



Mathematical Teaching Material Development Based on Inquiries Aided by Multimedia to Upgrade High School Students Critical Thinking Ability

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Absract

The objective of this observation is to describe: (1) Teaching materials construction process is based on inquiries aided by multimedia; (2) The construction through Geometry materials in particulars to qualify critical thinking ability of students. This obsersevation apply the tool of Qualitatif Descriptive Method Analysis with developed Model 4-D. The targeted subjects were over High School students of 10th who scattered demographically across North Sumatra. The object is is constructing mathematical teaching materials based on inquiries aided by Multimedia. The experimental obsersevation inferred that: (1) the 4-D Thiagarajan encompasses 4 phases, they are definition, design, construction, dissemination; (2) the results are feasible applied because meet the valid criteria, simple and effective. The valid criteria is visible from format aspect, language, illustration and content through expertise assessment. Simplicity criteria emerged from teachers' activity to prepare the good learning in other hand that teaching materials regarded simple. Meanwhile effectivity criteria perceptible from students' activity in learning and positive response.

Keywords: Teaching Materials; Inquiries Aided by Multimedia; Critical Thinking Ability.

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1. Introduction

In manner of educational quality is one of crucial matters which is being dealt with developing countries including Indonesia. The government has many endeavors treated cope with the matters such as upgrading teachers quality, curriculum modification, provision of any facilities. Nonetheless the efforts is universal and global, not sound touching very matters dealt in class. Consciously indeed that how good prepared educational curriculum would be, how complete the facility had been, but if not well and right implemented by teachers and students in the class, however would not proceed optimal result the author in [2]. One of the efforts to enhance educational quality is to do innovations or new breakthrough in realm of education, in learning activity which might touch certain aspects on oneself in particular so he/she is able to grow up his/her potentiality optimally the authors in [8]. Since Educational Unit Level Curriculum prevailed and curriculum of 2013, teachers are obliged critically in constructing interesting teaching material and various with choosing one learning model which is able to motivate their students to be active and participative in learning Khoiryah and his colleagues in [5]. Constructing teaching material is an absolute responsibility of teachers. By teachers' creativity in forming teaching materials would proceed meaningful learning teaching activity. Within learning teaching process teachers would have assignment to choose learning encouragement along with apt media with presented material in order to achieve learning goal the author in [3]. Because all times learning at school is teachers oriented. Given teaching materials as a media means of learning unable to drive students to think of critically so achievable learning competency is only a square of memorizing without implication in lives the author in [15]. Likewise in learning activity as well which prevailed all times, more directed to a student's ability to memorize information, so their brain enforced to keep in mind and pile up various information without required to sense the remembered information the author in [3]. Besides that learning process not quite accommodating upgraded students' ability in solving problem, reasoning, connection, and mathematical communicative the author in [9]. As a result, students' cognitive ability are very poor because of usual learning activity done only to drive students to think on low level extent. An effective learning model can be applicable to grow mathematical ability one of them is Learning Inquiry Model. Learning Inquiry Model is student oriented becoming students are really get involved actively in learning process. The active students' involvement existence in learning process enables to drive students to get a better comprehensive concept or mathematical principles, rather students more interested at mathematics the author in [13]. And students are guided to apply or communicate mathematical ideas, concept, and skills of things that learned to find out new science. Every student has an opportunity to think of matters presented by their teachers or the matters are coming forth from students themselves and then they are able to review the matters and able to find out concept or mathematical principles through the course of teacher's guidance as far as students as needed the author in [10].

Some process skills can be gotten through into learning by inquiry approach they are: (1) students are formulating or fostering a hypothesis of presented matters, (2) students are able to modeling presented matters orally or written, (3) students interpret and evaluate their mathematical ideas, (4) students review the mathematical ideas

through conjectures and believable reviews, (5) students construct their own knowledge openly to verify the truth of presented hypothesis the author in [9]. From that of process skill the students would have been able to draw an implication out of matters and able to communicate openly by orally or written. Learning by inquiry model the students will be more actively, creatively, and more skillfully to foster mathematical communicative ability. Bruce and Weil the author in [4] denote that: "Learning Inquiry Model attempts to teach various skills and scientific languages". Learning inquiry is a concatenation of learning activity which emphasized on critical thinking process and analytically to seek and find themselves the answers of questioned matters. Thinking process itself its usually put into action by answers of questions between students and teachers. Along with disclosed by Bruce and Weil the author in [4] noted that: "Exercising Inquiry might have increased knowledges of science, proceeds creative thinking ability, skills in acquiring and analyzing of data". Discovering is a crucial part of contextual learning. Discovering process itself that more important in learning. When we find out something sought, our memory more sticky in contrast to others that who found it. As well as in acquiring knowledges and learning experience, thoughts, senses, and our locomotion will be integrated and balance in responding any acquired of initiative learning through discovering process the author in [11]. Its different with merely simply absorbing knowledges from learnt people, or more memorizing some disaggregated knowledges, ultimately upsetting potential balance of students the author in [4]. In order learning inquiry may more achieving enticed goal therefore within this model may apply mathematical tools as a learning media demonstrated by teacher. Nevertheless, we often see the teachers not working with mathematical visual aid, teachers likely to excite students motivation themselves to learn further material. One of a media used in learning mathematics is applying mathematical learning material inquiry-based aided by multimedia the author in [12]. This is because of high school students are generally have been familiar with high technology especially work with computer and internet. The application of learning inquiry-based aided by multimedia will bring up logical thinking, systematic, objective and rational that more competent to form critical thinking of students. One of the ways which regarded aptly to bolster up the efforts is through developing research. This research is begun with mathematical learning analysis of high school inquiry-based Suryaningtyas W and his colleagues in [14]. The next will be applied learning system design inquiry-based of constructing manuals and worksheet by task analysis. After that will be stepped into reviewing and examining validation of teaching apt applied material teaching applied in order that learning may be effective and efficient.

2. Research Method

The sort of ongoing observation is a development research and phases of constructing learning models following a procedure of constructed learning model 4-D of Thiagarajan, Semmel & Semmel the author in [7]. The observer will constructing teaching material of inquiry-based aided by multimedia on Geometry. Teaching material constructed in form on Teachers Manual and Student Hand Book. Learning Implementation Plan, and Students Activity Worksheet. This research categorized descriptive research due in this observation craved to describe or illustrate the real thing about variable, indication or conditions observed the author in [1]. This is the first step research in the year of 2016, implemented at high school stretch demographically across North Sumatera for construction and the trial error of teaching material. The time duration of this observation took 8 (eight) month

began with March thru October 2016, at odd Semester, that was learning material of Geometry in 10th class. Subjected observations were students of 10th class of high school scattered over North Sumatera. Objected observation is mathematical teaching material construction inquiry-based aided by multimedia to upgrade students of 10th high school critical thinking ability in first semester based on National Curriculum. Development of this research has 4 four path phase activity they are: Preparation, Implementation, Data Analysis, and Providing Report. At the mean time the procedure of construction teaching material with 4D Thiagaranan encompassed four phases of Define, Design, Develop, Disseminate. Applied Data collection method of this research is Studying Literature, Validation Expertise, Observation, and Filling Questionnaires. Observation Instrument is Validation Sheet of Students' Hand Book, Learning Implementation Plan, and Student Activity Worksheet, Teachers Activity Worksheet, and students' response questionnaires;

Herewith technical analysis implemented in this research:

2.1 Validity Data Analysis

The result of validity analyzed by really considering expertise input. The process of analyzing teaching material (for Teachers Manual and Students' Hand Book, Learning Implementation Plan, and Students Activity Worksheet) begun with figuring out rendered average score by validator to each teaching material. And then this average score (x) compared with rating of interspace criteria as the table below:

Table 1 : Rating of Interspace Criteria

Interspace	Rating Criteria
$1 \leq x < 1,75$	Very Poor
$1,75 \leq x < 2,5$	Poor
$2,5 \leq x < 3,25$	Good
$3,25 \leq x \leq 4$	Very Good

Teaching material is valid, if each teaching materials for every aspects of rating being on minimal good category. When in determination, there is actually not qualified criteria, therefore revision needed based on validator inputs.

1. Practicality Data Analysis

Teachers Manual and Students Hand Book and Learning Implementing Plan and Students Activity Worksheet stated practically if the ability of teachers to prepare the learning in Minimally Good Criteria as illustrated in table 1

2. Effectiveness Data Analysis

The effectiveness of Teachers Manual and Students Hand Book and Learning Implementng Plan and Students Activity Worksheet is visible after analysis as follows:

a. Analysis of Students Data Activity

The data of the Students Activity Observation Result during learning activity its analyzed based on percentage. Students activity percentage is a frequency of observation aspect divided by total frequency of all aspects of observation times 100% or

$$\text{Student Activity Percentage} = \frac{\text{An Aspect Observation Frequency}}{\text{Total All Aspects Observation Frequency}} \times 100\%$$

Effectiveness Criteria Determination of students based on Ideal Time Achievement which reaffirmed in Learning Implementing Plan, as with table below:

Table 2: Ideal Time Percentage for Students Activity On Learning Teaching Material Inquiry-Based Aided by Multimedia

No	Students Activity Category	Ideal Time	Effective Percentage (P)
			Ideal Time Span With Tolerannce 5%
1	Listening/pay attention of teacher's explanation/classmate	27,50%	26,13<P<28,88%
2	Read/Do Students Activity Worksheet	10,00%	9,5%<P<10,5%
3	Work with Multimedia Inquiry-Based	31,25%	29,69%<P<32,81%
4	Explicate/Answer Teacher's Question or Classmates	10,00%	9,5%<P<10,5%
5	Asking to Teacher or Classmates	8,75%	8,31%<P<9,19%
6	Others Activity(other than which Mentioned Above)	12,5%	11,88<P<13,13%

Explanation: P is Students Activity Percentage

Students Activity ascertained effective if the time used to to any observed activity on each Learning Implementing Plan along with Ideal Time Span which comprised in Learning Implementing Plan with Tolerance 5%.

b. Analysis of Students Responsive Data

Analysis of Students Respons on learning process applied percentage analysis. Percentage of each student's respons figured out of formula

$$\frac{\text{Total Students Positive Response of Each Emerged Aspect}}{\text{Total Overall Students}} \times 100\% \quad (2)$$

Students response it is said positive if minimal 75% or more students responding in in category of gladness, new, interesting, clear, or condone, to any responded aspects.

3. Results and Discussions

The first step of define consisted of 5 steps they are the front end analysis, students' analysis, task analysis, learning specification indicator. The second step of design comprised of 4 steps they are optional media, optional format, pre-designed. On the design step resulted *draft I*. The third step of Developing, contained two steps they are: expertise validation, examined legibility, revision, trials, and trials II reading material. On the step of development resulted *draft II* experimented in order to get practicality and effectivity and resulted *final draft*. The fourth step of Dissemination, on this step its only has one activity that is validity. This activity employed teaching material in a process of learning in class. The publishing of teachers manual and students hand book, Learning Implementing Plan, Students Activity Worksheet ascribed to achievable learning indicator. The first experiment to position distance, and great angles includes point, line, and sector in three-dimensional space and specify interval and point to line and from line into three-dimensional space and specify great angles between line and sector and between two sectors in three-dimensional space. The Teacher Manual and Students Hand Book, Learning Implementing Plan, and Students Activity Worksheet inquiry-based aided by multimedia considered well if meeting validity criteria, practicality and effectivity. Validity criteria acquired from the results of analysis on validation done by expertise. The rating of learning material validity revised according three aspect rating they are: Format, Language, Illustration, and Content. The result of validators' validation inferred. Based on table 3 above that total average of teaching material stands on interval $3.25 \leq x \leq 4$. This case has met Valid Criteria, they are each of material teaching for rating aspect stand on good minimal category. Based on validated pages by validator acquired that some validators said that developed teaching material less usable and without revision. The validators recommended improvement teaching material.

Table 3: The Summary of Teaching Material Validation by Expertise

No	Rated Object	Total Average Score Validity	Rating Criteria
1	Teachers Manual and Students Hand Book	3.25	
2	Learning Implementing Plan	3.52	Very Good
3	Student Activity Worksheet	3.43	

Teachers Manual Practicality and Students Hand Book, Learning Implementing Plan (LIP) and Students Activity Worksheet (SAW) acquired by analyzing teachers' ability to prepare learning as follows:

Table 4: Observation Result of Teachers' Ability Preparing Learning

No	Observed Aspects	Rating	
		LIP-1	LIP-2
I	Introduction		
1	Ability to focus on students at the learning start	3	4
2	Ability to motivate and drive students' interest	2	3
3	Ability to Present Learning Goals and Learning Steps	3	4
4	Ability to Remind Pre-requisite Material	2	3
II	Activity gist		
1	Ability to present/demonstrate with multimedia	3	4
2	Ability to observe and guide each students/group in rotation	4	4
3	Ability to Assist of Students/Group who are in trouble	4	4
4	Ability to turn feedback in	4	4
5	Ability to motivate students to work and learn	3	4
III	The Closing		
1	Ability to conclude the lesson	3	4
2	Ability to close the lesson	2	4
IV	Ability to Manage the Time	2	3
V	Class Environment		
1	Students' anthusiastic	4	4
2	Teachers' anthusiastic	4	4
Average		3,07	3,79
Category		Good	Very Good

Based on Table 4 above, the observation result of teachers' ability in learning managing can be described as follows: On the experiment 1 for material/topic specified position, interval, and great angles which includes point, line, and sector in three dimensional space, teachers in managing time in class generally has good grade.

Nonetheless on the aspect of 1 that is teachers' introduction not somewhat able to motivate and arouse students' interest at the beginning of learning and not sounds good to manage learning time allocation adapted with provided Learning Implementing Plan.

At the mean time experiment 2 based on the input of observer team of teachers has been able to manage class with “very good” category, though teachers experience a few troubles in managing time. Based on analysis result, therefore a result acquired that teachers’ criteria in managing learning at experimented class categorized practical. However teachers manual and students hand book, learning implementing plan and students activity worksheet its also utterly practical. The effectivity of Teachers Manual and Students Hand Book, Learning Implementing Plan (LIP) and Students Activity Worksheet acquired from the analysis of students’ activity, and students’ response on questionnaires as follows:

Table 5: The Observation Results of Students During Learning Activity

No	Observation Category	Percentage of Students Activity in Learning (%)		Effectivity Limit	Criteria
		LIP-1	LIP-2		
1	Listen/take heed teachers’ explanation/classmates	28.6%	28.62%	26.13<P<28.88%	
2	Reading/doing LIP	10%	10.2%	9.5%<P<10.5%	
3	Employing multimedia inquiry-based	31.2%	31.27%	29.69%<P<32.81%	
4	Expounding/answering teachers’ questions or classmates	10%	10.1%	9.5%<P<10.5%	
5	Asking teachers or classmates	8.72%	9%	8.31%<P<9.19%	
6	Other Activity (beyond what stated above)	12.7%	12.87%	11.88%<P<13.13%	

Based on Table 5 above, its visible that any aspects to any meetings (each LIP) stand on criteria of learning effectivity limitation such as described on Paragraph IV that is the time used to do any observed activity on each LIP according to Ideal Time Span consisted in LIP with tolerance 5%. However the students’ activity on learning with employing teaching material inquiry-based aided by multimedia on learning for experiment class meets the effective criteria.

At the mean time the result of the analysis of students’ response on questionnaires acquired as followsBased on the result of questionnaires respnses on the table 6 above implied that the responses during attending learning with applying teaching material inquiry-based aided by multimedia is positive because 75% or more students responded in a happy category, new, interesting, or agree, for any responded aspects Based on all descriptions above therefore its concludable that Teachers Manual and Students Hand Book, Learning Implementing Plan (LIP) and Students Activity Worksheet (SAW) inquiry-based approach aided by multimedia could be stated good/worthy applied because it has met validity criteria, practicality and effectivity.

Table 6: Data of Students' Response Result

No	Students' Responses	Type of Responses	
		Happy %	Unhappy %
1	Sensation during learning	83.3	16.7
2	Teaching Component		
	Teaching material	96.7	3.3
	Students Hand Book	96.7	3.3
	Students Activity Worksheet	93.3	6.7
	How to Learn	83.3	16.7
	Class Environment	76.7	23.3
3	Learning	Yes	No
		%	%
	Comprehension on material in learning	86.7	13.3
	New experience with learning with inquiry-based aided multimedia	96.7	3.3
	Happiness of learning with inquiry-based aided by multimedia	93.3	6.7
	Learning inquiry-based aided by multimedia is a variation of learning mathematics	96.7	3.3
4	Opinion about Language	Clear	Not Clear
		%	%
	Students Hand Book	93.3	6.7
	Students Activity Worksheet	90	10
	Opinion about other subject if employing learning inquiry-based aided by multimedia	Agree	Disagree
5	during learning.	%	%
		86.7	13.3

4. Conclusion

Based on this research its concludable that in progressive constructive research report has produced teaching material inquiry-based aided by multimedia on the material of Geometry with:

1. Construction teaching material inquiry-based aided by multimedia on Geomery developed by constructing 4D-Thiagarajan which encompasses four phases, they are definition phase, design phase, developing

phase, dissemination phase. Data analysis applied Descriptive Analysis on descriptive observation, qualitative referred to construction of material teaching like Teachers Manual and Students Hand Book, Learning Implementing Plan (LIP) and Students Activity Worksheet (SAW)

2. The result of this construction of teaching material is teaching material inquiry-based aided by multimedia which is good/worthy applicable for teaching Geometry on the first semester in the academic year of 2016/2017, because has met valid criteria, practical and effective. Valid criteria is visible from format aspect, language, illustration and content, acquired that the teaching material is valid based on expertise rating. The practicality criteria is visible from teachers activity to manage learning which categorized good so otherwise the teaching material utterly practical. Meanwhile effectivity criteria is visible from students activity in learning including effective criteria and responses exhibited by students in learning is positive.

5. Implication

Alluded to observation result as well concluded as above, hence implication defined as follows:

1. To activate and upgrade of students thinking ability during learning process, teachers could apply learning model inquiry-based aided multimedia as ones alternative as innovative learning.
2. Multimedia in a form of macro plus applied to motivate and appeal interest in learning implementation. So the media could be employed as alternative creative learning.
3. Learning goal achievement should have been upgraded to create a learning quality and learning effectivity will be able achieved in order to be able to enhance ability better.
4. Learning model implication must have paid attention of time allocation conformity, so the implication model will be going effectively on.
5. The application of learning teaching material should have been upgraded after evolved effective learning.
6. Developing teaching material need more next observation to get insight of the extent of data consistency whether this teaching material really able to upgrade critical thinking if its applied on its next experiment.

6. Recommendation

Based on the result and discussion of research could be recommended as follows:

1. Learning model with inquiry-based aided by multimedia is not only eminent to upgrade critical thinking ability in learning concomitant with the case, therefore rendered material should have been in a form of matters which more challenging so referring cognitive conflict occurrence, so will be able to upgrade thinking ability optimally. So teachers expected to design learning employing innovative learning model.
2. The goal of learning model inquiry-based is to aid students to develop intellectual skills and other skill such as: proposing questions and skills to find out (seek) answers initiated from their curiosity. Inquiry its also a learning model applied in learning mathematics and allude to a way to question, to quest science or information, or to learn an indication so in implementation of inquiry should have been applied accurately

by teachers as facilitator in learning so students' activity will be more active.

3. Teaching material construction multimedia-based on Geometry material, in terms of material or media so the next will be able applied by teacher and students as a standard to compile teaching material in High School.
4. Within this research, the writer has only a limitation to construct teaching material inquiry-based aided by multimedia on Geometry material. However the writer recommends to observer to construct teaching material inquiry-based aided by multimedia on other material.

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