INNOVATIVE E-WORKSHEETS FOR CLIMATE CHANGE EDUCATION: LEVERAGING GUIDED INQUIRY AND GOOGLE SITES TO ENHANCE STUDENTS' CRITICAL THINKING SKILLS

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DOI: 10.66538/DH.2025.1.2.2

Abstract

Critical thinking is one of the competencies needed in the development of the 21st century, especially for students at the high school level. Therefore, teaching materials are needed to support students in practicing critical thinking integrated with increasingly advanced technological developments. One of these teaching materials is an E-worksheet based on guided inquiry assisted by Google Sites. In addition, students need to know more deeply about handling the global issue of SDGs (Sustainable Development Goals) through the learning process at school.

This study employs the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) model to develop the e-worksheet. This research was conducted at a senior high school in Kota Tangerang Selatan, Banten, Indonesia, selected for its adequate facilities, such as Wi-Fi, to support the use of digital learning material. The E worksheet development process involves validation tests by media, material, and language experts, as well as readability tests by students. Additionally, students', critical thinking was assessed using a pretest and posttest.

The results of the E-worksheet development research assisted by Google Sites based on expert validation obtained a percentage of 92%, a very feasible category based on the average of each expert validation assessment indicator. The readability test of the E-worksheet product assisted by Google Sites by students obtained an average percentage of the graphic, presentation, and linguistic components of 94% with a very readable category. The test was used to measure the indicators of students' critical thinking training using statistical tests in the form of validity and reliability tests with the results obtained. Namely, the test used is valid and reliable. In addition, the training of students' critical thinking skills is reviewed through the N-Gain Score pretest and posttest with a result of 0.74, which is included in the high N-Gain score category. Based on the results of the study, it can be concluded that the E- Worksheet assisted by Google sites that have been developed is declared feasible to be used as a support for the biology learning process and can train students' critical thinking skills on environmental change materials related to SDGs issues.

Keywords: Innovative E-Worksheet, Climate Change, Critical Thinking Skills, Guided Inquiry

1. Introduction

According to Permendikbud number 103 of 2015, the characteristics of 21st-century learning require student-centred learning. However, the learning process tends to be still teacher-centred, which causes students to be less interactive, lazy to learn, feel bored, and do not understand the concept of the material given by the teacher during the learning process. This is a current educational problem that requires student-centred learning (Suryaningsih & Nurlita, 2021).

Facing the Industrial Revolution 4.0. certainly not unfamiliar to discuss, especially in the field of education. The Industrial Revolution 4.0 makes innovative technology the leading centre for connecting various fields of human life. However, technology

has not fully developed in Indonesia's education field. The solution to this problem is that educational institutions must provide HR or human resources, such as reliable educators, to deal with technological developments (Windi et al, 2023).

21st-century learning has one framework: critical thinking and problem-solving. The many innovations and information students receive require high essential thinking skills (Aisya, et al, 2017).

Data from the Program for International Student Assessment (PISA) in 2018, released by the Organisation for Economic Co-operation and Development (OECD), shows Indonesia is in the low performance quadrant with high equity. However, the results of PISA 2022 show that Indonesia's ranking has increased by 5 to 6 positions compared to PISA 2018. The factor that caused the increase in the PISA score in 2022 can improve the quality of education in Indonesia. In addition, one of the abilities that can encourage students to excel in PISA scores is critical thinking skills that are honed through the learning process (Pers, 2018).

Inquiry-based learning models have various levels that enable students to develop skills and understanding of scientific inquiry (Nugroho, 2021). The implementation component of the Guided Inquiry model is carried out by students, so that students can ask questions, formulate problems, make hypotheses, and design research (Herlanti, Zulfiani, & Arnasari, 2013). The WIVS technological innovation, integrated with the inquiry learning model, can be used as a meaningful online learning alternative for science education (Suwarna, IP & Zulfiani, 2024).

Reviewing the report on Indonesia's Sustainable Development Goals in 2024, Indonesia is ranked 78 out of 167 countries participating in the SDGs sustainable program. Of the 17 sustainable development goals, only the goal of ending poverty (goal 1) and quality education (goal 4) with the status of having maintained the achievement of SDGs. Apart from these 2 goals, the status is improving and stagnant including goal 13 of SDGs, namely handling climate change in Indonesia with a fairly improving status. Based on the SDGs Climate Action indicator, carbon dioxide emissions from fossil fuel combustion in 2022 are included in the stagnant category or there is no increase until 2024 (Sachs, Lafortune, & Fuller, 2024).

Based on these data, it can be seen that awareness of climate change management in Indonesia is not yet optimal, so that the contribution of all components in Indonesia is needed to support climate change management actions, one of which is the education component. The material on environmental change and preservation in Phase E of the Merdeka Curriculum can be linked to one of the Sustainable Development Goals (SDGs) which is a global action plan designed by UNDP as an effort to achieve shared prosperity, balance of life in nature, and encourage awareness of environmentally friendly behavior. The material on environmental change and preservation is very appropriate to be linked to the issue of SDGs Climate change. With this link, learning in the classroom will be more interesting and meaningful for students.

Based on the background of the study, to train critical thinking of students adapted to 21st Century competencies, it is necessary to develop an Electronic Student Worksheet assisted by Google Sites on the issue of SDGs Climate Change which can be linked and applied to learning materials in SMA Phase E Merdeka Curriculum, namely the material on environmental change and preservation. The goal is for students to be able to understand and apply sustainable living, which begins with analysing environmental changes and finding solutions. Students can more easily achieve critical thinking competencies by developing innovative E-Worksheets based on guided inquiry.

This research is based on the change in the educational paradigm in the independent curriculum, which is a transition from initially teacher-centred learning to student-centred learning. The changes that occur require that the learning process in the classroom be active, which can be supported by the right learning approach and teaching materials. One relevant and student-centred approach is the guided inquiry-based approach using innovative E-Worksheet teaching materials, leveraging guided inquiry and Google Sites. The innovative E-Worksheet can be applied to environmental change material related to the SDGs and the Climate Change Issue.

2. Methods

The research method used is the Research & Development method. The Research & Development (R&D) method is a research method that functions to test, develop, and create specific products. Development or innovation means improving and perfecting existing products to make them more practical, effective, and efficient (Sugiono, 2013).

The E-LKPD product development model used is the ADDIE term according to Dick and Carry (1996) which is one of the systematic learning design models and is oriented towards the theoretical basis of learning design. This model consists of five stages, namely:

1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation, which can be translated into development research.

1. The research conducted at the analysis stage is an observation related to using E-LKPD based on guided inquiry on the issue of SDGs climate change assisted by Google sites to train students' critical thinking. The observation was carried out by analyzing references and literature studies in journals, books, or other sources related to E-worksheet development. The analysis stage is also supported by interviews with biology teachers at SMAN 1 Tangerang Selatan and an analysis of the results of student questionnaires totaling 20 questions via Google Forms.
2. In the design stage, the researcher prepares a design or outline for designing e-worksheets based on guided inquiry on the issue of SDGs climate change, assisted by Google sites, to train students' critical thinking. The preparation of learning objectives and materials is based on essential thinking indicators according to Facione and guided inquiry indicators according to Zulfiani. At the design stage, researchers must determine the development environment, choose a location, and identify students who will be tested, content experts, learning experts, assignment test experts, teaching materials and learning media design experts (Rayanto & Sugianti, 2020).
3. The development stage in this study includes activities to produce products in the form of E-worksheets assisted by Google sites suitable for use in the learning process, by going through a teaching material validation process. The validation process by expert validators aims to determine the material's feasibility, readability, and suitability from E-worksheets assisted by Google sites.
4. The implementation stage in this study includes the N-Gain test of critical thinking indicator questions reviewed through pretest and posttest learning outcomes. The N-Gain essential test of thinking indicator questions was conducted with small group-based research, namely in class X.7 at SMAN 1 South Tangerang City with 33 students. The pretest and posttest questions were tested with critical thinking instruments prepared to determine the use of E-worksheets assisted by Google sites on the SDGs climate change issue, to train students' critical thinking.
5. In the last stage of the analysis, researchers obtained improvements or innovations with the ADDIE model, namely, evaluation. At this stage, each stage from analysis, design, development, and implementation will go through an evaluation stage to disseminate the results of each stage and to find out the shortcomings of each stage of development carried out by presenting reflections and recommendations for further research.

3. Results and discussion

3.1. Analysis

Based on the results of the analysis of interviews with biology tutors for grade 10, it can be concluded that E-Worksheets assisted by Google sites, can support the implementation of the independent curriculum with the main principle of being student-centered. Material in schools that is linked to the SDGs issue is rarely done, especially in the environmental change material, where, in previous learning, the material was not related to the SDGs issue of Climate Change; therefore, teaching materials are needed that can link the SDGs issue to the material in schools (Setyaningsih et. al, 2024). Students need critical thinking skills and can be trained during the learning process with the learning model used by the teacher, one of which is the guided inquiry learning model (Konieczny, 2024).

3.2. Design

In the design stage, researchers prepare a design or grid for designing an electronic student worksheet based on guided inquiry on the SDGs climate change issue, assisted by Google Sites to train students' critical thinking. The preparation of learning objectives and materials is based on essential thinking indicators according to Facione and guided inquiry indicators according to Zulfiani.

Figure 1. Gambar 1. Home View



Figure 2. Gambar 2. E-worksheet View



3.3. Development

E-Worksheet assessment is carried out with several aspects, namely media, materials, and language, with validators from lecturers and teachers. The following is an analysis of the feasibility of E-Worksheet in each indicator.

Table 1. Accumulated Value Results Validation by Expert Lecturers and Field Practitioner Teachers

Indicator	Lecturers	Teacher
Suitability of material with learning outcomes and SDGs Issues	22	25
Accuracy of material	25	30
Stimulates students' curiosity	18	20
Suitability with student development	14	15
Critical thinking E-Worksheets components	29	35
Graphic components	53	65
Presentation components	23	35
Language components	30	30
Total	214	255
Maximum Score	255	255
Percentage	84%	100%
Average Percentage	92%	
Criteria	Very Worthy	

Based on the results of the validation accumulation in the table, it can be seen that the E-LKPD, assisted by Google Sites, which was developed, obtained a percentage of 92% with very decent quality criteria. Based on the results of the revision and validation results that researchers at the development stage have carried out, the most crucial thing achieved at the development stage is to improve the teaching materials used to achieve the learning objectives that have been formulated so that the level of feasibility of the product that has been developed can be known (Arofah, 2019).

Students' readability test of the E-LKPD product was also conducted at the development stage. The readability test was carried out on a limited scale of 12 students with different areas of expertise. There were three groups with students in the category of biology experts, quite expert in biology, and less expert in biology, as seen from the analysis results with biology teachers at SMAN 1 Tangerang Selatan City.

Based on the development stage of the E-LKPD product, the product validation process is essential to perfecting the product before it is ready for use in the field. With the validation of media, language, material, and field practitioner experts, several revision points were obtained that built the E-LKPD product, assisted by Google Sites, to be more feasible for dissemination outside the research stage. Based on the validation results, all validation results were found to be very possible; therefore, after the validation and revision stages were carried out, the researcher continued to the next stage, namely implementation on grade 10 SMA/MA students of the independent curriculum.

3.4. Implemetation

The implementation stage is carried out by testing the N-Gain score of student learning outcomes on critical thinking indicator questions.

Table 2. Student Learning Outcomes

Aspect	Pretest	Posttest
Mean	55	88
Median	58	90
Mode	63	95
N Gain Score	0,74	
N Gain Score (%)	94	

The existence of pretest and posttest questions is used to obtain the N Gain score value, which can show concretely and based on data from student learning outcomes using the E-LKPD product that has been developed. The N-Gain Score determines how much students' understanding of a material has increased. Based on the data in Table 2, it can be seen that the N-Gain Score result in this study was 0.74, where the N-Gain Score with a value of $0.70 \leqslant g \leqslant 1.00$ can be categorised as an increase in the N-Gain score obtained, which is high (Sukarelawan, Indratno, & Ayu, 2024). The high N-Gain Score results indicate that the application of inquiry-based learning models can significantly improve students' understanding, in line with the findings of Setiyaningsih et (2024), which showed a positive relationship between students' critical thinking skills and sustainable awareness through ESD-based learning.

3.5. Evaluation

The concept of the evaluation stage includes assessing the quality of the product with the learning process and general procedures for determining evaluation criteria, selecting evaluation tools, and conducting revisions. The results of the evaluation stage, namely the evaluation plan in which, in this study, each stage, starting from analysis, design, development, and implementation, will reveal the essence of the results of each stage and the shortcomings of the development stage, with the aim of reflection and recommendations for further research.

4. Conclusions

Based on the research, the final product has been produced as E-worksheets based on guided inquiry on the SDGs Climate Change issue, assisted by Google sites, to train students' critical thinking with very feasible criteria. The developed e-worksheets have gone through validation stages with the final validation value obtained by media experts, materials, language, and field practitioners of 92% (very feasible) and a readability test by students with a result of 94% (very readable). The results of the validity and reliability test of critical thinking indicator questions obtained the results of all questions being declared valid and reliable, and the N-Gain Score results being categorized as high. Based on the guided inquiry into the issue of SDGs and climate change, we will use Google Sites to train critical thinking. It is worthy of being used as a biology learning material for class 10 of high school with the independent curriculum.

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