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Development of Physics Teaching Materials Containing Local Wisdom to Train Students Critical Thinking Skills

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Abstract

This study aimed to describe the feasibility of physics teaching materials containing local wisdom to train students' critical thinking skills. This study aims to describe the validity, practicality, and effectiveness of teaching materials and the achievement of critical thinking skills. This type of research is called research and development. The development model used for this is the ADDIE which consists of 5 stages: analysis, design, development, implementation, and evaluation. Data collection techniques include validation tests, student response questionnaires, and critical thinking skills assessments. The results obtained: 1) validity of teaching materials get 4,29 in the very good category, lesson plans with an average of 4,14 in the good category, student worksheets with an average of 4,27 in the very good category, and study result test with an average of 4, 26 categorized as very good; 2) the practicality of teaching materials with an average of 3,93 in the good category; 3) the effectiveness of teaching materials meets the criteria for completeness in the good category; 4) critical thinking skills through a high category learning outcome test. Therefore, electronic teaching materials containing local wisdom to train critical thinking skills are suitable for use in learning.

Keywords: Critical Thinking Skill; Local Wisdom; Physics; Teaching Materials

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INTRODUCTION

Science and Technology have developed rapidly, so the information received is also diverse. This requires all parties to adapt to the existing conditions. In line with this, according to Patmawati in (Rahmawati, 2014), the field of education has also changed from time to time. Therefore, critical thinking skills are needed in learning to deal with this. Critical thinking skill is one of the life skills needed in the educational process in the 21st century. Critical thinking

skills are clear and directed thinking processes used to solve problems, make decisions, analyze opinions, and act scientifically. So, critical thinking requires a person not to believe in conjectural or approximate knowledge immediately. In critical thinking, one must be able to select or prove any knowledge or information that is an assumption. As a result, critical thinking skills are expected to be a requirement for students to face the future and demands



of the 21st century and the Revolution era 4.0 (Perdanasari et al., 2019).

However, depending on the outcomes of observations by researchers at a Senior High School in Banjarmasin by giving a critical thinking test with indicators from (Ennis, 1981), those are elementary clarification, basic support, inference, advanced clarification, as well as strategy and tactics. It was discovered that students' critical thinking was still not optimal, so they needed to be trained and accustomed. But, based on an interview with a physics teacher at a Senior High School in Banjarmasin, it is known that there are limited learning resources for students where there are no teaching materials that can train students' critical thinking skills.

Students' critical thinking skills can be trained through teaching material containing local wisdom. Through local wisdom, students will be given real examples of physical phenomena they can find in their surroundings (Hartini et al., 2018; Hartini et al., 2017; Misbah et al., 2020). Research results by Perdanasari et al. (2019) support that teaching materials with local wisdom can enhance students' critical thinking skills. Then, research by Wahyuningtyas & Simanjuntak (2020) also concluded that local wisdom modules are appropriate for learning to enhance critical thinking skills. Although these various studies address local wisdom, no research focuses explicitly on traditional games.

The physics subject chosen for this study is impulse and momentum because there are many formulas and physics concepts in this subject that require teaching materials to help students build their understanding. In addition, basic competencies in this subject also require students to be able to apply the concepts and principles they have in everyday life. In contrast, in this case, students need high-level or critical thinking skills.

Based on problem analysis and previous relevant research studies, it is

necessary to have teaching material with local wisdom. In contrast to other relevant research, this research will focus on traditional South Borneo games: balogo, bagasing, babanga and basimban, so teaching materials are expected to train students' critical thinking skills. It all has to do with impulse and momentum.

Based on the above background, the problem formulation is, "how is the feasibility of physics teaching materials containing local wisdom to train students' critical thinking skills?". This study aimed to describe the feasibility of physics teaching materials containing local wisdom to train students' critical thinking skills.

METHOD

This research uses the type of research and development (R&D). The development model used for this is the ADDIE which consists of 5 stages: analysis, design, development, implementation, and evaluation. At the analysis stage, the researcher analyzed the need to develop teaching materials on impulse and linear momentum. So to find out and determine it, the researcher carried out several analytical activities, namely in the form of an analysis of the needs of teaching materials, curriculum analysis, analysis of material characteristics of impulse and linear momentum, and analysis of students. At the design stage, design begins with developing teaching materials, learning activities, and research instruments. At the development stage, researchers develop electronic teaching materials that will be used in learning activities. The next stage is the implementation of teaching materials that have been developed and declared valid. Teaching materials are then applied in real classes to determine the practicality and effectiveness of these teaching materials. At the evaluation stage, the quality of the electronic teaching materials being

developed is assessed. The researcher will calculate the feasibility of the electronic teaching materials based on practicality and effectiveness.

The test subjects of this study were students of class X MIPA 1 at a Senior High School in Banjarmasin. The subject of this research is teaching materials containing local wisdom to train students' critical thinking skills. And the object is the feasibility of physics teaching materials containing local wisdom to train students' critical thinking skills. The research was conducted in the even semester of the 2021/2022 academic year.

The validity of teaching materials is measured using a validation sheet, practicality using a student response questionnaire, effectiveness using a study result test, and critical thinking skills are measured using a study result test that contains critical thinking indicators. The data from the validation results are calculated with the average score and adjusted according to Table 1.

Table 1 Criteria for the validation

Average	Criteria
$\bar{x} > 4,2$	Very good
$3,4 < \bar{x} \leq 4,2$	Good
$2,6 < \bar{x} \leq 3,4$	Good enough
$1,8 < \bar{x} \leq 2,6$	Not good
$\bar{x} \leq 1,8$	Not very good

(Widoyoko, 2017)

Table 2 Criteria of the reliability

No	Reliability coefficient	Criteria
1	$0,80 < r \leq 1$	Very high
2	$0,60 < r \leq 0,80$	High
3	$0,40 < r \leq 0,60$	Medium
4	$0,20 < r \leq 0,40$	Low
5	$r \leq 0,20$	Very low

(Arikunto, 2016)

For reliability, use the Alpha-Crombach equation. The results are adjusted to the reliability criteria in Table 2. The practicality is seen in the results of the student response questionnaires. Then adjusted to the practicality criteria in table 3.

Table 3 Criteria of the practicality

Average	Criteria
$\bar{x} > 4,2$	Very good
$3,4 < \bar{x} \leq 4,2$	Good
$2,6 < \bar{x} \leq 3,4$	Good enough
$1,8 < \bar{x} \leq 2,6$	Not good
$\bar{x} \leq 1,8$	Not very good

(Widoyoko, 2017)

Effectiveness is seen by the achievement of students in learning. The category is shown in Table 4.

Table 4 Completeness Criteria

Interval	Criteria
$x > 80\%$	Very good
$60\% < x \leq 80\%$	Good
$40\% < x \leq 60\%$	Good enough
$20\% < x \leq 40\%$	Not good
$x \leq 20\%$	Not very good

Adaptation (Widoyoko, 2017)

As a comparison, the student's learning outcomes are also calculated gain scores. The results are adjusted by the following Table 5.

Table 5 Category N-gain

Gain Score	Category
$\langle g \rangle \geq 0,7$	High
$0,3 \leq \langle g \rangle < 0,7$	Medium
$\langle g \rangle < 0,3$	Low

(Hake, 1999)

The critical thinking skills of the student are obtained through the results of the study result test assessment which contains critical thinking indicators. The values obtained from the calculations are then categorized according to the following Table 6.

Table 6 Category of critical thinking skill

Critical thinking skill	Category
$81,25 < X \leq 100$	Very high
$71,5 < X \leq 81,25$	High
$62,5 < X \leq 71,5$	Medium
$43,75 < X \leq 62,5$	Low
$0 < X \leq 43,75$	Very low

(Karim & Normaya, 2015)

RESULT AND DISCUSSION

The final product is electronic teaching materials containing local wisdom on

impulse and linear momentum to train critical thinking skills. Teaching materials are designed using the software Flip PDF which can be accessed online through various smartphone devices Android and iOS based, laptops, and computers. This teaching material is composed of several parts, that is (1) cover; (2) foreword; (3) table of contents; (4) serving instructions; (5) basic competencies and critical thinking indicators; (6) concept map; (7) material description; (8) sample questions; (9) practice questions; (10) summary of the material and (11) bibliography. The validation test of teaching materials was obtained as shown in Table 7.

Table 7 Validity of teaching material

Assessment Indicator	Average	Category
Content	4.33	Very good
Display	4.25	Very good
Validity	4.29	Very good
Reliability	0.82	Very high

Table 7 shows the teaching materials obtained in a very good category with a degree of reliability in a very high category. The assessment of the content aspect obtained a very good category. The application's output is HTML which can be successfully run using a browser without extra applications. This teaching material does not affect any device's RAM or memory capacity when used, so it is safe to be accessed on all types of devices. This teaching material focuses on cognitive aspects that train students' critical thinking skills and is packaged attractively by using additional features such as pop-ups that can provide other information or enlarge the display of images/videos. These hyperlinks can be

connected to YouTube, and go to a page that can save time. The produced electronic teaching materials can be accessed without encountering any problems. The language used is also simple, systematic, and easy to understand by students. This is supported by (Prastowo, 2017) who states that teaching materials must be organized logically and in easily understandable language following the students' knowledge levels.

In the aspect of displaying teaching materials, the color, and layout are constant throughout each sub-chapter. This electronic teaching material used the font of Sans Serif fonts Comic Sans MS and Berlin Sans FB Demi. Sans Serif fonts were chosen because they are simpler to read than Serif fonts. (Fitrialny & Ardoni, 2013) supported that characteristics of Sans Serif letters are that have no hooks, only stems, are simple and very easy to read, suited for the e-book, websites, databases, and basic monitor displays. Sans Serif fonts appear more basic and easy to read in various sizes.

Electronic teaching materials on impulse and momentum are up-to-date compared to previous studies. The local wisdom used is the traditional game of South Borneo, which is related to impulse and linear momentum such as balogo, bagasing, babanga and basimban. At balogo and bagasing games connect with the concepts of impulse and momentum (Figure 1). Then there is a connection in the babanga game with the law of momentum conservation (Figure 2). At the basimban game there is a connection with the partially elastic collision material (Figure 3).



Figure 1 Concepts of impulse and momentum on Balogo and bagasing games

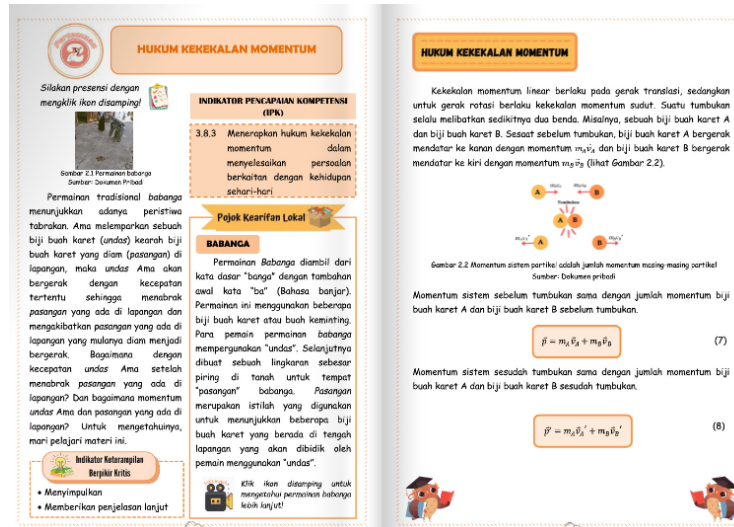


Figure 2 Law of momentum conservation on babanga game

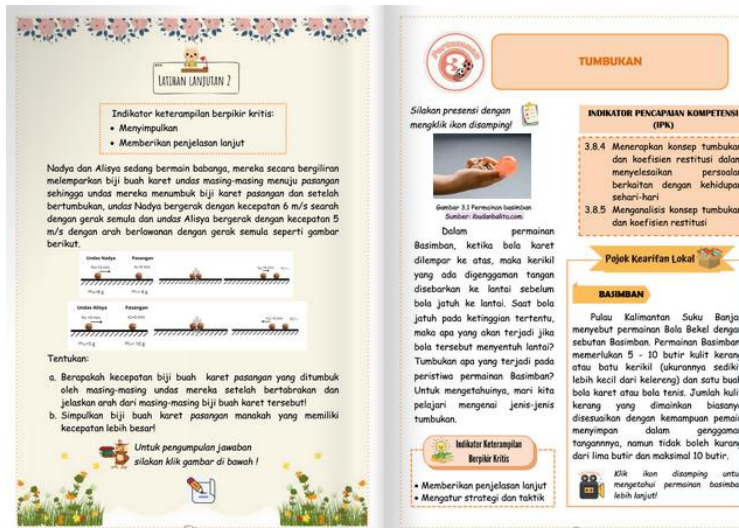


Figure 3 Partially elastic collision material on basimban game

The selection of teaching materials containing local wisdom makes it easier for students to understand the material because it can provide an overview of real phenomena around students. In line with research by Fuad et al. (2018) which states that the local wisdom of the local area can provide a very contextual picture of phenomena to facilitate the approach to learning materials. This is also supported by research by Makhmudah et al. (2019) which states that the physics module based on local wisdom of traditional games can improve student learning outcomes in learning physics on momentum and impulse materials.

Another innovative feature of this teaching material is can train students' critical thinking skills. The critical thinking indicators are trained as indicators by Ennis (1981) including elementary clarification, inference, advanced clarification, and strategy and tactics. At each meeting, some questions contain critical thinking indicators, so that they can train and familiarize students with critical thinking. This is important because as stated by Sarjono (2017), to fix the quality of human resources through education, a teacher must make critical thinking habits for students in every lesson. By having good critical thinking skills, students can be equipped in facing various challenges faced by students in learning and life. Istianah in Husnah (2017) stated that critical thinking and creative thinking are necessary for every student to solve problems in life.

Teaching materials containing local wisdom support students' critical thinking skills. Sarjono (2017) states that there are several ways of habituating critical thinking in physics lessons, including linking the subject matter in physics lessons with natural phenomena or real events around us. Wahyuningtyas & Simanjuntak (2020) supported that teaching materials with local wisdom can enhance students' critical thinking skills.

Then the validation results are shown in Tables 8,9, and 10.

Table 8 Results of lesson plan validation

Aspect Overview	Average	Category
Format	4.15	Good
Language	4.25	Very good
Contents	4.14	Good
Validity	4.18	Good
Reliability	0.76	High

Table 9 Results of student worksheets validation

Aspect Overview	Average	Category
Format	4.28	Very good
Language	4.25	Very good
Content	4.29	Very good
Validity	4.27	Very good
Reliability	0.82	Very high

Table 10 Results of the study result test validation

Aspect Overview	Average	Category
Construction	4.03	Good
Language	4.50	Very good
Validity	4.26	Very good
Reliability	0.79	High

Table 8 shows the validity of the lesson plan based on format, language, and content aspects, obtaining a good category with a degree of reliability in the high category. In the format aspect, the important components that must be included in the learning implementation plan include 1) School data, topic, classes/ semesters; (2) allocate time; (3) subject matter; (4) learning goals, basic competencies and indicators of competency achievement; (5) topic of learning; learning methods, learning tools media and resources; (6) the steps of learning activities; and (7) evaluation (Bangun, 2017). Format aspects have been adapted to the 2013 curriculum that is applied.

The content of the lesson plans has met the basic competencies of impulse and linear momentum materials. The objectives and learning activities have outlined the relationship between basic

competencies and indicators, then with the objectives to learning activities that must be carried out following the 2013 Curriculum references (Yunus & Alam, 2018).

The supporting devices mentioned in the lesson plan are media, tools, materials, and learning resources that researchers will use during learning activities. According to Rusman (2017) the application of information and communication technology can be used according to the situation and conditions in learning.

Table 9 shows the results of the student worksheet obtained a category is very good with a degree of reliability in the very high category. On the format aspect, it is categorized as very good. In the language aspect, it contains criteria for correct language rules, using simple language, sentences that are simple to understand and appropriate for students' abilities and there are no sentences that cause multiple interpretations. One of the requirements for the student's preparedness worksheet construction guidelines states that student's worksheet must adapt their language use to their respective cognitive abilities, use a clear sentence structure, and be able to illustrate activities through a collection of words (Yunus & Alam, 2018). In the content aspect, student worksheets can train students thinking skills. A student worksheet is also flexible because can be used anytime and anywhere, and a student worksheet can be accessed directly.

Table 10 shows the results of the study result test validation obtained in a very good category with a high degree of reliability. The results on the general construction aspect for the 6 essay questions were rated as being in a good category. The development of the study result test follows the statement Daryanto & Dwicahyono (2014) that the preparation of the study result test must use good language so that it does not

cause double meaning and also pays attention to the allocation of time following the learning activities provided.

The practicality of teaching materials was measured using a student response questionnaire. The results of the practicality can be seen in the Table 11.

Table 11 Practicality of teaching materials

Aspect	Rating	Average	Category
Benefit		4.02	Good
Efficiency		3.78	Good
Convenience		3.99	Good
Average		3.93	Good
Reliability		0.89	Very high

Table 11 shows the practicality of teaching materials obtained in a good category with a very high degree of reliability. A score is obtained in a good category in the aspect of benefits. This shows that the produced teaching materials provide benefits because they help students understand physics problems and can make studying engaging and enjoyable. A student may be more interested and motivated to learn if the learning environment is enjoyable (Hartanti, 2019). This is supported by (Riwu et al., 2018), that teaching materials can increase students learning motivation. Students are also motivated to learn physics through illustrations that are linked to local wisdom. With local wisdom, the physics learning process can be meaningful learning for students because it can be felt and easily sensed directly by students (Wati et al., 2017; Wati et al., 2019). In line with research by Makhmudah et al. (2019) that the physics module based on local wisdom of traditional games can improve student learning in learning physics. Besides that, these teaching materials can also be used independently. Prastowo (2017) states that good teaching materials is simpler for use by students and make them independently.

In the aspect of learning time efficiency, the good category was obtained. This shows that teaching materials can save time so the learning process in the classroom can be completed on time and learning continues to run effectively. This time efficiency is because students can move to the required sub-chapter or page by using hyperlinks. Students can access additional content on teaching materials simultaneously with hyperlinks. In addition, teaching materials do not use excessive electricity or internet bandwidth. The existence of features such as hyperlinks can make it simpler for students to access teaching materials without spending a lot of internet data packages (Jazuli et al., 2017).

In terms of ease of use, a good category was obtained, meaning that the electronic teaching materials developed were able to facilitate students in displaying and packaging teaching materials. The display on electronic teaching materials pays great attention to the type and size of the letters used so that students do not experience difficulties in reading and understanding the learning material. According to Rusman (2017),

the characteristics of good electronic teaching materials must be mindful of the suitability of the level of media readability, color, font selection, font size, and writing layout.

The effectiveness of teaching materials was measured using study result test-based pretest and posttest, which was reviewed with the minimum completeness criteria and also supported with the N-gain test. The results of the effectiveness of teaching materials based on minimum completeness criteria and based on the N-gain test can be seen in Tables 12 and 13.

Table 12 Effectiveness based on minimum completeness criteria

Description	Pretest	Posttest
The highest score	7	85
Lowest value	0	60
Average value	2.02	71.74
Standard deviation	2.26	7.04
Complete amount	0	16
Percentage of completeness	0%	76%
Category	Very low	Good

Table 13 Effectiveness based on n-gain test

Pretest average	Posttest average	<g>	Category
2.02	71.74	0.71	High

According to Table 12, the students' pretest and posttest results showed that at the time of the pretest, all students still had not reached the minimum completeness criteria with an average value of 2.02 where the minimum completeness criteria score of the research subject's school was 70. At the time of the posttest, there was an enhancement in learning outcomes. Students where overall students get an average score of 71.74 which has reached the minimum completeness criteria value. This shows that the teaching materials can make learning effective and

improve student learning outcomes. The pretest and posttest assessments can define the effectiveness of the developed electronic teaching materials (Sani et al., 2020).

Students' learning outcomes through the pretest and posttest were also compared with the normality test and N-gain. The normality test aims to test the values obtained. The results of the normality test using the Kolmogorov-Smirnov test obtained the data are normally distributed with a significance value of more than 0.05, namely for the pretest and posttest were 0.176 and

0.343. This means that the data obtained during the pretest and posttest can be trusted and has been tested for accuracy. Furthermore, the effectiveness calculation is carried out using the n-gain equation and obtained as in table 13; the n-gain value is 0.71, which is in the high category. The criteria that are met, so that teaching materials are declared effective are the average N-gain categorized as at least moderate and there is an increase in learning outcomes (Sonda et al., 2016). Thus, the developed teaching materials are effective against N-gain.

It can be concluded that the measurement of effectiveness in terms of minimum completeness criteria as a whole obtains good completeness criteria, meaning that this electronic teaching material can enhance student learning outcomes. The teaching materials developed have some advantages, including containing local wisdom so that it can make it simpler for students to understand the topic because students can interpret learning with real phenomena. In addition, this electronic teaching material also contains questions and discussions that can train students' critical thinking skills, so that students become accustomed to answering questions and during the posttest learning that has been carried out for 3 meetings can lead students to the achievement of a gain score of 0.71 which is in the high category.

However, there is a weakness in this study, namely that not all students of class X MIPA 1 participate in learning activities in each meeting completely because some students do not fully participate in learning activities from meeting 1 to the last meeting. Thus, the subject of the research trial, which should have been 38 people, was reduced to only 21 people.

Critical thinking skills in study result tests that contain questions with critical thinking indicators. The results of

students' critical thinking skills achievement showed in Table 14.

Table 14 Achievement of critical thinking skills

Critical thinking skills	Pretest	Posttest
	Average	Average
Elementary clarification	12.38	49.52
Inference	4.13	64
Advanced clarification	0	77.46
Strategy and tactics	1.57	72.81
Critical thinking skills	4.52	65.98
Category	Very low	Medium

Table 14 shows the results of critical thinking skills. At the time of the pretest, it was known that students' ability on each indicator was still very low. The unavailability of teaching materials that practice critical thinking skills is why students' critical thinking skills are low. After applying electronic teaching materials to students, at the posttest, there was an increase in the average score of students on all critical thinking indicators used in this study. On indicator, elementary clarification gets the lowest score increase compared to other critical thinking indicators. This happens because of several factors, one of which is the lack of understanding of students in high-level thinking on applying physics concepts. On the other hand, students are less interested in writing long answers. (Lahope et al., 2020) mentions that students tend to find it easier to solve problems related to mathematical equations but have difficulty solving mathematical equations related to physics, especially physics questions that understand the physical meaning and basic concepts.

On indicator, advanced clarification gets the highest score because this indicator is found in questions that have a cognitive level between C3-C4.

According to (Mona et al., 2020) on the topic of impulse and linear momentum, the higher the level of the question, the lower the percentage of students' cognitive abilities. Overall, students' critical thinking skills have increased after using these electronic teaching materials. This increase is inseparable from the benefits of electronic teaching materials containing local wisdom that they have studied intensively. This is supported by (Perdanasari et al., 2019) who state that teaching materials with local wisdom can be a choice that can be used in the learning process to enhance students' critical thinking skills. Thus, their critical thinking skills reached the very good category based on the overall average score on the questions obtained from the posttest.

CONCLUSION

The physics teaching materials containing local wisdom were feasible to train students' critical thinking skills. This is according to the results of the validity as seen from the validation sheet which gets a very good category, practicality as seen from the response questionnaire gets a good category, the effectiveness based on the study result test in terms of the minimal completeness criteria gets a good category and from the n-gain test scores gets a high category, then The achievement of students' critical thinking after using teaching materials is included in the high category. Thus, the results of this study can be used by teachers as a reference in learning. Further research is needed to review several aspects of students as the benefits of this development, such as student attitudes or religious attitudes.

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