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Development of Mathematics Learning Tools of Group Investigation (GI) Model with Characters Contain to Increase Critical Thinking Ability

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Abstract

Critical thinking helps students to study the problems systematically, face challenges with an organized, formulate innovative statements, and design original solutions. This research aims to describe the characteristics of development mathematics learning tools of GI model with scientific approaches, and examine the effectiveness of learning by using developed mathematics learning tools with scientific approach GI model's with character contain to improve critical thinking students'. This research method is R & D using 4-D models developed by Thiagarajan, Semmel & Semmel (1974) but in this research only used of three stages, namely: (a) definitions, (b) design, and (c) development. Research data obtained by observation method, documentation, questionnaire, and test. All data were analyzed descriptively, except test analyzed by statistically using validity, reliability, level of difficulty and distinguishing test. Hard work in learning is the behavior of students who show serious effort in completing tasks, focus on lessons and try to find information about lessons. The results showed that development mathematics learning tools GI model with scientific approaches integrates between indicators of competency achievement with indicators of critical thinking skills accompanied with hard work character and learning tools with scientific approaches GI models with character contained showed a significant impact in improving critical thinking student.

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INTRODUCTION

Education is a process to develop all aspects of the human personality which includes knowledge, values, attitudes, and skills. According to Wardono, Waluya, Kartono, Mulyono & Mariani (2018) education is a means for risk prevention, as well as a tool that can help improve the quality of human life in a sustainable manner. The reference to guide implementation in the field of education is the curriculum because the key to education is concerned with determining the direction, content, and processes that culminate in graduate qualification standards. In the curriculum 2013 developed with the mandate must be able to foster Pancasila values in the souls of students. The strategy of implementing the desired learning activities of students according to the curriculum 2013 is to apply a scientific approach which basically focuses on the inquiry-based knowledge acquisition process as well as in-depth and meaningful knowledge internalization that takes place gradually.

One of the subjects in the curriculum in elementary education level in mathematics. Mathematics needs to be given to all students starting from elementary school aims to equip students with the ability to think logically, analytically, systematically, critically and creatively, as well as work skills to work together. By learning mathematics students can foster the arrangement of reasoning or then thinking skills that are useful for learning science and in the application of mathematics in everyday life.

Suyitno (2008) states that mathematics is a bridge between humans and nature, between the inner world and born, besides that mathematics is a tool of thought, the language of science, the procedure of knowledge, and deductive inference. Success in taking the level of mathematics education is needed to support the learning success of students in taking a higher education level, as well as develops their thinking ability.

Thinking activities are closely related to the learning process. Someone who is thinking is also doing the learning process at the same time. Thinking ability is possible to develop because humans have a growing curiosity. Kurniasih (2012) express, critical thinking skills need to be developed in every individual including students. Students need to have the ability to think critically in order to be able to apply it in their daily lives. Someone who has the ability of critical thinking will be able to examine the problems faced, find and choose the right solution, logical, and useful. Critical thinking enables students to study the systematic problem, face various challenges in an organized manner, formulate innovative statements, and design original solutions. Choy & Oo (2012) explained that critical thinking is the ability to analyze and make decisions about what to do. Fadhiila, Sunarso & Aji (2016) strengthened that idea critical thinking skills will help in solving problems.

In reality, learning by implement critical thinking skills is still very rarely found in elementary education, so students often have difficulty developing the critical thinking ability in solving problems and applying the concepts learned in school. These problems also occur in PGRI Junior High School Pabuaran, Cirebon. Based on the initial investigation it was obtained that a condition of critical thinking abilities students' is still low. Teachers rarely give questions that train critical thinking skills of students. The provision of story problems is rarely done because of the large amount of learning material that must be given to students. The provision of story questions only comes from textbooks. Besides that learning is still teacher oriented so students have difficulty developing critical thinking skills. In the learning process students tend to be passive, do not have the courage to ask when experiencing difficulties in understanding the lessons, and students are slow in doing assignments and some do not do the assignment. Therefore, it is important to make an effort in conducting research to improve and develop the potential for critical thinking while increasing the character of students' hard work. The learning model that is considered to improve students' critical thinking skills and is also fun in

the learning process is the Group Investigation (GI) model.

Isjoni (2011) states that GI learning model is a complex cooperative learning model because it combines the principles of cooperative learning with constructivism-based learning and democratic principles. Şimşek, Yilar & Küçük (2013) GI learning model that focuses on group activities where each student in the group investigates a topic and then reports the results of their investigation. Jongsermtrakoon & Nasongkhla (2015) interpreting GI as a group learning where students participate in investigative activities that are analyzing and solving certain problems. GI learning model students are required to be more active in learning, students learn in groups to understand the material. During the learning process, almost all learning activities are carried out by students. Students are required to always think about a problem and they seek their own solutions. So that they are more trained to always use their knowledge skills. In the GI model students are required to be more active in solving problems given, so that the assignments given can be completed on time

Based on the description of the background that has been explained, the purpose of this study is to (1) describes the characteristics of the developmental mathematics learning tools GI model with scientific approaches, (2) examine the effectiveness of learning by using developed mathematics learning tools with the scientific approach of the GI model's and character contain to improve critical abilities students'.

METHODS

This research is a research and Development (R & D). In this research, the mathematics learning tools with scientific approach GI model of the algebraic lesson was developed refers to the Four-D development model. Thiagarajan, Semmel & Semmel (1974) the development model consists of stages: define, design, develop, and disseminate. This study did not arrive at the dissemination stage but only reached limited dissemination that is an effort to evaluate and revise until obtained a final prototype of the learning tools through the trial process.

The learning tools developed in this study include (1) syllabi, (2) lesson plan, (3) supplementary books, (4) students worksheet, and (5) critical thinking test. Subject early trials in this study were 20 students of class VII C SMP PGRI Pabuaran with saturated sampling techniques, while the final test subjects in this study were conducted in class VII A and VII B of SMP PGRI Pabuaran totaling 42 students.

The instrument used were a validation sheet to obtain data on the results of the validation experts on learning tools, an observation sheet to obtain data on the implementation of learning tools that have been validated, effective device sheet for obtaining data on the effectiveness of learning using validated learning tools.

RESULTS AND DISCUSSION

At the define, stage begins with the front-end analysis activity which aims to identify the fundamental problems needed in the development of learning tools. The fundamental problem that needs to be pursued in learning is how to present teaching materials and the implementation of learning. Prior to learning in the classroom, doing first is an analysis of student. Class VII students are aged 12 to 14 years, according to Piaget that students at that age are in the formal operational stage, this is a consideration in preparing the material. Learning material is arranged from concrete things to more abstract things so that it is expected to facilitate the students' understanding process. Analysis of material is done before making the learning tools and conduct of the research. Task analysis aims to support the achievement of competence from the results of the material analysis, students are given a series of tasks that must be done in class or at home.

The design stage develops learning tools products that support the characteristics of the scientific approach with the GI model. Then design learning tools that match the

characteristics of the scientific approach with the GI model include a syllabus, lesson plan, supplementary books, students worksheet dan critical thinking test. The results at this design stage are called draft 1. Besides that, it also makes the design of learning tools, also prepared research instruments, among others: validation sheet along with scoring guidelines, observation sheet of the learning implementation process, student and teacher response questionnaire, observation sheet critical thinking skills dan hard work observation sheet.

The development stages to produce development products is carried out through two steps, that is: (1) expert judgment followed by revision, (2) development test. The purpose of this development is to produce the final form of the mathematics learning instrument of the GI model to improve critical thinking skills and critical thinking ability of students who have the character of hard work after revision based on the input of experts/practitioners and trial results data. As presented in Table 1.

The results of expert validation of the developed learning tools are presented in Table 2.

Table 1. Results of Development of Learning Tools

Development of learning tools	Before development	After development
Syllabus	Indicators of achievement competencies are defined from basic competencies	Indicators of achievement competencies are described from basic competencies that contain indicators of critical thinking abilities and indicators of the character of hard work
Lesson plan	The learning stages are adjusted to the learning model used	Learning stage uses the GI learning model which contains indicators of critical thinking ability, indicators of critical thinking skills and indicators of the character of hard work
Supplementary books	Contains examples of questions, discussion, and practice questions	Examples of questions and exercises are associated with aspects of critical thinking and include the character of hard work
Students worksheet	Contains a summary of lesson study and collection of questions	The problems presented are used to develop critical thinking ability, critical thinking skills that contain the character of hard work, and are associated with problems presented in supplementary books
Critical thinking test	Questions compiled based on learning indicators	The questions given combine the indicator competency achievement and indicator critical thinking ability

Table 2. The result of Average Validation of Learning Tools

Learning tools	Validator					Average	Criteria	Decision
	I	II	III	IV	V			
Syllabus	3.6	3.8	4.4	3.8	4.2	4.2	Good	Valid
Lesson plan	3.7	3.5	4.3	3.8	4.0	3.9	Good	Valid
Supplementary books	3.4	3.4	3.6	3.6	3.6	3.5	Good	Valid
Students worksheet	3.8	3.5	4.0	3.5	4.0	3.8	Good	Valid
Critical thinking test	3.8	3.0	3.8	3.8	3.8	3.6	Good	Valid

Based on the results of the device validation by the validator shows that the developed learning tools are valid so that that learning tools that have been developed can be used in learning with little revision.

Subsequently, field trials were conducted to assess the practicality and effectiveness of the develop learning tools. Practicality includes the implementation of learning tools, observations carried out during the learning process that was carried out in four meetings. The recapitulation of observational data on the implementation of learning is presented in Table 3.

Table 3. Recapitulation of Observational Implementation of Learning

RPP/Meeting to	Total score	Total average	Criteria
RPP 1	3.14	3.72	Good
RPP 2	3.68		
RPP 3	3.86		
RPP 4	4.18		

Based on the results of the recapitulation of observational data on the learning device, the average total score was 3.72 which was included in the good category. Thus learning devices can be used well in the learning process.

Based on the results of student responses as a whole the results of student responses to learning tools that 81% of students gave a positive

response. This shows that the positive response given by students is in very good criteria. The response results given by students are not the main reference in improving the quality of learning, but the learning tools developed are also assessed by the teacher. The result of the teacher's response to the learning tools is 4.12, with the criteria for assessing the teacher's response to the learning tools including good. So it can be concluded that the learning tools can be used.

The results of the teacher's response to the developed learning tools as a whole can be accepted, the teacher feels happy and is helped by the developed learning tools. According to the teacher, using the learning tools developed adds a reference to student learning and helps students learn independently, thus inspiring teachers to develop similar learning tools on other material.

Hard work data is obtained from observations made by observers when learning takes place during four lessons. Hard work observation data are analyzed by summing all scores obtained by students from all observed and calculated average aspects. Indicator in observing the character of hard work includes: (1) not desperate in facing learning difficulties, (2) focus on the lesson, (3) doing tasks carefully and neatly, (4) use time effectively to complete tasks in class and outside the classroom, and (5) trying to find information about subject lessons from various sources. The results of the observational data on hard-working characters are a figure in Table 4.

Table 4. Recapitulation of Observational Students Hard Work

Meeting	Percentage (%)	Criteria
Meeting 1	53.93	Start developing
Meeting 2	66.04	Has developed
Meeting 3	68.75	Has developed
Meeting 4	79.06	Has developed

With the percentage, criteria can be seen in Table 5. (Kemendiknas, 2010).

Based on Table 4 for each meeting, there is an increase in the character of hard work in students. Learning tools that are used indirectly can be positive towards increasing the character of hard work. During the learning process takes place interspersed with advice to try harder in learning and instill ethical values that can be implemented in everyday life.

Table 5. Reference to Student Hard Work Criteria

Percentage %	Criteria
81-100	Entrenched
61-80	Has developed
41-60	Start developing
21-40	Start to look
0-20	Not seen yet

Effective learning device characterized by students' mastery learning both individually with a grade of 65 and 75% classical class. The results of the experimental class critical thinking ability test showed that 18 out of 22 students got grades that reached the minimum completeness criteria while 4 other students scored below the completeness criteria. Also known as the average value of the critical thinking ability of the experimental class is 72.6. Based on this data, an analysis of the completeness of critical thinking skills was carried out to find out the average completeness and the proportion of students who were completed. To find out the completeness of the average critical thinking skills students', the average completeness test is done by t-test. Based on the results of the t-test, obtained values t_{value} is 4.19, and value t_{table} with $\alpha = 5\%$ is 1.72. So, the value $t_{value} > t_{table}$. The test results prove that the average critical thinking ability exceeds the minimum completeness criteria (KKM = 65). In addition, a proportion test with the z-test was conducted to determine the completeness of critical thinking skills in achieving the specified standard of 75%. Based on the z-test, it is known that the value z_{value} is 1.72 while value z_{table} is 1.64. Thus it can be seen that $z_{value} > z_{table}$ or 1.72 higher than 1.64. It can be concluded that the critical thinking ability in students with the GI model of the scientific approach that gets more than 65 points reaches 75%. Based on the results of these tests, it can be concluded that GI learning helps students achieve learning completeness. This is in line with Almeda & Sahyar (2017) stated that GI activities encourage students to be active in discussion activities, share information and help each other in difficult groups.

Besides that, the effectiveness of the learning tools is also obtained from the comparison of the experimental class with the control class. From the results of the homogeneity test on posttest data, it has been known that the data on critical thinking abilities of class students who are given the GI model scientific approach and the classes given conventional learning have the same variance. By using the t-test formula the values are obtained t_{value} = 3.36 with α = 5% and dk = 41 get value $t_{1-\alpha} = t_{1-0.05} = t_{0.95}$ = 1.68. Thus it is known that $t_{value} > t_{1-\alpha}$ so H_0 rejected. It can be concluded that critical thinking abilities students' who were given learning scientific approach GI model were better than that of students who were given conventional learning. The results of this study are in accordance with Sangadji (2016) which shows that GI learning is learning that helps students to be more active in the learning process.

Table 6. t-Test Result

Average		Standard deviation		t_{value}	t_{table} (α = 5%, dk = 41)
X_1	X_2	X_1	X_2		
0.62	0.45	0.39	0.23	1.97	

Information:
X_1 = experimental class
X_2 = control class

Increased of critical thinking skills based on the gain value is 0.62, which means the interpretation of the improvement of critical thinking skills in students who are given a scientific approach to the GI model is in the medium category. Then the mean difference test of the gain score. This mean difference test is used to compare the average gain score between classes that are given a scientific approach to the GI model and the class given conventional learning. By using t-test gain score, it is obtained t_{value} = 1.97 with α = 5%, dk = 41 and $t_{1-\alpha} = t_{1-0.05} = t_{0.95}$ = 1.68. Thus it is known that $t_{value} > t_{1-\alpha}$ so H_0 rejected. It that the mean value of the improvement of critical thinking ability of students who were given a scientific approach with GI model was better than that of students who were given conventional learning. This is in accordance with Prihartanto, Trapsilasiwi & Setiawan (2013) the application of the GI learning model contributes well to students' abilities and supports character formation that is implemented by a collaboration between students. The comparison is presented in Table 7.

Table 7. Comparison of Critical Thinking Ability in Experimental Classes and Control Classes

Indicator	Experimental class	Control class
Proof	71.9	65.7
Generalization	65.0	68.9
Problem-solving	80.9	48.6

Based on Table 7, it can be concluded that the overall average score for each indicator of experimental class critical thinking ability is better than the control class. However, for the generalization indicator of the experimental class is lower than the control class, this is because students have understood the problem questions that are identifying the problematic relationship patterns presented can be resolved using rules/patterns, meaning that students are able to draw conclusions, in general, resulting from observation of the main structure, general patterns, and principles. Although on the generalization indicator the average post-test score of the control class students is better than the experimental class but for general problem-solving indicators the control class students still cannot solve problems related to problem-solving this is because students have not been able to identify the required element adequacy in solving problems.

Regression test calculation to determine the effect of hard work and critical thinking skills on critical thinking ability. The results of the multiple regression analysis can be seen in Table 8.

Table 8. Output ANOVA Result

Model	Sum of squares	df	Mean square	F	Sig.
Regression	641.546	2	320.773	23.126	000a
Residual	263.547	19	13.871		
Total	905.093	21			

a. Predictors: hard work, critical thinking skills
b. Dependent variable: critical thinking ability

Based on Table 8 obtained F_{value} = 23.126 and value sig = 0.000 = 0% < 5%, so reject H_0 and accept H_1. So it can be concluded that hard work

and critical thinking skills together have a positive effect on critical thinking ability. The R score is 0.842 and R Square = 0.709 which explains that 70.9% of students' critical thinking abilities are influenced together by hard work and critical thinking skills.

Table 9. Output Regression Coefficient Results

	Unstandardized coefficients		Standardized coefficients		Sig
Model	Beta	Std. Error	Beta	t	
Constant	3.384	11.914		.284	.779
Critical thinking skills	21.145	4.971	.746	4.254	.000
Hard work	4.069	5.582	.128	.729	.475

a. Dependent variable: Critical thinking ability

Based Table 9 obtained values a = 3.384; b = 21.145; and c = 4.069, so multiple regression is $\hat{Y} = 3.384 + 21.145X_1 + 4.069X_2$. Seeing the influence of each independent variable on the dependent variable is done through a partial test of the t-test, to accept or reject the hypothesis can be confirmed in the sig value of distribution t in Table 9. Value significant for hard work variables sig = 0.475 = 4.75% < 5%, so H_0 reject, that means hard work has an influence on the variable critical thinking ability. As for the critical thinking skills variable sig = 0.000 = 0% < 5% so H_0 reject, meaning that critical thinking skills affect the variable critical thinking ability. This also means that both jointly and partially, hard work and critical thinking skills influence critical thinking skills.

CONCLUSION

The results showed that the development of mathematics learning tools GI model with scientific approaches integrates between indicators of competency achievement with indicators of critical thinking ability accompanied by hard work character. Learning tools with scientific approaches GI models character contained to improve students' critical abilities concluded the effect

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