

# Development of Electronic Student Worksheets with a Scientific Approach to Static Fluids Material to Improve Critical Thinking Skills of SMAN 9 Merangin Students

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**Abstract:** Teaching materials in their role as providers of information are really needed by educators and student. The purpose of this research is to develop teaching materials in the form of e-LKPD with a scientific approach to static fluid material to improve critical thinking skills at SMAN 9 Merangin which can be used in the learning process. This development research uses a 4D development model. The test subjects consisted of a small group consisting of 10 people and a large group consisting of 30 people who were students of SMAN 9 Merangin. The instruments used in this research were interviews, questionnaires, pretest-posttest questions, and validation assessment sheets. The data analysis technique used in this research is descriptive research with a quantitative approach. The validation results from material and media experts show that the teaching materials developed are very valid for small group trials. Teacher assessments and student responses to the media are very good. The effectiveness of e-LKPD teaching materials in improving critical thinking skills was carried out by a Paired Sample T-Test with the decision that the hypothesis was accepted and a large group test was carried out to obtain a fairly effective level of effectiveness with an average value of 0.6187 or 61.8696%. It can be concluded that the development of e-LKPD teaching materials with a scientific approach to static fluid material to improve critical thinking skills is feasible and effective for use in the learning process. 6187 or 61.8696%. It can be concluded that the development of e-LKPD teaching materials with a scientific approach to static fluid material to improve critical thinking skills is feasible and effective in the learning process. 6187 or 61.8696%. It can be concluded that the development of e-LKPD teaching materials with a scientific approach to static fluid material to improve critical thinking skills is feasible and effective for use in the learning process.

**Keywords:** Critical thinking ability; E-LKPD; Scientific approach; Static fluid

## Introduction

In education in Indonesia, there has been a change in curriculum development from the education unit level curriculum (KTSP) to the 2013 curriculum. Based on Permendikbud No. 22 of 2016 concerning Primary and Secondary Education Process Standards, it explains the implementation of learning in education and secondary education units to achieve graduate competency. 21st century competencies in the learning process include strengthening character education

(PPK), literacy, higher order thinking skills (HOTS), and 4C competencies which include critical thinking, creative thinking, collaboration, and communication, (Mulyasa, 2018). 21st century or 4C skills are likely to be able to prepare human resources (HR) in the education sector to face challenges in the world of education in the future (Afandi et al., 2019).

Critical thinking ability is an ability that involves cognitive processes that involve students to think within the limits of their abilities about a problem (Demirbag et al., 2016; Fadhlullah & Ahmad, 2017; Susetyarini &

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Fauzi, 2020; Juliyantika & Batubara, 2022). Critical thinking is defined as a thinking process in terms of skills, applying analysis, synthesis, evaluating, information and generalization (Aji et al., 2017; Dewi et al., 2018; Fitriyah & Ghofur, 2021; Affilia et al., 2023). This is supported by the results of interviews and initial observations at SMA N 9 Merangin with a physics teacher who said that critical thinking skills are still quite difficult to practice. This is evidenced by several indicators of critical thinking skills such as, concluding, providing further explanation of the material provided, develop strategies and tactics to determine next actions in the learning process.

Some students still find it quite difficult to understand abstract physics concepts, there is a lack of preparation to prepare themselves before learning begins, and for certain material students are not yet able to solve a problem that requires good analytical skills which reflect critical thinking skills. Therefore, skills or abilities are needed which are expected to improve students' critical thinking abilities in the learning process (Amijaya et al., 2018). One of the factors that support success in the learning process is the ability to think critically which also supports understanding of the subject matter (Mulyana et al., 2022), and for certain materials students have not been able to solve a problem that requires good analytical skills that reflect critical thinking skills. Therefore, skills or abilities are needed which are expected to be able to improve students' critical thinking skills in the learning process.

One approach that can develop critical thinking skills is a scientific approach. The scientific approach develops critical thinking skills, develops problem solving abilities, asks questions, is able to differentiate information from various sources, communicates to other people, and develops based on information processing (Kusumah, 2019). Preliminary observation results show that a scientific approach has been used in the physics learning process at SMA N 9 Merangin.

Supporting learning achievement with a scientific approach to train critical thinking skills, the need for appropriate teaching materials is a very important factor in improving students' ability to understand the material. Therefore, teaching materials that suit students' needs are very necessary. Teaching materials are a collection of knowledge or information that contains concepts or principles that help students create concepts based on scientific processes to master the material (Fitriana et al., 2016; Wulandari et al., 2019; Rahmawati et al., 2019; Hardianti et al., 2020). Initial observation results show that, in physics learning, teachers use printed books as a learning resource, the LKPD used is in the form of simple sheets. Technological developments in the digital era should be utilized as

much as possible in the learning process. But, in the physics learning process at SMA N 9 Merangin there is no visible use of available technology. Part of developing teaching materials by utilizing technology, including the development of electronic worksheets or e-LKPD (Oktaviara & Pahlevi, 2019; Liana et al., 2022; Uma'iyah et al., 2023). The use of electronic learning media is an effort to integrate developments in digital technology into the educational process. Following increasingly modern developments, the learning process can utilize digital technology which can help the continuity of the learning process (Pebriani et al., 2022; Rahmi et al., 2023; Windayani & Pertiwi, 2023). To complement the availability of teaching materials to improve critical thinking skills, it is necessary to develop teaching materials in the form of e- LKPD with a scientific approach to static fluid material. Static fluids are one of the interesting materials in learning physics. Because with simple equipment students can practice it in everyday life both at home and at school, so students can easily understand the material being studied by carrying out simple experiments and using simple equipment.

Previous research on the development of e-LKPD based on a scientific approach to train students' critical thinking skills has shown that the developed e-LKPD is feasible to use based on aspects of validity, practicality and effectiveness for learning (Wahyuni et al., 2021; Novitasari & Puspitawati, 2022; Dewitasari & Rusmini, 2023). Meanwhile, Junita et al. (2022) and Yudha et al. (2023) shows that the e-LKPD developed is declared valid, practical and effective to be applied to the learning process. This is supported by Khotami et al. (2023) research, concerning the importance of electronic student worksheets in the 21st century learning process, showing that the development of e-LKPD teaching materials developed can be used in the science learning process.

Based on the explanation of the background and previous research, research will be carried out regarding: "Development of Electronic Student Worksheets with a Scientific Approach on Static Fluid Material to Improve Critical Thinking Skills of Students of SMA N 9 Merangin.

## Method

This study uses research and development methods using the 4D model (four D models) following the flow of Thiagarajan et al. (1974) has 4 stages of development namely Define, Design, Develop, and Disseminate or adapted into a 4P model, namely definition, design, development and dissemination.

*Test Subjects*

The trial was carried out in small group trial stages and large group trials. Small group trials were carried out with 10 students from class XI MIPA SMA N 9 Merangin. If there are suggestions for improvement, a revision will be carried out and the results of the revision will be tested again on the target students. If there are none, then the trial immediately continues with experimental research (Large group trials). Experimental research was conducted to determine the level of effectiveness the e- LKPD developed. The sample used was 30 students of class XI MIPA SMA N 9 Merangin in actual learning conditions, so that data with a high level of accuracy would be obtained. During the large group trials, students were given a pretest and posttest to see their critical thinking skills.

*Data Analysis Techniques*

The data obtained was data analysis in the form of the results of a needs questionnaire, using the rating scale formula, material expert validation questionnaire, media expert validation questionnaire, teacher response questionnaire, and student response questionnaire using a Likert scale. Test the effectiveness of using the test Paired Sample T-Test and the N-Gain test.

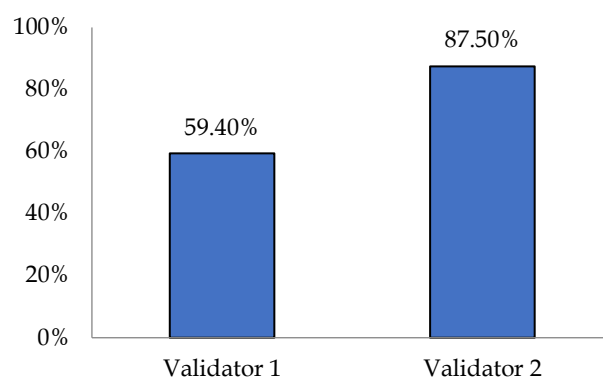
**Results and Discussion**

The procedure for developing e-LKPD teaching materials with a scientific approach using a 4D design according to Thiagarajan et al. (1974) which includes definition (Define), design (Design), development (Develop) and deployment (Disseminate). From the results of the researcher's analysis, it is known that students in class XI MIPA SMA N 9 Merangin need electronic teaching materials that can facilitate students and teachers in the learning process. At the defining stage, an initial and final analysis is carried out, needs analysis, task analysis, concept analysis and learning objectives analysis to find out the initial problems and needs needed so that the process of developing teaching materials can be used and achieve development goals and can improve critical thinking skills.

The design stage starts from compiling test instruments, media selection, format selection and initial design and e-LKPD storyboard which will be developed to achieve learning objectives that can improve critical thinking skills. Next, the development stage is carried out, at this stage material validation and media validation are carried out to find out whether the product being developed is suitable for testing. E-LKPD teaching materials can be said to be suitable if the assessment of material and media expert validators says

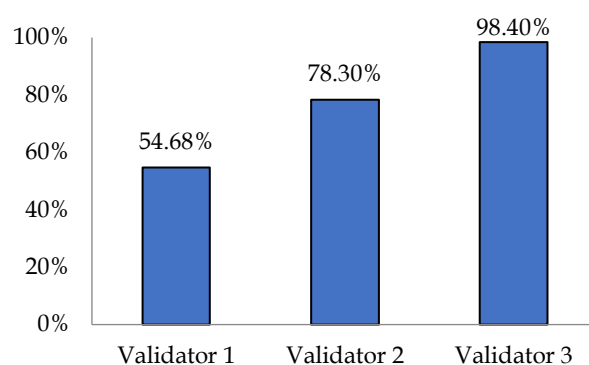
that the teaching materials are valid and ready to be tested.

Material validation is carried out to assess the clarity of the material whether it is in accordance with the existing curriculum and whether it is in accordance with the needs of students. Material validation is at the very feasible category level.



**Figure 1.** Material expert validation results

Media validation is carried out to see whether the media developed is appropriate to the material and can be used in the learning process. The media validation results are in the very suitable category for testing in the field.



**Figure 2.** Media expert validation results

In addition to validating material and media experts, assessments were carried out on teachers and students by conducting small group trials and large group trials. to see student responses to the products that have been developed. Small group trials were carried out on 10 students in class XI MIPA SMA N 9 Merangin. In the small group test scores were obtained 84.1% with a very good category so it can be concluded that e-LKPD teaching materials with a scientific approach are ready to be used as teaching materials to improve critical thinking skills. Validation is the most important stage in development. The e-LKPD teaching materials with a scientific approach were assessed by the physics subject

teacher at SMA N 9 Merangin by providing a teacher assessment questionnaire. Based on a questionnaire from the teacher's assessment of 95.8% with very good category. This shows that e-LKPD teaching materials with a scientific approach have practical feasibility and can be used in general.

Based on the analysis test of the validity of the items, the questions were tested on 10 students of class XI MIPA. Obtained from 15 items, 10 items were declared valid, and 5 items were declared invalid. In the Excel program, determining whether an item is valid or not is based on the interpretation of the  $r$  product moment table with  $N = 10$ . The validity of a question item is said to be valid if each question item has a value of  $sig > 0.5$  and  $r_{count} > r_{table}$ . The five questions that were declared invalid had a value of  $sig < 0.5$  and  $r_{count} < r_{table}$  ( $r_{table}$  for  $N = 30$  was 0.6319). So questions that are declared invalid are not used to test critical thinking abilities. After the validity of the question items is known, proceed with determining the reliability of the question items. The reliability results of the questions are at high reliability with a score of 0.915. Based on the CA value  $> 0.70$  and close to 1.0, it can be stated that the 10 questions given to students are reliable. Based on the results of the analysis, the level of difficulty of the items, 9 questions are in the difficult category and 3 questions are in the medium category and 3 questions are in the easy category. Results power of difference analysis is known that 13 items are in the very good category, 2 questions are in the good category and 1 item is in the sufficient category.

Furthermore, practical feasibility is carried out by students in validating student responses. The results of student responses in small groups of e-LKPD teaching materials with a scientific approach are categorized as very good and suitable for use in learning with percentage results 84.1%. So that the e-LKPD teaching materials with a scientific approach are materials that are needed and deserve to be tested further. After the product was tested on a small group and got very good results, then the product was tested on a large group of 30 students in class XI MIPA SMAN 9 Merangin.

Large group testing to see the increase in critical thinking skills and to see the effectiveness of the products that have been developed. Pretest and posttest were applied to large groups to see a comparison of critical thinking skills. Critical thinking ability pretest average score namely 10, the average posttest score for critical thinking skills is 35. The results of pretest and posttest testing are used to see any changes in critical thinking skills before and after using e-LKPD teaching materials with a scientific approach. From the pretest and posttest results, it can be seen that there are differences in use before and after. So the Paired Sample T-Test was carried out it is known that the sig (2-tailed) value is  $0.001 < 0.05$ . So it can be concluded that "The hypothesis is accepted", thus it can be said that there is a difference between the pretest and posttest of using e-LKPD with a scientific approach to improve critical thinking skills.

**Table 1.** Paired Sample T-Test

	Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference		t	df	Sig.(2-tailed)
				Lower	Upper			
				Pair 1 Pretest-Posttest	-24.933			

The effectiveness test was also carried out by the N-Gain test to see how effective the resulting product was in improving students' critical thinking skills using SPSS version 27. Based on the N-Gain test calculations, critical thinking ability showed an average value 0.6187 is

included in the high category and the percentage value obtained is 61.8695 e- LKPD teaching materials with a scientific approach are included in the quite effective category in improving the critical thinking skills of class XI MIPA students at SMA N 9 Merangin.

**Table 2.** N-Gain Test

	N	Minimum	Maximum	Mean	Std. deviation
N gain score	30	0.38	1	0.6187	0.14628
N gain percentage	30	37.50	100	61.8695	14.62846
Valid	30				

**Conclusion**

Based on the results of research into the development and discussion of e-LKPD teaching materials with a scientific approach, it can be concluded

that the process of developing e-LKPD teaching materials with a scientific approach uses the 4D development model according to Thiagarajan. At the definition stage, the results of the initial and final analysis of students' needs for existing problems, in the

design stage, flowcharts and storyboards were obtained which became reference material for the development of e-LKPD, in the development stage validation was carried out by material experts and media experts, in the distribution stage, product assessment was carried out by teachers and trials were carried out on students who received very good student responses. The process of material validation and media validation of e-LKPD teaching materials with a scientific approach obtained "very valid" results. The teacher's assessment of e-LKPD teaching materials with a scientific approach obtained very good results. So it can be said that this product is very suitable as teaching material in the physics learning process with static fluid material. Student responses to teaching materials with a scientific approach obtained very good results. The effectiveness of e-LKPD teaching materials with a scientific approach in improving critical thinking skills was carried out by a Paired T-Test with the hypothesis results being accepted and a trial run on a large group to obtain quite effective interpretations.

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#### Author Contributions

Nurtanti Yutia conceptualized the research idea, designed of methodology, management and coordination responsibility, analyzed data, conducted a research and investigation process; Yusnaidar and M. Haris Effendi Hasibuan conducted literature review and provided critical feedback on the manuscript.

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#### Conflicts of Interest

The authors declare no conflict of interest.

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