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Optics Visualization Web-Based as A Physics Learning Media in Senior High School

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ABSTRACT

The laboratory has an important role in the learning of physics. The experimental characteristics and abstract concepts of physics that cause difficulties in the physics learning process. Tools and materials are limited often used as an problem in the practicum activities. This study aims to develop a learning media of optics visualization based website as an alternative the limited of laboratory tools. This research includes research and development with ADDIE model (Analysis, Design, Development, Implementation and Evaluate). To collect the data, instrument are used to analyze such as a validation questionnaire. The data analysis were used the Aiken,s V formula. Based on the results of the validity test by experts, the optics visualization learning media web-based was declared valid with an average rating of 0.87 on the design aspect, 0.89 on the pedagogic aspect, 0.88 on the content aspect and 0.84 on the technical aspect. Thus the optics visualization learning media web-based developed has been declared valid and can be used as a media of learning in teaching and learning activities in class.

1. Introduction

The laboratory has a very important role in Physics Learning. The laboratory activities, student can be trained and equipped with some skills such as observing, classifying, measuring, communicating, interpreting data, and making conclusion. In physics learning, it should be supported by laboratory facilities, so that students can understand physics more actual and not boring students (Azhar, 2008). Laboratory activities make physics learning more interesting and fun (Gunawan et al., 2017). Through student laboratory activities can develop academic and social skills. From a social point of view, students will be accustomed to appreciate the opinions of others learn to communicate ideas, and working together in teams. Activities Experiments are important in Physics

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learning, because aspects of the product, process, and attitude participant educatcould more developed (Irfan Yusuf & Widyaningsih, 2018). One of the factors that affect the success of laboratory activities is the availability of resources, including materials and equipment, space and furniture, laboratory staff, and technicians (Gunawan et al., 2017). The availability of adequate resources will obviously support the implementation of laboratory activities, on the contrary the limitations of tools and materials will lead to the ineffectiveness of laboratory experiments.

Laboratories and their support equipment require cost support for management, storage, laboratory maintenance, equipment dan materials, and availability of trained staff. The lack of experimental equipment in schools is not a secret anymore. The limited funds channeled by the government to buy KIT Physics have caused physics teachers to teach as they are from the available facilities (Zulhelmi et al., 2019) . This result in some experiments not being optimal, and some other are unworkable. In addition, not all experiments can be carried out not only because there are no tools, but the characteristics of the experiment itself which involves processes and abstract concepts, so an alternative is needed so that experimental activities including abstract concepts can still be carried out (I. Yusuf & Subaer, 2013).

The material of optical instruments is one of the abstract concepts of physics. His competence is to analyze the workings of optical instruments using the laws of reflection and refraction of light by mirrors and lenses. However, physics laboratories and practical equipment are not yet available in schools. Practical activities of optical instruments also require a dark room to observe the process of forming shadows. So that teachers and students really need media that can explain the concepts of how abstract optical instruments work. One of the media that can be used to visualize physics material, especially on abstract concepts, is a virtual laboratory. Utilization of virtual laboratory learning media is also a solution if laboratory equipment is inadequate. The use of virtual laboratories can overcome some of the problems encountered related to inadequate laboratory equipment and make a positive contribution to achieving learning objectives.

Based on these problems, it is necessary to develop a learning media to overcome the limitations of practical implementation on optical instruments. So that research and development is needed on web-based optical visualization as a medium for learning physics in high school

2. Methodology

This research is a research and development (R & D) study using ADDIE instructional design model. The design model of ADDIE consists of 5 stages: Analysis, Design, Development, Implementation, and Evaluation (Nadiyah & Faaizah, 2015). The ADDIE model was chosen because this model is a procedural model, namely a descriptive model, showing clear and careful steps to produce a product. (Mulyatiningsih, 2011). this research to produce certain products and test

the validation of these products. The stages of the ADDIE model can be seen in Figure 1.

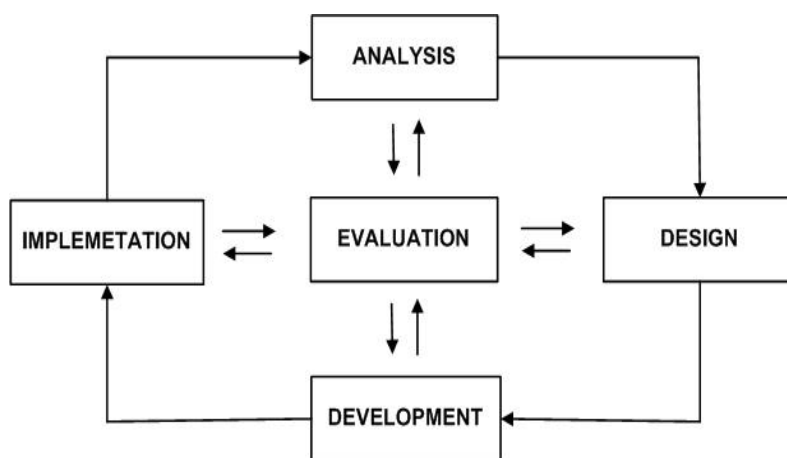


Fig 1. Stages of the ADDIE (Nasir et al., 2018)

Data collection techniques used in this study were to determine the validity of optics visualization that was developed based on the validation of 3 experts, bound by an assessment questionnaire filled out by the validator. Evaluation or assessment that will be conducted by experts include: expert design (design), expert content (content), Expert Engineering (technical) and Expert Pedagogy (Pedagogy) (Jasmy Abd Rahman et al., 2014). Assessment or evaluation is given by filling in questionnaires which provides answers to Likert scale. Where the validation assessment criteria are illustrated in Table 1 (Sugiyono, 2013).

Table 1. Validation Eligibility Criteria

Criteria	Score
SS : Very Agree	5
S : Agree	4
KS : Not Agree	3
TS : Dissagree	2
STS : Strongly Dissagree	1

The media is declared valid and feasible to use if the average validator's assessment is categorized as valid. The assessment of the validity of this media is adopted from the formula used from the validity of Aiken's V (Aiken, 1985). This formula is based on the results of the expert panel's assessment of n people on an item regarding the extent to which the item represents the construct (Anshary & Edidas, 2018). The content validity of the expert agreement was calculated using the Aiken validity index (Kumaidi, 2015) formulated as in Equation (1), where V is the index of item validity; $\sum S$ is the score set by each evaluator and reduced by the lowest score in the category. ($S = r - I_0$), with r is evaluators' category score and I_0 is the lowest score in the scoring category); n is the number of evaluators, and c is the number of selected categories by evaluators.

$$V = \frac{\sum s}{[n(c-1)]} \dots\dots\dots (1)$$

According to (Retnawati, 2016), the results of the Aikens agreement index is categorized into three categories: (1) low validity if the score is less than 0.4; (2) medium validity if the score is 0.4-0.8; and (3) high validity if the score is more than 0.8. the optics visualizations learning media web-based in this research is valid If the index Aiken's $V \geq 0.4$. which means it is in medium category and high category.

3. Results and Discussion

The result of this research is optics visualization web-based as a media for learning physics in senior high school. The product developed consists of visualization of image formation on optics instruments and the contents of optics visualization learning media. The following is the final display of the developed optical visualization learning media:

Visualization Display

The optics visualization that has been developed consists of visualizations for curved mirrors, thin lenses, glasses for myopia sufferers, magnifying glass, microscopes and binoculars. The way to operate on the visualization is to input the value in the column provided and then click calculate, the output value will appear along with the visualization results of the shadow formation. The display of optics visualizations as fig. 2 to fig. 9.

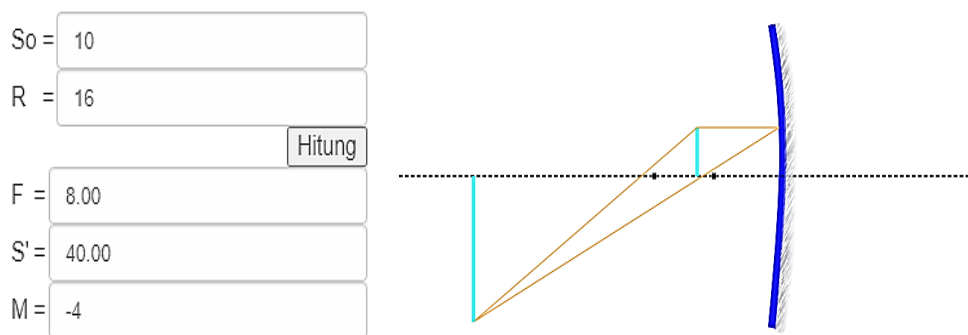


Fig 2. Visualization on a Concave Mirror

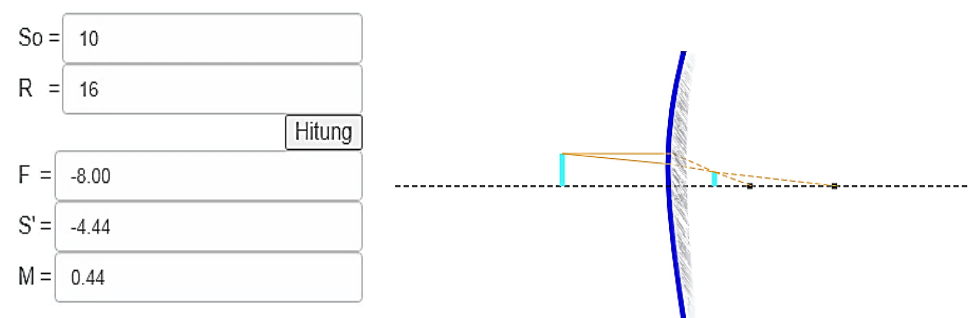


Fig 3. Visualization on a Convex Mirror

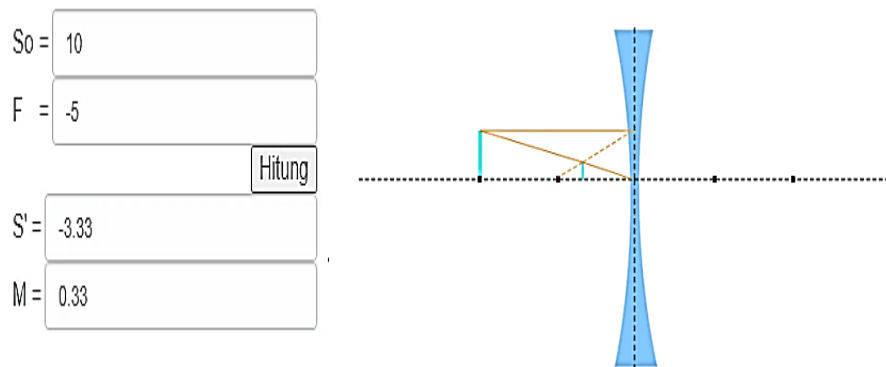


Fig 4. Visualization on a Concave Lens

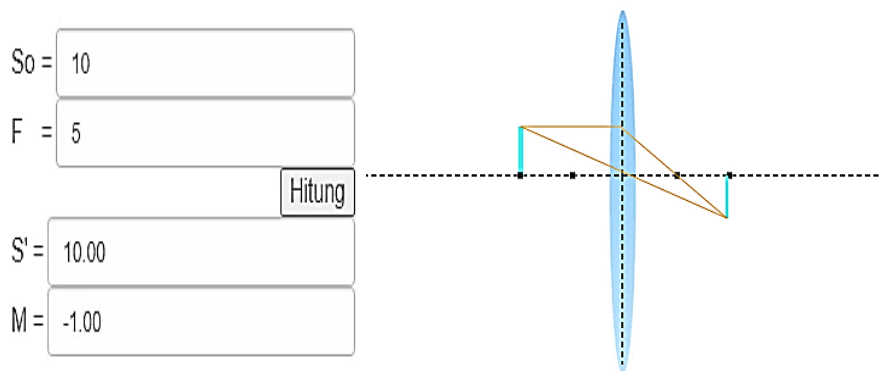


Fig 5. Visualization on a Convex Lens

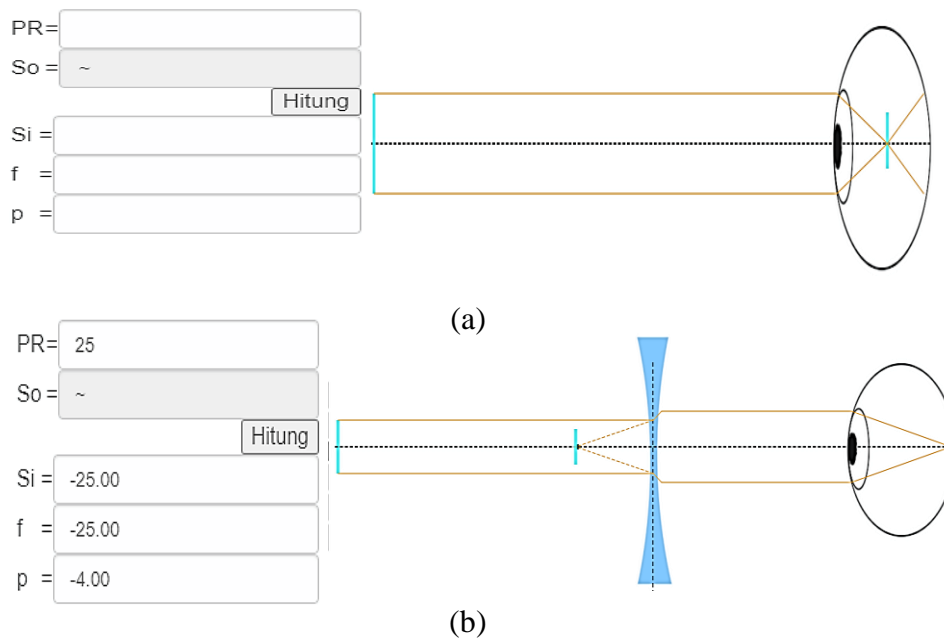


Fig 6. (a) Visualization Before Input Value
(b) Visualization After Input Value

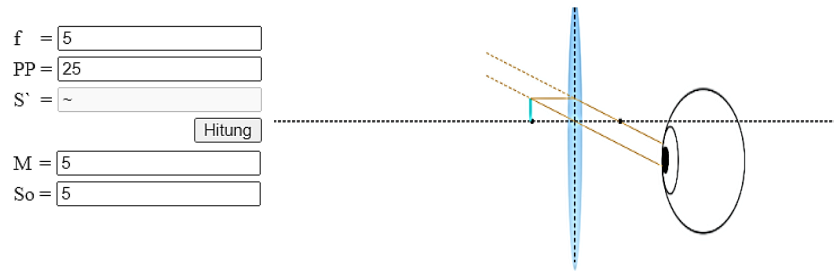


Fig 7. Visualization on Magnifying Glass

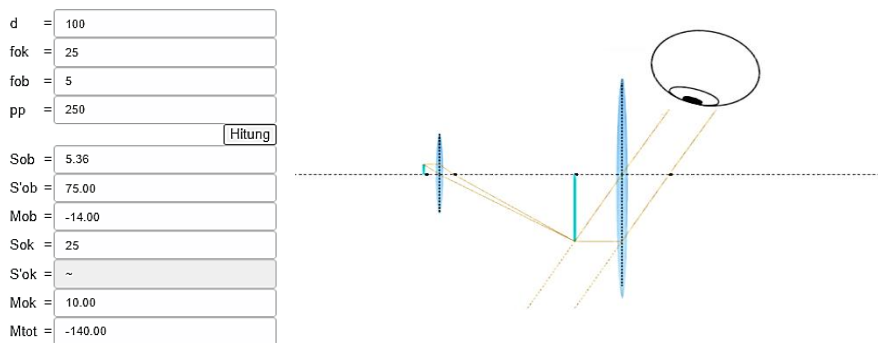


Fig 8. Visualization on a Microscope

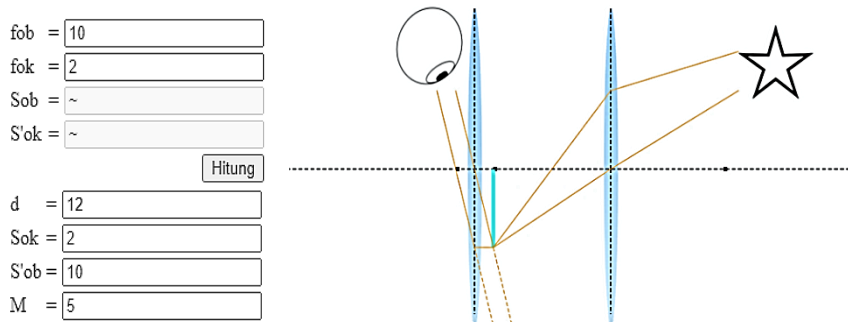


Fig 9. Visualization on Binoculars

Display of Optics Visualization Media Contents

The optics visualization that has been developed is then integrated into the optics visualization media content display which consists of several menus, namely competence, material, visualizations, exercise, worksheets, evaluation, profile, reference, guide, and FAQ. Access to learning media is by entering the address husnul.virtual-lab.xyz. The following is a display of the home page of the optics visualization media content as Fig. 10.



Fig 10. Home Page Media

The competency menu contains core competencies, basic competencies, learning objectives, indicators of competency achievement and learning implementation plans. Optics visualization learning media is designed for 6 meetings, namely on the material of the law of reflection and reflection on the mirror, the law of refraction and refraction on thin lenses, eyes and glasses, loupe, microscope and binoculars. Optical visualization media is equipped with practice questions along with discussion questions, equipped with worksheets and evaluation questions which are also equipped with discussion questions. Discussion of practice questions and evaluation questions can only be accessed by students when the teacher as an administrator has activated their access through the administrator menu controlled by the teacher. Access to administrator page is by entering the address husnul.virtual-lab.xyz/administrator. The administrator page displays as fig. 11

No	Nama Siswa	Kelas	P 1	P 2	P 3	P 4	P 5	P 6
11	Falimah	XI	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
12	si alifan	XI ipa 1	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
13	devi fitriani	XI IPA 1	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
14	cherry maharani	XI IPA 1	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
15	RANI PRATIWI	XI 3	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
16	Devi Aswari	XI IPA	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
17	Cedy melani	XI MIPA	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan
18	Wica Tania	XI ipa	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan	Aktifkan

Fig 11. Administrator Page

The administrator's page display consists of several menus including the student data menu which is used to record students who have accessed and worked on evaluation questions so that teachers can find out the evaluation scores obtained by students. The practice menu contains access permissions for students to view the discussion of practice questions. The visualization menu contains access permissions for students to work on evaluation questions, discussion of evaluation questions will appear after students get a score above or equal to the specified minimum completeness criteria.

Validity Test by Expert

The assessment by experts is performed using questionnaire and using a Likert scale according to the aspect design, aspect content, aspect Engineering and aspect Pedagogy. The validation of the media by each validator is carried out twice, until the media are said to be valid. In the first validation, many validators provide input and suggestions for improvement. The following suggestions and input for improvement and follow-up from each validator are presented in Table 2 to Table 5.

Table 2. Suggestions and Inputs and follow-up from Experts of Aspect Desain

No.	Suggestions and Feedback	Follow Up / Repair
1.	The screen on the media is given an image that is relevant to the material	Changing the media screen with blue with icons of optical devices in daily life
2.	Virtual naming on media screens to be considered for example: a. SMA optical visualization b. Virtual optical learning	Media naming into SMA optical visualization
3.	Add user guide	Addition of a user guide that can be accessed by users in learning media in the form of downloadable pdf files
4.	In optical visualization, fix the program output value to be 2 digits after the comma.	Fixed optical visualization program so that the output value becomes 2 digits after the comma

Table 3. Suggestions and Inputs and follow-up from Experts of Aspect Pedagogic

No.	Suggestions and Feedback	Follow Up / Repair
1.	Optical visualization media should be added instrumental to attract students' attention in the learning process using optical visualization media media	Added a musical instrument entitled ukulele

Table 4. Suggestions and Inputs and follow-up from Experts of Aspect Content

No.	Suggestions and Feedback	Follow Up / Repair
1.	Each exercise should be accompanied / ended with a discussion of practice questions. Discussion of practice questions can only be accessed by students who have worked on the questions.	Added discussion of practice questions on the practice menu, discussion of questions in the form of pdf files that can only be read.
2.	At the end of the evaluation should be given a discussion about the evaluation that can be	Added discussion of evaluation questions on the evaluation menu,

accessed by students whose scores have met the minimum completeness criteria discussion of questions in the form of pdf files that can only be read.

Table 5. Suggestions and Inputs and follow-up from Experts of aspect Engineering

No.	Suggestions and Feedback	Follow Up / Repair
1.	Discussion of practice questions should be controlled by the teacher through an administrator account	Added the Exercise menu on the administrator page to enable student access to the discussion of practice questions
2.	Access to evaluation questions should be controlled by the teacher through an administrator account	Added a visualization menu on the administrator page to enable access for students who are allowed to work on evaluation questions.

The results of the validation of optics visualization learning media by experts are illustrated in Figure 12.

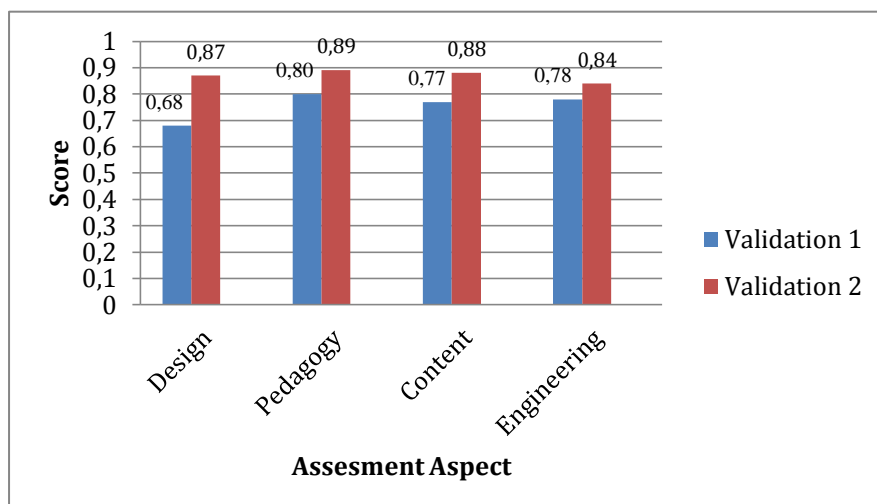


Fig 12. The Expert Validation Result

In Figure 12, the graph of the results of the validation of the optics visualization web-based shows that there are four aspects of media evaluation: by three experts. In the design aspect, the index increased from 0.68 to 0.87. The increase in the index was caused by the first validation, the three validators gave a lot of suggestions and input about the media in terms of design. In the design aspect in the first validation, the validator gives suggestions to change the background on the media to match the material to be delivered, change the name of the media, add a user guide, and change the output value in the visualization to be two numbers after a comma.

The researcher made improvements to the suggestions and inputs given by the validator by improving the page screen to match the material presented, changing the media name to SMA optical visualization, adding a user guide menu in the form of a pdf file, and fixing the output value for all visualizations to two numbers. after the coma. After the repair is to make the media re-validated by the

validator and the second validation index of the three validator experts on the design aspect is 0.87 with a valid category.

In the pedagogic aspect, the index increased from 0.80 to 0.89. This percentage increase was caused by the first validation, the third validator providing suggestions and input about the media from the pedagogic aspect. Improvements in pedagogic aspects include the addition of instrumental music on optical visualization media in order to attract students' attention in the learning process so that it is not boring. Improvements were made on the suggestions and inputs given by the validator by adding an instrumental music entitled ukulele, this musical instrument can be deactivated by pressing the off button on the media. After repairing the media, it was re-validated by the validator and the second validation percentage of the three expert validator media on the pedagogic aspect was 0.89 with a valid category.

In the aspect of content there was an increase in the index, from 0.77 to 0.88. The increase in percentage was caused by the first validation, the three validators gave a lot of suggestions and input about the media from the content aspect. Suggestions on the content aspect include each practice question should be accompanied by a discussion of the questions and at the end of the evaluation also accompanied by a discussion of the questions..

Researchers made improvements to the suggestions and inputs given by adding discussion of practice questions that students can see in the form of pdf files that cannot be downloaded, and adding discussion of practice questions that will only appear after students finish working on evaluation questions with scores above the completeness criteria. specified minimum. After making improvements, it is then validated again by the validator so that the second validation index of the three validator experts on the content aspect is 0.88 with a valid category.

In the aspect of engineering there was an increase in the index, from 0.78 to 0.84. The increase in percentage was caused by the first validation, the three validators gave a lot of suggestions and input about the media from the content aspect. Suggestions on the technical aspect include discussion of practice questions controlled by the teacher so that students can see the discussion of questions after students work on practice questions, access to evaluation questions should be controlled by the teacher through an administrator account. After making improvements, it is then validated again by the validator so that the second validation index of the three validator experts on the technical aspect is 0.88 with a valid category.

Overall, of the four aspects of validation, three experts are 0.87. Based on the assessment criteria Aiken's V is stated with valid criteria. So that optical visualization learning media products can be used as learning media.

4. Conclusion

Based on the data from the data analysis and discussion, the development of web-based optical visualization learning media through the ADDIE type instructional design learning media design model, has resulted in online learning media that are legitimate / suitable to be used as physical learning media as a solution to the limited laboratory facilities and infrastructure. Suggestions that can be submitted based on the results of this study are that educators are expected to be able to use optical visualization as a learning medium to convey material so that in addition to facilitating and helping teachers, media that can be dynamic can make students feel happier, attract attention, and also don't make them bored. in the teaching and learning process so that it will create an active atmosphere in learning.

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