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High School Students' Ability to Design Physics Experiments through the ARBASC Model

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ABSTRACT

One of the problems in physics learning is the low level of students' ability to design experiments, especially on abstract concepts. Therefore, the purpose of this study was to determine the effectiveness of the application of the Augmented Reality-Based Argument of Society Commonsense (ARBASC) model on the ability to design physics experiments of high school students in West Kalimantan. This study is an applied research as a continuation of the development of the Augmented Reality-Based Argument of Society Commonsense (ARBASC) model. This model is applied to high school students in the West Kalimantan Province and is divided based on inland and coastal areas. Inland areas include Bengkayang Regency and Landak Regency while coastal areas include Sambas Regency and Singkawang City. The quantitative data analysis planned in this study for students' ability to design physics experiments by calculating the total average score and the average score of each element of the experimental design for each learning meeting. Data on students' ability to design physics experiments is obtained by looking at the trend of increasing average scores and scores for each element of the experimental design which are arranged in the form of Student Worksheets in designing experiments. Data collection on the ability to design experiments is carried out from one learning meeting to the next.

INTRODUCTION

In the 21st century, work demands require employees to have various skills. The world of work requires employees who are innovative, creative, have initiative, are independent, can lead, work in teams, are literate, are able to communicate effectively, and are able to make decisions and solve problems [1]. Joint decision-making is often colored by debate and argument. Every view, opinion or claim must be supported by valid data and evidence. 21st century skills also consist of argumentation skills. For scientific argumentation, empirical data is needed which is produced from experimental or investigative activities [2]. Understanding and knowledge of scientific concepts and practices are often

associated with scientific arguments. Argumentation as an intellectual practice can involve students in constructing and criticizing scientific ideas. They will gain experience from scientific practices that can be used to justify and support their arguments [3] [4] [5] [6].

Based on an initial study conducted in one of the high schools in West Kalimantan, it showed that the quality of the arguments put forward by students was still relatively low, namely still dominant at level 1 by 50% and the rest at level 2 by 30%, level 3 by 20%, and none were at level 4 and level 5. Likewise, the level of understanding of students' physics material was still relatively low, namely understanding incorrectly (level 3) by 40%, understanding partially (level 4) by 20%, not understanding (level 2) by 30%, and not giving an answer (level 1) by 10%. There were no students at the level of understanding completely (level 5). The results of interviews with physics teachers in ten high schools in West Kalimantan obtained information that students were less able to explain science concepts which were seen when students answered teacher questions verbally, students conveyed answers or arguments without any evidence or reasons to support their answers [7].

One effort to improve students' understanding of abstract physics concepts is to utilize the latest technology. The use of technology in the form of simulation and visualization is one of the learning tools to obtain more real information from abstract information [8] [9] [10]. One of the contributions of the latest digital technology that can be used in education is the application of Augmented Reality (AR). The AR application is a technology that inserts virtual objects into real life. The use of AR has also been recognized as a technology that can help students complete real-world tasks such as practicums with the support of digital systems [11] [12]. The use of AR will be combined with the Argument of Society Commonsense (ASC). Society commonsense is one of the materials that is worthy of being raised for discussion and debate between groups. Society commonsense is knowledge that is adopted by a society whose truth is based on common sense, life experience, and hereditary habits [13]. The difference between commonsense and science lies in the scientificity of knowledge that science relies on systematic scientific methods and empirical testing, while commonsense is more based on personal experience and views that are rooted in culture [13] [14]. Therefore, this study aims to determine the effectiveness of the application of the Augmented Reality-Based Argument of Society Commonsense (ARBASC) model that has been developed to improve the ability to design physics experiments of high school students in West Kalimantan.

METHOD

This research is a continuation of previous development research using 4D design (Define, Design, Develop, Disseminate). Define, Design, and Develop activities are carried out in the early stages of research. Then, Disseminate activities are carried out at the implementation stage. In detail, the stages of research are as follows.

1. Define, includes literacy studies and field studies, including relevant literature reviews, learning curriculum analysis, school needs analysis related to the use of technology, material coverage, and teaching modules to formulating problems.
2. Design, focuses on designing a draft of the learning model and instruments to measure the feasibility, practicality, and effectiveness of the draft learning model.
3. Develop, the draft model at the design stage is validated by experts and then revised, followed by an initial field trial at one school in Singkawang City, followed by revision and refinement of the final product.
4. Disseminate, the final product is implemented in a field test, covering four schools in Singkawang City, Sambas Regency, Bengkayang Regency, and Landak Regency. At this stage, the treatment given uses a quasi-experimental method with a Nonequivalent Control Group design. This design is usually used in existing classes, so samples are not selected randomly [15]. During the treatment, an analysis was also carried out regarding the practicality and effectiveness of the ARBASC model. The results are then interpreted based on the results of the quantitative analysis. For data on the effectiveness of the ARBASC model, it was obtained from data on the level of

students' physics experiment design abilities obtained by looking at the trend of increasing average scores and scores for each element of the experimental design arranged in the form of Student Worksheets (LKPD) in designing experiments. Data collection on the ability to design experiments was carried out from one learning meeting to the next learning meeting.

Participants in this study consisted of high school students in West Kalimantan Province. This study was conducted for one year. Participants who will be involved in this study are high school students who are divided based on inland and coastal areas. Inland areas include Bengkayang Regency and Landak Regency while coastal areas include Sambas Regency and Singkawang City.

Data analysis of students' physics experiment design skills by calculating the total average score and the average score of each element of the experimental design for each learning meeting, then the trend of experimental design ability score data from one learning meeting to another is depicted in the form of a graph and interpreted as a graph of the increase in the experimental design ability score.

RESULTS AND DISCUSSIONS

The profile of the improvement of the ability to design experimental activities (KME) is described based on the score of making experimental designs from meeting to meeting. Figure 1 shows the improvement curve of each element of experimental design from one learning meeting to the next.

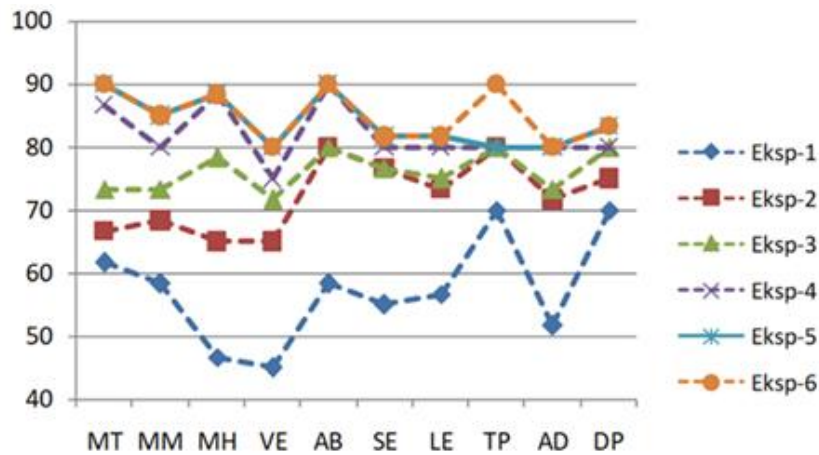


Fig 1. Graph of improvement for each element of the experimental design

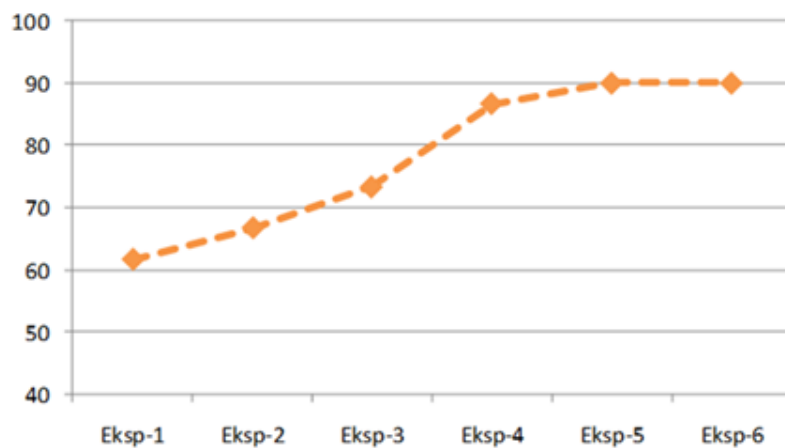


Fig 2. Graph of increasing score for the element of designing an experiment for the element of formulating goals (MT)

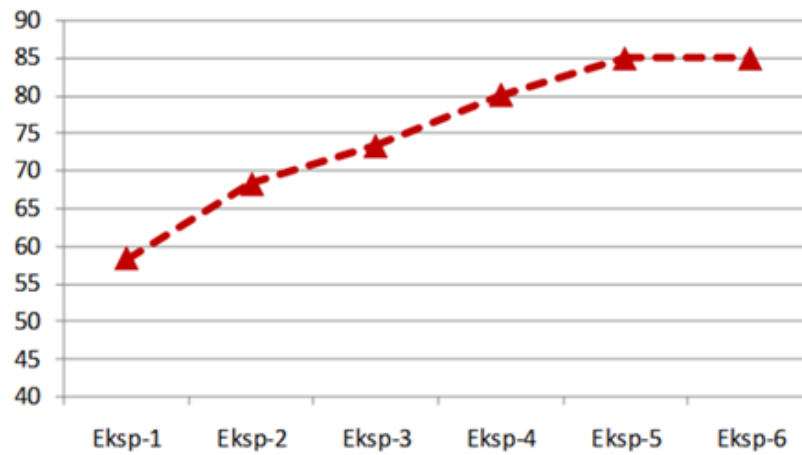


Fig 3. Graph of increasing score for the element of designing an experiment for the element of formulating a problem (MM)

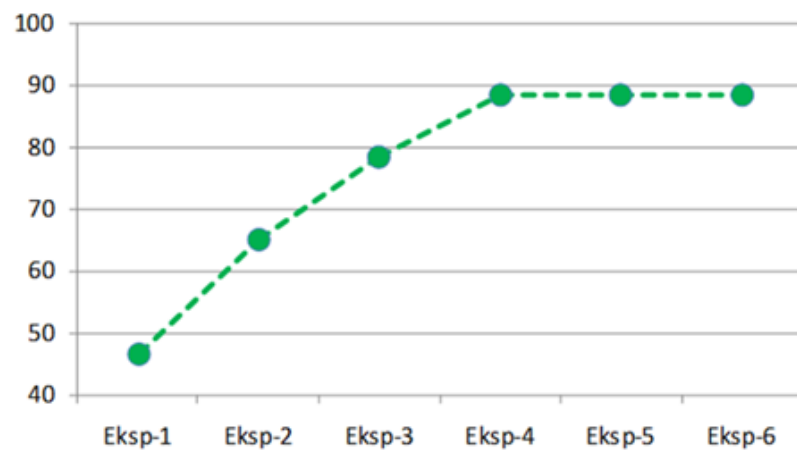


Fig 4. Graph of the increase in scores for the element of designing experiments, element of proposing hypotheses (MH)

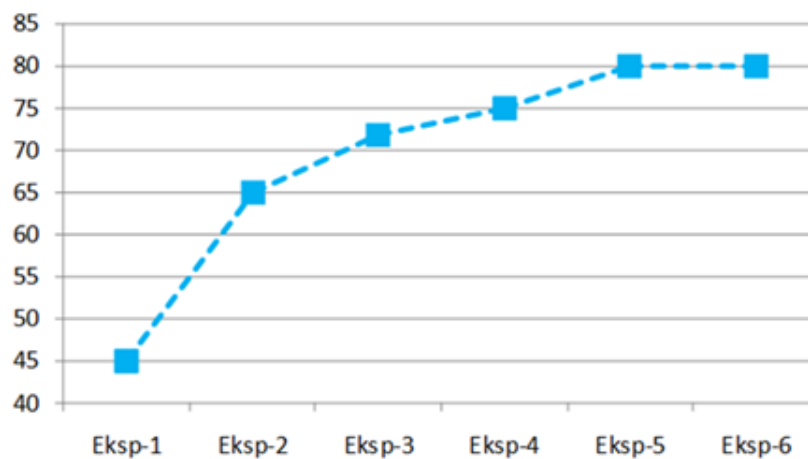


Fig 5. Graph of the increase in the score of the Experimental Variable (VE) element for designing experiments

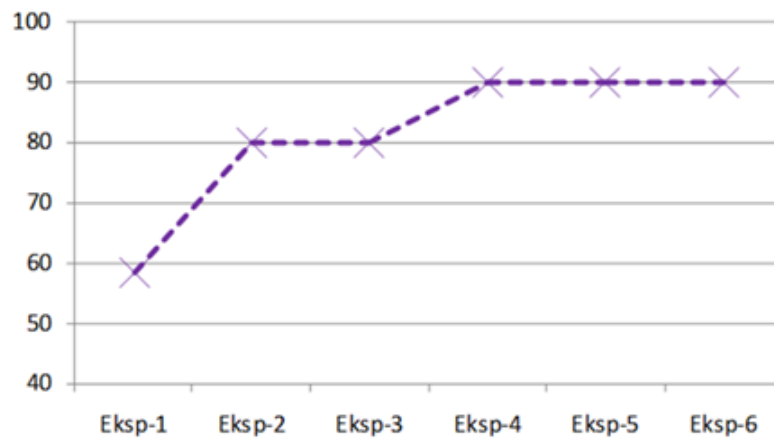


Fig 6. Graph of increasing score for the elements of designing experiments for the elements of Tools and Materials (AB)

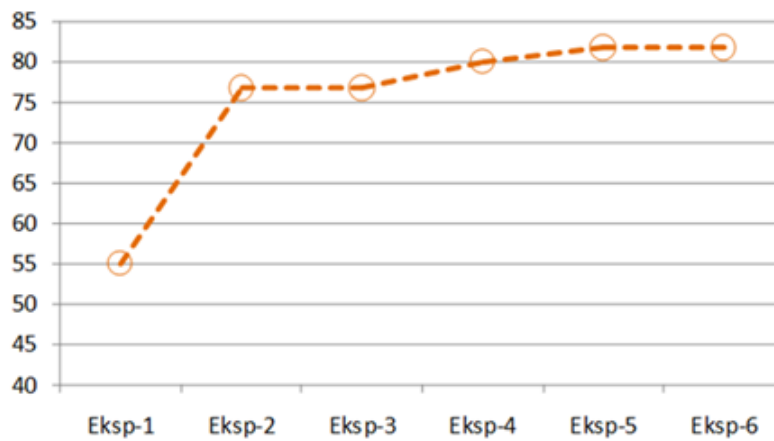


Fig 7. Graph of increasing score for elements of designing an experiment, elements of an experimental scheme (SE)

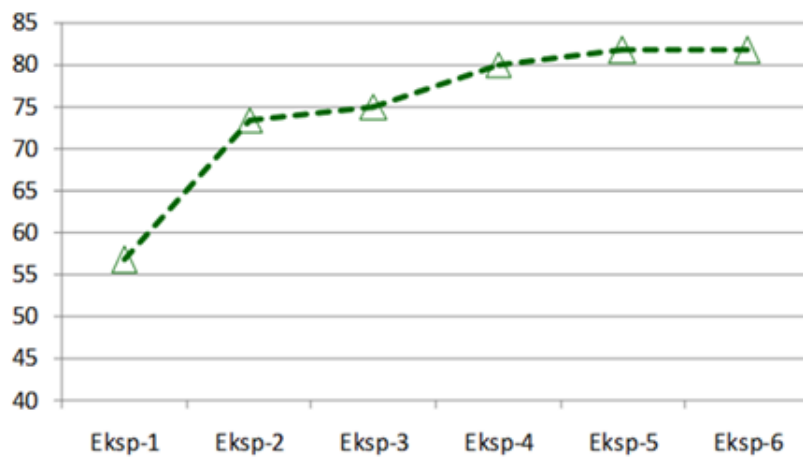


Fig 8. Graph of increasing score for elements of designing experiments, elements of experimental steps (LE)

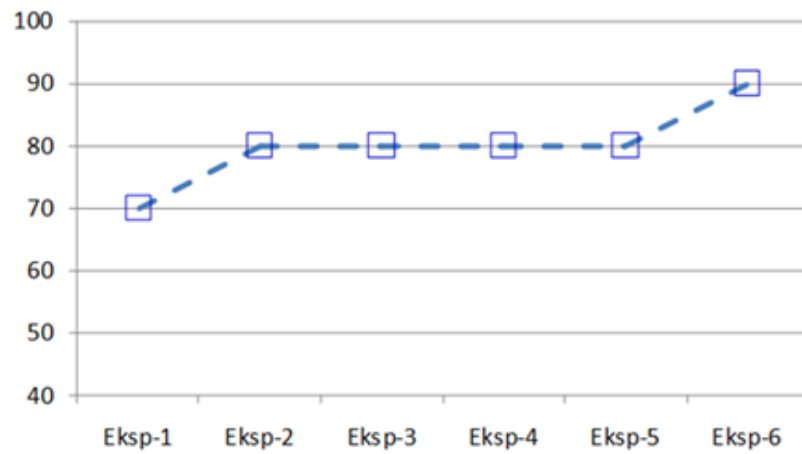


Fig 9. Graph of the increase in scores for the elements of designing experiments for the observation table (TP) elements

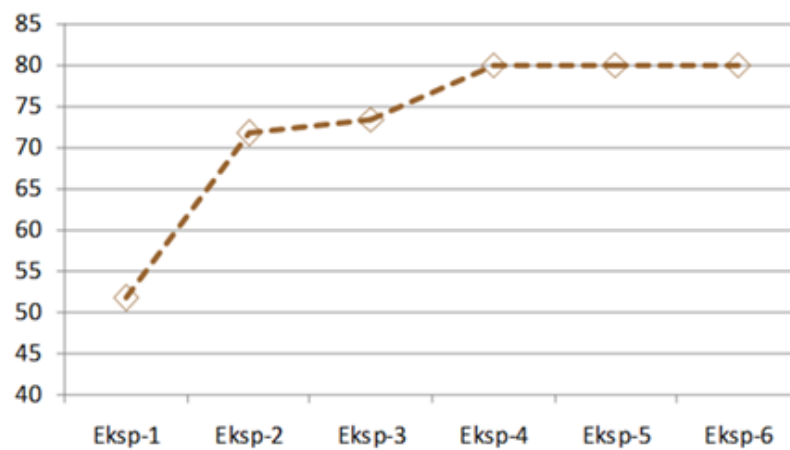


Fig 10. Graph of increasing element scores for designing data analysis (AD) element experiments

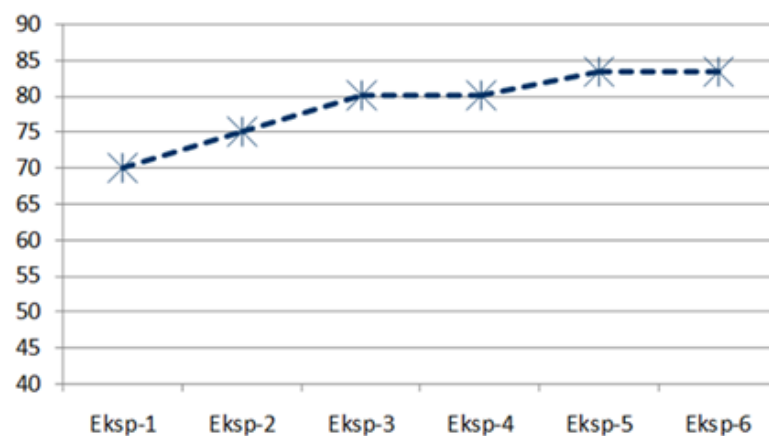


Fig 11. Graph of the increase in scores for the element of designing experiments for the bibliography element (DP)

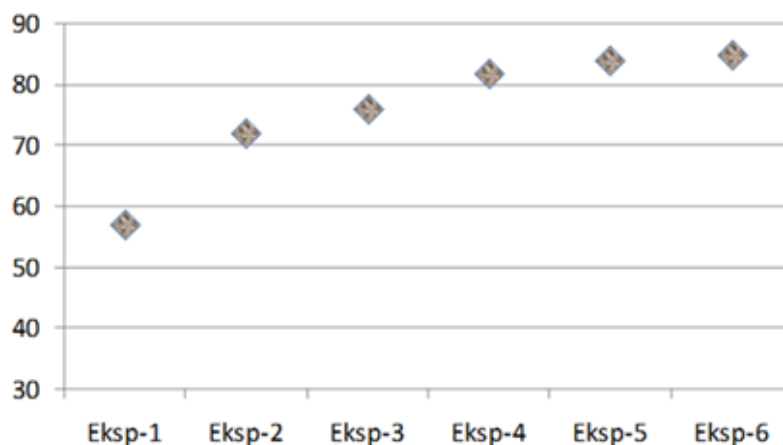


Fig 12. Graph of the increase in the ability to design experiments from meeting to meeting

These results show that the implementation of the ARBASC model in learning Physics on the subject of Heat and its Effect on Objects can train the ability to design experiments to collect data to support claims in arguing.

It appears based on the profile of the ability to design experiments, the ARBASC model can train and improve the ability to experiment from meeting to meeting. This result is in line with research conducted by Cahyati et al [16] and Yulianci et al [17] that argumentation-based learning can improve experimental skills. The implementation of the ARBASC model based on Toulmin's argumentation, one of the syntaxes of which is conducting experiments to test arguments, is very relevant to improving students' ability to experiment. This is supported by Wattimena et al [18] which has succeeded in developing learning tools based on physics experiments and is able to improve the creativity of prospective teacher students in designing practical activities. It is also supported by Wicaksono & Hayat [19] that Guided Inquiry-based learning which contains the syntax of designing experiments and conducting experiments, is able to improve Students' Experimental Skills on the topic of Ohm's Law. The results of research by Yulianci et al [17] and Yuningsi et al [20] also support the results of the ARBASC implementation that experimental activities can improve students' activeness in learning, students' ability to design experiments, students' understanding of physics material and students' ability to argue.

CONCLUSION

From the discussion of the results, it can be concluded that:

1. Based on the profile of the ability to design experiments, the ARBASC model can train and improve the ability to experiment from meeting to meeting. This is because argumentation-based learning can improve experimental skills.
2. The implementation of the ARBASC model based on Toulmin's argumentation, one of the syntaxes of which is conducting experiments to test arguments, is very relevant to improving students' ability to experiment. This is because learning devices based on physics experiments can increase creativity in designing practical activities.

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