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The Validity of the Sustainability Based Argument-Driven Inquiry to Improve Students' Critical Thinking Skills

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The sustainability based argument-driven inquiry learning model is designed to improve students' critical thinking skills. The sustainability based argument-driven inquiry learning model as an effort in the education to prepare human resources ready to support the Sustainable Development Goals (SDGs). This study aimed to investigate the validity of the sustainability based argument-driven inquiry learning model to improve students' critical thinking skills. Validation is carried out with the stages of discussion, revision, and then filling out the validation sheet by experts. The results of the content obtained a score of 3.52 or included in the very valid category, and the construct validity obtained an average score of 3.67 or included in the very valid category. The validation results show that the lesson plan scored 72 out of 80 or 90% and is in the very valid category. The results of expert validation of the student worksheets obtained 55 out of 60 (92%) and were included in the very valid category. The results of expert validation of the assessment instrument show that the twelve questions are included in the valid category, and three questions are included in the very valid category.
Keywords: Validity, Sustainability based Argument-Driven Inquiry, Critical Thinking Skills

INTRODUCTION

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (ARIES, 2009; Emas, 2015). Sustainable development has three essential perspectives: socio-cultural, environmental, and economic. Socio-Cultural Perspective is an understanding of social institutions and the role of humans in change and development. The environmental perspective is an awareness of natural resources, a sensitive physical environment, the impact of human activities, and decision-making related to the commitment to create social and economic development policies. Economic perspective is sensitivity to the limitations and potential of economic growth and its impact on society and the environment, associated with a commitment to evaluate the level of consumption of individuals and communities as a form of concern for the environment and social justice. These three perspectives are interrelated and are the driving pillars for sustainable development. This means that in carrying out sustainable development, one can consider one aspect, such as the economic aspect, and consider other aspects such as socio-cultural and environmental aspects (Balitbang Kemdiknas, 2010; Ferguson, Roofe & Cook, 2021; Koskela & Kärkkäinen, 2021).

Sustainable development is a hot topic discussed in the world of education. The United Nations (UN), in the general assembly at the 57th session in 2002, declared the period 2005-2014 as the decade of education for sustainable development (ESD). The goal of ESD is to

integrate the principles, values, and practices of sustainable development into all aspects of education and learning. This effort is expected to encourage a change in attitude that can create a sustainable future in the context of environmental integrity, economic development, and a just community for present and future generations (Balitbang Kemdiknas, 2010; Burden & Sprei, 2020; Verhelst, Vanhoof & Van Petegem, 2022).

The world of education is also faced with preparing human resources to realize the Sustainable Development Goals (SDGs). This challenge is very relevant if it is associated with critical thinking skills as one of the 21st-century skills that students must master. Later, students will not only master knowledge but also must find the values of sustainable development in that knowledge. Thus, teachers must be able to integrate sustainable development values into basic competencies and design learning scenarios that can increase students' critical thinking power in sustainable development issues.

It should be underlined critical thinking is a required skill so that students are sensitive to sustainability issues. This ability is a skill that students must master in the 21st century. Critical thinking means to reason effectively, recognizing the relationship between systems, concepts, and scientific disciplines to solve problems and make decisions (Germaine, Richards, Koeller, & Schubert-Irastorza, 2016; Xhomara, 2022). Indicators of critical thinking activities are grouped into the following five major activities. In practice, can unite to form an activity or separate only a few indicators, namely providing simple explanations, building basic skills, concluding, providing further explanations, and setting strategies and techniques, which consists of determining actions and interacting with others (Ennis, 2011).

The results of a preliminary study on students' critical thinking skills at one junior high school in Indonesia found that there were only six students with high critical thinking skills (17.6%). The remaining 28 students (82.4%) are still low and moderate in ability. The average of students' critical thinking ability is 17.3 (43%) from the maximum value of 40. In terms of indicators, the ability of students to provide simple explanations is 3.3 (81%), building basic skills is 2.1 (53%) , the ability to conclude is 1.7(43%), the ability to provide a further explanation is 1.1 (27%), and the ability to set strategies and techniques is 0.5 (12%). From the conclusion, it is known that students' critical thinking skills are still low, and it is necessary to increase the indicators of providing further explanations and managing strategies and techniques (Sugandi, 2021).

Efforts to improve critical thinking skills have been carried out by many researchers including the Children Learning in Science (CLIS) learning model (Renjani, Susilawati & Khoiri, 2018), inquiry (Anggareni, Ristiati & Widiyanti, 2013), problem-based learning Setyorini, & Dwijananti, 201; Khoiri, Huda & Wiyanto, 2020; Usmeldi, 2019), also the use of

teaching materials based on Socio-Scientific Issues (SSI) (Septiningrum, Khasanah & Khoiri, 2021). One of the learning models that meet the criteria of 21st-century learning is argument-driven inquiry. In several research results, the argument-driven inquiry has been shown to have a positive impact on students' scientific argumentation skills and written arguments, sustainability awareness, scientific writing skills, scientific presentation skills, written, verbal and verbal communication skills, and scientific attitudes student (Sampson, Grooms & Walker, 2011; Songsil, Pongsophon, Boonsoong, & Clarke, 2019; Salsabila, Wijaya & Winarno, 2019; Çetin & Eymur, 2017; Wildan, Hakim, Siahaan & Anwar, 2019) .

However, the argument-driven inquiry learning model does not yet contain the concept of sustainable development goals. Reflecting on the research result on critical thinking skills and the argument-driven inquiry learning model is necessary to develop a lesson that can improve these abilities, especially on issues related to the Sustainability Development Goals (SDGs). The concept of education related to the Sustainable Development Goals is known as Education for Sustainable Development (ESD). In ESD, there is a strengthening of the learning syntax, in which students relate ESD concepts to the material to be studied. At this stage, students are given contextual problems related to the concept of sustainability. The subject matter is expected to revolve around facts, concepts, and procedures and to be associated with the impact of knowledge on socio-cultural, environmental, and economic aspects. The enrichment of this material is expected to expand student competencies, not only in the four competencies contained in the curriculum but also skills needed by children in the 21st century.

Based on the description above, a learning model based on sustainable development was developed, which was then termed "argument-driven inquiry based on sustainability." This research is important as an effort to improve student's skills in the 21st century, especially in critical thinking skills. In addition, this research is also an effort of the world of education in preparing human resources who are ready to support the Sustainability Development Goals (SDGs). A good learning model must meet three requirements: validity, practicality, and effectiveness. This article will describe the validity of the sustainability based argument-driven inquiry learning model to improve students' critical thinking skills.

METHOD

This research used a research and development approach. This method is used to develop a new product or improve an existing product in stages that can be accounted (Sukmadinata,2010). The product developed in this research is a sustainability based argument-driven inquiry learning model to improve students' critical thinking skills.

The main target in this research was to obtain a prototype of the sustainability based argument-driven inquiry learning model that ready to be tested at the design validation stage by experts. A learning model and learning tools are prepared at this stage including lesson plan, student worksheets, and assessment instruments. At the final stage, it is hoped that a prototype of the design/learning model and its supporting devices that have been validated by experts can be obtained.

To the validity of the learning model, we used data collection instruments in the form of expert validation sheets with technical data analysis in the form of description analysis. In this questionnaire, two experts reviewed the feasibility of designing a sustainability based argument-driven inquiry learning model. At this stage, the content and construct validity of the learning model is carried out. Content validity includes the curriculum basis as well as the theoretical basis that underlies the development of the model. While construct validity consists of the absence of conflicting model components with other models, the model syntax leads to achieving goals, social systems, reaction principles, and support systems supporting the developed learning syntax. The validity of the model is calculated in Table 1.

Table 1. Learning Model Validation Assessment Criteria

Interval score	Assessment criteria	Description
$3{,}25 < P \leq 4{,}00$	Very valid	Can be used without revision
$2{,}50 < P \leq 3{,}25$	Valid	Can be used with minor revisions
$1{,}75 < P \leq 2{,}50$	Less valid	Can be used with mayor revisions
$1{,}00 \leq P \leq 1{,}75$	Invalid	Can't be used yet and still needs consultation

Furthermore, the learning tools consisting of lesson plan, student worksheets, and critical thinking skills assessment instruments was validated by experts. Validation was carried out with the stages of discussion, revision, and then filling out the validation sheet by experts. The validation process of the learning model with the focus group discussion (FGD) method was carried out to obtain input and improvements to the learning model that had been developed. This validation method is in accordance with what Richey (2005) and Tracey and Richey (2007) stated, namely the validation of the learning model can be carried out through review activities by experts on the developed model Makhrus, Harjono, Syukur, Bahri & Muntari, 2018; Andersson, 2021; Sass, Pauw, Maeyer & Petegem, 2021; Demirci, Şahin, Teksöz & Marcinkowski, 2021).

The validity of the learning device is obtained by calculating the final score from the validator, and the score consists of a scale of 1 to 5 then the percentage is calculated using Equation 1 below (Akbar, 2013) :

$$V_a = \frac{T_{sa}}{T_{sh}} \times 100 \qquad (1)$$

Information:
V_a = validation score
T_{sa}= total empirical score from the experts
T_{sh}= total expected maximum score

After finding the percentage of each validator, the average is calculated to find the final score with Equation 2 below:

$$\overline{v_a} = \frac{\sum_{i=1}^{n} V_{ai}}{n} \quad (2)$$

Information:
v_a = average validation score from the experts
V_{ai} = validity score of each validator
n = number of validators

The validation criteria are based on the results of the final validation score using the reference, as shown in Table 2.

Table 2. Learning Tool Validation Criteria

Achievement level	Assessment criteria
85,01% - 100,00%	Very valid
70,01% - 85,00%	Valid
50,01% - 70,00%	Less valid
01,00% - 50,00%	Invalid

After conducting the validity test, we asked for suggestions to improve the validity of the learning model. Suggestions from experts and practitioners will be analyzed qualitatively, which is used to revise the validity of the learning model.

RESULTS AND DISCUSSION

Sustainability based argument-driven inquiry learning model was developed from the argument-driven inquiry learning model with strengthening aspects of the curriculum and learning models. In the curriculum aspect, basic competencies are strengthened by the concept of ESD so that students are expected to master ESD-oriented competencies. Table 3 is an excerpt from the syllabus of basic competencies 3.3 and 4.3 of Science Subjects for Class VIII at junior high school, basic competency indicators according to the 2013 Curriculum, as well as indicators strengthened by ESD principles.

Table 3. Experts of the Curriculum Syllabus reinforced with ESD principles

Basic Competencies	Indicators	Indicators Strengthened by ESD Principles
3.3 Understand the concept of work, simple machines, and their application in daily life, as well as their relationship to muscle work in the	3.3.1 Identify the types of simple machines that are applied to a tool 3.3.2 Explain the structure of a	3.3.5 Identifying positive and negative impacts on the economic, socio-cultural and environmental

human skeletal structure		simple machine on a device	aspects of the use of various tools that apply the simple machine principle
	3.3.3	Applying the simple machine principle to a device	
	3.3.4	Analyzing the principle of a simple machine based on its use in everyday life	
4.3 Presenting the results of an investigation or problem solving about the benefits of using simple machines in everyday life	4.3.1	Presenting an experimental report on the principle of a simple machine	4.3.2 Presenting diagrams of positive and negative impacts on the economic, socio-cultural and environmental aspects of the use of various tools that apply the simple machine

In the aspect of the learning model, there is reinforcement at the task identification stage, where students relate the ESD concept to the material to be studied, namely simple machine. At this stage, students are given contextual problems related to the concept of sustainability, namely the identification of principles and the impact of simple machines on everyday life.

Learning Syntax 1. Task Identification

Students carry out two stages of task identification. First, students identify the concept of ESD in a technology that applies the principle of a simple plane. The teacher provides a stimulus in the form of pictures and questions that direct students to be able to carry out these activities. The expected output is an identification chart of the impact of technology on economic, socio-cultural and environmental aspects. Second, students identify problems in everyday life related to the concept of simple planes. At this stage, students write the main questions that will be solved in the investigation, theories related to the problem, break down the main questions into a number of simpler questions, and develop hypotheses.

Learning Syntax 2. Data collection and analysis

At this stage, students design and carry out an investigation that will be carried out to answer the hypothesis.

Learning Syntax 3. Provision of Arguments

At this stage, students develop arguments based on the collected data and write them down on the flipchart provided. Arguments consists of claims (opinions or answers), warrants (theoretical basis), and evidence (data or evidence). The teacher directs students to prepare arguments must be based on data. The teacher guides and checks the progress of the preparation of arguments (make sure the teacher frees up the preparation of arguments and does not convey the correct arguments to students).

Learning Syntax 4. Argumentation Session

Students present their work to other groups in front of the class at this stage. The teacher moves from group to group monitoring the course of the session. The input received is written down and discussed again in the initial group.

Learning Syntax 5. Explicit and Reflective Discussion

The activities carried out at this stage are the teacher and students discussing the core concepts learned and improving the experimental design in the future. The teacher collects the results of the discussion from the whole group by pasting all flipcharts on the blackboard. The teacher appreciates and criticizes students' opinions during presentations and students' arguments. The teacher guides students to draw conclusions in the form of a number of core concepts obtained from students' arguments.

Learning Syntax 6. Reporting

At this stage, students compile reports individually with the structure: title of the experiment, objectives, hypotheses, experimental steps, results, analysis of results/arguments, and conclusions.

Learning Syntax 7. Double-Blind Peer Review

At this stage, students exchange reports and then provide input on the structure and content of other colleagues' reports.

Learning Syntax 8. Report Revision

The report that has been given input is then returned to the owner to be corrected according to suggestions.

Based on the questionnaire results, the content validity of the learning model was obtained with a score of 3.52 or categorized as very valid and construct validity with an average score of 3.67 or categorized as very valid. Content validity shows the curriculum and theoretical basis for model development. With a score of 3.52 and a very valid category, it can be stated that in the aspect of content validity, the development of the sustainability based argument-driven inquiry learning model is based on the curriculum and has an adequate theoretical basis. While the construct validation result is 3.67 (very valid). It indicates that the

components of the sustainability based argument-driven inquiry learning model do not conflict with other models, the syntax of the model leads to the achievement of goals, and the social system, reaction principle, and support system support the developed learning syntax.

Sustainability based argument-driven inquiry learning tools consisting of lesson plan, student worksheets, and critical thinking skills assessment instruments validated the results are presented in Table 4, Table 5, and Table 6.

Table 4. Validation of the Lesson Plan

No	Aspects	Score of Validator	Score Maximum	Conclusion
1.	Formulation of learning objectives	29	30	Can be used with revisions
2.	Content	20	25	
3.	Language	15	15	
4	Time	8	10	
Total score		72	80	
Validity Level		90%		
Category		Very valid		

Table 5. Validation of the Student Worksheets

No	Aspects	Score of Validator	Score Maximum	Conclusion
1.	Formulation of learning objectives	5	5	Can be used with minor revisions
2.	Content	30	35	
3.	Language	20	20	
Total score		55	60	
Validity Level		92%		
Category		Very valid		

Table 6. Validation of Critical Thinking Ability Assessment Instruments

Aspects of Critical Thinking	Question Number	Percentage Validity	Criteria
Give a simple explanation	1	83%	valid
	7	83%	valid
	11	90%	very valid
Building basic skills	3	86%	valid
	9	83%	valid
	12	86%	valid
Conclude	4	81%	valid
	10	86%	valid
	13	89%	valid
Make further explanation	14	91%	very valid
	6	86%	valid
	15	90%	very valid
Set strategy and technique	2	86%	valid
	8	83%	valid

Aspects of Critical Thinking	Question Number	Percentage Validity	Criteria
	5	81%	valid

The discussions results with experts, there were several findings of problems in the learning implementation plan and student worksheets, namely the concept of sustainability has not been found. The syntax of the sustainability based argument-driven inquiry learning model has not yet appeared in the lesson plan, and the narrow scope of material in the lesson plan is only on the lever sub discussion. These findings were then followed up with actions to include sustainability issues and concepts in the lesson plan and student worksheets, include and detail the sustainability based argument-driven inquiry syntax in the lesson plan, including the implementation steps and expand the scope of learning indicators from levers to levers, pulleys, and inclined planes.

The suggestions from expert validators have six key factors of the sustainability based argument-driven inquiry learning model can run well, including well-structured tasks, explanation of the argumentation process, use of group discussions, activities that focus on argumentation, direct feedback, and safe and respectful learning environment (Songsil, Pongsophon, Boonsoong & Clarke, 2019)

The concept of sustainability is integrally included in learning as an issue that students will discuss at the task identification stage. The factor considered is that to achieve sustainability, we need to challenge our way of thinking by questioning and reflecting on current activities and decisions and considering the need for new ways of acting. We need to change our behavior to avoid environmental and socioeconomic problems rather than being reactive by acting on symptoms (ARIES, 2009; García-Rico, Martínez-Muñoz, Santos-Pastor & Chiva-Bartoll, 2021; Moschen, Macke, Bebber & da Silva, 2019).

The validity of the lesson plan includes aspects of the formulation of learning objectives, content, language, and time. The expert result validation of the lesson plan obtained a score of 72 out of 80 or 90% and were included in the very valid category. Student worksheets validation includes aspects of the formulation of learning objectives, content, and language. The results of expert validation of the student worksheets obtained a score of 55 out of 60 (92%) and were included in the very valid category.

The assessment instrument is designed to measure students' critical thinking skills. The instrument is a written test in the form of fifteen multiple-choice questions. The questions are developed from indicators of competency achievement that have been integrated with the concept of sustainability. The questions are designed to fulfill aspects of critical thinking

skills according to universal intellectual standards, namely clarity, accuracy, precisions, relevance, depth, breadth and logic (Achmad, 2007).

The validation of the assessment instrument includes aspects of the material, construction, and language, which are described in fourteen aspects. The expert validation result of the assessment instrument from 12 questions included valid categories and 3 questions in the very valid category. In the fifteen items, two aspects are generally considered on very good by the validator, namely the aspect of the suitability of the questions with the basic competencies to be achieved. The clarity of the meaning of the questions, pictures, tables, and diagrams presented has the potential to improve student's critical thinking skills. At the same time, the other thirteen aspects were generally rated on good on all questions.

CONCLUSION

Content validity of the sustainability based argument-driven inquiry learning model with a score of 3.52 or categorized as very valid and construct validity with an average score of 3.67 or categorized as very valid. The validation results show that the lesson plan scored 72 out of 80 or 90% and is in the very valid category. The expert validation results of the student worksheets obtained a 55 out of 60 (92%) and were included in the very valid category. The results of expert validation of the assessment instrument show that twelve questions are included in the valid category, and three questions are included in the very valid category.

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