Picsar (Physics Augmented Reality) as a Learning Media to Practice Abstract Thinking Skills in Atomic Model

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Abstract. The research aimed at developing an augmented reality-based learning media to train abstract thinking skills that are feasible (practical and effective). Development research using the ADDIE model (Analysis, Design, Develop, Implementation, and Evaluation) guided the research methodology. Specifically, a one-shot case study was utilised in the research trial design. In the Spring Semester 2019, thirty three students from private high school in Surabaya implied the Picsar (Physics Augmented Reality). Data collection techniques used the form of observation sheet learning to assess the practicality of the media, assessment sheets, and student response questionnaires to assess the effectiveness of the media. The results of the research obtained some important points: 1) the percentage of learning implementation was 98.14% with a very good category; 2) the percentage of students’ abstract thinking skills indicated in varying numbers: 100% of proportional reasoning with very good categories, 66.67% of probabilistic reasoning with good categories, 75.76% combinatorial reasoning with good categories, and 66.67% of correlation reasoning with a good category), and the percentage of students’ responses by 92.76% with a very good category.

1. Introduction

Physics is a branch of natural science with the study material in the form of natural phenomena, so learning physics should be similar to learning natural science that starts from the scientific process and is based on scientific attitudes, then scientific products can be obtained [1].

Learning physics in schools tend only to discuss the theory of the textbook used, and then provide formulas and sample problems [2]. This resulted in reduced physical science into reading so that students can only imagine physics without physical phenomena directly. If the physical phenomenon that is being discussed has been experienced directly by students, students may have a better understanding.

Based on the questionnaire given to students grade eleven in a private High School in Surabaya, it was found that as many as 91% of students had difficulty with the material of atomic models. They argue that the atomic model material is one of the physical materials that is difficult to observe directly in physical phenomena or one of the material physics that is classified as abstract. In addition, the use of physics learning media in the classroom tends to use whiteboard and textbooks. This indicates that before conducting research, students have abstract thinking skills that are still relatively low, in addition to that electronic learning media are rarely used in the classroom.

Abstract thinking skills are the ability to think about things, events, or events that have not yet happened. Students are able to make predictions, make correct conclusions and solve problems without having to deal directly with objects, events, or real phenomena so that they can produce good learning
outcomes [3]. In general, by abstract thinking students can reflect events, ideas, and relationships. They can do deductive and inductive reasoning, analyze possibilities and utilize abstract ideas [4]. To find out students' abstract thinking skills, an abstract thinking skills test is used, in the test there are 5 indicators, namely: 1) Proportional reasoning; 2) Variable control; 3) Probabilistic Reasoning; 4) Correlational reasoning; 5) Combinatorial reasoning.

As technology develops, learning media also develops. One of the technologies currently being developed is augmented reality. In general, “augmented reality is an effort to combine the real world and the virtual world created through a computer so that the boundary between the two becomes very thin” [5]. In other words, augmented reality could able to display 3-dimensional animation directly using the help of a smartphone camera.

In a previous study conducted by Sannikov et al., with the title "Interactive Educational Content Based on Augmented Reality and 3D Visualization" concluded that augmented reality has the opportunity to foster student interest in the explanation of abstract topics [6]. Based on the background description above, the writer wants to develop augmented reality learning media to practice abstract thinking skills on the atomic model material.

2. Method
This type of research is development research (development research) on physics learning media based on augmented reality using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The design of this study can be described in Figure 1.

![Diagram](image)

**Figure 1.** The ADDIE model of development of Picsar [7]
The research trial design used was a one-shot case study. This research was conducted in Spring Semester 2019 at the private High School in Surabaya. The research subject used is the development and validation of instructional media carried out by expert lecturers from the public university in Surabaya and physics teachers from the school. While the application of learning media was carried out on 33 students at that school. Research data was explored in the form of the feasibility of augmented reality learning media in terms of practicality, and the effectiveness of the media [8]. The assessment of augmented reality media can be said to be feasible to use if it has a practicality and effectiveness score of ≥ 61% as in Table 1 [9].

### Table 1. Score Interpretation

| Percentage Score | Criteria   |
|------------------|------------|
| 0% - 20%         | Very Less  |
| 21% - 40%        | Less       |
| 41% - 60%        | Enough     |
| 61% - 80%        | Good       |
| 81% - 100%       | Very Good  |

![The main cover of Picsar](image1.png)  
![AR performance of Thomson Atomic Model](image2.png)  
![AR performance of Bohr Atomic Model](image3.png)

**Figure 2.** A sample of the performance of Picsar

#### 3. Results and Discussion

Based on the calculation data in Table 1 the results are obtained in the form of the practicality of the media and the effectiveness of the media in Figure 3.
Figure 3. Recapitulation of Learning Implementation

Based on Figure 3, the percentage of learning accomplishment obtained by 91.67% in the opening phase, 100.00% in phase 1 to closing with an average score of the whole phase of 98.14%. According to one observer, in the opening phase, there is one step of learning that is not implemented, namely checking the presence of students. Observers argue that in checking the attendance of students must be called one by one. Meanwhile, other observers argue that if the teacher has asked if anyone who was not present at the beginning of the lesson was enough to check the presence of students. Overall practical augmented reality media is used for learning because it gets very good criteria. This result is also supported by research written by Hafi, which states that augmented reality has a percentage of learning accomplishment of 95.3% so that augmented reality can be said to be practical to use. [10].

Figure 4. Recapitulation Abstract Thinking Skills

Based on Figure 4, the percentage of abstract thinking skills obtained from students who get good and very good categories on each indicator. In the variable control indicator and proportional reasoning, a percentage of 100.00% is obtained. The probabilistic reasoning indicator has a percentage of 66.67%. This is caused by the fact that augmented reality media still has incomplete features, so students have difficulties when testing abstract thinking skills. The combinatorial reasoning indicator has a percentage of 75.76%. This is due to the absence of animation that explains the classical physics phenomena in the Bohr atomic model, so students have difficulty in explaining the classical physics phenomenon in the
Bohr atomic model. The correlational reasoning indicator has a percentage of 66.67%. This is due to the influence of the quantum mechanical atomic model which, according to the validator, is not appropriate when it is made in 3 dimensions. With the mastery of knowledge about physical objects by students, it is possible to achieve the learning outcomes of understanding physics concepts can be achieved well. When physical objects can be observed directly, they will be able to help students practice abstract thinking skills. This factor causes scores on indicators of probabilistic reasoning, combinatorial reasoning, and students' correlational reasoning to have low scores [11]. Even though the percentage of probabilistic and correlational reasoning obtained a fairly low percentage, the augmented reality media still obtained a percentage ≥ 61% according to Table 1.

Based on Figure 5, the percentage of student responses obtained in the range of 90.00% - 96.00% in each aspect with a very good category. In the aspect of language that has the lowest percentage, students think that the language used in augmented reality media is too difficult to understand. In addition to the media aspect, some students had difficulty in operating the augmented reality media due to the low quality of the camera on the smartphone so that markers on the hand-outs were difficult to detect. This is consistent with previous research which emphasized that camera quality, light intensity, and distance to detect markers also influence the 3-dimensional objects that appear [5]. Because the percentage of abstract thinking skills and the percentage of student responses gained a percentage of ≥ 61%, the augmented reality media is effective for use in learning. Further study is recommended to explore the use of digital learning in physics as well as previous researchers done [12-15].

4. Conclusion
Based on the analysis of research data, it can be concluded that augmented reality media to practice abstract thinking skills on atomic models is declared practical and effective. On the practicality criteria, the percentage of learning achievement was 98.14% with a very good category. The effectiveness criteria consisting of the percentage of abstract thinking skills in the range of 66.67% - 100% (controlling variables 100% with very good categories, proportional reasoning 100% with very good categories, probabilistic reasoning 66.67% with good categories, combinatorial reasoning 75, 76% with a good category, and 66.67% correlational reasoning with a good category) and the percentage of student responses of 92.76% with a very good category.

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