

The Development of Inquiry-based Teaching Model to Enhance Critical Thinking Abilities on Circles in Junior High School

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Abstract: This study aims to develop inquiry-based teaching model that can enhance students' critical thinking abilities. The teaching model was developed through four stages, namely: (1) Preliminary Investigation, (2) Design, (3) Realization, and (4) Test, Evaluation and Revision. Teaching model developed consisted of five components, namely: (1) the model purpose, (2) syntax, (3) reaction principle, (4) social system, and (5) support system. The model purpose was to enhance the critical thinking abilities. Syntax of inquiry-based teaching model consisted of six phases, namely: (1) Confronting problem, (2) Asking conjecture, (3) Collecting Data, (4) Formulating explanation, (5) Explaining conclusion, and (6) Conducting Reflection. The principle of reaction was to provide technical assistance, ask for a review, and provide feedback. The social system emphasized cooperative learning, the medium social structure, and discussion. Support system included learning instruments as well as the tools and materials supporting the model. Development of teaching model was expected to meet the criteria of validity, practicality, and effectiveness. The study also developed research instruments in accordance with the purpose of research. The results of expert assessment showed that the teaching model developed meet the criteria of validity with a value of 3.22 and can be implemented in the field. Field test did twice in SMP Negeri 2 Bojonegoro in a different class because an enhance students' critical thinking abilities at first test less significant, although the model was already practical. The result of teaching model realization was 3.12 so it can be said that the teaching model meets the criteria of practicality. The result of t-test analysis of the students' critical thinking abilities showed a p-value of 0.028. This meant that there has been an increase in students' critical thinking abilities significantly. The response of students to teaching model was positively associated with the percentage of 73.77%. Result of the assessment of student activity during the learning of 3.07 was included in the active category. Based on these things can be said that the inquiry-based teaching model has enhanced students' critical thinking abilities effectively.

Keywords: development of teaching model, inquiry, critical thinking, circle

In order to meet the golden generation 2045 is projected to be a gift for the 100 years of Indonesian independence; education development policy has focused on efforts to prepare the future generation that has XXI century competences. As formulated in the 21st Century Learning Partnership Framework, XXI century competences man, among others: creativity and innovation, communication and collaboration, as well as critical thinking and problem solving [1]. All the competencies required of future generations to be able to compete in the modern world where the working and living environment is becoming increasingly complex. One goal is to show the attitude of learning mathematics logical, critical, analytical, meticulous, responsible, responsive, and does not easily give in solving the problem.

Critical thinking abilities students should possess. Students who have the ability to think critically will tend to respect and respect for others [2]. Critical thinkers also will not take it for granted way of doing things simply because during this time that was the way to do it and they

did not think a statement is true only because others justify it [3]. Characteristics like these are essential for the future generations who live in the modern world.

One model of learning that is expected to be able to train and improve critical thinking abilities is inquiry-based teaching model. Inquiry-based teaching means learning that involves the activities of inquiry in it. Inquiry is the act of collecting information about something. Victor and Kellogg explain that the inquiry is a process to answer questions and solve problems based on a logical test on facts and observations [4]. States that the inquiry is a process to formulate questions, cultivate ideas, explore and evaluate information, analyze data, and discover relationships and conclusions [5]. Inquiry-based teaching emphasizes the process of thinking critically and analytically to seek and find their own solution of a problem posed [6]. Inquiry-based teaching involves students actively to seek answers to questions or problems. Inquiry-based teaching model in this study meant as a guide for designers and educators which contain a series of systematic procedures for planning and implementing learning activities that involve formulating questions, finding information, process ideas, analyze data, and draw conclusions to solve the problem.

Their models and inquiry-based teaching tools are expected to motivate and direct the learning of mathematics oriented to building critical thinking abilities. Based on these explanations need to develop a Teaching Model that involves the activities of inquiry to enhance students' critical thinking abilities in learning mathematics. Furthermore, researchers will conduct research on "The development of inquiry-based teaching model to enhance critical thinking abilities on circle in SMP".

Thinking is a mental activity to help solve a problem, make a decision, or to meet the desires of curiosity [7]. Thinking as a mental activity is classified into several levels according Krulik and Rudnik described as follows:

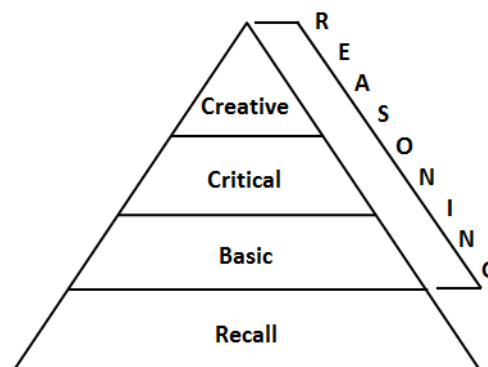


Figure 1 Hierarchy of Thinking

The third level of thinking is critical thinking. Krulik and Rudnick explains that critical thinking involves: Examining, relating, and evaluating all aspect of a problem; focusing on parts of a problem; gathering and organizing information; validating and analyzing information; remembering and associating previously learned information; determining reasonableness of an answer; drawing valid conclusions; and analytical and reflexive in nature [8].

Ennis classifies the ability of the principal of an ideal critical thinker into five ability groups, namely: elementary clarification; basic for decision; Inference; advanced clarification; and supposition and integration. The fifth group of critical thinking abilities is translated into twelve critical thinking abilities [9].

Based on twelve indicators of the ability of the critical thinking appears that rational thinking and reflective thinking cannot be separated in discussions about critical thinking. Skemp describes the process of reflective thinking consists of: (a) use any information or data that comes from within, (b) explain what he has done, (c) to realize the mistake and correct it

(if any), and (d) to communicate their ideas with symbols or pictures [10]. Indicators of critical thinking abilities that are used in this study refer to the opinion of Ennis and Skemp. Indicators of critical thinking abilities is to elementary clarification, basic for decision, inference, describe the conclusion, and revisiting.

Critical thinking abilities that a person has not acquired directly but need a process to train and develop these capabilities [11]. One model of learning that can be used to train students' thinking abilities in math is the inquiry training model. Inquiry Teaching Model training gives students the opportunity to invent freely, but in a disciplined way. At the beginning of inquiry training, the teacher presents to students a perplexing problem or incident. Students will naturally be motivated to solve those problems. The process towards completion can be used as an opportunity to teach the disciplinary inquiry procedure to students Inquiry learning model training gives students the opportunity to invent freely, but in a disciplined way.

However, inquiry training has some weaknesses in its application. The dominance of teacher in inquiry training is huge during the learning process. Joyce and Weil said that the inquiry training models can be quite highly structured with the social system largely controlled by the teacher; they have seen it used successfully with kindergarten children and encounter difficulty with third grades [12]. This high structured social systems less suited to the characteristics of junior high school students who began formal commissioning phase in cognitive development.

Syntax inquiry training mentioned their phase process and formulates an explanation. However, in the description of the syntax explanation of inquiry training is not mentioned in writing explaining the conclusions contained their activities. Whereas describe the conclusion of activity is an important part in order to train students' critical thinking abilities.

Teaching model in this study emphasizes the critical thinking abilities of students. The teaching model is designed with the needs analysis, inquiry training model analysis, and the development of learning models. Inquiry-based teaching model that was developed is a modification of inquiry training. The modified form of the activity lies in the addition of explaining the conclusions in the five phases of inquiry training. The whole series of activities in inquiry-based learning model mathematics is expected to train students' critical thinking skills. Activities of teachers and students in inquiry-based learning model to improve critical thinking abilities outlined in the following table 1 below

Tabel 1 Inquiry-Based Teaching Model to Enhance Critical Thinking Abilities

Phase	Teacher Activity	Student Activity	Critical Thinking Abilities
1 Confronting Problem	Provides an introduction to the material to be studied	Pay attention to the teacher's explanations	
	Presenting the initial problem	Observing the initial problem	
2 Asking Conjecture	Asks the students to write down conjecture	Asking conjecture or questions regarding the initial problem or concept to be studied	elementary clarification
3 Collecting Data	Guide and motivate students to do inquiry activities	Doing activities inquiry Recording the data obtained in the table	basic for decision
4 Formulating Explanation	Asking students discusses the answer of the question in a group discussion	Drawing conclusions based on the data obtained Answering the question of discussion Resolving problems early	inference
	Reminding students to revisit the work group	Revisiting the results of the work	revisiting

Phase	Teacher Activity	Student Activity	Critical Thinking Abilities
5 Explaining Conclusion	Setting the course of the presentation	Presenting the results of the work group Responding to another group presentations	describe the conclusion
6 Conducting Reflection	Inviting students to jointly reflect activity during the learning process	Delivering concepts or knowledge acquired during the learning	revisiting

RESEARCH METHODOLOGY

The subject of the trial is a class VIII-A and VIII-B SMP Negeri 2 Bojonegoro Academic Year 2015/2016. The instrument used in this study to assess teaching models and devices to collect data validity, practicality, and effectiveness of learning developed. The research instruments developed consists of three types, namely: validation sheets, observation sheets, and student questionnaire responses. This study uses a model of development that has been modified plump. This model consists of four stages of development, namely (1) early investigation, (2) design, (3) the realization, and (4) test, evaluation, and revision. Teaching model development and teaching instruments in this study can be illustrated schematically as shown in Figure 2

The analysis was conducted to assess whether the prototype models and teaching instruments have met the criteria of validity. The formula used is as follows:

$$K_i = \frac{\sum_{j=1}^n V_{ji}}{n} \dots\dots\dots(1)$$

Where K_i is average criteria to-I; V_{ji} is score validator assessment criteria j for all I; and n is number of validator. The criteria for the validity of the model and the quality of the learning device shown as follows:

$$\begin{aligned} 4 \leq \bar{K} < 5 & : \text{Very Valid} \\ 3 \leq \bar{K} < 4 & : \text{Valid} \\ 2 \leq \bar{K} < 3 & : \text{Less Valid} \\ 1 \leq \bar{K} < 2 & : \text{Not Valid} \end{aligned}$$

Criteria for the quality of the model and the learning device is said to meet the aspect of validity if the average total valid votes of at least validator.

The analysis below was conducted to assess whether the prototype model and teaching instruments have met the criteria of practicality. Practicality is a model that describes the quality criteria realized teaching model. Data practicality obtained from observation sheet realized models. The formula used is as follows:

$$K_i = \frac{\sum_{j=1}^n P_{ji}}{n} \dots\dots\dots(2)$$

Where K_i is Average criteria to-I; P_{ji} is score assessment observer j for the activity of all I; and n is number of observers. The criteria for quality and practicality of the model learning device are shown as follows:

$$\begin{aligned} 3,5 \leq \bar{K} & : \text{Very good} \\ 2,5 \leq \bar{K} < 3,5 & : \text{Good} \\ 1,5 \leq \bar{K} < 2,5 & : \text{Less good} \\ 1 \leq \bar{K} < 1,5 & : \text{Not good} \end{aligned}$$

Criteria for the quality of the model are said to fulfill aspects of practicality if the average value of total minimum realized well.

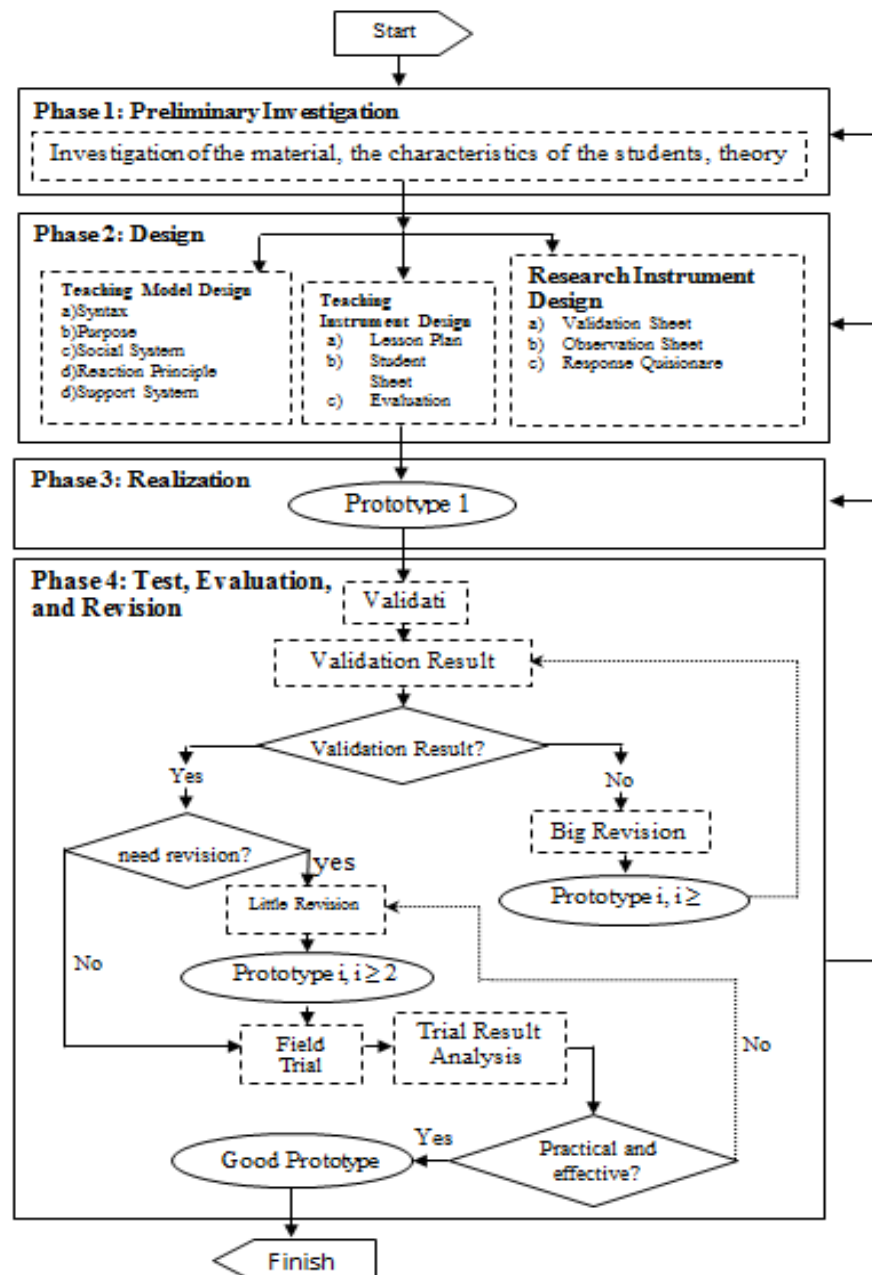


Figure 2. Learning Development Flowchart that modification of Tjeerd Plomp

The effectiveness of the model is measured by three indicators, namely: critical thinking abilities, student activities and student responses. In data analysis critical thinking abilities, criteria for the quality of students' critical thinking abilities are as follows:

- $3,5 \leq A$: Very critical
- $2,5 \leq A < 3,5$: Critical
- $1,5 \leq A < 2,5$: Less critical
- $1 \leq A < 1,5$: Not critical

Criteria for the quality of students' critical thinking abilities are said to fulfill aspects of effectiveness if the score students' critical thinking abilities in classical minimal critical. In data

analysis of student activity, criteria for the quality of student activity during the learning with inquiry-based teaching model are as follows:

- 3,5 ≤ A : Very active
- 2,5 ≤ A < 3,5 : Active
- 1,5 ≤ A < 2,5 : Less active
- 1 ≤ A < 1,5 : Not active

Criteria for the quality of student activity is said to fulfill aspects of effectiveness if the average score for the entire active minimal activity. In data analysis of student response, calculating the percentage of the value of student responses from the response value of each answer with the formula:

$$\%NRS = \frac{\text{total } NRS}{NRS \text{ maksimum}} \times 100\% \dots\dots\dots(3)$$

Where *NRS* is the value of student response; total *NRS* equal to *NRSS* + *NRS* + *NRS TS* + *NRS STS*; and *NRS* maximum equal to sum of responses times the best option score.

Result

This study focuses on the development of inquiry-based teaching model is valid, practical, and effective way to enhance students' critical thinking abilities. Besides teaching model, this development also resulted in the learning device in accordance with inquiry-based teaching model on circle. Activities undertaken during the research and development will be discussed in this section. The discussion includes the process and results of the development of research instruments, teaching instruments, and inquiry-based teaching model to obtain a valid model of learning, practical, and effective.

1. Development of Research Instruments

a. Instrument Validation of Model

The average value of the validity of the instrument validation teaching model is 3.43, this means that the instrument validation model developed included in the category of very valid. While the value of instrument reliability validation of the model of 0.90, this means that the instrument validation model developed included in the category of high reliability.

b. Instrument Validation of Lesson Plan

The average value of the validity of the instrument validation RPP is 3.38, this means that the instrument validation RPP included in the category of very valid. While the value of instrument reliability validation RPP by 0.87, this means validation instrument developed lesson plans included in the category of high reliability.

c. Instrument Validation of Student Activity Sheet

The average value of the validity of the instrument validation LKS is 3.42, this means that the instrument validation worksheets included in the category of very valid. While the value of instrument reliability validation LKS 0.89, this means validation instrument developed worksheets that are included in the category of high reliability.

d. Observation Sheet of Model Realization

The average value of the validity observation sheet of model realization is 3.50, this means that the observation sheet included in the category of very valid. While the reliability value of observation sheet of model realization 0.92, this means validation instrument developed observation sheet that are included in the category of high reliability.

e. Observation Sheet of Student Activities

The average value of the validity observation sheet of student activities is 3.35, this means that the observation sheet included in the category of valid. While the reliability

value of observation sheet of student activities 0.95, this means validation instrument developed observation sheet that are included in the category of high reliability.

f. Questionnaire of Student Responses

The average value of the validity of questionnaire of student responses is 3.22, this means that the instrument validation evaluation questions included in the category of valid.

2. Development of Teaching Model

The average value of the content validity of 3.25, this indicates a strong theoretical foundation of the Teaching Model. The average value of the construct validity of 3.21, it shows a consistency between components in the Teaching Model. The average value overall on Teaching Model developed is included in the category of 3.22 and is valid. Thus, it can be concluded that the inquiry-based teaching model has been qualified validity.

Activities fields test the model in real situations in class aims to determine the practicality and effectiveness of the model empirically. Practicality quality teaching model empirically obtained through adherence to a model. The quality of the teaching model effectiveness obtained from: (1) the observation of student activities, (2) the results of student responses, and (3) the results of students' critical thinking abilities. Implementation of the pilot study model requires teaching instruments. Development of learning tools that meet the criteria of validity, practicability and effectiveness will support quality learning model

3. Development of Teaching Instruments

The average value of the validity of the RPP is 3.55, this means that the RPP developed included in the category valid. The average value of LKS validity of 3.49, this means LKS developed belongs to the category very valid. The validity of the evaluation is about 3.25, this means that the developed evaluation questions included in the category of very valid. Field trial activities are essentially carried out to assess the practicality and effectiveness of the Teaching Model developed.

a. Results of Trial I

The trial results I obtained an average value of 2.85 realized Teaching Model. These values indicate that inquiry-based teaching model has been implemented well. Activities of students during study showed an average value of 2.71 so that according to predetermined criteria, student activities included in the active category. The percentage of students who responded to the Teaching Model based inquiry is 71.74%. These values indicate that the students' response to learning included in the category of positive. The results of the evaluation of student work on the matter shows that the results of the analysis of the t-test students' critical thinking ability scores showed a p-value of 0.065. It means that the critical thinking abilities of students have not increased significantly. So it can be said that the inquiry-based teaching model has not been able to enhance students' critical thinking abilities effectively.

b. Results of Trial II

Based on trial results II gained an average value realized Teaching Model is 3.12. These values indicate that the Teaching Model has been implemented well and supports the criteria of practicality. The average score of student activity based on observations is 3.07. Thus, student activity during the learning with inquiry-based teaching model is included in the active category. The percentage of students who responded to the inquiry-based teaching model amounted to 73.74%. These values indicate that the students' response to the model learning included in the category of positive. Analysis of the results of the evaluation of student work on the matter shows that the results of the analysis of

the t-test students' critical thinking ability scores showed a p-value of 0.028. The critical thinking abilities of students have increased significantly and are included in the critical category. It can be said that the inquiry-based teaching model has enhanced students' critical thinking abilities effectively.

DISCUSSION

Although the phase of collecting data on trials 1 performing well, but the time required to carry out this phase is relatively longer than the planned time allocation. As a result, the next phases in inquiry-based teaching model cannot be implemented optimally. Whereas phase of explaining conclusions and phase conducting reflection are the important parts of efforts to improve students' critical thinking abilities. Skemp stated that explains what has been done and communicate ideas are part of the process of reflective thinking, which is part of critical thinking [13]. Therefore, there should be improvements in the implementation of this third phase that the available time to be more effective and efficient, so that the next phase may be optimized.

Discussions in inquiry-based teaching model consist of two stages: a discussion group and inter-group discussion. Discussion among the group performed at the time of explaining conclusions. Unfortunately at some meetings in trials 1, students seem less eager to give its response. It is characterized by the low value of student activity on aspects provide feedback or questions to the group renderers and realization value of systems social on aspects of the discussion. Driver explains that knowledge and understanding are constructed if a person socially engaged in a dialogue or discussion [14]. In addition, Von Glasersfeld adding that the discussion activity is a way to create a reflection that demands awareness of what people thinks and does [15].

Reaction principle in inquiry-based teaching model has been mentioned reactions of teachers to provide feedback, including an appreciation of the students verbally. But based on results of trials 1, the reaction is less able to motivate students to be actively involved, especially in the phase of explaining the conclusions. Thus the need for additional reaction especially in giving awards for student involvement. One of the efforts to strengthen the expected behavior is to reward. Positive reward or reward can influence students to do something positive and be progressive. Also, it can be incentive for other students to follow. This is consistent with the view that behavioristic theory of learning as a change in behavior as a result of the interaction between the stimulus and response [16].

CONCLUSION

Inquiry-based teaching model to enhance critical thinking abilities meets the criteria of validity, practicality, and effectiveness. The results of expert assessment showed that the teaching model developed meet the criteria of validity with a value of 3.22 and can be implemented in the field. Field test did twice in SMP Negeri 2 Bojonegoro in a different class because an enhance students' critical thinking abilities at first test less significant, although the model was already practical. The result of teaching model realization was 3.12 so it can be said that the teaching model meets the criteria of practicality. The result of t-test analysis of the students' critical thinking abilities showed a p-value of 0.028. This meant that there has been an increase in students' critical thinking abilities significantly. The response of students to teaching model was positively associated with the percentage of 73.77%. Result of the assessment of student activity during the learning of 3.07 was included in the active category. Based on these

things can be said that the inquiry-based teaching model has enhanced students' critical thinking abilities effectively.

The components of the Teaching Model of the development consist of: (1) the model purpose, (2) syntax, (3) reaction principle, (4) social system, and (5) support system. The model purpose was to enhance the critical thinking abilities. Syntax of inquiry-based teaching model consisted of six phases, namely: (1) Confronting problem, (2) Asking conjecture, (3) Collecting Data, (4) Formulating explanation, (5) Explaining conclusion, and (6) Conducting Reflection. The principle of reaction was to provide technical assistance, ask for a review, and provide feedback. The social system emphasized cooperative learning, the medium social structure, and discussion. Support system included learning instruments as well as the tools and materials supporting the model. The learning instruments are lesson plan (RPP), student activity sheet (LKS), and the evaluation questions. The learning instruments also have met the criteria of validity, practicality, and effectiveness.

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