



## Design of Physics Teaching Material Based Guided Inquiry on Momentum and Impulse Materials to Support Critical Thinking Skills

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### ABSTRACT

The teaching material is an essential element of implementing education in schools. The teaching materials can be created in a variety of ways based on the requirements and qualities of the lesson to be given. Teaching material have quality and certain standards if on of them implementing critical thinking skill. Critical thinking is a student skill to challenge in the 21<sup>st</sup> century. This preliminary research aims to analyze requirements that underlie design of Physics teaching material that can support the proficiency of critical thinking. The type of research is using the Plomp model. This research is carried out until the stage of preliminary research consisting requirement analysis and literatur analysis. This study used questionnaires for students, teacher interview sheets and several of articles to analyze. Based on the result of this research, that the theaching material bases guided inquiry on momentum impuls materials can guide an investigating the active role of learners during the learning proceess independently. So it can be concluded that physics teaching material based guided inquiry can to support critical thinking skill of Student.

**Keywords:** Teaching Materials; Guided Inquiry; Critical Thinking; Momentum and Impulse.



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## I. INTRODUCTION

Education is one of the factors to achieve progress and development of a nation in a better direction. In order to succeed, great human skills must be prepared, and education is a key component of this process. In the 21<sup>st</sup> century education is developing rapidly, it is seen from the development of Science and Technology (IPTEK) in various fields of life. One of the skills is preparing students to face rapid and continuous changes in the 21<sup>st</sup> century. The ability to think critically is among skills [1].

Critical thinking skills is interpreted as the skill of students to think systematically to be able to formulate problems, so as to be able to provide new ideas from the results of their thinking [2]. Critical thinking is crucial in the face of the challenges of the 21<sup>st</sup> century and to achieve success. Critical thinking is important to verify and accuracy of information. Critical thinking skills are centered on deciding what to believe and what to do sensibly [3].

In addition, critical thinking skills are crucial in learning, which requires students to be able to apply learning materials in the phenomena of daily life. Critical thinking can help learners in understanding concepts because learners are actively involved in learning to find out concepts independently [4]. Critical thinking skills will emerge if students encountered a problem. In critical thinking students are required touse the right strategy to solve the problem and sharpen the ideas that appear to be tested in solving problem. Meanwhile, according to Fithriyah et al., (2016) ability learners in analyzing and evaluating information for decide whether the information can be trusted so that it can be used to draw valid conclusions [5]. Based on the understanding of critical thinking skills, can concluded that critical thinking skills are the ability to solve a problem by analyzing ideas in detail so you can come to the right conclusion. Critical thinking is a directed and clear process used in activities such as formulating a problem, solving a problem, taking decisions, analyze scientifically, conduct scientific research, deliver and analyze several arguments, until finally able to take a right decision and carry out an action to the problems that are being faced.

Critical thinking skills indicators according to Facione (2015), includes interpretation, analysis, evaluation, inference, explanation, and self regulation. Interpretation is a skill in understanding and reveal the meaning of the problem. Analysis is a deep skill identify and infer relationships between statements, questions, concepts, descriptions, or other forms [6]. Evaluation is skills in accessing the credibility of a statement/representation and

logically access the relationship between statements, descriptions, questions and concepts. Inference is a deep skill identify and acquire the elements needed to conclude. Explanation is a skill in setting and provide logical reasons based on the results obtained. Meanwhile, the last self-regulation indicator is monitoring skills a person's cognitive activity, the elements used in the activity problem solving, particularly in applying deep skills analyze and evaluate.

The demands of 21<sup>st</sup> century skills can be met by the implementation of education that preparing of students to dominate critical thinking skills in order to become successful individuals. The governments initiative is to develop a curriculum, the purpose is efforts to realize the critical thinking skills of students. Curriculum improvements continue to be carried out by the government from the beginning with the aim that education in Indonesia continues to improve. Today, the curriculum is used the 2013 curriculum revised in 2017. Learning in the 2013 curriculum revised 2017 applies learning approach of *student center*, means that learning is student-centered which requires students to be active in learning. The 2013 curriculum revised in 2017 aims, among others, for students to have 4C skills (*Critical Thinking, Creative Thinking, Collaborative, and Communicative*) and HOTS (*Higher Order Thinking Skills*).

The 4C and HOTS skills are interrelated. The ability to solve problems, think critically, think creatively, and make decisions are all indicators of obtaining HOTS. One of the indicators of HOTS achievement and the 4C skills, namely requires students to have critical thinking skills. The implementation of the 2013 revised 2017 curriculum in this learning is expected to hone critical thinking skills to be able to face the 21<sup>st</sup> century and achieve success.

The curriculum of 2013 is implemented in every learning in schools. One of the lessons taught in the Senior High School is Physics. Physics learning can be practice critical thinking skills of student [7]. Physics learning can provide learners with hands-on experience. This experience is obtained if the teacher uses a student-centered learning model, so that it will be seen that the activity of the learners in the learning process. The teachers can use the learning model that suggested in the 2013 curriculum emphasizing learner-centered [8]. In addition, by using learning models, physics learning activities cannot be separated from the teaching materials used. In developing teaching materials, the learning model becomes one units that must be adjusted during the learning process [9]. One learning model that guides participants active learners in the learning process is the guided inquiry model. The application of the guided inquiry model can develop skills students' critical thinking [10]. Because with the inquiry model Guided students are invited to actively process discovering own knowledge from the learning experience that is carried out.

The teaching materials are all systematically organized materials that obtain knowledge that can benefit to teachers and students in increasing learning achievement throughout the teaching process [11]. An essential element of implementing education in schools is the use of teaching materials. Teachers will discover that using teaching materials makes teaching simpler, and students will discover studying simpler. The teaching materials can be created in a variety of ways based on the requirements and qualities of the lesson to be given [12]. Teaching materials are packaged in such a way can increase students' interest and motivation in learning and can be a guide for teachers. The teaching materials needed to achieve 21<sup>st</sup> century skills are teaching materials that can support the teaching process. The existence of teaching materials makes students more active in building their knowledge and easily understand the material provided. The purpose of preparing this teaching material is so that learning becomes interesting and students can be more enthusiastic in following learning [13]. The textbook is one of the teaching materials often used in the learning process. Textbooks have quality and certain standards so that it can be said to be a good textbook. One of them is implementing critical thinking skills. Skills Critical thinking is a skill that equips students to be capable face challenges in the 21st century. Therefore, an open book that used in the learning process must be able to become learners to support critical thinking skills in order to face 21<sup>st</sup> century challenges.

The author is carried out a preliminary research to learn how teacher and students view about using teaching materials. The primary step of development research methods is this preliminary research. The results of preliminary study are used to design physics teaching materials based guided inquiry support students' critical thinking abilities.

## II. METHOD

From this research, the author method used the Plomp model. Plomp's model has three phase of research namely preliminary research, prototyping phase and assessment phase [14]. This research untill preliminary research.

Data analyze technique used descriptive method. Descriptive method is carried out to describe and explain a case that occurs factually. The authors of this research attempted to explain the events that represented as its main focus without giving them particular attention. A descriptive study is carried out to specify the value of one

or more independent variables without drawing comparisons or linkages to other variables. Two teachers and 31 students from one of West Sumatra's senior high schools participated as the study's responders. This research includes requirement analysis and literature analysis. This study used questionnaires, for students, teacher interview sheets and several of articles to analyze. The requirement analysis aims to identify the opinions or reactions of students and teachers on use of teaching materials in classrooms. The teacher interview sheet includes aspects of the models used in the learning process and teaching materials used by the teacher. The purpose of students filling out a questionnaire is to discover students' perceptions toward critical thinking skill of student. Meanwhile the literature analysis includes an analysis of low critical thinking skills in physics teaching materials and analysis of learning models that can support critical thinking skills. The questionnaire used the Likert scale to measure students' perceived interests, motivations and critical thinking skills. The data of teacher response and literature analysis were investigated using descriptive statistical of analysis method. The results are an combination of the responses and expectations of teachers and students about teaching materials that can support critical thinking skills of student.

### III. RESULTS AND DISCUSSION

The results of the preliminary research include requirement analysis and literature analysis. The results of the requirement analysis consist of the results of the questionnaire of the results of the student questionnaire and the results of teacher interviews. The results of the literature analysis were obtained from articles related to this study.

#### 1. Requirement Analysis

##### a. Analysis of Student Requirement

According to result of filling out the questionnaire by 31 students, the percentage of student interest in learning physics, student motivation in physics learning and critical thinking skill of student were obtained. According to the distribution of questionnaires, students' interest and motivation in student learning can be seen in figure 1 below.

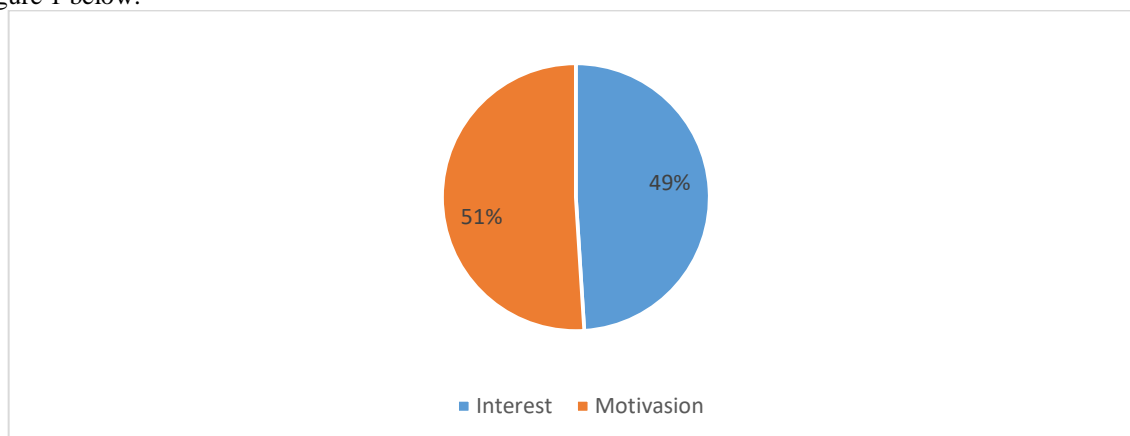


Figure 1. Students Interest and Motivation in learning Physics

From the results of the questionnaire, extacted of student in learning physics is 51%. Meanwhile the result of student motivation in learning physics is 49%. Students have a high interest in learning physics but have less motivation to learn.

The second of requirement analysis is the critical thinking skills of students. According to of the distribution of questionnaires, critical thinking profiency were obtained as follows in Table 1.

**Table 1.** Analysis of Critical Thinking Skills Indicators Based on Student Perceptions

Critical Thinking Indikator	Percentage
Interpretation	16%
Analysis	16%
Evaluation	18%
Inference	18%
Explanation	15%
Self-Regulation	17%

Based on Table 1, the results of filling out a student questionnaire containing perception about part indicators of critical thinking skills are obtained. Criteria of characteristics of critical thinking abilities namely students can express the meaning of the problem (interpretation), students are able to solve problems by connecting physics concepts (analysis), students can choose the use of equations to solve problems (evaluation), students can draw conclusions from the problems given (inference), students are able to re-explain the material explained by the teacher (explanation), and students are able to assess themselves in solving problems (self-regulation). Based on perceptions of students have critical thinking skills that are less than 20%.

#### b. Analysis of Teacher Requirement

In the interviewing, the requirement analysis is carry out to discover the learning model used by the teacher in the learning process in the classroom and teaching materials that support requirement of students in learning. According the results of interviews with two teachers, it is known that learning activities have been used the student center learning model, one of them is the guided inquiry model. The teacher stated that she has been used the guided inquiry model, but she did not fully understand the syntax of the learning model. In the guided inquiry learning model, learning materials are not given directly to students, but students who seek and find for themselves the answer to a problem in question, so that in the learning process students are more active and able to think critically and analytically. The syntactic of learning models that are not fully understood by teachers has caused the lack of optimal learning models in increasing the activeness of students in learning. This results in students not being able to apply the physics material that has been learned to solve a problem, resulting in a low level of students' critical thinking skills. The low level of students' critical thinking skills has an impact on low student learning outcomes. Student learning outcomes obtained in the field, namely 62.7% of students still obtained learning outcomes under the minimum completion criteria (KKM). Students' low critical thinking abilities are one factor to low learning results [15].

Teachers must apply lessons to encourage students to actively participate in the educational process [16]. Based on the Ministry of National Education, good teaching materials are teaching materials that are made by adjusting to the characteristics of students. Teaching materials made by the teacher himself if adjusted to the characteristics of students, so it will be able to increase the motivation of students to be active in learning. Based on the results of the interview, the teacher has made teaching materials in the form of handouts, modules and Student Worksheets (LKS). Based on the researcher's analysis, the material is arranged in the teaching materials has met the achievement of Core Competencies (KI), Basic Competencies (KD) and learning objectives. The use of the guided inquiry model in the presentation of the material has used the guided inquiry model, but the inquiry syntax has not been clearly seen. Teachers stated that existing teaching materials are not fully optimal to increase student learning motivation actively. Teaching materials when integrated with the syntactic of the guided inquiry model can increase student motivation and extracted in learning so that they can to know the material and think critically about the information the teacher has given to them, as well as in enjoyable learning process [17]. As a result of students' perceptions of learning as uninteresting, their enthusiasm to learn does not significantly increase. Students' capacity for critical thought did not greatly improve either.

## 2. Analysis Literature

The results of the literature analysis that have been conducted include information about the low critical thinking skills in momentum, impulse materials and information on the analysis of the use of guided inquiry-based teaching materials in supporting students' critical thinking skills.

#### a. Analysis of low critical thinking skills physics learning materials

**Table 2.** Groups of Articles Based on Learning Materials

<b>Material</b>	<b>Article Code</b>	<b>Percentage</b>
Newton's law	A <sup>[18]</sup>	56,00%
Work and Energy	A <sup>[19]</sup>	60,00%
Momentum and impulse	A <sup>[20]</sup>	35,41%
Heat and Temperature	A <sup>[21]</sup>	48,35%

Based on Table 2, it can be deduced that critical thinking skills are low on momentum and impulse material. Nuryanti (2018) explained that teachers must show innovative thinking when creating and modifying learning materials to help students acquire critical mindset [22].

b. Analysis of the use of learning models to support critical thinking skills

**Table 3.** Groups of Articles Based on Learning Models

<b>Learning Material</b>	<b>Article Code</b>	<b>Percentage</b>
Learning material based discovery learning	A <sup>[23]</sup>	76,00%
Learning Material based guide inquiry	A <sup>[24]</sup>	81,17%
Learning material based scientific approach	A <sup>[25]</sup>	63,35%

From the table 3 above, it can be deduced that the learning model can support critical thinking skills is a guided inquiry model. Guided inquiry can support critical thinking since inquiry is a process to find of concept it self. It will help the student critical thinking.

According to the result of requirement analysis and literature analysis, it can be said that the learning process is conducted and teaching materials have not optimally supported critical thinking skills of student. This is indicated by the low critical thinking skills obtained from the analysis of requirement and analysis of literature. For this reason, it is necessary to make physics teaching materials based on guided inquiry on momentum and impulse materials to support students' critical thinking skills.

This guided inquiry-based physics teaching material has several advantages, one of them is that teaching materials can help teachers in the learning process. Teaching materials is arranged by integrating a syntactic guided inquiry model that can guide the active role of learners during the learning process in investigating concepts independently. The teaching materials are arranged with discovery-based learning. The syntactics of the guided inquiry model uses according to Sanjaya (2017), is direction, formulation of questions, hypotheses formulation, gathering of data, testing of hypotheses, and drawing conclusions [26]. The syntactic of the guided inquiry model will guide the active role of learners in learning and can support physical thinking skills. The teaching materials also contain questions with indicators of critical thinking skills, the part of indicators critical thinking is analysis, evaluation and inference. The existence of critical thinking skills indicators in teaching materials is expected to support critical thinking skills of students.

#### IV. CONCLUSION

The teaching materials and learning models used by teachers are not optimal to interest motivation of student to be active in the learning process. This results in low students' critical thinking skills which are indicated by low learning outcomes and low students' critical thinking skills based on student perception. In addition, literature analysis is also considered before the teacher makes teaching materials. It is hoped that implementing a model of guided inquiry-based learning will help students' critical thinking.

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