The development of *smoky glass box* as a physics instructional medium on light subject

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**Abstract.** We had conducted a research and development (R&D) about one of the physics instructional media namely *smoky glass box* on the light subject. This research aimed to produce proper *smoky glass box* instructional medium based on the validation, practicality, and effectiveness of the media. The type of research is research and development which refers to the ADDIE model. The subjects of the try out were the eight grade of SMPN 9 Banjarmasin. The instruments of this research were validation sheet, questionnaire, and learning outcome test. The results showed that: (1) the category of validity media is highly valid, (2) the category of practicability media is good, and (3) the category of effectiveness media is high. Based on the results of the research *smoky glass box* instructional medium is proper to use in learning physics.

1. Introduction

Education is a conscious and planned effort to create a learning atmosphere and process so that learner can actively develop his/her potential to have spiritual strength, self-control, personality, intelligence, character, and skills that needed by himself/ herself, nation and state society [1]. Education is the representation of a nation progress. Qualified education is supported by an effective learning system. An effective learning is a learning that allows learners to learn easy and fun and can achieve the learning objectives that have been set [2]. Effective learning cannot be separated from the role of teacher, learning condition, involvement of learner, facilities/media/resources/learning aids, classroom size/ condition/atmosphere and effective time [3].

Instructional media play an important role in the learning process. They can convey messages and stimulate students’ thoughts, feelings, and willingness on the learning processes [4]. Instructional media can make students’ attitude more positive, encourage their self-motivation, demonstrate associated factors and ideas, highlight specific topics and concepts, encourage relevance and credibility, and enhance understanding [5]. Through the instructional media, the obscurity of the material can be clarified, especially for sciences that have a high level of abstraction [6]. Props is one type of instructional media [7]. Props are instructional media that contain or bring the concepts studied [8]. They can change the abstract teaching materials become more concrete so that it can help students understand the concept of the material [9]. Therefore, the use props as instructional media is an important aspect of the learning process of science studies that have a high level of abstraction.

Based on the results of interviews at SMP Negeri 9 Banjarmasin, the instructional media used, especially the visual aids in the light-matter is less practical to use. The available props cannot
properly display the light phenomena in experimental activities. This makes teachers struggling to use props.

One of many efforts to overcome the problem is through the development of instructional media in the form of props. Developed aids should be able to display the phenomenon of light well so that students can obtain the understanding of the material taught maximally. Props play an important role as a tool to help the teaching-learning process so that communication can work well and effectively [10]. This is in line with [11] the use of props will make it easier for students to understand a concept, in this case, instructional media of smoky glass box is developed to teach light teaching material.

Based on the background, a research and development of smoky glass box instructional medium on the Light subject was done for junior high school students. The purpose of this research is to produce proper smoky glass box instructional medium on the Light subject for junior high school students based on validity, practicality, and effectiveness of the instructional media developed.

2. Method

2.1. Type of Research
This research is a development research with ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) [12]. This smoky glass box instructional medium was tested to 35 students of the eight grade of SMP Negeri 9 Banjarmasin as the subjects of this research. The instruments used were validation sheet, questionnaire, and learning result test.

2.2. Data Analysis Technique

2.2.1. Validity. Validation was done by two media validators by using a validation sheet. The validity in this study is calculated based on equation (1) [13].

\[
Validity = \frac{X}{X_{max}} \times 100\% \tag{1}
\]

Where are \(X\) = the total of the obtained scores and \(X_{max}\) = maximum score. The validity category of the instructional media is shown in Table 1 [13].

| The score of validity (%) | Category       |
|--------------------------|----------------|
| 86 \(< x \leq 100\)      | Highly Valid   |
| 71 \(< x \leq 85\)       | Valid          |
| 56 \(< x \leq 70\)       | Moderately Valid|
| 41 \(< x \leq 55\)       | Poorly valid   |
| 25 \(< x \leq 40\)       | Not valid      |

The percentage of agreement from Borich on equation (2) was used to calculate the reliability value of the validation results of two validators [14].

\[
PA = 1 - \frac{A-B}{A+B} \times 100\% \tag{2}
\]

Where are \(A\) = larger validator score; \(B\) = smaller validator scores. The results of the calculation of the reliability are described in the form of categories in Table 2 [15].
Table 2. Reliability category

| Reliability coefficient (r) | Category     |
|-----------------------------|--------------|
| 0.80 \( \leq r \)          | High         |
| 0.40 < r < 0.80             | Moderate     |
| r < 0.40                    | Low          |

2.2.2 Practicality. Instructional media practicality was counted by using equation (3).

\[
P = \frac{\sum K}{\sum N} \times 100\%
\]  

(3)

Where are \( P \) = students response percentage, \( \sum K \) = sum of obtained score, and \( \sum N \) = sum of maximum score. The results of the instructional media practicality is described in the category of Table 3 [15].

Table 3. Practicality category of instructional media

| The mean of the practicality (%) | Criteria       |
|----------------------------------|----------------|
| 20.00 < x \leq 36.00            | Poor           |
| 36.01 < x \leq 52.00            | Not Good       |
| 52.01 < x \leq 68.00            | Moderately Good|
| 68.01 < x \leq 84.00            | Good           |
| 84.01 < x \leq 100.00           | Very Good      |

The reliability of practical instructional media is analyzed using equation (4) [15].

\[
r_{11} = \left( \frac{k}{k-1} \right) \left( 1 - \frac{\sum \sigma^2}{\sigma_t^2} \right)
\]  

(4)

Where are \( r_{11} \) = reliability ; \( k \) = number of item; \( \sum \sigma^2 \) = number of item variance; \( \sigma_t^2 \) = total variance. The variance value on equation (4) is given in equation (5).

\[
\sigma = \frac{\sum x^2 - (\sum x)^2}{N}
\]  

(5)

Where are \( X \) = total score; \( N \) = number of respondents. The results of the calculation of realizability are described as in Table 2 [15].

2.2.3 Effectiveness. The effectiveness of the instructional medium was analyzed by using equation (6).

\[
\langle g \rangle = \frac{S_f - S_i}{S_{max} - S_i}
\]  

(6)

Where are \( S_f \) = mean score of posttest, \( S_i \) = mean score of pretest, and \( S_{max} \) = maximum score that can be achieved.

Before analyzing using equation (6), the data obtained should meet the prerequisite test of Normality test. The data is normal if sig (p) > 0.05 [16]. The result of the instructional media effectiveness is described in the category of Table 4 [17].

Table 4. Category of the effectiveness

| Effectiveness | Category |
|---------------|---------|
| \( \langle g \rangle > 0.7 \) | High    |
| 0.3 \( \leq \langle g \rangle \leq 0.7 \) | Moderate|
| \( \langle g \rangle < 0.3 \) | Low     |
3. Result and Discussion

3.1 Product of the research and development

The result of the development of *smoky glass box* instructional medium is shown in Figure 1. The developed instructional media can display fourth experimental activities: light travels in a straight line, the law of reflection, the law of refraction, and shadow formation on mirrors and lenses. *Smoky glass box* developed uses a glass box that serves as a smoke confinement. The confined smoke in the box is aimed to make the fired light through the smoke show a propagation line. This is because smoke is one of the colloidal particles that can cause Tyndall effects. If the light laser/flashlight used in the experiment can show the light propagation, then the light phenomenon can be displayed better than by using experimental devices in the school. The developed instructional media can display more real light phenomenon so that the light subject that is delivered becomes more concrete. This is in accordance with [9] who stated that props can change the abstract teaching materials become more concrete so that it can help students understand the concept of the material that is being taught.

![Image](image.png)

**Figure 1.** Result of the development of *smoky glass box* instructional medium

3.2 Validity

Validation of *smoky glass box* instructional medium consists of three aspects, namely suitability, quality and usability (ability). The suitability is categorized as highly valid. The quality aspect is categorized as highly valid. The usability aspect is categorized as highly valid. The overall validity of *smoky glass box* instructional medium is categorized as highly valid. The reliability coefficient is categorized as high. According to [18] the higher level validity of a teaching media, more authentic it becomes. Based on [19], the developed instructional media must meet the needs, and the components must be based on science and all components must be consistently connected to each other. If the product meets these requirements, then the product is valid.

| Aspect           | Mean (%) | Category      |
|------------------|----------|---------------|
| Suitability      | 92.00    | Highly Valid  |
| Quality          | 87.60    | Highly Valid  |
| Usability        | 93.75    | Highly Valid  |
| Validity         | 90.95    | Highly Valid  |
| Mean of the validity | 91.08    | Highly Valid  |
| Reliability      | 0.99     | High          |
3.3 Practicality
The practicality of this medium consists of three aspects namely: benefit, efficiency, and convenience. The aspect of benefit is categorized as good. This shows that benefits of the instructional media developed can be perceived by students. The aspect of efficiency is categorized as good. This shows the instructional media is efficient when used by the students. The aspect of convenience is categorized well. This shows the developed instructional media is easy to use by the students. The overall practicality of smoky glass box is categorized as good. The reliability coefficient is categorized as high. This shows that smoky glass box developed is practical. Students can use the instructional media that is developed practically when experimenting. According to [20], practicality is seen from whether or not the props can be applied/used in the classroom when the learning process takes place. According to [21], practicality means that the props that are produced are easy to use by the user, in this case, the student. Practicality refers to the level that users consider the props can easily be used for them in a way that is largely in accordance with what the researchers intended [22].

Table 6. Practicality result of instructional media

| Aspect                | Mean (%) | Category |
|-----------------------|----------|----------|
| Benefit               | 79.10    | Good     |
| Efficiency            | 70.94    | Good     |
| Convenience           | 78.12    | Good     |
| Mean of the practicality | 76.05  | Good     |
| Reliability           | 0.84     | High     |

3.4 The effectiveness
The effectiveness of the media was analyzed by using N-gain test. Before analyzing using N-gain, the normality test was done. The result of the normality test of the pretest data (0.123) and the posttest data (0.130) are significance. The results of this test show that the pretest and posttest data are normally distributed because (p)> 0.05. The result shows that the N-gain score is categorized as high. This shows that smoky glass box can help students achieve learning objectives and meet the feasibility of developing an instructional media on the aspect of effectiveness. According to [22], instructional media will be effective if it gives a positive impact on the learning process. The effectiveness of an education product that indicates the characteristic of the high-quality product is a product that can give the desired result [19].

Table 7. The effectiveness of instructional media

| Score | (g) | Category |
|-------|-----|----------|
| Pretest | Posttest | Max    |      |
| 3.09  | 76.89 | 100.00  | 0.76  | High  |
4. Conclusion
The product produced in this research is *smoky glass box* instructional medium on the Light subject for junior high school students. This media is proper to use in the learning process. This is supported by the experimental results of the *smoky glass box* instructional medium that is categorized as highly valid, the good category of practicality, and high category of effectiveness.

The researchers suggest for further development that the design of the *smoky glass box* props need to be developed so that the props are more interesting. It is also suggested that the material for the box of glass material can be developed from the fiber glass material so that it is not easily broken and it is portable.

Acknowledgment
The authors thank Faculty of Teacher Training and Education, Universitas Lambung Mangkurat due to the funding of DIPA-2017 for this research.

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