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DEVELOPMENT OF INTERACTIVE MULTIMEDIA MODULES IN PROBLEM-BASED LEARNING MODELS TO ENHANCE CRITICAL THINKING ABILITIES OF HIGH SCHOOL STUDENTS

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Abstract. Objective: to produce interactive multimedia modules in the Problem Based Learning (PBL) model to increase critical thinking skills that are valid, practical and effective. This type of research is R & D with a 4D models development model consisting of define, design, develop, and disseminate phases. At the define stage, a preliminary analysis, students, assignments, concepts, and formulation of learning objectives are carried out . The design phase is done by designing interactive multimedia modules in PBL models. The develop phase, validation by experts on interactive multimedia modules, and then carried out limited trials to see the practicality and effectiveness. Practical data is obtained from teacher and student questionnaires, then the effectiveness data is obtained from the achievement of knowledge, attitudes and skills competencies. The result of define phase is obtained information about the need to develop interactive multimedia modules in PBL models to increase critical thinking skills. The results of the design phase obtained the design of interactive multimedia modules referring to the needs analysis define phase. The results of module development meet valid criteria (0.88). Practical results according to teachers (96.4) and students (92.1). Thus it can be concluded that interactive multimedia modules are in a very practical category. Furthermore the effectiveness of the module on attitudinal competence (84.2), knowledge (81) and skills (71.9). The conclusion of this study is that interactive multimedia modules in the PBL model meet valid, practical and effective criteria.

Keywords: *Interactive Multimedia Module, Vector Operations, Problem Based Learning.*

INTRODUCTION

Information and communication technology is a powerful tool for the development of quality teaching and learning; it is a catalyst for radical change in existing school practices and a veritable vehicle for preparing the students for the future.(Yusuf, 2005)

One of the challenges of education today is building 21st century skills, including critical thinking skills. This skill is what according to the United Nations (UN) is a feature of today's global era society, namely knowledge-based society (Chaeruman, 2010). Critical thinking skill is a thinking process that aims to make decisions that make sense (Marzano, 1989), so that what we think is best about truth can be done correctly (Siegel, 2010). These skills in critical thinking are not only vital for students to perform well in school, but also needed in future workplaces, social and interpersonal contexts where sound decisions are to be made carefully and independently on a daily basis (Ku, 2009). In order for students to become critical thinkers, attitudes must be developed to reason, be challenged, and seek the truth. It can be said that the critical thinking requires thinking deeply, being active, having purpose, being conscious, questioning, judging, thinking what to believe or not, and thinking what to do, and regarding these while deciding (Aktamiş & Yenice, 2010). To describe a measuring instrument or test to measure critical thinking skills developed from five subscales, namely: (1) analysis, measuring whether one can understand and express the meaning of a variety of data, experience, and consideration, (2) evaluation, measuring one's ability to see information and real power or conclusion relations, the ability to express one's thoughts, (3) inference, measure one's ability to identify and secure information needed to draw conclusions, (4) deductive reasoning, measuring one's abilities starting with things general or premise that is considered correct, comes to specific conclusions, (5) inductive reasoning, measuring one's abilities starting from the premise and applications related to knowledge and experience, reaching general conclusions (Clausen & Abramson, 1982).

Critical thinking skill can be empowered by the teachers providing questions or problems that challenge students' thinking (Wartono et al., 2018). To foster

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critical thinking skills, teachers need to use a model that shows the application of physics concepts and solving everyday problems. The model must give students the opportunity to think critically in solving problems. One model that can be used is Problem Based Learning (Amalia & Harahap, 2016)

Problem-based learning (PBL) is an instructional method in which students learn through facilitated problem solving. In PBL, student learning centers on a complex problem that does not have a single correct answer. Students work in collaborative groups to identify what they need to learn in order to solve a problem (Hmelo-Silver, 2004). In the problem based learning model, the focus of learning is on the problem (Rusman & Pd, 2012) chosen so that learning not only learns the concepts related to the problem but also the scientific method to solve the problem. Students not only have to understand concepts that are relevant to the problem at the center of attention but also gain learning experiences related to the skills of applying scientific methods in problem solving and fostering critical mindsets. In problem based learning (PBL) students use "triggers" from the problem case or scenario to define their own learning objectives. Subsequently they do independent, self directed study before returning to the group to discuss and refine their acquired knowledge (Williams, 2011) .

The application of the problem-based learning model consists of seven steps, namely: (1) clarify, understanding the problem and clarifying various words, equations, and physical concepts that have not been understood by students, (2) define, working together in groups to discuss what is issues to be discussed. (3) the analysis, analyzes the problems that have been determined by brainstorming where students freely express all ideas that arise without any filtering of the emerging ideas, (4) review, filter and compile ideas that can be used to solve problems, (5) identify learning objectives, agree on learning objectives that include concepts to be studied, activities to be carried out, and supporting information on what to look for, (6) self study, each student collects the information needed and prepares to share the results their discoveries in groups, (7) report and synthesis, students share findings to find solutions to problems and teachers facilitate and direct students in the process and at the end of this step, students compile reports of what has been done until they succeed find solutions to problems that have been given (Raine & Symons, 2005). The seven stages are things that must be done so that they can be used to foster critical thinking skills in accordance with indicators of critical thinking.

To realize this, education must be able to adapt to existing technological developments. The emergence of various technological applications that emphasize communication aspects, is expected to help in solving various learning problems in all subjects, including physics subjects. Physics examines the facts and principles that exist in natural phenomena and provides insight into how to obtain these facts and principles. Physics is related to how to find out about natural phenomena systematically, so that physics is not only mastery of a collection of knowledge in the form of facts, concepts, or principles but is a process of discovery (Nasional, 2006). Therefore physics should be studied pleasantly. How to deliver material will greatly affect the process and results of learning physics.

To realize a fun and directed physics learning atmosphere and to create students who think critically, analytically and systematically as demanded by the 2013 curriculum requires a teaching material that can create the learning atmosphere as expected. One teaching material that can be developed in learning is a module(Serevina, V., 2018). Modules are teaching materials arranged systematically with languages that are easily understood by students, according to age and level of knowledge (Prastowo, 2011), so that they can learn independently in achieving their learning goals (Sudjana & Rivai, 2007). Learning modules are complete unitsto support thelearning activities that are structured to assist students in achieving a number of objectivesor competencies (Mulhayatiah et al., 2019). The modules made must be interesting so that students will not feel bored quickly because the teacher presents the material in an attractive and varied manner, so that students will be motivated to learn. That way, the use of modules can really be applied so that they can be useful for achieving learning goals.

The reality in the field shows that the expectations described above have not been maximally fulfilled. This can be seen from the results of observations made at SMA N 1 Padang on April 15, 2016 by conducting questionnaires. The statements contained in the questionnaire refer to the indicators of attitudes, knowledge, skills and teaching materials used. Besides that, it is also seen how critical thinking skills of students.

From the results of the questionnaire analysis, the achievement of aspects of students' attitudes averaged 76%, knowledge 68%, skills 61%, and the last about teaching materials 61%. Next is the result of observations about students' critical thinking skills that are still relatively low. This can be seen from the results of the study the percentage of critical thinking skills in Padang city students as shown in Figure 1.

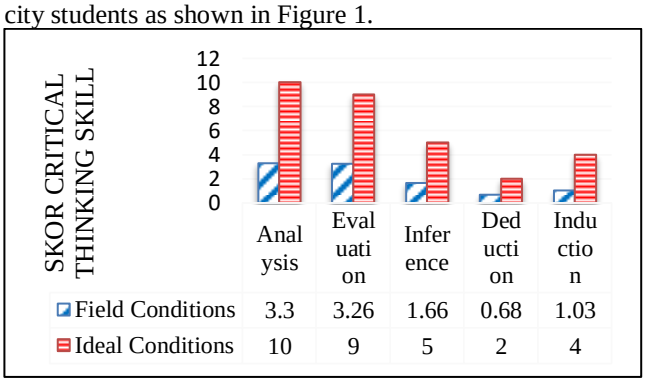

Figure 1. Percentage of Critical Thinking Skill Indicators for Students of SMAN Padang (Djamas, 2013)

Based on Figure 1, it can be seen that in the initial observation, the percentage of students' critical thinking

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skills was classified as low. For the analysis indicators obtained 3.3%, evaluation 3.26%, inference 1.66%, deduction 0.68% and induction 1.03%.

The reality in the field based on observations and preliminary investigations conducted at the school also shows that the teacher only uses teaching materials in the form of printed books issued by the publisher, not yet developing his own teaching materials. In the learning process, the teacher has also never provided interactive teaching materials to students.

Based on the questionnaire analysis and the results of the observations, it was seen that the learning process was not maximized. This results in the acquisition of student competencies not yet fully achieving the minimum completeness criteria (KKM) as shown in Table 1.

Table 1. Average Daily Value of Physics of Vector Material and Straight Motion of Grade X Students of IPA 1 Semester 1 of SMA N 1 Padang Academic Year 2015/2016.

No	Aspect	Material	
		Vector	**Straight Motion**
1	Average value	77,5	65,3
2	The number of students who reach KKM	15	10
3	The number of students who did not reach KKM	13	18
4	Number of Student	28	28
5	Percentage of completeness	53,6%	35,7%
6	Percentage of incompleteness	46,4%	64,3%

(Source: Physics teacher at SMA N 1 Padang)

Based on Table 1, it appears that not all students have fully achieved the Minimum Completion Criteria (KKM). KKM physics subjects set at SMA N 1 Padang are 80. So what is expected in achieving competence is not in accordance with the reality that occurs in the field.

The results of the initial analysis given to the teacher, it is known that in the SKL analysis aspect the value of 76.56% is obtained in the good category. While for the aspects of performance, work and learning difficulties, each of them obtained 68.33%, 67.58%, 66.67% in the sufficient category. This shows that teachers have not used varied teaching materials so that students still have difficulty learning and solving work problems given by the teacher. In the learning process, teachers and students still use textbooks provided by the school.

One way that can be done to overcome the problem that has been raised is to develop teaching materials in the form of modules that can help students in the learning process and can increase their critical thinking skills. For this reason, the steps that can be taken is to develop interactive modules in the Problem Based Learning model to increase students' critical thinking skills.

RESEARCH METHODS

This type of research is carried out in the form of research and development. The module developed refers to the Four-D models, namely through defining, designing, developing and disseminating (Thiagarajan, 1974)

The implementation of this research begins with define phase. The define stage is carried out in steps, namely preliminary analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. Furthermore, the design phase aims to create interactive multimedia modules in the Problem Based Learning model with predetermined indicators. Modules made in accordance with the 2013 curriculum then existing KI and KD as well as predetermined indicators. At this stage there are several activities that need to be carried out, which include: constructing tests with criteria, media selection, format selection, and initial design of interactive multi-module modules.

The develop phase aims to produce valid, practical and effective modules. The develop phase is done by validity test, practicality test, and effectiveness test on the module developed. The final stage is disseminate, carried out to promote development products so that they can be accepted by users, both individuals, groups, or systems. Dissemination can be done in other classes with the aim of knowing the effectiveness of using modules in the learning process.

After the product is declared valid by the expert, a limited trial is conducted. This limited trial aims to obtain practicality data and effectiveness of the modules developed. The trial subjects in this study were class X students of SMA N 1 Padang in the academic year 2016/2017. The type of data taken from the development of this module is data on validity, practicality and effectiveness. These three data are primary data. The instruments used to collect data in this study are instruments of validation, practical instruments and effectiveness instruments.

Data analysis of this study was carried out using descriptive statistics. Validity analysis using the Aiken's V formula, namely:

$$V = \frac{\sum s}{[n\ (c-1)]} \quad \text{.....(1)}$$

Where, s = r - lo, lo is the lowest validity score, c is the highest rate of validity assessment, r is the number given by an appraiser, n is the number of assessors (Azwar, 2012).

The validity category of interactive multimedia modules based on the final values obtained can be seen in Table 2.

Table 2. Product Validity Category

Level of Achievement	Category
≥ 0,6	Valid
< 0,6	Invalid

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Practical data analysis was obtained from the observation instruments for the implementation of RPP, questionnaires for teacher and student responses to the learning devices developed. Giving practicality values is done by using the following formula:

$$P = \frac{Q}{R} \times 100\% \quad \text{.....(2)}$$

Where, P is the practical value, Q is the score obtained, R is the highest score (Riduwan, 2008). The practicality assessment criteria can be seen in Table 3.

Table 3. Practicality Assessment Category

No	Score	Criteria
1	80% < x ≤ 100%	Very practical
2	60% < x ≤ 80 %	Practical
3	40% < x ≤ 60 %	Practical enough
4	20% < x ≤ 40 %	Less practical
5	0% < x ≤ 20 %	Less practical

The effectiveness of the module is then evidenced by the increase in competency aspects of knowledge (critical thinking skills), attitudes and learning skills of students at each meeting. The completeness of student competencies both individually and classically for knowledge competencies using Equations (3) and (4).

$$KI = \frac{SB}{SM} \times 100\% \quad \text{.....(3)}$$

$$KK = \frac{JT}{JS} \times 100\% \quad \text{.....(4)}$$

Where KI is individual completeness, SB is the correct score obtained, SM is the maximum score, KK is classical completeness, JT is the total number of students completed, and JS is the total number of students (Arikunto, 2012). Interval of knowledge assessment predicate (Kemendikbud, 2015) can be seen in Table 4.

Table 4. Knowledge Assessment Predicate Interval

KKM	Predicate			
	D = Less	C = Enough	B = Good	A = Very Good
80	<60	60-74	75-89	90-100

Knowledge competency data (critical thinking skills) of students analyzed were derived from the pretest and posttest values using the gain score. Pre-test for meeting I, then the value of meeting I to meeting II, Meeting II with III, and Meeting III with IV. Analysis of knowledge competence (critikal thinking skills) at each critical critique of thinking using Equation 5:

$$N = \frac{x}{Maximum\ Number\ of\ Score} \times 100 \quad \text{.....(5)}$$

Where, X is the number of scores obtained by students. Classification of critical thinking skills can be seen in Table 5.

Table 5. Critical Thinking Skill Criteria

Interval	Kriteria
0 ≤ N ≤ 39	Not Critical
40 ≤ N ≤ 55	Less critical
56 ≤ N ≤ 65	quite critical
66 ≤ N ≤ 100	Critical
80 ≤ N ≤ 100	Very Critical

Data analysis of students' increased critical thinking skills used normalized gain test can be calculated using the gain score normalized by Equation (6) as follows,

$$< g >= \frac{< s_f > - < s_i >}{(100 - < s_i >)} \quad \text{.....(6)}$$

Where, Sf is the final score, Si is the initial score (Hake, 1999). Determination of conclusions that have been reached is based on the gain score category in Table 6.

Table 6. Gain Score Category

No	Categori	Average *Gain Score*
1	Low	(<g>) < 0,3
2	Is being	0,7 > (<g>) >0,3
3	High	(<g>) > 0,7

Attitude competency analysis is used to find out the attitudes that arise in the learning process. Data analysis was carried out by knowing the percentage of completeness using Equation (7):

$$S = \frac{B}{C} \times 100\% \quad \text{.....(7)}$$

Where, S is the attitude value, B is the score obtained, C is the maximum score (Riduwan, 2008). Competence of students' attitudes is categorized as complete if it has reached a minimum value of good. If 85% of the students' scores have reached good or very good categories, the interactive multimedia modules used can be said to be effective according to the assessment criteria in Table 7.

Table 7. Attitude Assessment Category

Value Interval	Category
0 - 20	Very Poor
21 - 40	Poor
41 - 60	Average
61 - 80	Good
81 - 100	Excellent

Skills competency analysis is used to see students' skills during the learning process. To analyze the data used Equation (8):

$$K = \frac{B}{C} \times 100\% \quad \text{.....(8)}$$

Where, K is the skill value, B is the score obtained, C is the maximum score (Riduwan, 2008). Student competency categories can be seen in Table 8.

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Table 8. Skills Competency Category

KKM	Predicate			
	D = Less	C = sufficient	B = Good	A = Very Good
80	<60	60-74	75-89	90-100

The assessment of students 'skills is categorized as complete if it has reached the value of 80> with the acquisition of scores reaching A or B. If 85% of the students' grades have reached good or very good grades, the interactive multimedia module used can be said to be effective.

RESULTS AND DISCUSSION

Research Result

The development of this interactive multimedia module uses a 4-D development model (Define, Design, Develop, and Disseminate) which includes the stages of defining, designing, developing, and distributing.

Define phase is a process of analyzing the basic things needed in development research which includes initial analysis, analysis of students, task analysis, analysis of concepts and formulation of learning objectives. The preliminary analysis aims to collect data regarding the planning and implementation of interactive multimedia modules. Data collection was carried out through observation questionnaires whose results can be seen in Table 9.

Table 9. Final Analysis Results

No	Indicator	Average (%)	Categori
1	Performance Analysis	68,33	sufficient
2	SKL Analysis	76,56	Good
3	Job Analysis	67,85	sufficient
4	Learning Difficulty Analysis	66,67	sufficient

The analysis of students was carried out by using questionnaire sheets with instruments developed including the dimensions of knowledge, attitudes, skills and teaching materials. The results of the analysis of students can be seen in Table 10.

Table 10. Results of Analysis of Students

No	Dimension	Average	Categori
1	Attitude	75,7	Good
2	Knowledge	68,1	sufficient
3	Skills	60,5	sufficient
4	Teaching materials	61,4	sufficient

Task analysis includes the task of knowledge and task competencies in skills competencies. In the knowledge competencies students are assigned to work on practice questions and Worksheets, while in the skills competencies students are assigned to present the results of the discussion in solving problems on the Worksheet.

The results of material analysis are the basis for determining the main concepts in vector operating material and straight motion. The main concepts of these two materials are related to the problem based learning model steps where this learning model can be used to help implement the learning process optimally with the aim of increasing students' critical thinking skills. The formulation of learning objectives is obtained by changing the results of task analysis and concepts into goals that must be achieved by students. This set of tasks is the basis for compiling tests and designing instructional materials which are then integrated into teaching material materials developed for later use by students.

The design phase aims to create interactive multimedia modules in the Problem Based Learning model with predetermined indicators. The interactive multimedia module consists of several parts, namely: 1) cover, 2) preface, 3) table of contents, 4) module description, 5) instructions, 6) competence, 7) learning scenarios, 8) learning activities, 9) sheets work, and 10) references. The interactive multimedia module is designed for four meetings. The design of the interactive multimedia module is as follows:

Figure 2. Cover

Figure 3. Foreword

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Figure 4. table of contents

Figure 5. Module Description

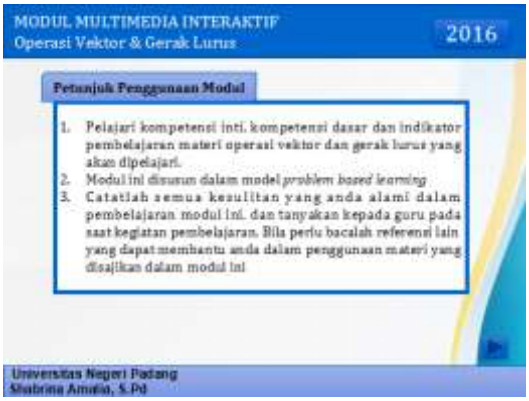

Figure 6. Instructions

Figure 7. Competence

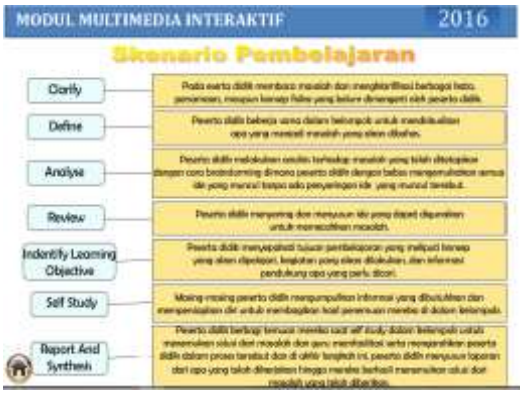

Figure 8. Learning Scenario

Figure 9. Learning Activities

Figure 10. Worksheet

Figure 11. Reference

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The develop phase is done by validity test, practicality test, and effectiveness test on the module developed. The module designed was validated by 4 validators (3 UNP lecturers and 1 practitioner / physics teacher) whose results can be seen in Table 11.

Table 11. Interactive Multimedia Module Validation Results

No	Component	Average (V)	Categori
1	Contents	0,85	Valid
2	Construct	0,85	Valid
3	Language	0,81	Valid

From Table 11 it can be seen that the results of the validator's assessment show that all the components of the module are in the valid category. Thus this interactive multimedia module can be tested in learning in class. The trial was conducted at SMAN 1 Padang. The trial was conducted in four meetings. The results of the practical questionnaire from the responses of teachers and students can be seen in Table 12 and Table 13.

Table 12. Results of Practicality Questionnaire for Teacher Response

No	Meeting	Average (%)
1	I	92,9
2	II	96,4
3	III	96,4
4	IV	100
	Average	**96,4**
	Category	**Very Practical**

Table 13. Results of Questionnaire Practicality of Students' Response.

No	Meeting	Average (%)
1	I	89,4
2	II	91,5
3	III	93,4
4	IV	94
	Average	**92,1**
	Category	**Very Practical**

From the data on the practicality of the module it can be concluded that interactive multimedia modules are practical to use and can help and facilitate teachers and students in learning. The effectiveness of interactive multimedia modules is seen from the learning outcomes of students in competency attitudes, knowledge competencies (critical thinking skills), and skill competencies. Knowledge competency data (critical thinking skills) of students are obtained from the results of written tests at each meeting which can be seen in Table 14.

Table 14. Results of the Pilot Class Knowledge Competency Assessment

No	Meeting	Average Value	the number of students complete	the number of students is not complete	completeness (%)
1	I	79,8	22	10	68,75
2	II	75,5	20	12	43,75
3	III	82,4	23	9	71,88
4	IV	86,3	29	3	90,63
Average		81			

The results of the average value of knowledge competence (critical thinking skills) for four meetings is 81 in the good category. This shows that interactive multimedia modules in the problem based learning model effectively improve student learning outcomes in knowledge competencies. More clearly the increase in value in knowledge competencies can be seen in Figure 12.

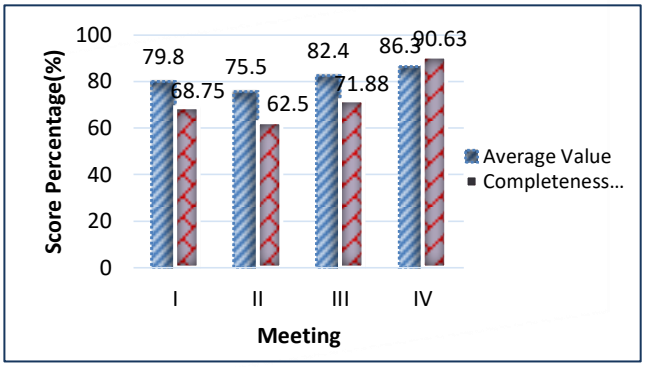

Figure 12. Graph of Test Class Knowledge Competence

The results of student attitudes assessment are obtained from the results of student behavior observations during the learning process. The results of observations on students' attitudes can be seen briefly in Table 15.

Table 15. Observation Results of Trial Class Attitudes

Indicator	The Value of Each Meeting				Average
	1	2	3	4	
Curiosity	84	84,8	85,2	87,1	85,3
Discipline	80,1	82,3	84,9	84,8	83
Responsible	79,5	83,1	84,5	85	83
Cooperation	83,2	84,8	86,7	87,5	85,6
Average	**81,7**	**83,8**	**85,3**	**86,1**	**84,2**

Table 15 shows that overall, students' attitudes are in a good category with a class average of 84.2%, meaning that the learning devices developed are effectively used in

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learning. The values obtained by students in each aspect of attitude can be illustrated in Figure 13.

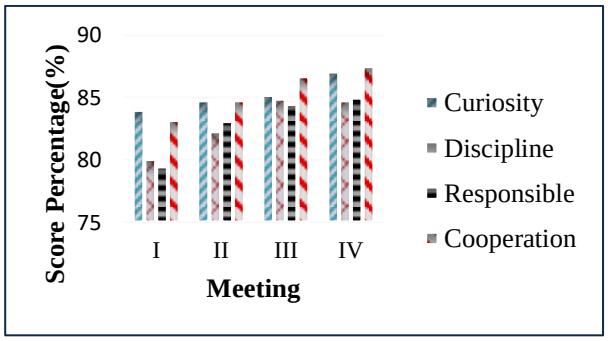

Figure 13. Competency Chart of Trial Class Attitudes

Learning outcomes of students in competency skills are taken from the activities of students in discussing to solve problems. In summary the results of the skills value analysis can be seen in Table 16.

Table 16. Results of Observation Skills Test

Indicator	Value of each meeting				Average
	1	2	3	4	
Asking	74,2	75,8	78,1	80,5	77,2
Answer	66,8	67,2	69,9	71,5	68,9
Respond	64,8	66,4	69,9	71,9	68,3
Percentage	72,7	73,4	73,8	73,4	73,3
Average	**69,6**	**70,7**	**72,9**	**74,3**	**71,9**

Table 16 shows that overall, students' skills are in a good category with a class average of 71.9%, meaning that learning devices developed are effectively used in learning. The results of the skills competency at each meeting can be seen more clearly in Figure 14.

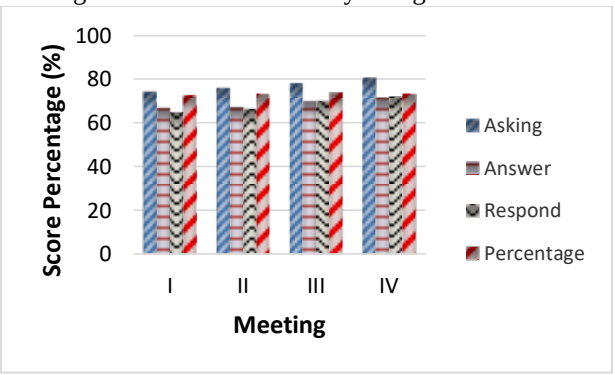

Figure 14. Trial Skills Competency Chart

The disseminate stage is carried out after the trial phase has been completed. The purpose of this deployment stage is to see the effectiveness of interactive multimedia modules when disseminated to a wider class or group. At this stage the dissemination in the research school took place in different classes at SMA N 1 Padang. The results of the analysis of knowledge competencies (critical thinking skills) in the disseminate class can be seen in Table 17.

Table 17. Results of Knowledge Disseminate Class Competence

No	Meeting	Average Value	Number of Students Completed	The number of students not completed	Completeness (%)
1	I	81,2	22	11	57,6
2	II	82,6	23	10	69,7
3	III	88,6	29	4	87,9
4	IV	90,2	31	2	93,9
Average		85,7			

Based on the analysis carried out, the scores obtained by students were in the range of 80 to 91 with an average of 85.7 in the complete category. So it can be said that interactive multimedia modules are developed effectively to help students achieve learning goals. The results of knowledge competency clearly can be seen in Figure 15.

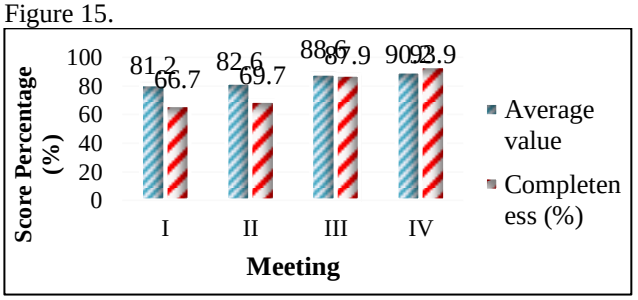

Figure 15. Graph of Disseminate Knowledge Competence Classes

The observation results of the competency of students' attitudes in the disseminate class can be seen briefly in Table 18.

Table 18. Observation of Attitudes in Disseminate Classes

Indicator	Value of each meeting				Average
	1	2	3	4	
Curiosity	79,3	80,1	86,7	88,3	83,6
Discipline	60,1	77,2	77,7	81,8	74,2
Responsible	65,1	75,2	79,2	84	75,9
Cooperation	78,2	80,8	85,6	90,2	83,7
Average	**70,7**	**78,3**	**82,3**	**86,1**	**79,3**

Table 18 shows that overall, students' attitudes are in a good category with a class average of 79.3%. The results obtained by students in each aspect of attitude in the disseminate class are more clearly seen in Figure 16.

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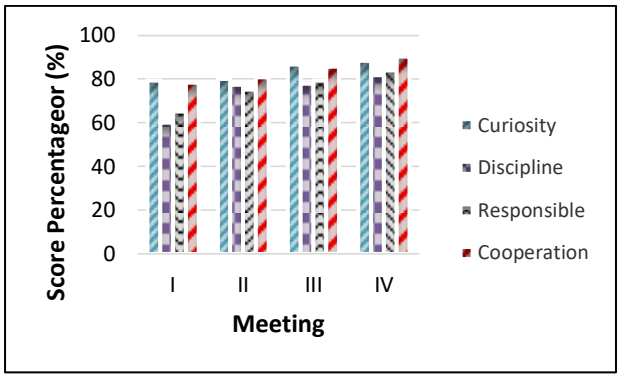

Figure 16. Competency Chart of Disseminate Attitude Classes

The results of observing the competency of students' skills in the disseminate class can be seen briefly in Table 19.

Table19. Skill Observation Results in the Disseminate Class

Indicator	Value of each meeting				Aver age (%)
	1	2	3	4	
Asking	72,7	75	77,7	80,3	76,4
Answer	64	64,4	67	68,6	66
Respond	60,6	64,4	67,4	73,1	66,4
Percentage	69,7	73,9	74,2	75	73,2
Average	**66,8**	**69,4**	**71,6**	**74,3**	**70,5**

Table 19 shows that overall, students' skills are in a good category with a class average of 70.5%, meaning that learning devices developed are effectively used in learning. The results obtained by students in each aspect of skills in the disseminate class are more clearly seen in Figure 17.

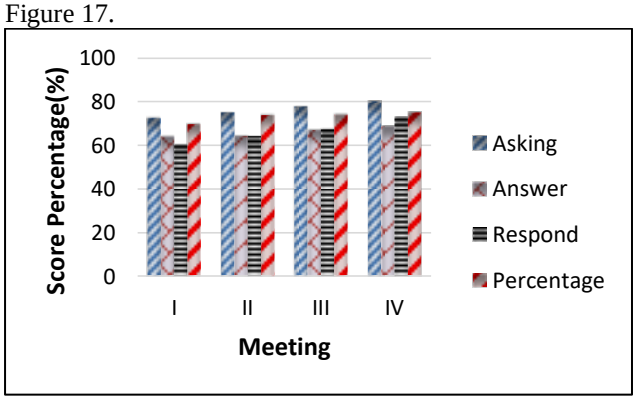

Figure 17. Class Disseminate Skills Competency Chart

Discussion

The module developed in this study is an interactive multimedia module in a problem based learning model that aims to increase students' critical thinking skills. Module development carried out in this study uses a 4D development model. This development model was modified from Thiagarajan which consisted of 4 phases, namely defining, designing, developing and dissemination.

Define stage is the stage of determining the teaching material needs carried out through several analyzes including: preliminary analysis, student analysis, concept analysis (material), task analysis and formulation of learning objectives. The results of the analysis will be the basis for developing teaching materials. The preliminary analysis was observed using an observation sheet addressed to the teacher. The indicators analyzed include: performance analysis, SKL analysis, job analysis and analysis of learning difficulties. Based on the results of the initial analysis, it is known that in learning, teachers still rarely use the learning model demanded in the 2013 Curriculum. The instructional materials used are less varied, even for interactive teaching materials that have never been used in learning at all. The teaching material used is the publisher's output, not the result of the teacher's making. Material presentation also rarely pays attention to the achievements of students in developing higher-order thinking.

Analysis of students includes the ability of students in aspects of attitudes, knowledge and skills as well as teaching materials used. From the results of the analysis of students obtained information that for the attitude aspect, the lowest indicator is responsibility. There are still many students who have not been able to study independently if the teacher is not in the classroom. Furthermore, the knowledge aspect, with the lowest indicator, is linking the facts of physics to formulate a concept. In addition, students' knowledge about the application of physics in everyday life is still lacking. Next to the dimensions of skills, the lowest indicator is productive, meaning that there are still many students who have not been able to or rarely produce a scientific work in physics learning. The last is the dimension of teaching materials, with the lowest indicator being the use of interactive teaching materials. Most students say that teachers have never used interactive teaching materials. In addition, the use of animation is still rare, even though some students say that learning by using animation is very interesting.

The results of the task analysis include the task of knowledge competencies, namely working on practice questions and Worksheets, in addition to the skills competencies of students assigned to present the results of the discussion in solving problems on the Worksheet. At the stage of concept analysis (material), an assessment and adjustment is made to the curriculum requirements. From the results of task analysis and concepts, the objectives to be achieved by students are formulated.

The design phase (design) of interactive multimedia modules is based on the analysis that has been done before. Each analysis result contributes to the development of modules which are complemented by RPP and assessment. The first step is to develop a criteria reference test to formulate assessment indicators for the module developed. The indicators are formulated based on the criteria to be measured. All module components are assessed in terms of validity, practicality and effectiveness. The second step is media selection. In the development of this module, media selection is based on the results of material analysis and adapted to the characteristics and environment of the students. This is so that students can

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easily find material concepts learned in conducting learning activities, because the modules used are presented in interesting media. The next step is the format selection. The module design is adjusted to the format used as a reference. Modules developed in the form of interactive multimedia. The module design refers to the 2008 MoNE module development guide.

The learning steps developed in interactive multimedia modules refer to the problem based learning model. This aims to help students achieve the set learning goals, namely increasing critical thinking skills. To measure student achievement, a set of assessment tools is needed that can measure the level of achievement of students in learning competencies.

The develop phase consists of validation, practicality test and effectiveness test. At this stage of development, the researcher tested the validity of the interactive multimedia module that had been made, for further testing. The interactive multimedia module used for testing must be valid so that it is suitable for use. An instrument is said to be valid if the instrument can be used to measure what should be measured (Sugiyono, 2008). Validation carried out in the form of: content validation, construct validation and language validation. In this study, the validation carried out emphasized content validation, construct validation and language validation.

Based on the results of the research described, information was obtained that the interactive multimedia module developed was in the valid category. The module developed is in accordance with the indicators that have been set on the instrument as well as aspects of measuring validity (construction, content and language). The development of interactive multimedia modules has fulfilled the criteria for content validation because the development has been based on the theory that is used as a guideline for formulating and compiling modules. Furthermore, interactive multimedia modules have fulfilled the validity of construction because in its development it has taken into account the relevance of the components of teaching materials and their suitability with the learning model used, namely problem based learning. Then in terms of language, interactive multimedia modules have used good and correct Indonesian.

The practicality of interactive multimedia modules relates to the ease of use of modules by teachers and students in carrying out the learning process. Practicality is an aspect that can determine an instrument easy to use, practical and uncomplicated (Arikunto & Jabar, 2004). The practicality test results of interactive multimedia modules for teacher response questionnaires are in the very practical category with a value of 96.4%. Test the response of students when the module developed has been used at each meeting. From the whole meeting, the results of the practicality test of interactive multimedia modules are in the very practical category with a value of 92.1%. This means that interactive multimedia modules are very practical to be used as a source of learning. In general, the teaching materials developed are easy to use and very helpful for teachers in the preparation, implementation and assessment of the learning process. This is in accordance with the opinion of Arikunto and Jabar (2004), practicality is an aspect that can determine an instrument is easy to use, and not complicated.

The effectiveness of this interactive multimedia module is seen from the recall of competencies in the aspects of knowledge, attitudes and skills of students after using interactive multimedia modules. The competency of students' knowledge is seen from the evaluation results at the end of each meeting. Increasing the competency of students' knowledge to see critical thinking skills is analyzed by using the gain score. The results of the knowledge competency of the average student are 81 with classical completeness which is quite high. Competence of students' attitudes is seen from the results of observations during the learning process carried out by observers at each meeting. The average results of competency assessment of students' attitudes from the four meetings were 83. Competency attitudes continued to increase at each meeting. The results of the average competency assessment of students' skills from the four meetings are 71.9. From the results of good competency of knowledge, attitudes and skills, it can be said that interactive multimedia modules in the problem based learning model to improve the critical thinking skills of students developed are effectively used in learning.

The disseminate stage is carried out to determine the effectiveness of interactive multimedia modules if tested in another class. The stage of deployment of the writer did in class X MIA2 SMA N 1 Padang. The author takes this class because he is in the same school and has the same characteristics of students as the trial class. From the results of the effectiveness test analysis in the disseminate class, the results of knowledge competence obtained an average value of 85.7, with classical completeness quite high. Furthermore, the results of the attitude assessment of all meetings obtained an average value of 73.4. Then for the assessment of skills for the four meetings obtained an average value of 70.5. In general, the acquisition of competency knowledge, attitudes and skills continues to increase at each meeting.

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the development of interactive multimedia modules in the problem based learning model to increase students' critical thinking skills is done through 4 stages, namely defining, designing, developing and distributing. The results of the development of interactive multimedia modules meet the criteria of valid, practical and effective. The application of interactive multimedia modules in problem based learning models to increase students' critical thinking skills is carried out at the stage of dissemination. Deployment is done by means of interactive multimedia modules used in other classes. The results of competency of students for attitudes, knowledge and skills can be said to be effective and can increase students' critical thinking skills.

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