



Validity of Optical Practicum KIT Equipped with Guided Inquiry-Based Worksheet for Madrasah Aliyah Students

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Abstract:

The background of this research is the lack of supporting facilities for physics practicum activities, such as laboratories and teaching aids, so skills competence in optical material is not carried out. This study aimed to determine the validity of the Optical Practicum KIT with the validity of the Guided Inquiry-based worksheets. This study uses the Research and Development (R&D) method with the ADDIE model (Analyze, Design, Development, Implementation, and Evaluate). The data in this study are product validity obtained from 3 expert validators. The research results data were then analyzed using quantitative descriptive and qualitative descriptive analysis techniques. The results showed that the validity of the Optical Practicum KIT was stated to be very valid by the validator with a value of 84,83%, and the validity of the Guided Inquiry-based worksheet was also stated to be very valid with a value of 89,56%, so it was suitable for use as a physics learning medium. Hopefully, this research can be further refined in terms of construction and adding components such as microcontroller sensors, as well as implementing or testing products with experimental research.

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Introduction

Physics, a branch of natural science, is not just about studying natural phenomena. It's about understanding the world around us, from the way a ball bounces to the way a car moves. Physics is not just about the content, but also about the process of understanding these natural phenomena (Sulistiyono, 2020).

By its characteristics, physics learning must include direct measurement and observation activities through experimental or practical methods (Islami et al., 2019). Practical activities can help connect two knowledge domains, namely, natural objects observed with mental knowledge (Usmeldi & Amini, 2021). So, a balance is needed between conveying concepts and theory with practical activities so that students can achieve the three expected competencies: cognitive, psychomotor, and affective (Masril et al., 2019). However, in reality, the learning tends to be one-way or teacher-centered and does not involve students in the learning process. So, learning is limited to remembering information only by connecting it to daily life (Zulaikha et al., 2021).

Based on the results of interviews with physics teachers at MAN 2 Banjar, it is known that physics learning is still in the form of teachers providing material directly to students through lectures and question-and-answer methods. Apart from that, due to the lack of facilities to support physics learning, such as laboratories and teaching aids, physics practicum activities were eliminated. This finding is in line with research by Rahmadi et al., (2021) and Kumalasari et al., (2022) which describes that physics learning in schools still tends to be monotonous due to a lack of learning facilities such as teaching aids, so physics learning is limited to the lecture method only. Sasmita & Hartoyo (2020) state that weak physics learning can impact students' High Order Thinking Skills (HOTS) abilities. So, we need a learning media such as Practicum KIT to motivate and facilitate students' learning absorption (Maharani et al., 2017).

The practicum Integrated Instrument (KIT) component is a set of practicum tools that are packaged in such a way as to help describe abstract material concepts in a natural, clear, and observable manner, making it easier for students to understand them (Masyruhan et al., 2020; Usmeldi & Amini, 2021). One of the physics materials that requires learning media in the form of a practical KIT to explain the concept is optics. The Optical Practicum KIT is a series of tools that help students understand the principles of light reflection in mirrors, light refraction in lenses, shadows of objects, and other optical experiments (Wibowo & Marzuqi, 2022).

Based on research and development conducted by Rohmansyah & Kholiq (2020), IT Optics is very suitable as a learning medium for practical activities on optical materials, especially on the principles of light refraction in convex lenses. In line with this research, Wibowo & Marzuqi (2022) also developed an Optical KIT for light reflection and refraction experiments in liquids. Apart from that, research by Ramadhani et al., (2022) also produced a simple Optical KIT, which can be used to describe the concept of light reflection and image formation in concave mirrors with very reasonable validity.

Physics practical activities also needs to support by worksheet (Islami et al., 2019; Putri et al., 2019). Student Worksheet is a form of teaching media that is prepared so that students can use it to obtain information related to the material being studied and helps increase students' understanding and active involvement in a learning process (Hamidah et al., 2018; Islami et al., 2019). Firdaus & Wilujeng (2018) state that

worksheet is a learning activity sheet used to discover material concepts through theoretical presentations, demonstration activities, or investigations. It contains clear work procedures for completing tasks according to the indicators and learning objectives to be achieved.

So that the use of worksheet can build active participation of students during learning, an appropriate learning model is needed to guide students. One suitable alternative learning model that can be used in physics learning is the guided inquiry model (Sulistiyono, 2020). Through guided inquiry learning, students will be encouraged to think analytically, critically, and systematically (P. I. Ramadhani et al., 2023) to discover for themselves the concepts of the material they are studying through practical activities (Faradilla et al., 2023), so that learning is not only in the form of knowledge of concepts and facts but also understand the discovery process (Siahaan et al., 2021). The advantage of the guided inquiry learning model is that it helps develop students' cognitive skills and processes because students will be directly involved in discovering concepts independently through practicum activities (Nugroho & Suliyana, 2018). Apart from that, the application of the guided inquiry model can train students to solve problems in learning independently through group discussions (Nurlaila & Lufri, 2021).

Guided inquiry-based worksheet can make it easier for teachers and students to discover physics concepts through practical activities both independently and in groups (Firdaus & Wilujeng, 2018). In research by Islami et al., (2019) it was found that guided inquiry-based worksheet can improve students' science process skills, where science process skills in the experimental class are in the very high category, while the control class is in the low category. Likewise, research by Mahjatia et al., (2020) shows that the use of guided inquiry STEM-based worksheet can improve students' science process skills, with the n-gain value being in the "medium" category. Meanwhile, in research by Mawardi et al., (2020) guided inquiry-based worksheet was able to increase students' HOTS.

The difference in this research lies in the Optical Practicum KIT, which can be used for three different types of experiments: convex lenses, concave mirrors, and convex mirrors. Through this KIT, students can also investigate the position of the image, the optical focus point, and the nature of the image. The KIT also has a simple construction made from strong, easy-to-find, cheap, and by the eligibility requirements issued by Direktorat Pembinaan SMA (2011). So, this KIT can be an alternative for teachers and schools that cannot yet provide physics teaching aids of national and international standards.

Based on the urgency described, this research aims to develop an Optical Practicum KIT equipped with guided inquiry-based worksheet for madrasah aliyah students. With the development of this research, it is hoped that students can carry out practical activities on optical material topics.

Research Method

This type of field research involves collecting data from informants and validators through interviews, questionnaires, and other methods (Rahmadi, 2011). Our research and development (R&D) methods are instrumental in our study. The research model we have adopted, the ADDIE model, was popularized by Reiser and

Mollenda in the 1990s. This model guides our research through its five stages of Analysis, Design, Development, Implementation, and Evaluation. However, our research focuses explicitly on the development and evaluation stages (Lestari & Sucahyo, 2023; Setiawan et al., 2021). This limitation ensures the feasibility of the product under development (Purwanto et al., 2022). The subjects of our research, the three validators, play a crucial role in our study. They include two Lecturers at UIN Antasari Banjarmasin and one Physics Teacher at MAN 2 Banjar.

This research has two instruments: the Optical Practicum KIT validation sheet and the worksheet validation sheet. Research data was then collected through two product questionnaires submitted to the validators. The KIT and worksheet validity data will be analyzed using quantitative and qualitative descriptive techniques.

Analysis Stage

This stage contains an analysis of learning needs, types of models, methods, learning resources, and learning media that are often used in physics learning (Siswono, 2019). At this stage, an unstructured interview was conducted with the physics teacher. Based on the interviews, it was found that physics learning is still dominated by the lecture method and assignments using handbooks in the form of worksheet. So far, students have never done physics practicum due to lacking school facilities such as laboratories and teaching aids. The solution to these findings is developing a Practical KIT equipped with worksheet, especially on Optics material, hoping that students can have direct experience in learning physics.

Design Stage

The design stage begins with designing the Optical Practicum KIT and determining the components and materials used to make the KIT. Templates, concepts, and content included in the worksheet have also been designed. The initial design of the Optical Practicum KIT can be seen in the following figure.

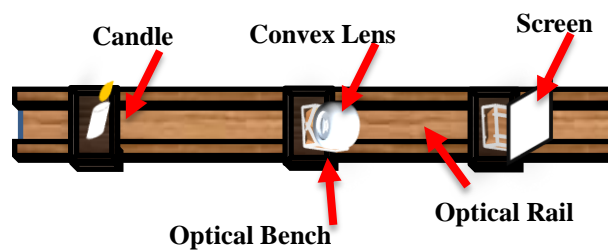


Figure 1. Convex Lens Experiment Design

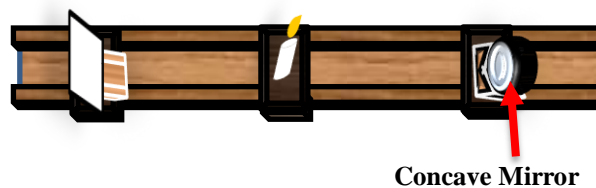


Figure 2. Concave Mirror Experiment Design

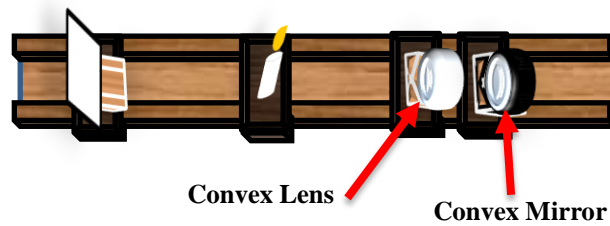


Figure 3. Convex Mirror Experiment Design



Figure 4. Initial Design of the Optical Practicum KIT

Figure 4 is the initial view of the Optical Practicum KIT, which consists of several components: optical rail, optical bench, screen, candle, concave mirror, convex mirror, and convex lens. The KIT components can be assembled according to the experimental topic, as shown in Figures 1, 2, and 3. The initial appearance of the guided inquiry-based worksheet is shown in Figure 5 below.

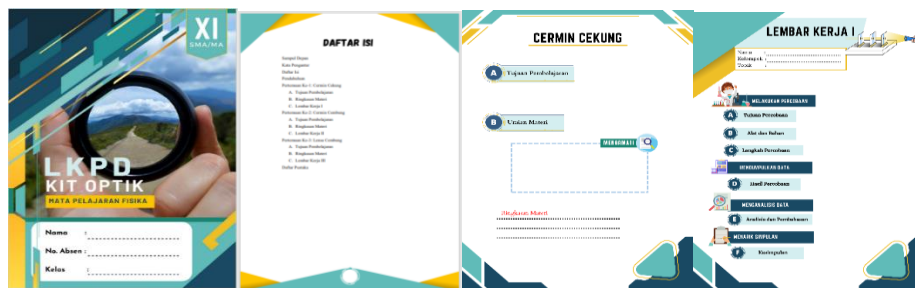


Figure 5. Initial Design of Worksheet

Figure 5 shows the initial design of the worksheet, which is structured based on the stages of the guided inquiry model: observing, asking questions, planning experiments, collecting data, analyzing data, and drawing conclusions (Nurdyansyah & Fahyuni, 2016). The initial worksheet only consisted of a front cover, table of contents, material topics, and worksheets.

Development Stage

The development stage is the stage of producing a product, which consists of a validation process and limited testing of the tool to determine errors in the tool

(Nurmaya et al., 2021). The initial design plans carry out the development of KIT and worksheet. The KIT has several additional components, including layers, meters, and optical supports. The KIT that was developed was also tested to determine the level of accuracy and degree of error. Meanwhile, the worksheet adds material summary content, pictures, experimental procedures, and a "Find Out" column.

After the development stage, the KIT and worksheet products undergo rigorous testing and validation to ensure their suitability and accuracy. The results of this process, analyzed using quantitative and qualitative descriptive techniques, provide a comprehensive understanding of the product's validity. Product validity is calculated using a specific formula, as Sudijono (2015) outlined

$$P = \frac{f}{N} \times 100 \%$$

Information:

P = Questionnaire data percentage figures

f = Total score obtained

N = Maximum total score

The results of the formula calculation above are then interpreted using the following product validity criteria Table 1:

Table 1. Score Criteria



Percentage (%)	Criteria
0 - 20	Very Invalid
21 - 40	Invalid
41 - 60	Less Valid
61 - 80	Valid
81 - 100	Very Valid

Source: (Riduwan, 2011)

Evaluation Stage

Product evaluation is carried out at the end of each research and development stage. Apart from that, the product evaluation process also refers to comments and suggestions provided by validators. So, this research can produce a suitable product for use in the learning process. The following Table 2 and 3 are summary of the evaluation of the development of KIT and worksheet.

Table 2. Evaluation of Optical Practicum KIT

No.	Validator Comments/Suggestions
1.	The thickness of the wood on the carriage affects the accuracy of the experimental data and reduce the robustness optical bench and layer when mounted on an optical rail
	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Before</p> </div> <div style="text-align: center;">  <p>After</p> </div> </div>
2.	The board cannot be bent and a large storage box is required



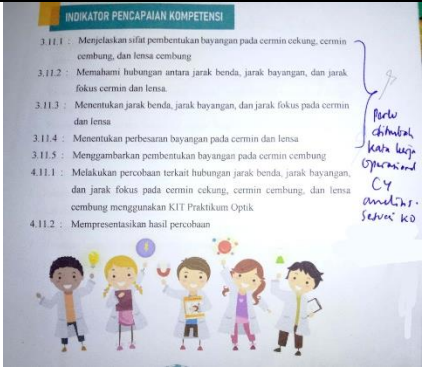
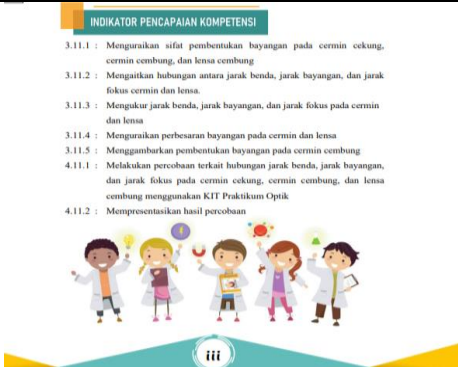
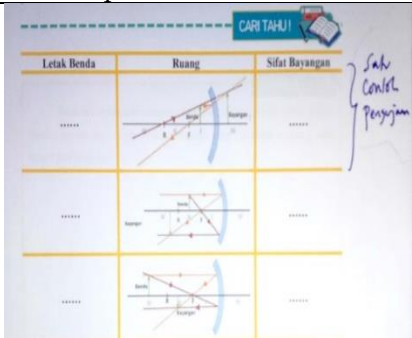
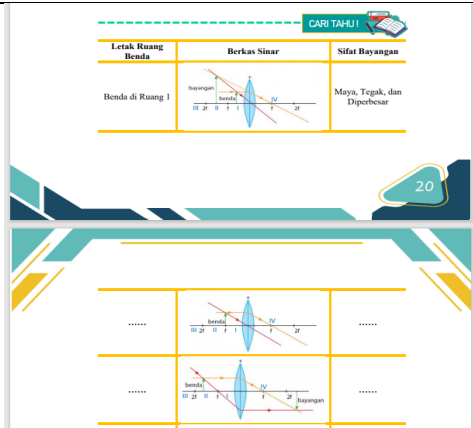
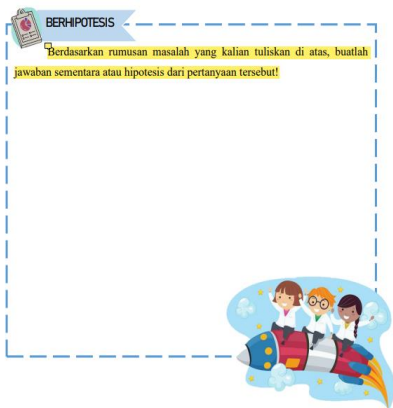
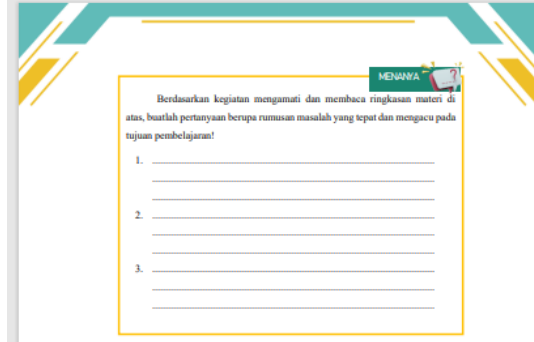
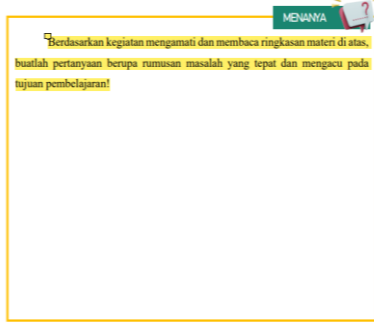
No.	Validator Comments/Suggestions
 <p data-bbox="371 600 821 694">The optical rail is 112 cm long and has several tool/material components and cannot be bent so it is not <i>easymobile</i>.</p>	 <p data-bbox="887 660 1385 721">A container box is provided to store tool components/materials in the KIT</p>

Table 3. Evaluation of Worksheet

No.	Validator Comments/Suggestions
<p data-bbox="263 884 1308 918">1. Use operational verbs at level C4 (analysis) in competency achievement indicators</p>  <p data-bbox="555 1290 638 1310">Before</p>	 <p data-bbox="1114 1290 1181 1310">After</p>
<p data-bbox="263 1321 1402 1388">2. Add a "Find Out" activity on the topic of convex mirrors and convex lenses, and provide an example of the work!</p>  <p data-bbox="563 1827 646 1848">Before</p>	 <p data-bbox="1114 1827 1181 1848">After</p>
<p data-bbox="263 1881 1402 1915">3. Need to make numbering and dots in the "Ask" and "Hypothesize" tasks</p>	

Validity of Optical Practicum KIT Equipped ...

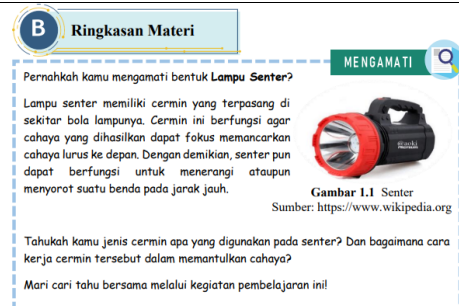
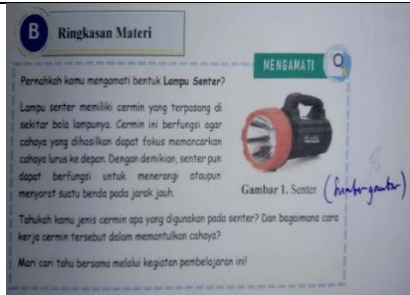
No.	Validator Comments/Suggestions
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Before

After

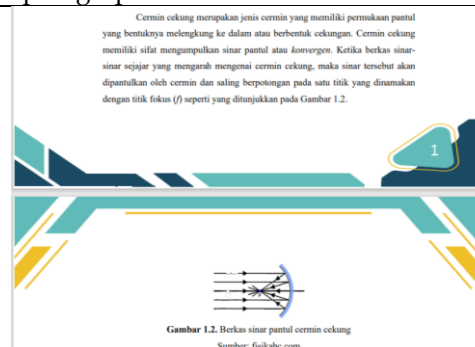
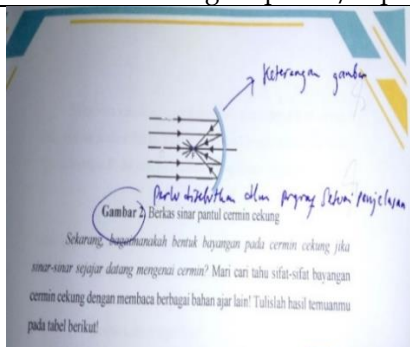
4. Need to include the source of the image



Before

After

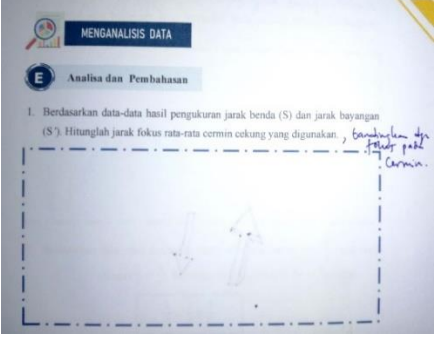
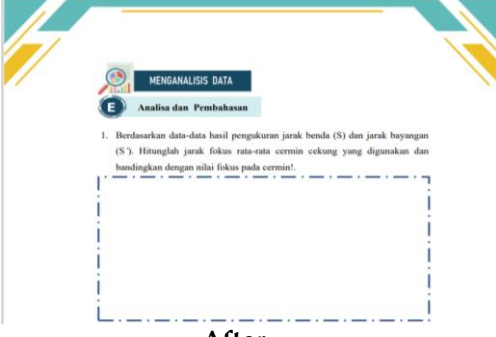
5. Need to add image captions/explanations to the paragraph



Before

After

6. In the 1st question on page 7, and the 2nd question on page 24, you need to add the sentence "Compare with focus on the mirror/lens"

No.	Validator Comments/Suggestions
	
Before	After

Result and Discussion

Validity of the Optical Practicum KIT

The validity test of the Optical Practicum KIT was carried out by a team of validators consisting of 2 Physics Tadris lecturers at UIN Antasari Banjarmasin and one physics teacher at MAN 2 Banjar. Validity tests were carried out on nine aspects representing the feasibility assessment of the Optical Practicum KIT – the validity of the Optical Practicum KIT results' Figure 6.

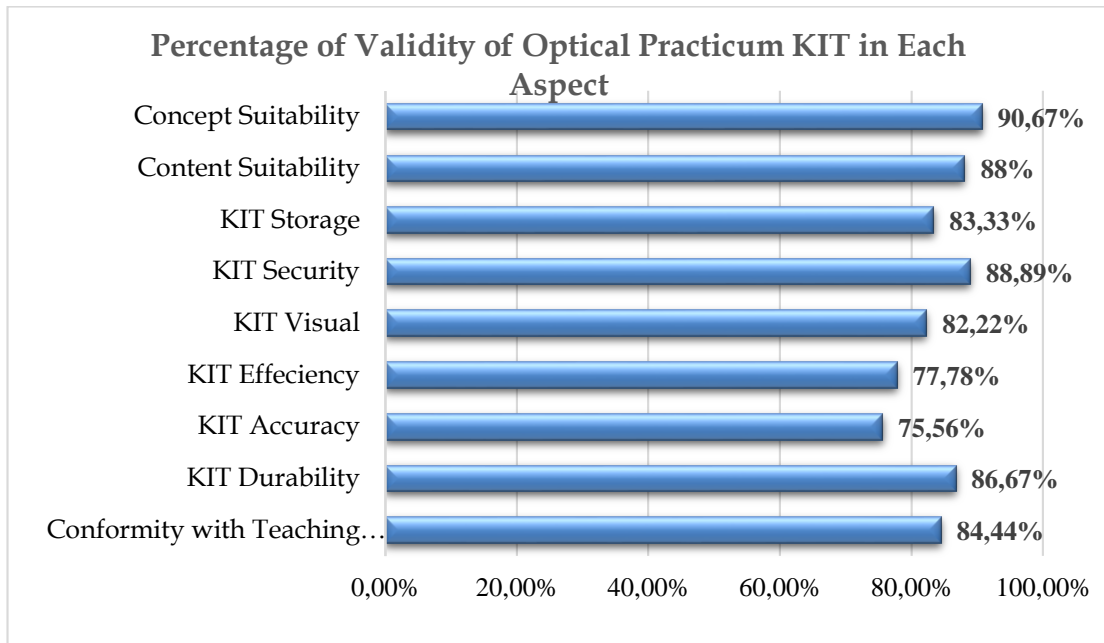


Figure 6. Percentage Diagram of the Validity of the Optical Practicum KIT

Figure 6 shows that the optical practicum KIT that has been developed has been tested for its feasibility, with an average percentage of 84.83%, and with very valid criteria from experts. The optical practicum KIT can be used as a practical learning medium in explaining optical concepts with a feasibility value of 84.44% and very valid criteria in the suitability aspect of teaching material. This aligns with research by Rohmansyah & Kholiq (2020) which states that Practicum KIT can help students analyze the abstract concepts they are studying. Apart from that, KIT can also provide direct experience for students in applying concepts so that it helps build their knowledge (Pramudyawan et al., 2020).

The Optical Practicum KIT that has been developed has also been adapted to the KI/KD in optical material as well as indicators of competency achievement and predetermined learning objectives. Thus, KIT is stated to be able to help visualize the material as research results from Riyadi et al., (2018) show that teaching aids that are designed according to learning objectives can be a good learning resource for students. This is measured through the content suitability aspect, which obtained a validity value of 88%, using very valid criteria. These findings are then strengthened by suitability, which measures how KIT can describe physical quantities in optical materials. These physical quantities are object distance (s), image distance (s'), and focus distance (f) in mirrors and lenses, with a value of 90.67% and very valid criteria. So, using this optical practicum, KIT can help students discover the truth of concepts through direct experience, which is difficult to describe through the lecture method (Masturoh et al., 2019).

In explaining the correctness of concepts in optical materials, the accuracy of the Practicum KIT is first measured to determine the accuracy of the measurement results using the KIT that has been developed. Based on the error calculations that have been carried out in testing the tool, the following values are obtained in Table 4.

Table 4. Optical Practicum KIT Trial Results

No.	S (cm)	S' (cm)	f (cm)	$\Delta f \times 10^{-2}(\text{cm})$	KR (%)	DK (%)	$(f \pm \Delta f)$ (cm)
Experiment 1: Concave Mirror							
1.	12	63,4	10,09	3,54	0,35	99,56	$(10,09 \pm 0,0354)$
2.	14	38,6	10,27	2,71	0,26	99,74	$(10,27 \pm 0,0271)$
3.	15	31	10,1	2,33	0,23	99,77	$(10,1 \pm 0,0233)$
4.	16	28,2	10,21	2,14	0,21	99,79	$(10,21 \pm 0,0214)$
5.	18	23	10,098	1,845	0,183	99,817	$(10,098 \pm 0,018)$
Experiment 2: Convex Mirror							
6.	10	40	8,00	3,21	0,40	99,60	$(8,00 \pm 0,0321)$
7.	10,5	37	8,18	3,043	0,372	99,628	$(8,18 \pm 0,03043)$
8.	11	35,5	8,40	3,13	0,37	99,63	$(8,4 \pm 0,0313)$
Experiment 3: Convex Lens							
9.	12	58	9,94	3,43	0,345	99,655	$(9,94 \pm 0,0343)$
10.	15	29	9,87	2,76	0,28	99,72	$(9,87 \pm 0,0276)$
11.	18	22,2	9,94	1,82	0,184	99,816	$(9,94 \pm 0,0182)$
12.	20	19,5	9,87	1,75	0,177	99,823	$(9,87 \pm 0,0175)$
13.	25	16,5	9,94	1,98	0,2	99,80	$(9,94 \pm 0,0198)$

Table 4 shows that the accuracy level of the optical practicum KIT is classified as very good, as per the research results of Rohmansyah & Kholiq (2020) which obtained an Optical KIT accuracy level of 99.47% and a relative error of 0.53%. Apart from calculating errors, accuracy was also measured through validator assessments, and a score of 75.56% was obtained using valid criteria. Thus, these results show that the accuracy of the Optical Practicum KIT in measuring physical quantities and phenomena in concave mirrors, convex mirrors, and convex lenses is excellent and successful in conceptualizing scientific concepts and minimizing student misconceptions (Direktorat Pembinaan SMA., 2011).

Based on its construction, the practical KIT is made of wood, which is strong, cheap, and easy to obtain. The tools and materials that make up this KIT series have

met the tool durability requirements with a validity of 86.67% and very valid criteria. So, the Optical Practicum KIT developed does not wear out quickly or run out in one use (Direktorat Pembinaan SMA., 2011). Because the KIT is made from environmentally friendly and non-hazardous materials, the Optical Practicum KIT has adequate safety (Saputra & Mahmudah, 2022). The KIT security aspect received a score with a percentage of 88.89%, and the criteria were very valid. The KIT developed has no risk factors and is safe and comfortable for students.

Apart from being solid and safe, the practical KIT developed was also declared efficient in use by validators with a score of 77.78% and valid criteria. These results show that KIT is easy to use regarding time, use, and storage (Riyadi et al., 2018). According to Solehan et al., (2022) the efficiency aspect of KIT is seen from 3 indicators, namely ease of assembling the tool, ease of use, and suitability of the tool to the learning environment.

The Optical Practicum KIT is also considered to have an attractive appearance or visuals with a validity of 82.22% and very valid criteria. The Optical Practicum KIT is stated to have neat colors and an attractive shape, and even though it is made from simple materials, it does not reduce the tool's performance. A simple Optical Practicum KIT can still motivate students when using it (H. N. Ramadhani et al., 2022).

So that the Optical Practicum KIT can be organized and stored correctly, a container box is also provided to store the components of the KIT series, such as optical benches, screens, mirrors, and lenses that are prone to breaking. The KIT storage aspect scored 83.33%, with very valid criteria. KIT storage is stated to function well in facilitating the process of storing and retrieving tools so that they are maintained, safe, and ready for use in each practical session (Direktorat Pembinaan SMA., 2011).

Validity of Guided Inquiry-Based Worksheet

Three expert validators carried out the guided inquiry-based worksheet validity test on three assessment aspects, and the results are presented in Figure 7.

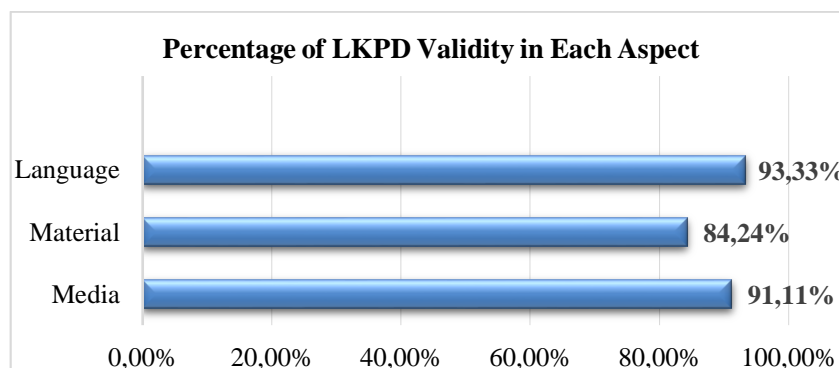


Figure 7. Percentage Diagram of Worksheet Validity

Figure 7 describes that the validity of the guided inquiry-based worksheet is in the very valid category with an average gain of 89.56%. These results show that the worksheet has been well developed and in accordance with worksheet eligibility standards and guided inquiry learning stages, so that it is able to meet students' learning needs. There are three aspects that represent the feasibility of guided inquiry-based worksheet, namely media, material and language aspects.

The media aspect has functions to assess the feasibility of worksheet based on technical requirements (Rizalini & Sofyan, 2018). Technical requirements relate to display formats such as placement of images and graphs or tables, use of type and size of letters, as well as creativity in presenting content so that it can attract students' learning attention (Pawestri & Zulfiati, 2020; Risky et al., 2023; Sulistiyono & Triyanti, 2024). The validator states that the worksheet developed has presented content appropriate to the guided inquiry learning stages and is equipped with pictures and procedures for using the KIT. This is shown by the validation results on the media aspect, which obtained a score of 91.11% with very valid criteria. Worksheet is stated to facilitate students' participation in the learning process, especially when carrying out practical activities.

The guided inquiry-based worksheet material aspect obtained a score of 84.24% with very valid criteria. Assessment of material aspects relates to didactic requirements that measure the suitability of worksheet in terms of its ability to guide students to be actively involved in the concept discovery process through providing various stimuli with media and other learning activities (Lase & Zai, 2022; Pawestri & Zulfiati, 2020; A. S. Ramadhani et al., 2021). From these results, the worksheet was developed by the KD and GPA on the topic of optical materials. As in Fitriyah & Madlazim (2021) research, the validity of the material was 96.8% with very valid criteria, so the material contained in the worksheet was declared to be in sync with the learning objectives and indicators. Thus, guided inquiry-based worksheet can help students master concepts and creativity in learning physics (Aziziyah et al., 2022).

Furthermore, a language aspect is carried out to assess the feasibility of the worksheet based on its construction requirements. The construction requirements for worksheet are based on the rules for using Indonesian, sentence structure, and vocabulary use (Estitika et al., 2022) and have grammar commensurate with the student's level of thinking (Fadhilatunnisa et al., 2021). This aspect obtained a validity value of 93.33% with very valid criteria. This result is in line with the findings of Astri et al., (2024), Pabri et al., (2022) and Yani et al., (2021), who each obtained a very valid category in the language aspect, so that the worksheet was declared to be by the rules Indonesian and by student development. Based on this, writing worksheet based on guided inquiry has applied appropriate Indonesian language rules so students can understand it well.

Conclusion

Based on the results of research that has been carried out, it is found that the validity of the Optical Practicum KIT has very valid criteria with a value of 84.83% and is declared very suitable for use as a physics learning medium. The validity of guided inquiry-based worksheet also has very valid criteria, with a score of 89.56%. It is suitable as a learning medium that supports using the Optical Practicum KIT in physics practicum activities. As a consideration for future research, it is hoped that researchers will improve the Practicum KIT by adding a microcontroller sensor to record measurement results automatically. The next researcher can implement the product with experimental research to test the effectiveness of the Optical Practicum KIT and its worksheet.

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