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Research Article

Development of guided inquiry model mathematics learning tools to practice critical thinking skills for students in linear program materials

Nerva Nur Opticia✉, Siti Khabibah, Masriyah

Magister of Mathematics Education, State University of Surabaya, Surabaya, Indonesia
nerva.17070785030@mhs.unesa.ac.id; sitikhabibah@unesa.ac.id; masriyah@unesa.ac.id

✉Corresponding Author: nerva.17070785030@mhs.unesa.ac.id

ABSTRACT

This study aims to describe the process of developing the device and producing a good quality guided inquiry model mathematics learning tool on linear program material for class XI SMA, and to describe the effectiveness of guided inquiry model mathematics learning which can train students' critical thinking skills on linear program material. This type of research is development research (RnD). The learning tools developed in this study are the Learning Implementation Plan (RPP), Students Worksheet (LKPD), and Critical Thinking Ability Test (TKBK) are developed using a 4-D development model which consists of four stages, namely the define stage, the design stage, the develop stage, and the disseminate stage. The research subjects for the trial class were 13 students of class XI MIPA 3 and the research subjects for the implementation class were 17 students of class XI MIPA 1. Based on the results of descriptive analysis, it was found that the learning tools developed were of good quality because they met valid, practical, and effective criteria. The learning device is said to be valid because all validators give a minimum score of 3 for each aspect of the assessment on a scale of 1-4 and the critical thinking ability test questions meet the valid, reliable, and sensitive criteria. The learning device is said to be practical because the teacher's activities in managing learning meet good criteria and the activities of students meet the active criteria. Learning devices are said to be effective because students 'responses to learning devices and learning activities meet the positive category, guided inquiry mathematics learning model to train students' critical thinking skills is achieved.

Keywords: Guided Inquiry Model; Mathematics Learning; Critical Thinking Ability; Linear Program

1. INTRODUCTION

One of the essences of learning mathematics is to develop students' critical thinking skills which are needed when solving problems, both those related to mathematics and everyday problems (Andalia et al., 2019; Badriyah et al., 2020; Fathoni et al., 2019; Hutabarat et al., 2019; Lubis et al., 2019; Shomad & Soetopo, 2020). The term thinking refers to the mental activity of processing information received as an effort to solve problems (Aida, 2020; Arifin et al., 2020; Erawati et al., 2020; Fardani et al., 2022; Ilma et al., 2020; Munawi et al., 2020). This is supported by the opinion of Santrock (2011). Thus, it can be said that thinking is a core activity in solving problems. Critical thinking is thinking logically and carefully when evaluating the reasons used as the basis for making decisions or actions (Chukwuyenum, 2013). According to Ennis (1996), "Critical thinking so defined involves both dispositions and abilities". Categories in the abilities section include:

> *"Focusing on a question, analyzing arguments, asking and answering question of clarification and or challenge, judging the credibility of source, observing and judging observation reports, deducing and judging deduction, inducing and judging inductions, making and judging value judgments, defining terms and judging definitions, identifying assumptions, deciding on a actions, interacting with others" (p.35).*

According to Ennis (1996) suggests: "There are 12 indicators of critical thinking which are summarized in 5 groups of thinking skills, namely providing simple explanations (elementary clarification), building basic skills (basic support), concluding (inference), making explanations. further information (advanced clarification), as well as strategy and tactics (strategy and tactics). Based on the researcher's experience while teaching as a mathematics teacher at the Superior MA CMS Pitutur, Pasuruan, it is known that related to the use of teacher centered learning, it is still dominant among mathematics teachers and the average student learning outcomes at the Superior MA CMS Pitutur are below the Minimum

Completeness Criteria. The low learning outcomes of students in learning mathematics are not only caused by difficult material, but also due to the weakness of the learning process carried out by the teacher in the classroom. Tarigan (2006: 4) states that "the learning of mathematics has been too influenced by the view that mathematics is a ready-to-use tool". This view makes teachers tend to tell the concept and how to use it. Many teachers only rely on the work of students without seeing the importance of discussing the involvement of their way of learning (Aprilianu et al., 2020; Dariman, 2019; Janewar et al., 2020; Suartama et al., 2021; Zulfakri et al., 2019). Teachers carry out learning activities not only to abort obligations. When carrying out the task, the teacher does not care what has been taught it can be understood or not here the teacher only carries out learning activities according to the time and schedule determined by the school. If they can only teach, then everyone who has the courage to stand in front of the class and is able to deliver the subject matter, will be able to become a teacher.

The inquiry learning model emphasizes maximum student activities to seek and find and place students as learning subjects. Calder and Brough (2013) research results show that the use of inquiry models in learning has a positive influence on mathematics learning outcomes. According to (Aida, 2020; Anggraini et al., 2020; Fatonah et al., 2020; Ilma et al., 2020; Jehadan et al., 2020; Saepudin, 2020) there are three kinds of inquiry learning models or approaches, namely: First, guided inquiry is an inquiry approach that uses guidelines in the form of questions that are used to guide students. So the task of the teacher in this approach is to guide and direct students broadly and develop lesson plans. Guidance by the teacher is adjusted to the level of development of the student's experience. This approach is used especially for students who have not experienced learning with an inquiry approach. Second, free inquiry is an inquiry approach that gives students the opportunity to do their own research like a scientist. This approach requires students to be able to identify and formulate various kinds of problems to be investigated in groups. Third, modified free inquiry is an inquiry approach where the teacher gives problems and then students are asked to solve these problems through observation, exploration and research procedures.

In this study, the researcher chose one type of inquiry learning model, namely Guided Inquiry. In essence, inquiry is a process that starts from formulating problems, developing hypotheses, collecting evidence, testing hypotheses, and drawing temporary conclusions, testing temporary conclusions in order to arrive at certain conclusions that are believed by students. Guided inquiry learning is a learning model that emphasizes the process of searching and finding where the material is not given by the teacher to students directly. From a 2009 study conducted by Richard Meyer, a psychologist from America, it is known that in the inquiry learning process, students learn better when they are active in learning activities, but student activity requires guidance (Arends 2012: 345). Some students cannot learn well about the concept that is the target of inquiry, so the right amount of guidance is needed. Guidance or instructions in the right amount can make it easier for students with low abilities to follow the learning process that is being carried out and students with high abilities do not monopolize learning activities.

Through the guided inquiry model, it is hoped that it can be an alternative to train students' critical thinking skills in learning mathematics. According to (Aida, 2020; Anggraini et al., 2020; Saepudin, 2020) one of the objectives of guided inquiry learning is for students to have critical thinking skills. This is because students perform mental activities before the material being studied can be understood. Such mental activities include analyzing, clarifying, making guesses, drawing conclusions, generalizing and manipulating information. According to Johnson (2006: 100), critical thinking is an organized and clear process that is used in mental activities such as problem solving, decision making, analyzing assumptions, and scientific discovery.

In addition to overcoming the difficulties of students, the inquiry learning model is suitable to be applied to linear programming material because this material is one of the materials related to problems in everyday life. This is supported by (Fatonah et al., 2020; Saepudin, 2020) who state that inquiry learning is an investigative process that involves students in solving real-life problems. Linear programming material is related to everyday life so that it can increase the motivation and interest of students (Akter et al., 2021; Hammad et al., 2021; Rahman et al., 2021; Suriyapriya et al., 2022). Because the learning steps in the inquiry model require the participation of students, the motivation and interest can have a positive influence on the implementation of the learning steps in the inquiry model (Aida, 2020; Anggraini et al., 2020; Helviyana et al., 2020; Janewar et al., 2020; Pohan, 2019). Based on the description above, researchers are interested in conducting research with the title Development of Guided Inquiry Model Mathematics Learning Tools to Train Critical Thinking Skills for Class XI Students in Linear Program Materials.

2. RESEARCH METHOD

The development research in question is research on the development of guided inquiry learning tools which include Learning Implementation Plans (RPP), Student Activity Sheets (LKPD), and Critical Thinking Ability Tests (TKBK). The development of tools refers to the 4-D model (Thiagarajan, 1974). In this study, the effectiveness of guided inquiry learning will be described in linear program material for class XI high school. The effectiveness in question includes: 1. The ability of teachers to manage learning in a minimally good category, 2. The activeness of student activities during the learning process, 3. Student responses to positive learning, 4. Critical thinking skills of students are trained. This research will be carried out on students of class XI SMA AL-FALAH Surabaya, MA Featured CMS Pitutur Pasuruan for the 2020/2021 school year and teachers who teach mathematics in these classes. The class used at this stage is a different class from the device development trial class. During the Covid-19 virus pandemic, researchers carried out research using online learning and took the subject of 13 students who were divided into 4 groups for the learning device trial class and 18 students who were divided into 6 groups for the implementation class. When conducting research at Al-Falah High School Surabaya, subject teachers could not teach, therefore the researchers took data for the implementation class at the Superior MA CMS Pitutur.

3. RESULTS AND DISCUSSION

The data obtained from the analysis results are then used to revise the learning tools developed in order to produce good learning tools in accordance with the specified criteria. This learning device will be applied to students to determine the effectiveness of learning. The following is an explanation of the data analysis process.

Expert Validation Data Analysis

The steps taken in analyzing the validity of the learning tools (RPP, LKPD, and TKBK) are as follows: The learning device is said to be valid, if the assessment of the three validators of the instrument on each component of the device developed is in the valid or very valid category.

Data Analysis of the Practicality of Learning Devices

Data analysis of the practicality of learning devices was carried out at the Superior MA CMS Pitutur because when conducting research at Al-Falah High School Surabaya, partner teachers could not conduct research with the learning tools provided, so the researchers themselves used learning tools to be applied in the implementation class.

a. RPP Practical Analysis
The RPP is said to be practical if the validator states that the RPP can be used in the field with little or no revision. Likewise, the results of observations on the ability of teachers to manage learning are in good or very good categories and students carry out learning activities well.

b. LKPD Practical Analysis
The LKPD is said to be practical if the validator states that the LKPD can be used in the field with little or no revision.

c. TKBK Practical Analysis
TKBK is said to be practical if three validators state that the TKBK can be used in the field with little or no revision.

Data Analysis of Learning Device Effectiveness

a. Students Response Questionnaire Analysis
Students response data obtained through questionnaires were analyzed based on percentages. The percentage of each response is calculated by dividing the number of student responses for each aspect that appears by the total number of students multiplied by 100%. Student responses are said to be positive if 80% or more students respond in positive categories (happy, new, interested, clear, and interested) for each aspect that is responded to. Can be accessed at http://bit.ly/angketresponnerva

b. Critical Thinking Ability Test Analysis
The critical thinking ability test (TKBK) in this research is said to be able to train students' critical thinking skills if the critical thinking ability test score is reduced by the initial score of students' critical thinking skills is more than 5 or students have achieved a maximum TKBK score of 100. Thus, learning tools are said to be of good quality in this study, namely learning that meets the following criteria:
1. Valid, which is based on: assessments from three experts (validators), and tests of students' critical thinking skills that meet the criteria of validity, reliability and sensitivity.
2. Practical, which is characterized by the ability of teachers to manage learning in the category of at least good enough, and the activities of students during the learning process meet the minimum criteria of good in every aspects.
3. Effective, if the response of students in positive learning and critical thinking skills tests can train students' critical thinking skills.

3.1 Learning Device Development Process

Guided inquiry model of mathematics learning tools on linear programming materials developed using a 4-D model. The tools developed include 1) Learning Implementation Plan (RPP), 2) Student Worksheets (LKPD), 3) Critical Thinking Ability Test. The stage of device development based on the 4-D model begins with the definition stage. The first time that was carried out at this stage was the initial late analysis which aimed to raise and determine the basic problems faced in learning mathematics at SMA AL-Falah Surabaya. In the initial-final analysis, the researchers conducted a study of the applicable mathematics curriculum, field investigations on learning tools used by teachers, source books, and a study of library sources relevant to development research. Furthermore, student analysis was also carried out to examine the characteristics of class XI students at SMA Al-Falah Surabaya which included cognitive development and academic abilities. This analysis is used as a reference in conducting concept analysis and task analysis. Concept analysis and analysis refers to the revised 2013 Curriculum Competency Standards (SK) and Basic Competencies (KD). The results of the analysis are described to formulate learning objectives.

The second stage is the design. At this stage, the first thing that is done is the preparation of the TKBK test. Next is the selection of media and formats that are suitable for learning mathematics using guided inquiry models. Lastly, is the initial design, which is to make an initial draft of learning tools and research instruments. The third stage is development (develop). At this stage, the first thing to do is to validate the learning tools that have been made in the previous stage. The results of the validation of the learning devices by the three validators are used as a reference for revising the learning tools in accordance with the suggestions from the validators. After obtaining a valid learning device, the next step is to conduct a

readability test to 3 students of class XI MIPA 2 who have heterogeneous abilities and a mathematics teacher. Based on the results of the readability test, a small revision was made to the learning device. The revised device can then be tested in class XI MIPA 3, which consists of 13 people.

Students are given a pretest before learning and posttest after the last meeting for testing, as well as providing student response questionnaires to learning tools and the learning process. The learning was carried out in three meetings with the researcher as the executor of the learning. Partner teachers observe the teacher's ability to manage student learning and activities during the learning process for three meetings. The data obtained in the trial class include 1) observation data on the ability of teachers to manage learning, 2) observations of student activities during the learning process, 3) student response data, 4) TKBK data. The trial of this learning device was carried out once because the learning device developed was a learning device that had met the criteria of validity, practicality, and effectiveness. The validity criteria were obtained from the validation results of learning devices by three validators, and the TKBK items must also meet the valid, reliable, and sensitive categories. Practicality criteria were obtained from observations of the teacher's ability to manage learning and student activities during the learning process. The effectiveness criteria were obtained from the results of the student response questionnaires and the results of the TKBK students. Furthermore, the learning tools were implemented in class XI MIPA 1, which consisted of 17 people. Because learning is done online and the researcher is a teacher who implements the developed learning tools, the researchers conducted research at the Superior MA CMS Pitutur which was carried out offline (face to face) with partner teachers who taught using the learning tools provided by the researchers. While at the Superior MA CMS Pitutur, the researcher was an observer. The implementation of the implementation in two schools which was carried out online and offline aims to determine the effectiveness of learning mathematics using guided inquiry models to train students' critical thinking skills to carry out well. Just like the trial, the data obtained in the implementation class include: 1) observation data on the ability of teachers to manage learning, 2) observation of student activities during the learning process, 3) student response data, 4) TKBK data. TKBK data is used to determine students' critical thinking skills.

3.2 Results of Learning Device Development

1. Validation of Learning Tools
The learning tools developed were first consulted with the supervisor before being validated by the validator. This validation aims to obtain appropriate learning tools used in research trials. Based on the results of the assessment by the validator on the learning tools developed, valid learning tools were obtained with revisions according to the suggestions of the validators and could be used for testing.

2. Readability Test Results
In the readability test, it appears that students quite understand the directions and instructions contained in the LKPD, while in the TKBK there is a slight revision of the sentence editor on the question, the teacher's readability test on the developed lesson kit includes: a) LKPD, b) RPP, and c) TKBK. Based on the readability test by the teacher, it was found that the teacher could understand well the learning device.

3. Learning Device Trial Results
Based on the results of the learning device trial, it was found that the teacher's ability to manage learning at each meeting got a minimum score of 3 in each aspect. Likewise, the results of observing student activities during the learning process get a minimum score of 3 in each aspect. These two things indicate that the results of both observations are in the good category. Student responses showed more than 80% of students who gave positive responses to every aspect. As many as 83.87% of the students in the trial class experienced an increase in critical thinking skills. The developed TKBK items meet valid criteria with a minimum test item coefficient of 0.699 (high category), a test reliability coefficient of 0.46 is in the sufficient category, and a test item sensitivity index of at least 0.505 in a sensitive category.

Data on the results of students' critical thinking skills were obtained through the implementation of pretest and posttest written tests in the form of TKBK to students which were used to see whether guided inquiry learning mathematics could train students' critical thinking skills. Based on the results of statistical analysis of t-test correlated right-side test and decision-making criteria in Chapter III, the results obtained are $T_{count} < T_{table}$ (-36.082 < 2.063) with (dk n-2) (26-2). These results can be said that the alternative hypothesis (Ha) is accepted and the null hypothesis (H0) is rejected, statistical calculations can be seen in the Appendix. Thus, it can be concluded that there is a significant difference (generalizable) in the effectiveness of learning mathematics with guided inquiry models before and after being given treatment. The recapitulation of the achievement of the criteria for the guided inquiry model of mathematics learning tools to train critical thinking skills on linear programming material is presented in **Table 1**.

Table 1. Achievement of Learning Device Criteria in the Trial Class

No.	Criteria	Aspects	Descriptions
1	Valid	Expert Validation	Valid
		Test Item Validity	Sufficient and High
		Reliability Test	High
		Item Sensitivity test	Sensitive
2	Practical	Teacher Activities Manage Learning	Good
		Student Activities	Active
3	Effectife	Student Response	Positive
		Improving Students' Critical Thinking Skills	Achieved

Based on the description above, the resulting learning tools have met the valid, practical, and effective criteria. This has met the criteria that Nieveen calls a good learning tool.

3.3 Effectiveness of Guided Inquiry Model of Mathematics Learning to Practice Students' Critical Thinking Skills

Based on the results of data analysis in the implementation class, the teacher's ability to manage mathematics learning with guided inquiry models on linear programming material for each aspect at least gets a score of 3 in each meeting. This shows that the teacher's ability to manage learning reaches a good category. Preliminary to closing activities were carried out well. In group discussions and class discussions, the teacher acts as a facilitator for the discussion to work well. The teacher's ability to manage this learning has met the indicators of learning effectiveness (Nahdi et al., 2021), namely the indicators of the quality of learning (quality of instruction). The quality of learning is based on the level of ease of presenting information or skills that help students learn learning materials, namely LKPD.

The next indicators of the effectiveness of the guided inquiry model of learning mathematics is the activities of students during the learning process. This is in accordance with the opinion of (Aida, 2020; Anggraini et al., 2020; Ilma et al., 2020), namely the attitude and appearance of students in the classroom is one of the things that can affect the learning process in the classroom. Similar to this opinion (Aida, 2020; Badriyah et al., 2020; Ernest, 2019; Pohan, 2019) states that the measurement of effectiveness can be seen from the ability of students to complete the learning objectives specified in each unit, one of which is based on observations of student behavior. In this study, student activities were designed based on the steps of guided inquiry learning mathematics, namely at each meeting students understood and solved contextual problems in the LKPD, then students expressed their opinions/ideas in group discussions to complete the tasks given in the LKPD. to get a conclusion about the best opinion / idea in completing the task. During the learning process, the observer observes the activities of the students. Based on the results of observations during the learning process in one group of students who were randomly selected, the students perform each learning activity well for each meeting.

The effectiveness of the guided inquiry model of mathematics learning is also seen from the percentage of students who respond positively to the guided inquiry model of learning and learning mathematics that they have gone through. A total of 80.645% of students gave a positive response based on the results of the student response questionnaire analysis. The percentage of the results of the student response questionnaire analysis as stated by (Aida, 2020; Helviyana et al., 2020; Lukitasari et al., 2020; Purwanita et al., 2019), has exceeded the minimum limit specified to measure the effectiveness of learning, which is 80%. Specifically in this study, the guided inquiry model of mathematics learning is also effective for training students' critical thinking skills. This is based on the results of the TKBK analysis with as many as 100% of students getting an increase of 5 scores of individual critical thinking skills. Based on the description above, it can be concluded that the guided inquiry model of mathematics learning on linear programming material is effective for training students' critical thinking skills. This is also similar to the research conducted by (Jehadan et al., 2020; Saepudin, 2020) which shows that realistic mathematics learning can train students' critical thinking skills on similarity material.

CONCLUSION

Based on the results of data analysis and discussion of the results of research on the development of mathematics learning tools guided inquiry models in linear programming matern. the following conclusions are obtained:

a.   The process of developing a guided inquiry model of mathematics learning tools to train students' critical thinking skills in class XI SMA Al-Falah Surabaya on the material for the lienar program is to use the four-D development model (*Define, Design, Develop, and Disseminate*). The process of developing learning tools begins with the definition stage. The results of the analysis at this stage are used to design learning devices at the design stage. The results of the draft at that stage produced Draft I, then Draft I was validated by three expert validators. After being validated by the validator, the researcher revised the learning tool according to the validator's suggestion which resulted in Draft II. After all the learning tools meet the valid criteria, then the readability test is carried out on the RPP, LKPD, and TKBK. The next stage is develop, the researcher conducts a trial of learning devices in the trial class. The data obtained in the trial class were analyzed to determine whether the learning tools developed had met the criteria of good quality.

b.   The results of developing a guided inquiry model of mathematics learning tools to train students' critical thinking skills in class XI SMA Al-Falah Surabaya and MA Unggulan CMS Pitutur on linear programming materials using the 4-D development model produce learning tools (including RPP, LKPD, and TKBK) that meet the criteria of a good quality device. This is evidenced by the fulfillment of the requirements of good quality learning tools, namely:

1) Valid

a)   The learning device is declared valid by the validator.
       Based on the results of the analysis of the results of the validation of the learning device, it shows that it has met the valid criteria. This is evidenced by the minimum score given by the validator for each aspect of the assessment of RPP, LKPD, and TKBK is 3.

b)   TKBK meets the criteria of validity, reliability, and sensitivity.
       The results of the data analysis of students' mathematical connection abilities met the criteria of validity, reliability, and sensitivity. This is indicated by the interpretation of the validity of the items meeting the medium and high criteria, the interpretation of high reliability, and the sensitivity of the items meeting the sensitive criteria.

2) Practical

a)   Teacher activities manage learning well.
       Based on the results of data analysis, it shows that the scores for each assessment in learning for lesson plans for

meetings 1, 2 and 3 are 3 and 4. These values are based on the criteria for the ability of teachers to manage learning in Chapter III already meeting the good criteria.

b)   Student activities in active learning.
Based on the results of the analysis of the observational data on the activities of students during learning, they have reached the tolerance of effectiveness, because they meet the criteria for the ideal time span set in Chapter III, active student activities.

3) Effective
a)   Student responses to positive learning.
Based on the results of the questionnaire data analysis of student responses, it shows that each aspect is more than or equal to 80%, so it can be concluded that the student's response to the guided inquiry model of mathematics learning to train critical thinking skills is positive.
b)   The guided inquiry model of mathematics learning to train students' critical thinking skills is achieved. This is indicated by the achievement of predetermined criteria.
Based on this, it can be concluded that this research has produced a good quality guided inquiry model of mathematics learning tools to train students' critical thinking skills in class XI linear programming material.

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AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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