Physics Props Development based on Personal Desk Laboratory System to Improve Creative Thinking Ability and Students' Scientific Attitude

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Abstract. This research aims to determine the feasibility of a Personal Desk Laboratory (PDL)-based physics teaching aids system, as well as to find out whether PDL-based physics teaching aids can improve students' creative thinking skills and scientific attitudes. The method used in this study uses the Research and Development method. Data obtained from the results of observations, the results of the questionnaire responses, and the results of the pretest-posttest scores. The products are in the form of PDL-based physical teaching aids systems and supporting devices in the form of Student Worksheets on static fluid material, lesson plan, and practicum guidelines. Validation results calculated using CVR scores and CVI scores stated that PDL-based physics teaching aids are feasible to be tested in the field.

Keyword: Development; Physics props; Personal desk laboratory; Creative thinking ability; Students' scientific attitude.

1. Introduction

Among students develop a strong impression that physics is a lesson that is difficult to understand and less interesting [1]. This is due to a lack of understanding of the nature, usefulness, beauty and employment that can result from learning physics. In order to learn physics feels more fun, the benefits of learning physics need to be understood. Physics learning will be more meaningful if students are actively involved in observing, understanding and utilizing natural symptoms in the surrounding environment. In this process students are trained to have the ability to observe and experiment which is more emphasized on training thinking skills and scientific work. In addition, students are trained to conduct experiments by knowing the equipment used in the measurement both in the laboratory and in the natural surroundings of students. With the support of the mathematical abilities possessed, students are trained to develop compliant thinking and reasoning skills, and this ability to think and reason is trained through accurate data management, whose truth is undoubtedly [2].

Learning media is something very important in the learning process because it can be one of the determinants of learning success [3]. Special learning media such as teaching aids can be used to show abstract phenomena and concepts, so that they are difficult to understand if they are only explained verbally or through images [4]. Therefore, teaching aids are needed that can provide direct experience to students through practicums or demonstrations conducted by the teacher. Learning by using teaching aids is a series of activities to deliver learning material aimed at giving students the opportunity to be active in learning so that it allows students to gain knowledge and develop psychomotor skills and foster creativity of students to solve problems faced [5]. Creativity is
important in human life. Teachers need to be creative in developing practicum activities as an effort to bring students' creative thinking skills [6].

The importance of thinking ability needs to be comprehensively emphasized in solving various real-life problems [7]. The ability to think high students is still low, especially in the aspect of creating [8]. Creative thinking skills are a way of thinking with high imagination so that it can produce innovative and original ideas and change existing ideas and products [9]. Besides creative thinking, practicum can also develop students' scientific attitude by preparing directed scientific activities, such as involving students in scientific discussions and designing an interesting experiment in a new way [10]. In line with these activities, scientific attitudes such as honesty, objectivity, openness, tenacity, critical, discovery and can cooperate with others are also attached to students.

The development of the level of creativity to support the ongoing learning process is increasingly enhanced by using existing facilities and learning from nature and the environment in which they learn. This requires a high enough imagination and creativity from students to support the learning process. In Japan the learning system especially learning that is more practicum or understanding that requires a model or demonstration is increasingly developed, one of which is the PDL (Personal Desk Laboratory) system.

In line with the development of physics teaching aids, students' creative thinking skills and scientific attitudes can be enhanced by PDL systems. The PDL system is proven to be very effective and innovative in order to support the learning process in order to make the learning process as a vehicle for learning for self-development and knowledge learned. The PDL provides a large enough space for the development of students' creativity and innovation by utilizing existing facilities or objects around them to be used as models that are used as props according to the material taught at that time.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

This research was conducted in Sedayu Senior High School, Yogyakarta, Indonesia. The research subjects were students of class XI Science. Data sources are obtained from the results of observations, the results of the questionnaire responses, and the results of the pretest&post-test scores. The products are in the form of PDL-based physics teaching props and supporting devices in the form of Student Worksheets (LKPD) on static fluid material, lesson plan (RPP), and practicum guidelines. For teaching, development models are needed in accordance with the education system. The development model in this study is R & D (Research and Development). The research and development (R & D) approach in education includes ten steps [3], namely preliminary studies, research planning, design development, limited field testing, revision of limited field test results, wider testing, wider revision of field test results, due diligence, revision of the results of the feasibility test, dissemination and implementation of the final product.

To determine the feasibility of PDL system-based physics teaching aids and LKPD, feasibility validation was carried out by material and media experts. An instrument of feasibility assessment uses a feasibility instrument based on the Ministry of Education and Culture which has been modified by researchers. Aspects assessed include: (1) Linkages with teaching materials, (2) Educational values, (3) Material integration, (4) Creative thinking skills, (5) Scientific attitudes, (6) Compliance with development principles, (7) Resilience tools, (8) efficiency of tools, (9) security for students, and (10) aesthetics. Besides that, students' questionnaire responses were used to determine the appropriateness of teaching aids.

Analysis of the results of the validation of the PDL-based Physics Props and learning support tools developed was obtained from the validation experts for each component of the assessment items available in the assessment instrument. Analysis of the validator's assessment was carried out by calculating CVR (Content Validity Ratio) and CVI (Content Validity Index) from Props and learning support devices [12]. The CVR and CVI values can be calculated using the following equations.
\[ CVR = \frac{(Ne - N)}{2} \]
\[ CVI = \frac{CVR}{Number\ of\ sub\ questions} \]

Information:
Ne = Number of validators that give an assessment “Yes”
N = Number of all validators

CVR and CVI calculation results are in the form of a ratio of 0-1. This number can be categorized as follows:
0-0.33 = Not suitable
0.34-0.67 = Appropriate
0.68-1 = Very Suitable

3. Results and Discussion
The PDL system-based physics teaching aids are some of the props developed by special researchers to explain static fluid material. Materials in teaching aids include concepts of static fluid in the form of hydrostatic pressure, Pascal's Law, Archimedes Law, and Surface Voltage. The characteristics of the PDL system based physics props are as follow (1) the price of cheap equipment, (2) the size of small equipment in the form of miniature, (3) the tool can work in a cemetery-driven, can be run without an electric cable, (4) each set consists of some parts are divided according to their function, (5) all parts are designed to be easy to make, maintain and repair.

3.1. PDL-based physics props
The physics teaching aids developed by the researchers were validated by three validators consisting of media experts, material experts and physics subject teachers at Sedayu Senior High Scholl, Yogyakarta, Indonesia. After validating the validators stated that the props developed were worth testing in the field with the Content Validity Ratio (CVR) value. CVR analysis results can be seen in Table 1.

| Statement Number | CVR score | Criteria |
|------------------|-----------|----------|
| 1                | 1         | Very good|
| 2                | 1         | Very good|
| 3                | 1         | Very good|
| 4                | 1         | Very good|
| 5                | 1         | Very good|
| 6                | 1         | Very good|
| 7                | 1         | Very good|
| 8                | 1         | Very good|
| ∑(amount)        | 8         |          |

Based on these results it can be concluded that the assessors stated that the physics teaching aids developed were feasible to be tested in the field and all assessors agreed to all aspects contained in PDL-based physics teaching aids.
3.2. Learning Support Devices (RPP, LKPD, and practicum manuals)

The learning device used in this study serves to support learning activities carried out by using teaching aids that are developed namely PDL-based physics teaching aids. Learning tools used are LKPD, RPP, and practicum manuals. The RPP is prepared based on the 2013 curriculum and the learning model used in classroom learning is Project Based Learning. This RPP is validated by three validators. The validators stated that this RPP was feasible to use. CVR assessment results can be seen in Table 2.

| Statement Number | CVR score | Criteria      |
|------------------|-----------|---------------|
| 1                | 1         | Very good     |
| 2                | 1         | Very good     |
| 3                | 1         | Very good     |
| 4                | 1         | Very good     |
| **∑**            | **4**     |               |

Based on these results it can be concluded that the assessors stated that the RPP was feasible to be tested in the field and all assessors agreed to all aspects contained in the RPP. LKPD developed in this study is LKPD based on problems. LKPD is provided as a reference for students to carry out practicum, develop creative thinking skills and scientific attitudes. LKPD is structured in a structured manner. LKPD is equipped with instructions and direction as well as core material from the concepts discussed. LKPD is validated by three validators. Validation results show that this LKPD is suitable for use in the field. The results of the LKPD CVR assessment can be seen in table 3.

| Statement Number | CVR score | Criteria      |
|------------------|-----------|---------------|
| 1                | 1         | Very good     |
| 2                | 1         | Very good     |
| 3                | 1         | Very good     |
| 4                | 1         | Very good     |
| 5                | 1         | Very good     |
| 6                | 1         | Very good     |
| 7                | 1         | Very good     |
| 8                | 1         | Very good     |
| 9                | 1         | Very good     |
| 10               | 1         | Very good     |
| 11               | 1         | Very good     |
| 12               | 1         | Very good     |
| 13               | 1         | Very good     |
| **∑**            | **13**    |               |

Based on these results it can be concluded that the assessors stated that the LKPD was feasible to be tested in the field and all assessors agreed to all aspects contained in the LKPD. The practicum manual developed by researchers in this study is used by students and teachers as a reference or guideline for practicum implementation. This book contains procedures for preparation, implementation, data analysis and reporting. This practicum guide is designed to guide students in practicing and assist teachers in achieving learning goals.

This practicum manual is validated by three validators. Validation results show that this practicum manual is suitable for use in the field. The results of the calculation of the CVR value can be seen in Table 4.

| Statement Number | CVR score | Criteria      |
|------------------|-----------|---------------|
| 1                | 1         | Very good     |
| 2                | 1         | Very good     |
| 3                | 1         | Very good     |
| 4                | 1         | Very good     |
| 5                | 1         | Very good     |
| 6                | 1         | Very good     |
| 7                | 1         | Very good     |
| 8                | 1         | Very good     |
| 9                | 1         | Very good     |
| 10               | 1         | Very good     |
| 11               | 1         | Very good     |
| 12               | 1         | Very good     |
| 13               | 1         | Very good     |
| **∑**            | **13**    |               |
Based on these results it can be concluded that the appraisers stated that the Practicum Handbook was worthy of being tested in the field and all assessors agreed to all aspects contained in the Practicum Handbook. Based on the CVR score of the four products made by the researcher, the CVI score can be calculated. For each product the CVI score can be seen in Table 5.

Table 5. CVI Score Developed Product Assessment

| Rated Products                  | CVI score | Criteria |
|---------------------------------|-----------|----------|
| PDL-based Physics Props         | 1         | Very good |
| Lesson Plan                     | 1         | Very good |
| Student Worksheets              | 1         | Very good |
| Practicum Handbook              | 1         | Very good |

From Table 5 above, it can be seen that the products developed have CVI scores with very good categories. Based on these results it can be concluded that the products developed by researchers are worth testing.

4. Conclusion

This paper has presented the development of physics props based on personal desk laboratory system to improve creative thinking ability and students’ scientific attitude. Based on the results of the evaluation of the validators, it can be concluded that the Physics Viewer Tool Based on PDL (Personal Desk Laboratory) System to improve students’ creative thinking skills and scientific attitudes is very valid, practical, and effective to be used to improve students’ knowledge competencies.

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