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The Development of Electronic Students' Worksheets (E-LKPD) Based on Argument Driven Inquiry Learning Model to Improve Scientific Argumentation Skills

Suri Margi Utami[1,*], Haryanto[1], Agus Subagyo[1]
[1]Science Education, Pascasarjana Universitas Jambi, Jambi, Indonesia

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ABSTRACT

Purpose of the study: This research aims to develop electronic student worksheets (E-LKPD) based on the Argument Driven Inquiry (ADI) Model to enhance the scientific argumentation skills of high school students. The impetus for innovative educational tools is intensified by ongoing industrial and social revolutions, necessitating advanced human resource capabilities.

Methodology: Research and development, the study encompasses the stages of analysis, design, development, implementation, and evaluation. The subjects were 29 Class XI IPA students. Data analysis utilized descriptive statistics and paired sample t-tests to assess the effectiveness of the E-LKPD in improving students' argumentation skills.

Main findings: Validation results from material and media experts indicated that the E-LKPD is highly feasible. Furthermore, responses from science teachers and student trials in one-on-one, small, and large group settings rated the E-LKPD in the "very good" category. A notable finding was the significant improvement in students' argumentation skills when using the E-LKPD, as evidenced by the paired sample t-tests.

Novelty/Originality of this study: The originality of this study lies in its application of the ADI model to E-LKPD, tailored to meet the demands of the industrial and social revolutions by fostering an entrepreneurial mindset in students. This research underscores the critical need for educational innovation, particularly in integrating entrepreneurship-based learning videos in junior high schools. By instilling an entrepreneurial spirit, students are better equipped to navigate and compete in the contemporary landscape, making this study a pivotal contribution to educational practices and resource development.

Corresponding Author:
Suri Margi Utami,
Science Education, Universitas Jambi, Jambi, Indonesia
Jl. Raden Mattaher No.21, Ps. Jambi, Jambi City, Jambi 36133, Indonesia
Email: surimargiutami39@gmail.com

1. INTRODUCTION

The world is experiencing rapid changes due to developments in various aspects of life. This has an impact on increasing the need for quality human resources that can meet the demands of current developments. Education is one aspect that has an important role in preparing the nation's generation. The 21st century education era trains students to have 4C skills, namely critical thinking and problem solving, collaboration skills, creativity and innovation skills and communication skills. This is contained in Minister of Education and Culture Regulation No. 34 of 2018 concerning content standards as an effort to improve the quality of education while responding to the needs and challenges of current developments.

Scientific knowledge which is always developing also requires students to actively participate in scientific activities such as observation and argumentation. Scientific arguments are the basis for students to think, act and communicate[1],[2]. Scientific argumentation skills have a positive influence on students' self-confidence in conveying ideas or ideas based on supporting evidence and explanations[3]. Scientific argumentation skills are an interesting discussion to study and are important for students to master because they include two 21st century skills, including critical thinking skills and communication skills [4].

Arguments in the context of science education are different from those often used in everyday life. Scientific argumentation is an activity in the form of logical and rational conversation to find the relationship between an idea or statement and evidence and data that can support that idea [5],[6]. So the argument is correct and of good quality if the data and conclusions support each other. Often arguments are presented without being based on correct theories and opinions.

Basically, scientific argumentation-based learning does not happen naturally, but needs to be planned appropriately. Learning should provide opportunities for students to practice argumentation skills such as proving or refuting statements scientifically. One alternative that can be used to train students' scientific argumentation skills is the application of the Argument-Driven Inquiry (ADI) learning model. The ADI model is an inquiry-oriented learning model that emphasizes argumentation activities. This model can make students more active through practical activities as well as connecting the ideas and evidence obtained and communicating them. So ADI learning is seen as being able to facilitate and teach argumentation skills [7].

Irvan and Admoko [8] conducted research with results showing that the application of the Argument-Driven Inquiry (ADI) learning model had an influence on improving students' scientific argumentation skills. In addition, the Argument-Driven Inquiry (ADI) learning model is more effectively used to improve students' scientific argumentation skills[9]. In an effort to improve scientific argumentation skills, appropriate learning media are also needed that can support the learning process, including student worksheets (LKPD). Basically, LKPD is a sheet containing tasks or steps that students must complete to complete a task[10]. Learning media in the form of LKPD is flexible and can be developed to suit student needs or approaches that result in increased student skills. Student Worksheets based on Argument-Driven Inquiry (ADI) are one of the teaching materials that can make it easier for teachers to train students' scientific argumentation skills[11]-[13]. Especially in experimental activities, the use of LKPD will make it easier for students to understand the material and the course of the practicum [14].

Technology allows teachers and education providers to always innovate teaching materials so that learning takes place more effectively [15].Teaching materials that were originally printed can be designed using digital media to become electronic teaching materials. Electronic student worksheets can contain more effective pictures, animations and videos, so that students do not feel bored [16].This research utilizes the Canva application in the media development process. Canva is an online design program that has various tools or editing tools for creating various graphic designs [17].

Therefore, this study aims to develop electronic students' worksheets (E-LKPD) based on Argument. Driven Inquiry Model to improve scientific argumentation skills of high school students. The problem statements in this research include the development process of interactive E-LKPD based on the argument-driven inquiry model in the excretion system material to improve high school students' scientific argumentation skills, the conceptual feasibility of interactive E-LKPD based on the argument-driven inquiry model in the excretion system material to enhance high school students' scientific argumentation skills, and the procedural feasibility of interactive E-LKPD based on the argument-driven inquiry model in the excretion system material to boost high school students' scientific argumentation skills.

2. RESEARCH METHOD

The research carried out is development research (Research and Development). Development research is a research method used to produce certain products and test the effectiveness of these products [18]. The development design in this research uses the Lee and Owens development model. The reason for choosing this model is because this model is a model specifically for developing multimedia. The Lee & Owens model development procedure [19] consists of five stages, namely analysis, design, development, implementation and evaluation. Evaluation is carried out at each stage, so that an appropriate product will be produced.

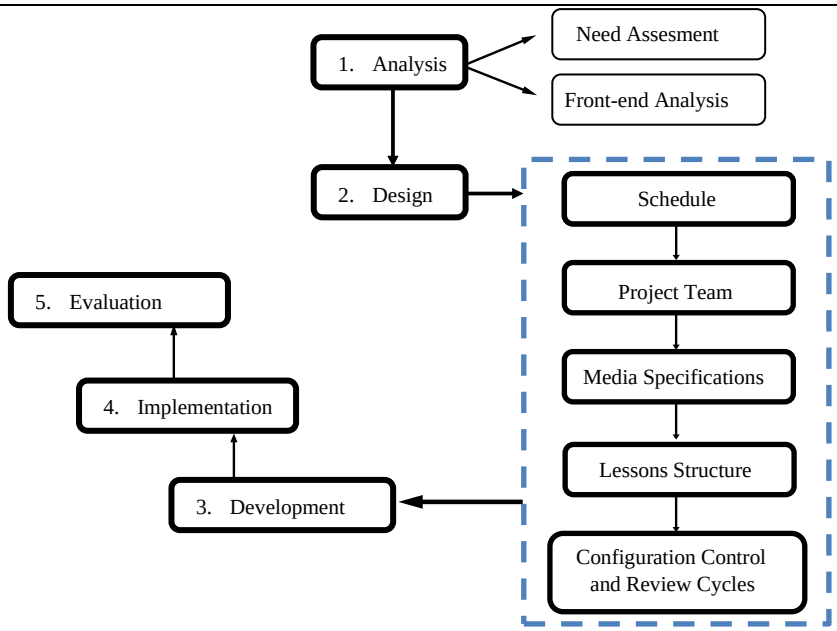

Figure 1. The steps of the Lee & Owens development model

The analysis stage aims to find out and determine what is needed in learning and collect various information related to the product that will be produced. Needs analysis was carried out using the interview method with biology subject teachers and distributing questionnaires to students. Interviews were conducted to find out what actually happened and what should have happened in order to be able to identify the right product to be developed according to students' needs and learning activities [20].

Design Stage, At this stage, research planning is carried out, namely determining the development team, research schedule, media specifications, material structure, making flow charts, story boards and evaluation. Development is the activity of realizing a storyboard. During this stage the researcher developed an interactive E-LKPD which included the application of Argument Driven Inquiry-based learning stages with the help of the Canva application. So as to produce a development product in the form of teaching materials in the form of an interactive E-LKPD based on Argument Driven Inquiry to improve students' scientific argumentation skills. At this stage, validation is also carried out by experts, namely media experts and material experts, the aim is to assess the product from the media aspect and material aspect.

Implementation Stage, after the interactive E-LKPD based on Argument Driven Inquiry is validated by experts and declared good and feasible, the interactive E-LKPD based on Argument Driven Inquiry can be tested, this stage is called the implementation stage. Trials are carried out to get feedback about the product through a questionnaire. Evaluation Stage, Evaluation is a process to see and measure the achievements of product development in the form of an interactive E-LKPD based on Argument Driven Inquiry. Evaluation carried out at the development stage is called formative evaluation, because its aim is for the need for media improvement or revision. Formative evaluation is carried out by material experts and media experts using material validation questionnaires and media validation questionnaires. Apart from that, there is a summative evaluation carried out after the final product is implemented, with the aim of assessing the feasibility of the Argument Driven Inquiry-based interactive E-LKPD that has been developed.

The instruments used in this study consisted of questionnaires and questions. The questionnaire in this study consisted of expert validation questionnaires, student response questionnaires, and teacher response questionnaires. To analyze questionnaire responses from teachers and students to the media using a Likert scale. Respondents asked to use the media as a whole were asked to provide one of the answer choices provided in the categories.

Table 1. Likert scale

Value Scale	Validation Scale
5	Very Good
4	Good
3	Enough
2	Not Good
1	Very Not Good

The effectiveness of interactive E-LKPD is measured based on increasing students' argumentation skills through pretest and posttest activities. The argumentation indicators used in this research are Claim, Data,

Warrant, and Backing, Qualifier and Reservation. Analysis Rubric for assessing students' TAP model scientific argumentation skills are presented in the following table [21].

Table 2. Analysis Rubric for assessing students' TAP model scientific argumentation skills

Level	Criteria	Value
5	Discourse contains claims, data, guarantors with supporters (Backing), qualifications and/or exceptions (Reservations) (DKWBQR)	5
4	Argumentation contains claims, data, guarantors with supporters (Backing), without qualifications and/or exceptions (Reservation) (DKWB)	4
3	Argumentation contains claims, data, guarantors without support (Backing)(DKW)	3
2	Arguments consist of arguments in the form of claims with counter claims accompanied by data (information supporting the statement) (DK)	2
1	Argument in the form of a simple claim with an opposing claim (Counter claim) (K)	1

The scores obtained are then analyzed using the following formula:

$$\text{Argumentation Test Score} = \frac{\sum Score\ obtained}{\sum Maximum\ Score} x\ 100$$

The score results obtained are interpreted based on the following assessment criteria :

Table 3. Criteria for Scientific Argumentation Ability

Criteria	Test Scores
> 81.25 – 100.0	Very Good
< 62.50 – ≥ 81.25	Good
> 43.75 – ≤ 62.50	Not Good
> 25,00 – ≤ 43.75	Very Not Good

To determine the increase in students' argumentation skills, the pretest and posttest scores are calculated using the Hake formula:

$$\text{N-gain} = \frac{Posttest - pretest\ score}{100 - pretest\ score}$$

The results of these calculations are interpreted based on the existing criteria adapted from Hake[22]. It is declared effective if it obtains an N-gain ≥ 0.3 in the medium category or a value > 0.70 in the high category, with the following criteria:

Table 4. N-Gain Level Criteria

Criteria	Test Scores
N-gain > 0.70	High
0.30 ≤ N-gain ≤ 0.70	Medium
N-gain < 0.30	Low

3. RESULTS AND DISCUSSION

The results of initial observation data analysis show that students' argumentation abilities are still low. This is caused by the lack of opportunities given to students to practice argumentation skills. The learning methods used previously did not involve students in building arguments or ideas in an effort to discover concepts in excretory system material. According to Piaget, children aged 11-18 years are at the formal operational stage, where at this stage children already have the ability to think abstractly, reason logically, and the ability to draw conclusions from some information. So learning for high school age students should be directed at training scientific argumentation skills.

The results of product development are assessed by the material expert validator and media expert validator to assess their feasibility. The aspects assessed in the development of entrepreneurship-based learning videos consist of material and media aspects. The Material Validation process is carried out in two stages. The following is a graph of the material expert's assessment. The criteria used to state that the product being developed meets the appropriate criteria is if the average assessment of media experts and material experts is in the percentage range of 61%-80%, while for the very good category the percentage value is 81%-100%. The first

validation obtained a result of 63% with the note that improvements needed to be made according to suggestions. After the improvements were made, a second validation was carried out with the results of the feasibility percentage being 93% and categorized as "very feasible". Validation by material experts was carried out twice until it was declared suitable for testing. Material expert validator results with a feasibility percentage of 51%. This figure is still included in the unfeasible category. So the developer makes improvements to the E-LKPD according to the validator's suggestions. Next, the second validation stage shows the feasibility percentage, namely 95%. Based on this score, the E-LKPD developed is categorized as "very feasible". Conceptual feasibility based on the assessment of media experts and material experts shows that the E-LKPD based on the argument driven inquiry model developed is suitable for use as a learning media. Teacher Assessment Teacher assessment is carried out to determine the suitability of E-LKPD by users. Based on data analysis of the results of the biology teacher assessment questionnaire at SMA N 4 Tanjung Jabung Timur, it is known that the E-LKPD that was developed obtained a feasibility percentage score of 98.57% and was categorized as very good/feasible. In the results of the questionnaire assessment, the teacher responded that the E-LKPD developed was very attractive to students so they were enthusiastic about participating in learning activities and was presented in language that was easy to understand. Apart from that, teachers gave positive appreciation for the use of technology in developing learning media. This is included in one of the digital transformation efforts in the education sector.

The effectiveness of using E-LKPD in improving students' scientific argumentation skills is assessed based on the results of tests carried out before learning (pretest) and after learning using E-LKPD (posttest). The results of the pretest and posttest of students' scientific argumentation skills can be seen in Figure 2.

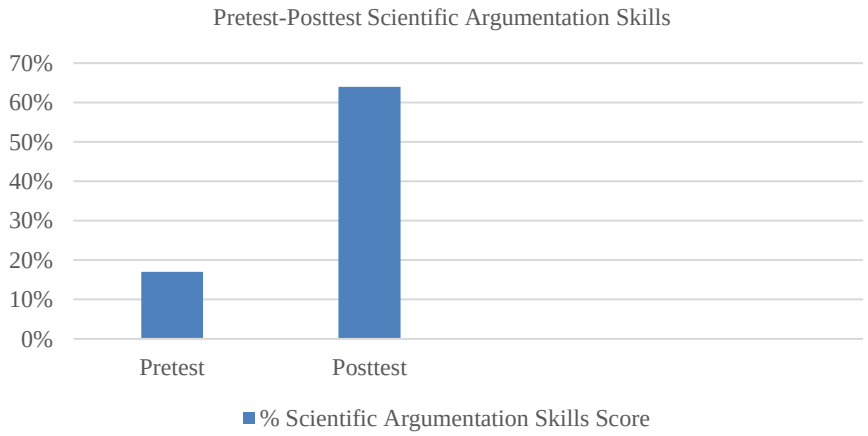

Figure 2. The pretest and posttest score of students' scientific argumentation skills

Based on the pretest and posttest score data in Figure 2, the average percentage of pretest scores for students' scientific argumentation skills is 17%. Meanwhile, after carrying out learning using E-LKPD, the posttest score for scientific argumentation skills was 64%. It can be concluded that the average posttest score is higher than the average pretest score for students' scientific argumentation skills. Sumanti [23] also conducted research related to scientific argumentation skills through the Argument Driven Inquiry model and obtained research results in the form of an increase in students' scientific argumentation skills from a pretest score of 25.33 to a posttest score of 76.06.

Determine the significance of the average difference between the posttest and pretest scores of students' scientific argumentation skills, a significance test of the average difference in N-Gain was carried out. This is done by first carrying out normality and homogeneity tests using IBM SPSS Statistics 25. From the test results, normality test results were obtained with a sample size of 29 and a confidence level of 95%, the significance of the pretest value data was 0.1 and the pretest value data was 0.3 (sig.0.05). Based on these results, it is known that the significance value of the pretest and posttest data is both greater than 0.05. So it can be concluded that the data is normally distributed. If the population distribution is approximately normal, a sample size of 29 is usually sufficient for the Central Limit Theorem to hold.

Meanwhile, for the homogeneity test, a significance value of 0.69 (sig.0.05) was obtained. The significance value obtained is more than 0.05 so the data is homogeneous. Next, a hypothesis test was carried out with a t-test which showed a significance value of 0.000 (sig, 0.05). This shows that there is a significant difference between the pretest and posttest results of students' scientific argumentation skills. This is in line with the results of research conducted by Khusnayain [24] which shows that the learning media product in the form of worksheets developed is effective in improving students' scientific argumentation skills. The statistical test results show the Sig value. (2 tailed) in the Paired Sample T Test of 0.000. This means that there is an increase in

the scientific argumentation skills score for the experimental class. Imaniar [25] also conducted research on the influence of the argument driven inquiry learning model on students' argumentation abilities in high school physics learning with t-test results showing that students' argumentation abilities using the argument driven inquiry model were higher than those using the conventional model.

The average N-gain value of the students' pretest and posttest scientific argumentation skills was 0.57. According to Hake, an N-gain value of 0.30-0.70 indicates an increase in students' scientific argumentation skills in the medium category. So it can be concluded that the use of E-LKPD based on argument driven inquiry is effective in improving students' scientific argumentation skills. As research conducted by Zhao [26] shows the results of a comparison test of the average N-gain value between before and after the argument driven inquiry learning model was implemented, there was an increase in students' scientific argumentation skills with a value of 0.47 in the medium category.

At the tentative argument preparation stage, students create an argument that supports a statement accompanied by facts from the results of the experiments that have been carried out. Apart from that, in the argumentation session, students provide opinions, suggestions, criticism and rebuttal. Through these activities students can make improvements to the conclusions obtained [27]. In line with the opinion expressed by Demircioglu [28] ADI learning model provides opportunities for students to build an understanding and explanation of a phenomenon through laboratory activities. This activity is an inquiry so that students investigate and obtain data independently. ADI also provides space for students to discuss and produce accurate final claims [29].

Scientific arguments are very important to be integrated into the science learning process. Apart from achieving learning objectives, students also carry out the process of elaboration, reasoning and reflection. Argumentation formed from collaborative activities will also develop social awareness in students. Getting used to argumentation skills in learning makes students more skilled at expressing opinions based on their knowledge. This is very helpful for participants when involved in arguments in environments outside of school such as at work and in the surrounding community [30].

Students' argumentation abilities are influenced by several factors, including the opportunity to argue and students' prior knowledge. Students are able to argue according to the knowledge they have and learning experience, which means students will argue when they know something related to the topic or problem being discussed. Therefore, the role of the teacher is very influential on students' scientific argumentation skills.

4. CONCLUSION

The development of interactive E-LKPD based on the argument driven inquiry model to improve students' scientific argumentation skills was carried out using the Lee & Owens Model development model (2004). Conceptual product feasibility assessment through media expert validation obtained a percentage of 95% in the very feasible category. Meanwhile, material expert validation obtained a percentage of 98.57% with a very feasible category. Procedural product suitability assessment resulted in a teacher assessment of 98.57% in the very good category. Testing of student responses, namely through one-on-one trials, obtained a feasibility score of 93.3% in the very good category, and in small group trials the feasibility score was 89% in the very good category. The effectiveness test was carried out based on the results of the t-test analysis showing that the Sig. (2-tailed) 0.000 < 0.05 means there is a significant difference between the pretest and posttest results of students before and after using E-LKPD. Then, from the results of the analysis using the factor g (N-gain) formula developed by Hake, the result was 0.57 and it can be interpreted that there was an increase in students' scientific argumentation skills in the medium category after using E-LKPD.

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