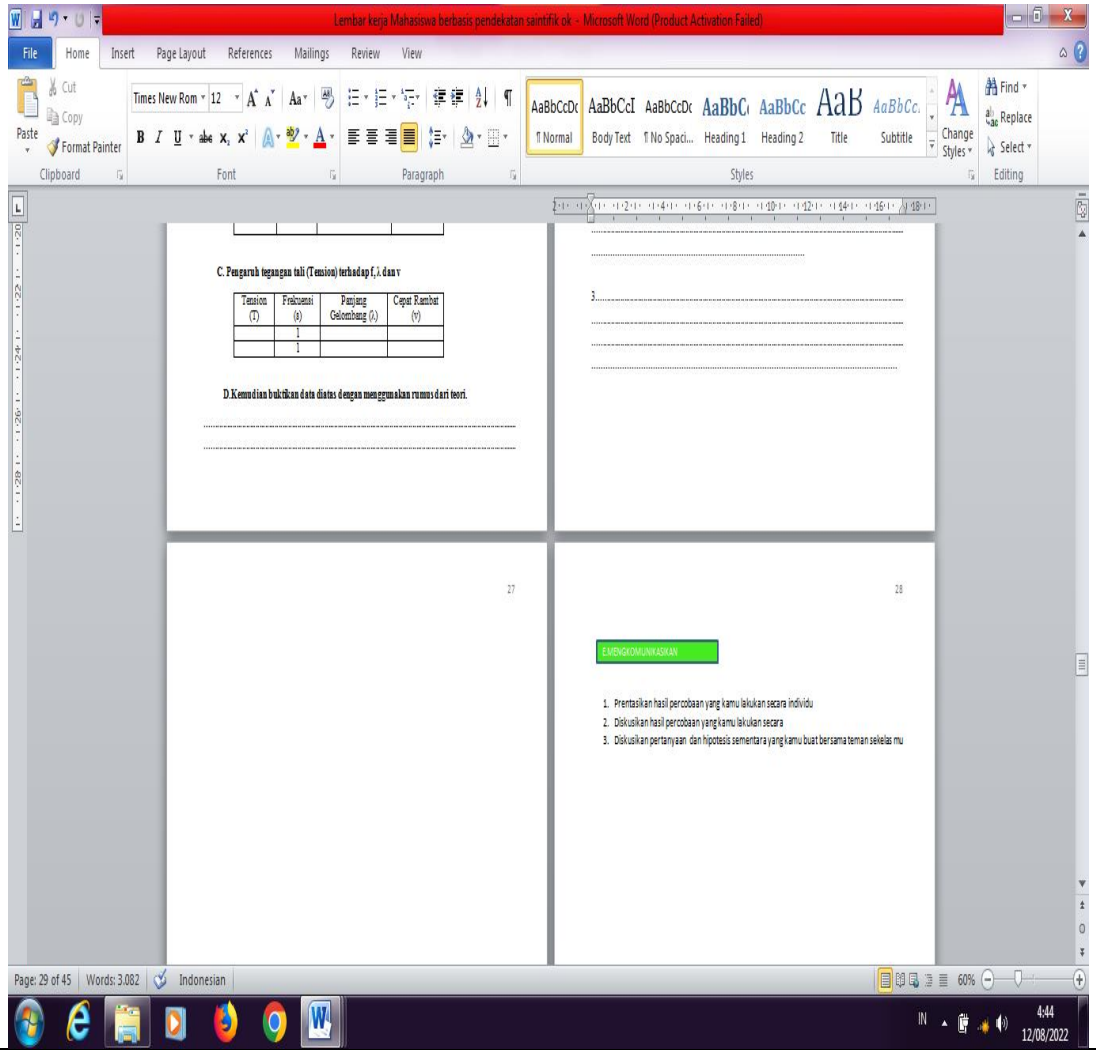
The initial product is a student worksheet.The student worksheet consist of 5 materials are measurement, dynamic electricity, waves, optics and Archimedes Law.The table below is the Student worksheet on wave material.

Table 6. The Student Worksheet on wave material

No	Figures	Description
1		Cover of student worksheet

2		Observe
3		Ask

4		Collecting data
5		Associate

6		Communicating

In the initial product development, student worksheets were validated by material experts and media experts.

In the initial product development, student worksheets were validated by material experts and media experts.

The results of developing Student Worksheets obtained data: (1) Material expert evaluation data consisting of data from feasibility results and input. (2) Media expert evaluation data consisting of feasibility results and input data. Overview of Experts

a. Material Experts

Based on a feasibility questionnaire by a material expert, it includes three aspects, namely content feasibility, presentation feasibility, and readability. The data on the results of the feasibility by the material expert can be seen in the table below is the result of the assessment of the material expert in terms of (1) content feasibility, obtaining a score of 76 (89,4%), (2) presentation feasibility obtaining a score of 17 (85%) (3) Language feasibility 18 (90 %) Overall, the eligibility questionnaire obtained a score of 111 (88,13%).

Table 7. Eligibility by Material Expert

No.	Aspect	Frequency					Score	Question points	Max	Percentage (%)
		1	**2**	**3**	**4**	**5**				
1	Content eligibility	0	0	1	7	8	76	17	85	89,4
2	Serving eligibility	0	0	1	1	2	17	4	20	85
3	Legibility	0	0	0	2	2	18	4	20	90
Total							**111**	**25**	**125**	**88,13 %**

Figure 1. Feasibility Diagram by Material Expert

So student worksheets based on scientific approaches assisted by virtual laboratories are very feasible. The material expert's suggestion for this LKM is for the LKM to follow systematic writing, using the language rules according to EYD.

b. Media Expert Review

The feasibility questionnaire for media experts includes four aspects: aspects of media appearance, presentation feasibility, visual aspects and linguistic aspects. The results of this media expert's assessment were viewed from the following aspects: (1) the display got a score of 8 (80 %), (2) the feasibility of the presentation got a score of 14 (93.33%), (3) the graphic got a score of 44 (80%) and (4) the feasibility of the language obtained a score of 18 (86.7%). Overall the level of media validation obtained a score of 84 (85, 75%). Look at the table below:

Table 8. Eligibility by Media Expert

No.	Aspect	Frequency					Score	Question points	Max	Percentage
		1	**2**	**3**	**4**	**5**				
1	Appearance	0	0	0	2	0	8	2	10	80%
2	Serving eligibility	0	0	0	1	2	14	3	15	93.33%
3	Graphics	0	0	2	7	2	44	11	55	80%
4	Language	0	0	0	2	2	18	4	20	86,7%
Total							**84**	**20**	**100**	**85,75%**

:

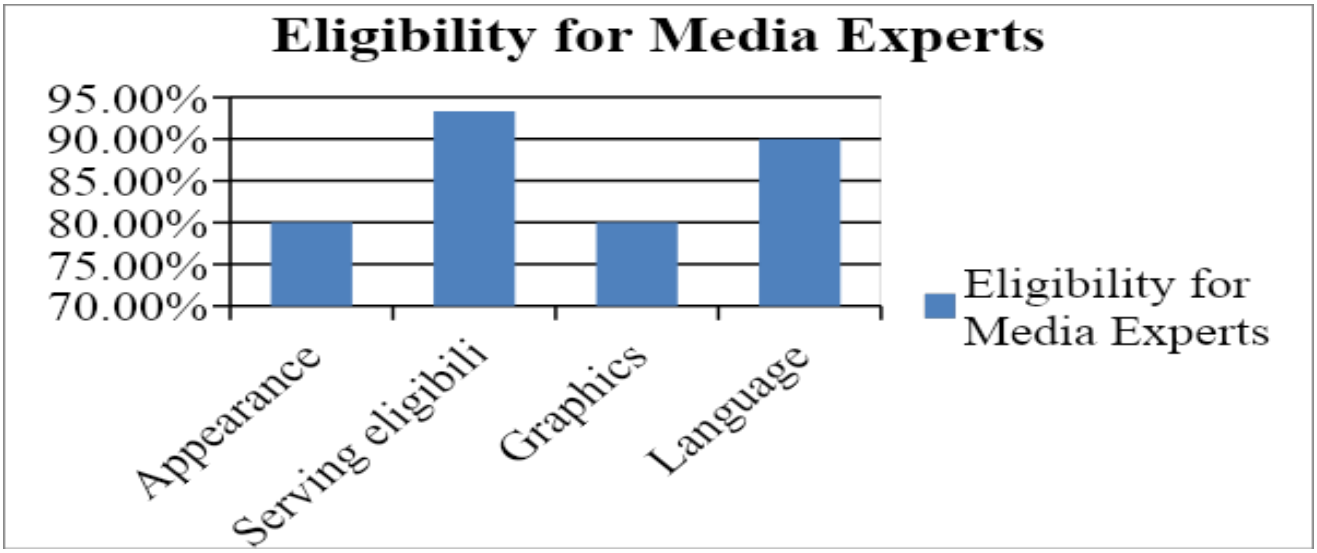


Figure 2. Feasibility Chart by Media Experts

Thus, a student worksheet based on a scientific approach assisted by a virtual laboratory is very feasible. Based on the results of the assessment by media experts, suggestions were given to improve; namely, one of the steps of the scientific approach that has not been included in the work is to communicate the results of the exploration by giving space to the Worksheet, for example after the conclusion section. Students are asked to make presentations, for example, by making graphics and pictures or forming other presentations. Pay attention to the use of PUEBI in worksheet typing, especially the use of punctuation marks.

4. Initial field trial

The student worksheet media were tested on 15 students of the 2020 Dik D Physics class who had taken the General Physics course. After students open the media worksheets, students are then asked to respond (responses) by filling out student response questionnaires. This response questionnaire consists of 24 questions. The results of this trial assessment are viewed from the aspects: (1) interest, obtaining a score of 209 (93%), (2) presentation of student worksheets, obtaining a score of 638 (87.36%), (3) learning components based on virtual-assisted scientific approaches laboratory, obtained a score of 629 (87.36%). Based on the table of the scale of the eligibility criteria, it is included in the very feasible category.

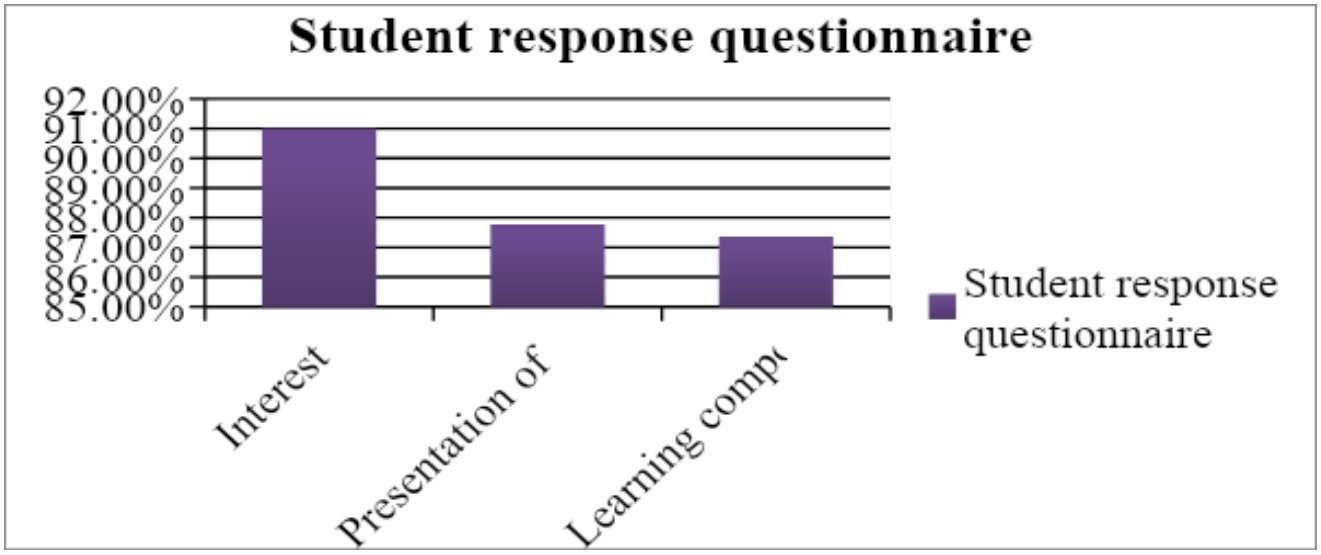


Figure 3. Dik D Class Stamp 2020 Small Group Response

Table 9. Student Questionnaire Response

No.	Aspect	Frequency					Score	Question points	Max	Percentage
		1	**2**	**3**	**4**	**5**				
1	Interest	0	0	0	16	29	209	48	225	91%
2	Presentation	0	0	3	16	113	632	144	720	87,77%
3	Learning Component	0	0	13	10	115	629	144	720	87,36%
Total							**1495**	**336**	**1680**	**89,71 %**

5. Revise the main product

After testing the product, the results of the data analysis showed that the student worksheet media was included in the very feasible category.

6. Main field trial

After the feasibility test from material experts, media experts, small group trials, and revisions, the student worksheets with a scientific approach assisted by virtual laboratories were tested in the main field, namely Dik D students. After students read and understand the following student worksheet, students are asked to respond (response) by filling out a response questionnaire. This response questionnaire consists of 20 questions. The results of the trial assessment in class D stamp 2022 are viewed from the following aspects: (1) interest, obtaining a score of 372 (95%), (2) presentation, obtaining a score of 153 (70.83%), (3) learning components, obtaining a score of 1170 (96.9%). The overall assessment of student responses to student worksheets is 2600 (93.5%).

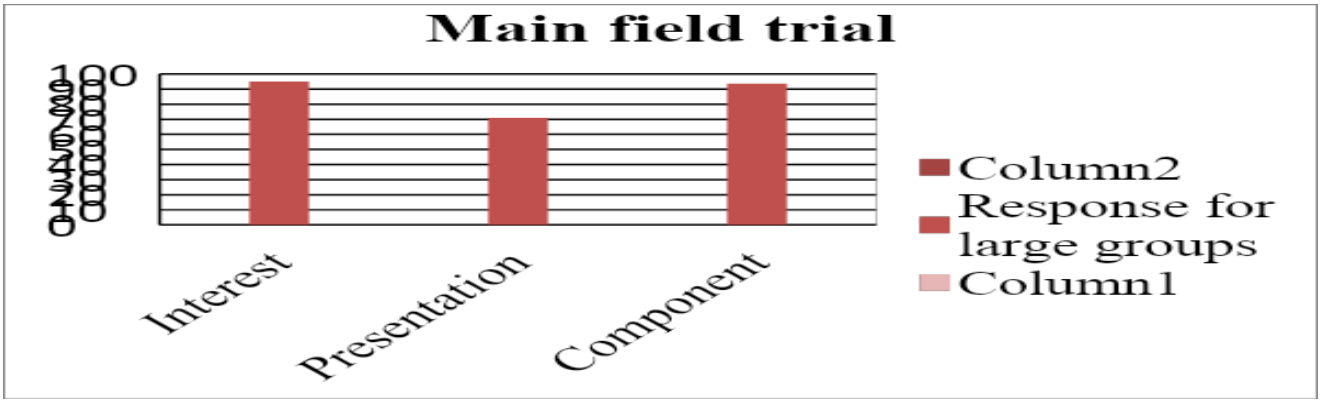


Figure 4. Dik D Class Stamp 2022 Large Group Response

Table 10. Large Group Response

No.	Aspect	Frequency					Score	Question points	Max	Percentage
		1	**2**	**3**	**4**	**5**				
1	Interest	0	0	0	18	60	372	78	390	95%
2	Presentation	0	0	6	24	204	1134	234	1170	96,9%
3	Learning Component	0	0	6	19	166	924	208	1040	88%
Total							**2430**	**520**	**2600**	**93,5 %**

The effectiveness of Student Worksheets in the Physics Department for Dik D stamp 2022 class was tested in the main field trial. From the research data processing, average learning outcomes were obtained from the pretest and posttest scores. The student test results with an average score of 45.56 for the pretest results, and the total average score for the posttest results were 85.31. After conducting the effectiveness test, it was found that the Student Worksheet with the Scientific approach had an N-gain score of 0.75 in the high category and an N-gain score (%) 75% with a practical interpretation.

Disscussion

In this study, the learning media developed was Student Worksheet media with a scientific approach based on a virtual laboratory in the General Physics course. The development model used Research and Development (R & D) from Borg and Gall up to stage 7. This student worksheet was designed to students understand using virtual laboratories in general physics courses. The material contained in the Student Worksheets are a) Measurement, namely using a caliper and micrometer screw b) Dynamic electricity, namely the relationship between the potential difference (V) and electric current strength (I), resistance wire conductors, electrical circuits and parallel circuits c) Waves d) Optics on concave lenses and convex lenses e) Archimedes' law.

Student Worksheets are produced via laptops using several applications, namely word, canva, and also a virtual laboratory. Word is used to write, and edit student worksheets. For Canva it is used to create covers and make student worksheets more attractive. This student worksheet was created so that students can conduct physics experiments in online learning using a virtual laboratory. A virtual laboratory is a learning experience that simulates an authentic laboratory. The laboratory is simulated and visualized through a digital format, so students can explore concepts and theories. The virtual laboratory used is the PhET developed by Colorado University, the Maya laboratory developed by the Ministry of Education and Culture, and the Amrita labs virtual laboratory. The three laboratories can be accessed for free via https://phet.colarado.edu/, https://vlab.learning.kemdikbud.go.id. and https://amrita.olabs.edu.in

Student worksheets are developed based on a scientific approach so that students can understand general physics practicum through the ability to conduct investigations, and are used as instructions in conducting virtual laboratory-assisted experiments. The practicums carried out by students in the laboratory are still under the supervision and supervision of the lecturers (Saparini., Wiyono, Ketang., Ismet. 2018) directing some students to do virtual practicums by following the worksheets. This student worksheet consists of five materials using three virtual laboratories, namely a) Colorado PhET for Dynamic Electricity and Waves b) Virtual Laboratory, used for Optics and Archimedes' Laws c) Amrita Olabs for measurement materials.

The scientific approach consists of several components, namely: a) observing, from the experience of reading, listening, listening, or seeing b) asking questions such as asking questions from factual to hypothetical from the observing stage c) collecting data/analyzing data such as data that has been obtained. you read and collect tested through experimenting to find out the truth d) associate, namely the results of all processes that are summarized and concluded e) communicating, namely conveying the results of conceptualization such as discussing and presenting experimental results in groups. After this student worksheet is designed and made, the feasibility of this media is assessed by material experts and media experts. The feasibility assessment was measured based on the results of material experts with a score of 111 with an achievement percentage of 88,13 % and media experts showed a score of 84 and a percentage of achievement was 85,75 %. Thus, this student worksheet media is classified as a very feasible criterion. After being assessed according to the expert, the media of this worksheet was revised according to the suggestions and comments of the experts. Furthermore, this media is given to the initial field or small groups, namely students from the Physics Department of Dik D stamp 2020. The results of the responses are scores and percentages of small group students, namely 1495 with 88,71% with very high criteria. Based on the table of the scale of the eligibility criteria, it is included in the very feasible category. Then the media for this student worksheet was revised. Furthermore, the main field trials were carried out on students of the Physics Department of Class D stamp 2022. The results of the responses were scores and percentages of small group students, namely 2600 with 93.5% with very high criteria. In the main field trial, the effectiveness of student worksheets was tested which was obtained from the number of pretest results, namely 45,56, and the number of posttest results 85,31. Then obtained an N-gain score of 0.75 with a high category and an N-gain score (%) 75% with an effective interpretation.

The responses from this student worksheet are that a) using a virtual laboratory can advance students' minds to use technology b) foster curiosity to learn it c) this worksheet is very easy to understand and attracts interest to study it (Sari, Ana K., Ertikanto, Chandra., Suana, Wayan. 2015 d) can be used wherever and whenever we are (Bimo, Muhammad Tri., Asrizal., Hidayati), not necessarily face to face e) this worksheet is very helpful for students in conducting experiments and understanding the material f) student worksheets with a scientific approach motivate students to study the material and conduct experiments g) these worksheets are very easy to understand h) using virtual laboratories are safer and more efficient i) student worksheets are clear, complete and easy to understand making readers interested in learning material j) This worksheet provides easy-to-open links and virtual laboratory barcodes, then also put the experimental steps and pictures taken from the virtual laboratory so that students are not confused in conducting experiments. Suggestions for this media are a) in using this virtual laboratory, it must have a good internet network b) The image in the experimental steps is enlarged c) The color of the cover of this worksheet is too soft, it should be combined with a light color to attract attention. Based on the results of the assessment and responses obtained from the questionnaire, and the test given, the resulting product in the form of a Student Worksheet based on a scientific approach is very feasible, very high, and effective to use and develop.

Conclusion

The conclusion of this research is

1. The results of the feasibility of material experts and media experts on Student Worksheets with a scientific approach assisted by a virtual laboratory show the criteria are very feasible.
2. The number of pretest results is 45,56 and the number of posttest results is 85,31. Then obtained an N-gain score of 0.75 with a high category and an N-gain score (%) 75% with an effective interpretation.
3. Based on the students' responses, the small group obtained 87, 36% very high category, and the large group obtained 93, 5% very high category.

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