

## THE VALIDITY OF STUDENT WORKSHEETS BASED ON ARGUMENT-DRIVEN INQUIRY (ADI) IN CELL STRUCTURE AND PLANT TISSUE MATERIAL TO TRAIN CRITICAL THINKING SKILL FOR SENIOR HIGH SCHOOL STUDENTS

**Aulia Itsnaini Salsabela**

Biology Education, Faculty of Mathematics and Natural Science  
Universitas Negeri Surabaya

E-mail: [auliasalsabela16030204096@mhs.unesa.ac.id](mailto:auliasalsabela16030204096@mhs.unesa.ac.id)

**Rinie Pratiwi Puspitawati**

Biology Education, Faculty of Mathematics and Natural Science  
Universitas Negeri Surabaya

E-mail: [riniepratiwi@unesa.ac.id](mailto:riniepratiwi@unesa.ac.id)

### Abstract

*Critical thinking skills is one of the 21st century competencies that students need to have in education. Therefore, teaching materials must be developed in learning process, one of them is student worksheets with Argument-Driven Inquiry (ADI) based. Argument-Driven Inquiry is an inquiry learning model that effective to improving the critical thinking skill students by argumentation skill. One of the materials appropriated with ADI model is the structure plant of cells and plant tissue. This study aimed to describe the validity and produce worksheets based on Argument-Driven Inquiry in structure of plant cells and plant tissue material to train critical thinking skill for senior high school students. The method used in this research is ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The phase carried out only reached the stage of student worksheets development. Student worksheets development carried out in Biology Department, Faculty of Mathematics and Natural Sciences, Surabaya State University. The validity of student worksheets obtained from the validators using the validation sheet. The results showed that the worksheets was declaring to be very valid with an average score of 3.74. Based on the data obtained, it can be concluded that student worksheets developed declared feasible based on its validity and could be used in the learning process.*

**Keywords:** Student worksheets, validity, critical thinking skills, Argument-driven Inquiry (ADI), structure of cells and plant tissue

### INTRODUCTION

Critical thinking skill is one of the competencies in the 21<sup>st</sup> century that a person must have. It is skilled to solve a problem logically and reflectively to draw conclusions and decisions about what to believe (Riskiyah, 2018). Critical thinking skills has divided into 6 sub-skills namely interpretation, analysis, inference, evaluation, and self-regulation (Facione, 2015). Critical thinking skill can be realized through the activity of analyzing a phenomenon that occurs in daily life, but in reality the critical thinking skill of students in Indonesia is still relatively low. It can be proven through the data from the Program for International Student Assessment (PISA) category of science in 2015, Indonesia ranks 64<sup>th</sup> with a total of 72 countries participating (OECD, 2016). Whereas in 2018 Indonesia ranked 72<sup>nd</sup> with a total of 79 participants (OECD, 2019). This indicates that critical thinking skill of students in Indonesia is still relatively low, because the PISA questions tested can teach students to analyze and determine a problem solving or decisions

related to daily life that can train critical thinking skills. Critical thinking skills can be taught in school with material that is closely related to daily life and by testing questions with cognitive levels C4 to C6 or High Order Thinking Skills (HOTS) questions type (Permendikbud, 2013). One of the materials that is closely related to daily life is biology.

Biology involves a process of discovery that is based on natural reality systematically with the knowledge that has been learned (Wahyudi, 2015). Also biology is a science learning that can be obtained by studying natural phenomena associated with research and the results can be communicated (Roshayanti, 2012). Biology can be taught for students to train critical thinking skills. Biology can be implemented well if an appropriate learning model is applied to stimulate the enthusiasm of each student to actively engage in learning and can accommodate the thought process and involving critical thinking (Prasetyani, 2016). There are a lot of learning

models that can be used in the 2013 curriculum, one of them is the inquiry learning model.

Argument-Driven Inquiry (ADI) is an inquiry learning developed model by Sampson and Gleim that is effective in improving critical thinking skill students through argumentation skills (Sampson, 2009). This model train students to analyze a natural phenomenon by providing a response or opinion which is a critical thinking process for students in learning to process and analyze various information obtained. Besides students can communicate the results of their analysis to other students. This model is easily applied in learning by developing a teaching material that can support learning. One of the teaching materials that can be used to implement this model is student worksheets.

Student worksheets is one of the teaching materials or media in the form of sheets containing assignments, materials, summaries, instructions, and steps that must be done by students. Student worksheets can increase student learning motivation, train students to find concepts, and help students to be more active in the learning process (Ahmadi, 2014).

Therefore, student worksheets based on ADI can be developed in biology learning. One of the materials in biology is structure of cells and plant tissues. This material can be used to practice critical thinking skills because it can train students to analyze a natural phenomenon by providing a response or opinion which is critical thinking process. The basic competency used are 3.3 and 4.3. basic competency for 3.3 is analyzing the relationship between cell structure in plant tissues and organ function in plants and the basic competency for 4.3 is presents the results of observations of tissue and organ structure in plants. Based on these basic competencies students are expected to be able to analyze the relationship of cell structure in plant tissues to the function of organs in plants through relevant studies. In addition, students are also expected to have communication skills, one of which is argumentation skills that can be practiced by presenting the results of observations of plant tissue.

Based on the results of an interview conducted by Kusumawati (2016) with a teacher at Senior High School 3 Klaten, it was found that the material of cell structures and plant tissues is difficult and can be seen through student learning outcomes that get low or below the minimum test scores. This is because learning in class is still monotonous and the questions given to students are still Lower Order Thinking Skills (LOTS) type so it is not relevant with basic competency 3.3 and 4.3. Also research conducted by Nurhasikin (2019) said that

students in the three schools in Pontianak, namely in Mujahidin High School, MAN 2 Pontianak, and Senior High School 4 Pontianak have difficulty learning in plant tissue material especially in the structure of each plant tissue function of each tissue. it difficult for students to remember this materials, because students have difficulty to remembering the differences between one plant tissue and another. It is also supported by data on assigment of this material.

Based on research conducted by Ginanjar (2015) who has developed the Argument-Driven Inquiry model successfully practiced the argumentation skill in students, both oral argumentation skill and written argumentation skill. This is in line with research on argumentation inquiry also conducted by Hasnunidah (2018) that applying the Argument-Driven Inquiry model in biology learning can improve students argumentation skills. The results of Safira's research (2018) also show that there is an increase in argumentation skills by applying the Argument-Driven Inquiry model. It can be seen from the results between the pretest and posttest scores which respectively amounted to 27.81 and 42.33.

Based on this description, research can be done to describe the validity of the student worksheets based on Argument-Driven Inquiry (ADI) in cell structures and plant tissue material to practice the critical thinking skill of high school students based on expert judgment.

## METHOD

This developmental research referred to ADDIE development model design including Analysis, Design, Development, Implementation, dan Evaluation. However, the phase carried out only reached the development without the implementation. At the analysis step included curriculum analysis (core competency analysis, basic competency, and indicators to be achieved), student analysis, concept analysis, and assignment analysis. The design step carried out in the preparation of student worksheets based on Argument-Driven Inquiry in structure of cells and plant tissue material, learning implementation plan, and student worksheets design. In the development step carried out by reviewing and revising the student worksheets, and validated by three validators (lecturer in biology, lecturer in biology education, and biology teacher at SMA Khadijah Surabaya).

The final step is the evaluation. At this step, student worksheets have been developed based on the revision after validation is done. The final draft is student worksheets based on Argument-Driven Inquiry in structure of cells and plant tissue material to train critical

thinking skills that is suitable for use. This research carried out during October 2019-May 2020. This research was begun in Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya.

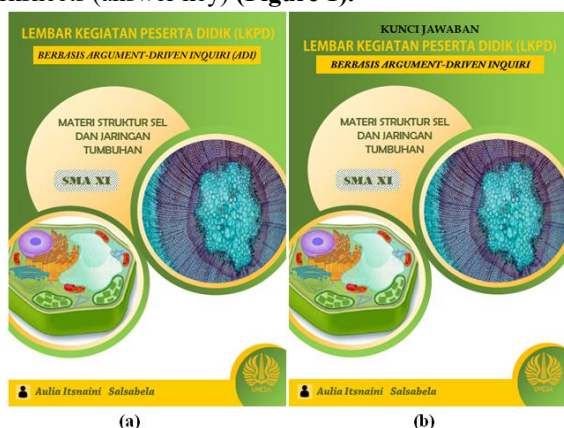
The validity of student worksheets based on the validators from biology and biology education expert. The validity of student worksheets measured based on the validity of the presentation, the validity of the language, and the validity of the content using the validation sheets instrument. The instrument of validation in the form of a table that has validity, linguistic and content criteria. The validation sheet is equipped with instructions for filling in. Validation results obtained from the validator are then interpreted in accordance with the criteria for interpretation of the validity score (Table 1).

**Table 1.** Criteria for interpretation of data validation results (Riduwan, 2013)

Average score (%)	Category
1,00 – 1,75	Less valid
1,76 – 2,50	Quite valid
2,51 – 3,25	Valid
3,26 – 4,00	Very valid

## RESULT AND DISCUSSION

This research development aimed to produce student worksheets based on Argument-Driven Inquiry in structure of cells and plant tissue material to practice critical thinking skills that are valid and can be used in the learning process. The results of student worksheets consist of two types, namely student worksheets and teacher worksheets (answer key) (Figure 1).



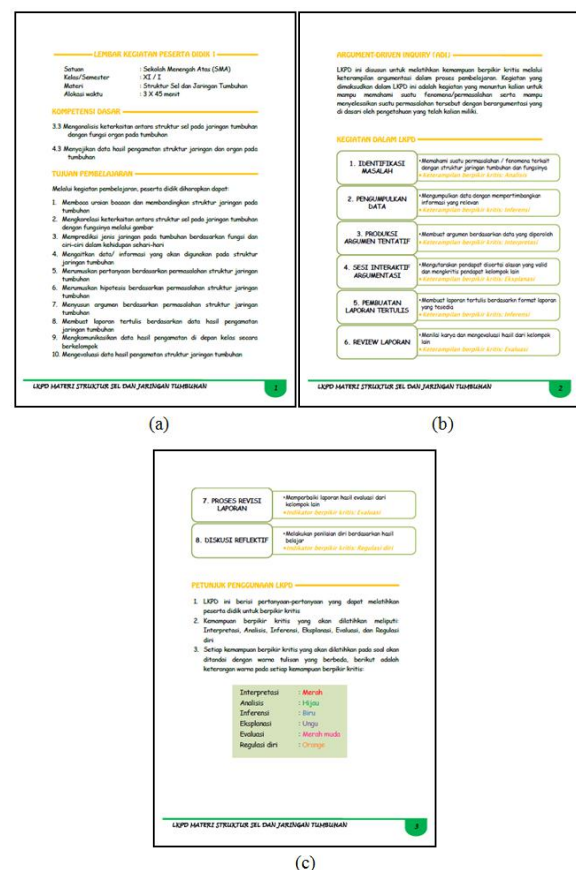
**Figure 1.** (a) Cover page for student worksheets, (b) Cover page for teacher worksheets

The student worksheets divided into two, namely student worksheets 1 is about the types of tissue in plants and transportation systems in plants, and student worksheets 2 is about the tissue of organ compilers in plants and the linkage of tissue functions with plant tissue

culture techniques (Figure 2). In each student worksheets there are three components, including the introductory component, the content component, and the closing component. Introductory components of student worksheets consist of Title, class/semester, time allocation, basic competencies, learning objectives, Argument-Driven Inquiry model based student worksheets explanation, activities in student worksheets, and instructions (Figure 3).



**Figure 2.** (a) Cover of student worksheets 1, (b) Cover of student worksheets 2



**Gambar 3.** (a) title, class/semester, time allocation, basic competencies, and learning objectives (b) Argument-



Driven Inquiry based student worksheets explanation, and activities in student worksheets, (c) instructions

The contents of student worksheets based on Argument-Driven Inquiry that was developed contains activities with the syntax of Argument-Driven Inquiry model and the activities of practicing critical thinking skills (Figure 4). the closing component contains a bibliography, attachments to the report on observations, and attachments to the rubric of evaluation of group results (Figure 5).

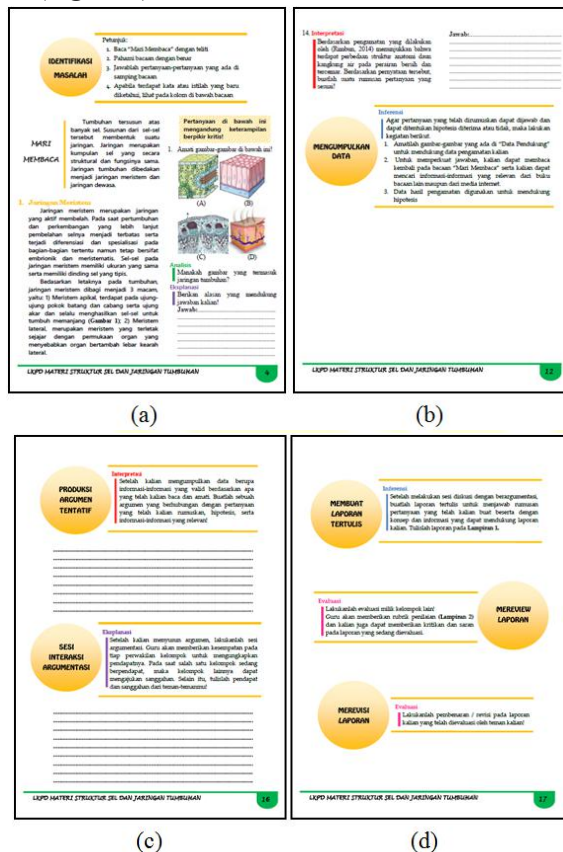


Figure 4. Argument-Driven Inquiry syntax including critical thinking skills

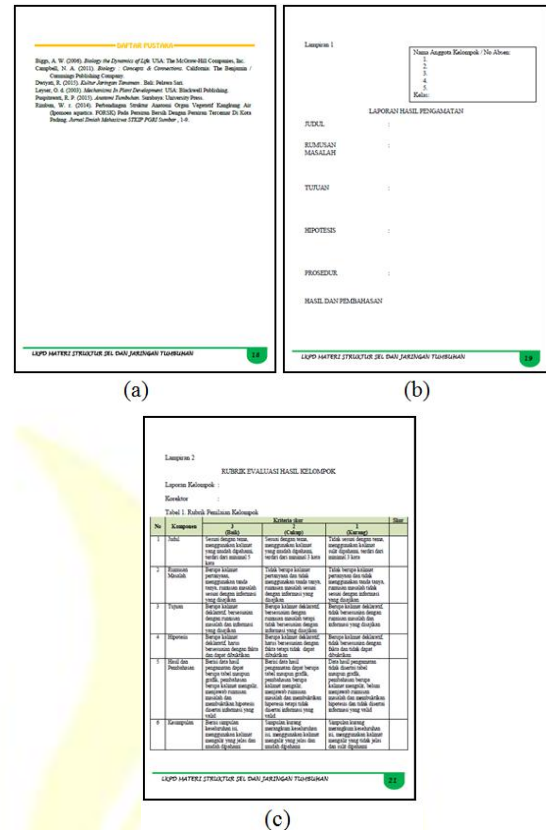


Figure 5. Closing page

Based on the student worksheets that has been carried out, the worksheets then validated by experts and validation data is obtained. The validity of student worksheets based on Argument-Driven Inquiry (ADI) reviewed from the results of validation by experts in biology and biology education. The results of the validation of student worksheets based on Argument-driven Inquiry (ADI) in structure of plant cells and tissue material are presented in the Graph.

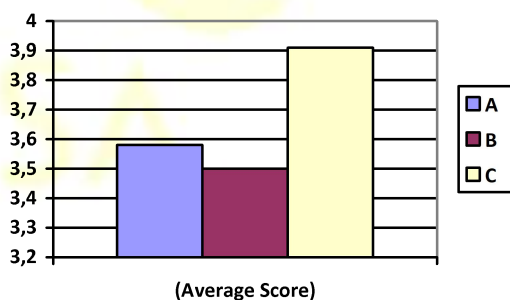
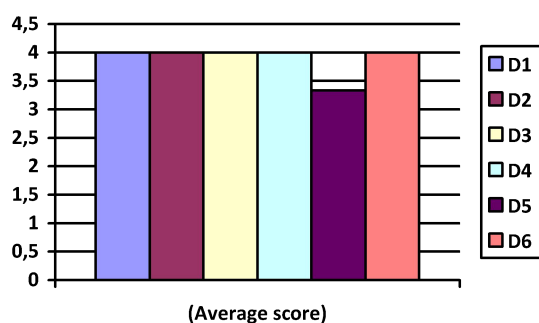
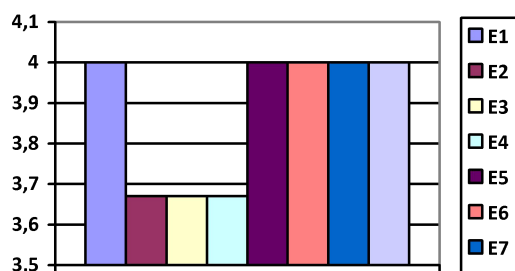


Figure 6. Validity score of student worksheets based on Argument-Driven Inquiry (ADI); A = presentation presentation, B = Language, dan C = Content



**Figure 7.** Validity score of student worksheets for practicing critical thinking skills; D1 = Interpretation, D2 = Analysis, D3 = Inference, D4 = Eksplanasi, D5 = Evaluation, dan D6 = Self regulation



**Figure 8.** Validity score of student worksheets based on Argument-Driven Inquiry; E1 = Problems identification, E2 = Collecting data, E3 = Production the tentative argument, E4 = Interactive argumentation session, E5 = Make a report, E6 = Review a report, E7 =Revise the report, dan E8 = Reflective discussion

#### Information:

Validator 1 : Dra. Isnawati, M.Si.

Validator 2 : Dr. Yuni Sri Rahayu, M.Si.

Validator 3 : Medina Andini, S.Pd., M.Pd.

The validity assessment of student worksheets based on Argument-Driven Inquiry (ADI) covered into five main aspects, namely the feasibility of presentation, language, content, characteristics of student worksheets to practice critical thinking skills, and the characteristics of student worksheets based on Argument-Driven Inquiry. Based on the validation results graph in **Figure 6**, it includes three aspects, namely the feasibility of presentation, language, and content, each with an average score of 3.58, 3.50, and 3.91 with a very valid category for all aspects.

The feasibility aspects of the presentation included the suitability of the cover with the topic, the inclusion of group identity and learning objectives in the student worksheets. Based on the results of the validation get an average of 3.58 with a very valid category, it was because the presentation of the content is suitable with student worksheets, aspects of writing suitability such as the title of the student worksheets must be relevant with the topic of the material, including the basis of learning, and the pictures used are relevant to the cell structure and plant tissue material. Images or figure that used in student worksheets must be relevant with material, it is accordance with Prastowo (2011) that appearance of student worksheets must be relevant with the topic and have a combination of pictures and writing. In addition, there is the inclusion of identity in the student worksheets (including the names of group members, class, and absence numbers), and the inclusion of appropriate learning objectives. According to Depdiknas (2008) and Prastowo (2015), there are several important structures in student worksheets including the title, learning instructions, appropriate material, basic competencies to be achieved and accordance with government regulations, the existence of tasks and activities, writing and letters used, and the effectiveness of the image specified. Besides that, still needed to repair in the feasibility of the presentation, which is on the cover of student worksheets must be easier to use, and as a guide for teachers and students in the learning process (Umbaryati, 2016).

In the language aspect get an average of 3.50 with a very valid category. That is because the Indonesian language used is accordance with PUEBI or General Guidelines for Indonesian Spelling and the grammar that used is accordance with SPOK (Subject, Verb, Object, and Adjective). However, there needed to repair t in the sentence so that it does not cause multiple meanings and is easily for students to understood. grammar in student worksheets based on Depdiknas (2008) said that student worksheets needed good sentences with grammar which doesn't cause multiple meanings and make it easier for students to understand the statement. Good sentence structure according to Prastowo (2011) needs grammar and spelling accordance with the general guidelines of Indonesian spelling.

In the content aspect get an average of 3,91 with a very valid category. It is indicated that the contents in student worksheets that were developed in accordance with the demands of the 2013 curriculum. Activities in student worksheets that support basic competency 3.3 is analyzing the relationship between cell structure in plant tissue and organ function in plants. However, activities

for basic competency 4.3 is presents data on observations of tissue and organ structure in plants. There is answer key in student worksheets that are marked with bold-italic type font in every answer key. It is easier for teachers in while using student worksheets. According to Arsyad (2014) bold or italicized letters can emphasize keywords or titles so that they can guide and draw attention to important information.

Based on the validity result graph in **Figure 7**. Is a characteristics student worksheets to train critical thinking skill aspect. Critical thinking skills used in student worksheets has divided into 6 sub-skills namely interpretation, analysis, inference, evaluation, and self-regulation (Facione, 2015). In the five subcomponents get an average score of 4, and there is only one subcomponent in the evaluation thinking indicator that gets an average score of 3,33. That is due to the lack of trained evaluation in student worksheets.

The last is characteristic student worksheets based on Argument-Driven Inquiry aspect. Based on graph in **Figure 8**, five subcomponents get an average score of 4, and there are three subcomponents namely data collection, production the tentative argument, and interactive argumentation sessions that get an average score on 3,67. It is because not all aspects contain data collection steps and the lack of instructions for students in collecting data, the lack of discussion columns at the interactive argumentation session step, and there is instructions in production the tentative argument step that are still difficult to understand.

Argument-Driven Inquiry (ADI) is an inquiry learning model that is effective in improving critical thinking skill students through argumentation skills (Sampson, 2009). Learning theory that is relevant with ADI model is behavioristic. This theory involved students to be more active in learning and requires students to be able to master in learning that is trained in accordance with learning that has been designed by teacher (Nurfarah, 2018). The syntax of ADI model consists of 8 steps, namely: 1. Problem identification; 2. Collecting data; 3. Production the tentative argument; 4. Interactive argumentation session; 5. Make a report; 6. Review a report; 7. Revise the report; and 8. Reflective Discussion (Sampson, 2009).

The problem identification step at point E1 gets an average score of 4 with a very valid category, it is very relevant to analysis thinking skill at point D2 which is also a very valid category. Analysis thinking skill in student worksheets required students to analyze a problem or phenomenon in the structure of plant tissue. According to Sulistyorini (2013) the level of analysis

involves a deep understanding of information, so students need to separate an idea into parts or elements and show an understanding of the relationship of the parts as a whole.

The result of collecting data step at point E2 gets a very valid category and it is relevant to inference thinking skill at point D3 which is also a very valid category. Inference thinking skill in student worksheets trained students to read and explaining about plant tissue to collect information needed to identify problems. According to Facione (2006) inference is activities of identification and collecting information for explaining a logical conclusion consider relevant information.

At the production the tentative argument at point E3 gets a very valid category. This step trained the interpretation thinking skills at point D1 which also gets a very valid category. Interpretation in student worksheets practiced students to create opinions or arguments based on data from reading student worksheets or other literature. Facione (2006) said that interpretation is the ability to understand, express the meaning of an experience, situation, data, and judgment.

The interactive argumentation session step at point E4 gets a very valid category, so at this step it is appropriate to practice explanation skill at point D4 which also gets a very valid category. Explanation skill in student worksheets required students to explain opinions through at this session.

The fifth step is making a report at point E5 get a very valid category accordance with inference skills at point D3 which also gets a very valid category. The critical thinking skill of inference at this step was required students to make a written report by analyzing and identifying relevant data and information.

The review a report step at point E6 gets an average score of 4 with a very valid category, it is very relevant to evaluation thinking skill at point D5 which is also a very valid category. Analysis thinking skill in student worksheets trained students to logically judge an argument or opinion. In this step, students were evaluating the result of the reports of other groups.

The revise the report step at point E7 gets an average score of 4 with a very valid category, it is very relevant to evaluation thinking skill at point D5 which is also a very valid category. The critical thinking skill of evaluation at this step trained students to repair the evaluation report from other groups.

The last step is reflective discussion at point E8. This step also gets a very valid category with an average score of 4. it is very relevant to self-regulation thinking skill at point D6 which is also a very valid category. Self-



regulation thinking skill in student worksheets practiced students to monitoring self cognitive activities by assessing self understanding based on learning outcomes.

Based on the validity results by three validators which were assessed based on five aspects of the assessment, it was found that the student worksheets based on Argument-Driven Inquiry (ADI) in cell structure and plant tissue material was declared to be very valid and suitable for use in school learning.

## CONCLUSIONS

based on the results of the analysis and discussion of research development based on Argument-Driven Inquiry (ADI) in Cell Structure and Plant Tissue Material to Train Critical Thinking Skill for Senior High school Students declared worthy based on the aspects of feasibility of presenting, language, content, characteristics of student worksheets to practice critical thinking skills, and the characteristics of student worksheets based on Argument-Driven Inquiry. with the acquisition of the average validation score of LKPD of 3.74 which is included in the very valid category.

## SUGGESTION

The Argument-Driven Inquiry (ADI) model can be used on other topic that has characteristic to analyze a natural phenomenon by providing a response or opinion and communicate the results. It should be noted that the time allocation used to be suitable for completing learning using ADI based student worksheet.

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