

# Improving Students' Reasoning and Communication Mathematical Ability by Applying Contextual Approach of The 21<sup>st</sup> Century at A Junior High School In Padang

1<sup>st</sup> Rafki Nasuha Ismail  
mathematics education department of  
post graduate school  
State University of Padang  
Padang, Indonesia  
rafkinasuhaismail25@gmail.com

2<sup>st</sup> I Made Arnawa  
mathematics department  
Andalas University of Padang  
Padang, Indonesia  
arnawa1963@gmail.com

**Abstract**— The reasoning and communication ability in learning mathematics junior high school still low. This indicated from the result of TIMSS and PISA. The aim of this research determine the improvement of student's reasoning and communication ability of mathematics SMP 7 Padang whose approach contextual teaching learning aided students worksheet based on the 21st century. This study is a pre-experimental research. The study design used One Group Design and sample collection technique is purposive sampling. The research sample involving students of class VII in the school year 2017/2018 with class VII8 as an experimental class which have 30 persons. The ability of reasoning and communication mathematical is measured by test. The data were analyzed quantitatively by using independent sample t-test and normalization Gain Score. The results showed that the students average pretest score is 5.50 while the students average posttest score is 15.50. The results of gain scores obtained an average gain index of 0.54, means that there is an increase in student's mathematical reasoning and communication abilities after learning through of contextual teaching learning aided students worksheet based on the 21st century to the medium category.

**Keywords**—reasoning and communication of mathematics, student worksheets, the 21st century

## I. INTRODUCTION

Mathematics is one of the compulsory subjects taught in all levels of education. The important role in standard of mathematics curriculum, according to NCTM Standards [1] as the main standards in mathematics teaching namely troubleshooting capabilities (problem resource), communication capabilities (communication), connection capabilities (connection), logic (reasoning ability), and ability representations (representation). Reasoning ability in mathematics teaching also aims to develop the communication skills, develop the ability to communicate ideas between others through oral talks, note, graphs, diagram in explaining the idea of [2] students who have a rational power mathematical prowess better then students will be able to communicate ideas in the form of verbal or written. Communication must occur when the learning process takes place not only versed communicate, but students can also understand.

The achievement of Indonesian students in the international scene is still low because of the characteristics of the questions that tested in TIMSS tend to test aspects of the logic, while Indonesian children are still dominant in the low level, or more on the ability to memorize in learning science and mathematics. The mathematics curriculum in Indonesia itself is too much emphasis on the mastery of basic skills count (basic skills) which has procedure, whereas learning mathematics should develop logic reasoning, and suited capabilities.

The result of the students in Indonesia who had reached by PISA not so good, [3] Indonesian ranks 64 from 65 countries that participate in the PISA test. Whereas the average OECD published score sequentially is 494, 496, and 501. PISA gauge of children age 15 years in implementing the problems in real life. Indonesia followed the three years test cycle since 2003. In figure 1 is served one of the questions that tested in PISA (<http://www.oecd.org>). [3] students in Indonesia who had reached by the age of 15

Example:

Below are 3 towers that have different height and are composed of two forms, namely the shape of the hexagon and rectangle. What is the tallest tower height?

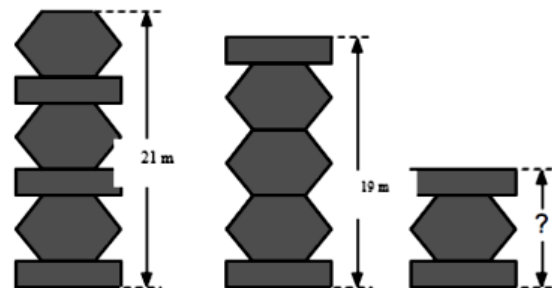


Fig.1. Example of PISA

Students mathematical communication capabilities are required in completing the questions. Students who have a good mathematical concepts but does not have a good mathematical communication capabilities yet, will have difficulty in troubleshooting questions. Students must be able

to interpret the idea of mathematics that is on the question of the students is required to connect a high tower and the tower two that have been known in the questions to get high tower three. On the question of PISA, needed mathematical communication skills students, namely explains the idea of the situation, and mathematical relations, orally or writings, with tangible objects, pictures, graphs, and algebra. Mathematical communication capabilities that both expected the problems given can be answered with clear and understood by other people.

Based on the results of the observations conducted on 17 October 2017 toward the 29 students of class VII SMP 7 Field with provide 2 questions explanation in writing. Introduction to research done by the researcher in the form of providing test the ability of the reasoning and mathematical communication regarding the material 1 solution to the problems of the operation of addition and subtraction sums in the form of algebra.

Low mathematical ability students can be seen from the result of observation that obtained in class VII8. Given the two items about which consist of one point the reasoning and one point the communication. The results obtained in general less than half of the students in the class has not been able yet to answer the questions correctly about reasoning and the students are still hindered in solving the question of reasoning following:

This can also be seen from the answer to the students on the following questions :

a probing the wells every 2 hours can dig as deep as metre. How the pit unearthed if probing working hours?

Students answer:

$$2 \frac{1}{2} \text{ jam} = 5 \text{ jam} - 1 = 4$$

$$2 \frac{2}{3} \text{ m} = 8 \text{ m} - 4 = 4$$

$$\frac{4}{6} = \frac{2}{3} \text{ m}$$

Fig. 2. Example Answers the Students

From the student's answers can be seen that they could not find the correct answer based on the existing information. The students could not perform mathematical manipulation to solve the issue. It can be seen that the students have not been able yet to draw conclusions from the symptoms that already exist. The students should be to compare the first condition that is given by the second condition that must be completed. First Steps, students should understand that 2.5 hours of working, the probing can be dug as deep as 2.67 meters. Back to the question the student should be able to compare with first condition. For 0.5 hours in the pit unearthed is  $(0.5 \times 2.67) / \text{metres}$ . From 29 students of class VII 8 exactly only 7 people (24%) students who were able to answer correctly.

However, the fact shown that the students are not being able to relate to previous existing condition so they could not solve the issue. This is due to the ability of the logic of the students that is still low and has not been able to draw conclusions from a statement. another evident of the low score of students ability of communication mathematical can be seen from the following question.

Budi has the pool surface is square long. The width of the surface of the pool of outstanding 6 metres shorter than length. If around the surface of the pool of outstanding 28 meters, write the form of algebra that states around the surface of the pool of wisdom and the overall size of the length and width of the surface of the pool of outstanding actually?

The questions above requires the students to be able to explain an idea through algebra and mathematics symbol and the students must be able to declare a day-to-day event into the language of mathematics. One example of the answer to the students can be seen in figure 2 as follows are:

Students answer:

Diket:  $k = 28$   
 Rebar lebih pendek 6 cm dari panjang  
 Tanya: Bentuk aljabar yang menyatakan keliling

Jawab:  $k = 28$   
 $p + 6 = 28$   
 $p = 28 - 6$   
 $p = 22$   
 $L = 28 - 22$   
 $= 6$

Fig. 3. The Example of the Answer Students

In Figure 3, it can be seen that students have not been able to explain the idea through algebra and mathematics symbol and has not been able yet to declare a day-to-day event into the language of mathematics properly. To provide a complete explanation and logical and produce the correct calculations. first, The student must be able to render the question of the story into mathematical language as to the length of the garden with  $p$ , and the width of  $l = (p - 6)$ . Because the requested matter the length and width of the vineyard, the students should be able to represent common  $p$  and  $l$  in the form of common  $k = 2p + 2l$ , so obtained  $2p + 2(p - 6) = 28$ . After the students are able to present their ideas into the language of mathematics, then the students will be able to do the correct calculations. From 29 students of class VII 8, only 9 people (31%) students who are able to answer correctly. This condition indicate that the student's ability of the logic and mathematical communication still in low level. If this matter is left behind, it surely will have a negative impact, except on the level of student mindset, it will also have an impact on the results of the study in the future.

Based on the observation that has been done and the data obtained, it can be seen that there still have problems in indicators on the student's ability of the reasoning and communication. So it can be concluded that the student's problem is in the ability of reason and mathematical communication. Teachers have tried to design the learning system that can improve the student's mathematical ability, but the designed device is not capable yet to improve the ability of the logic and communication students, due to a specific learning approach has not been used to develop the work sheets learners

If the problem persists, then the ability of students in logically critical thinking, analytical mind and creative that can be formed through the ability of the logic and communication students will not be actualized. In addition it is feared will also inhibit the development of the students in the 21<sup>st</sup> century. The low level of reasoning and mathematical communication of students cannot be separated from how the teachers deliver the subjects in the classroom. This is in line with the opinion of Mahmudi [4] who proposed that the change is required during the using of learning approach. Mathematics lessons should be associated optimally with the real life and the minds of the students so it will be meaningful. One of mathematics teaching approaches that can be used to develop the logic and communication is assisted contextual approach century worksheets 21.

Nowday, mathematics teacher is expected to be able to use various learning method and teaching models. Teacher collaboration meant that the mathematics teacher is expected to take advantage of the 21<sup>st</sup> century learning as a tool to enrich the knowledge and student interest. Therefore, teachers must also share ideas and contribute to the development of your mathematics teaching in the 21<sup>st</sup> century. The most important issues in mathematics teaching today is the importance of the development of the communication capabilities of mathematics students where in the information era, the students have to compete in the global community, [5] the students are required to have a creativity, the ability to think critically, communicate, and collaborate, better known by acronyms 'Four Cs' [6] needs of Mathematics skills 21<sup>st</sup> century, learning device is required to prepare the students to have the skills of 4C (critical, creative, communicative, and collaboration). The teacher must be focus on the problem and the process of the context of the real world provides the opportunity for learning approach with the project collaboration, and the must be focus to teach 'how to learn'. [7].

One way to overcome this problem is develop worksheets 21<sup>st</sup> century to be more meaningful and enjoyable, but not to take lot of time and cost in implementation. Based on the literature study that has been done, according to the researcher, one of the appropriate ways to solve the problem is to develop work sheets that integrate the skills of 4C-based approach Contextual Teaching Learning. The purpose of this research is to know whether the increased ability student's reasoning and communication of mathematical SMP 7 Padang the capacity of the logic and mathematical communication students learning using Contextual Teaching approach Learning assisted work sheets 21<sup>st</sup> century.

According to Johnson B. Elaine [8], contextual learning components include: (1) braid relations, which means (*making meaningful connections or constructivism*); (2) do the works, that means (*inquiry*); (3) Do the learning process that set itself (*self-regulated now learning or questioning*); (4) held a collaboration (*collaborating*); (5) critical thinking and creative (*critical and creative thinking*); (6) provides service individually (*nurturing the individual*); (7) strive to achieve a high standard (*recently high standards or modeling*); and (8) using the assessment authentic (*using heading authentic authored*)

Based on Kemdikbud formulate, learning paradigm stresses on 21<sup>st</sup> century ability learners in finding out from various sources and formulate the problem analytical thinking, cooperation and collaborate in solving the problem [9]. Now explanation about the framework of learning the twenty first century is as follows: (a) to critical-thinking and problem-solving), (b) to communicate and collaborate; (c) to creativity and innovation.

In addition to use the appropriate learning approach, the use of learning materials must be according to the student's thinking skills that can be trained. Teaching materials an important aspect in teaching and learning activities, one of them is a Worksheet Students [10]. With the approach of contextual learning teaching and learning is more focused on the students that involve students in working on worksheets to think critically, creative collaboration, and communication will provide meaningful learning and teaching are not only on the scope of the theory but associated with the skills of logic and communication provides an overview about a lesson materials that not only emphasize on the stages of the CTL 21<sup>st</sup> century but also skills 4C students so that the expected ability of the logic and the communication increased.

Some teachers stated that have yet to adopt such as what CTL approach 21<sup>st</sup> century in learning or in using worksheets therefore, research needs to be done to know the effectiveness of worksheet CTL 21<sup>st</sup> century is useful to train the ability

## II. RESEARCH METHODS

The pre experiment of this research use *one group pretest-posttest*. Thus to know the difference in the ability of the logic and mathematical communication students done with research design as follows [11]:

TABLE 1. RESEARCH DESIGN THE DESIGN OF ONE GROUP PRETEST POSTTEST

The group of observation	Observation Treatment		
	Observation	Treatment	
The experiment	O1	X	O2

On this design, the classification of the subject of this research are the students of class VII. The group of the experiment were given the pre-test (O1) before the treatment of Contextual Teaching approach Learning assisted worksheets 21<sup>st</sup> century (X), then at the end of the treatment given posttest (O2).

This research conducted at SMPN 7 Padang, carried out on the odd semester the school year 2017/2018. The population in this research is the students of class VII SMP, the samples is class VII.8 as classroom learning with a model of Contextual Teaching Learning assisted work sheets 21<sup>st</sup> century. Sampling techniques are done by using the technique of "Purposive Sampling". The collected data form is an essay questions *pretest* and *posttest*. Writing about adjusted with the indicator reasoning and mathematical communication used book. The instrument validated in this research namely worksheet, the question of the *pre-test* and *post-test* along with the guidelines scoring. After validation the instrument, the question of pretest and



posttest, is tested. Test questions aimed to determine the validity coefficient, level reliability index of the tribulation and the distinguished power, *pretest* and *posttest results in the form of the results of the test capabilities of the logic and mathematical communication students analyzed to give a score on the answer to the students and then the results of the test capabilities of the logic and mathematical communication students analyzed in 2 ways, namely with t-test and n-gain score to see the logic and mathematical communication students skills [11].*

Before hypothesis testing, check the normality of the data and the variance homogeneity of each group of population data. Kolmogorov test is used to the normality of the data and Levene test is used to the variance homogeneity of each group of population data. All the test in this research is using *Minitab program*. Known there is increased between the pre-test and post-test or gain. Great improvement is calculated with the formula of the gains normalized using the formula [12]:

$$N\text{-gain} = \frac{\text{postesscore} - \text{preteesscore}}{\text{maksimumscore} - \text{preteesscore}}$$

TABLE II. THE CLASSIFICATION OF N-GAIN

The Average of Normalizatio Classification of	
N-gain $\geq 0.70$	High
$0.30 \leq N\text{-gain} < 0.70$	Midle
N-gain $< 0.30$	Low

### III. RESULT

This research has done on the class VII.8 SMP 7. On this sample class will be given preferential treatment in the form of teaching and learning using CTL approach assisted worksheets 21<sup>st</sup> century on the matter the association. Research samples were 30 people.

- Description of the data capacity of the logic and mathematical communication students that covers the average pretest, average posttest, average N-gain, Standard of deviation (SD) N-gain based on learning approach is presented in Table 3

TABLE III. OF THE CAPABILITY REASONING AND MATHEMATICAL COMMUNICATION BASED ON CTL ASSISTED WORKSHEETS THE TWENTIETH CENTURY

Ability of Reasoning and Communication	CTL Assisted Worksheets the Twentieth Century			
	Group Statistics			
	Max Score	Min Score	Mean	SD
Pretest	12	1	5.50	3.12
Postes	22	7	15.90	3.78
Average Gain	17	3	10.40	3.06

Table III provides that the value of the post test the ability of the logic and mathematical communication

students who get assisted CTL approach worksheets 21<sup>st</sup> century higher compared to pre test the ability of the reasoning and mathematical communication students. This is shown with the average earnings of students postes 15.90 higher compared with average earnings pretes score students only by 5.50. Score comparison pretest and posttest on learning using CTL assisted worksheets 21 century served in the bar diagram in Figure 4 below.

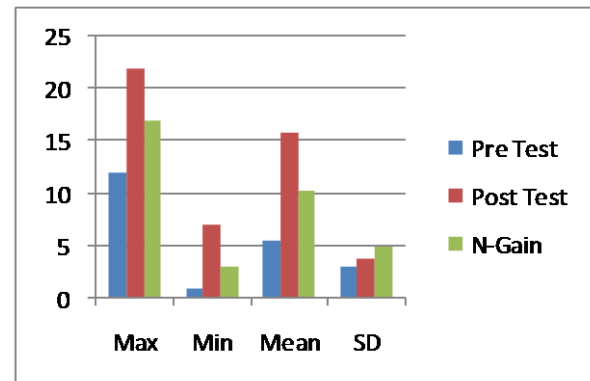


Figure 4. Diagram of the Ability of Reasoning and Mathematical Communication Students'

Based on Figure 4 are given that mean and standard deviation value of the post test are higher than the average and deviation pre score test students after learning using CTL assisted worksheets 21 century.

- Data analysis of the capacity of the reasoning and mathematical communication approach based CTL assisted 21 century work sheets

In according to the purpose of this research is to know whether there is an increase in the ability of the reasoning and mathematical communication students after learning is done using CTL approach assisted work sheets 21 century. The data statistics using the formula t test.

In trial normality, criteria normality pre test namely the acceptance of  $P\text{-value} = 0.064$  post test, and the acceptance  $P\text{-value}$  pre test =  $0.567 > 0.05$ . So homogeneity test is obtained  $P\text{-value} = 0.409 > 0.05$ . Because of pre test and posttest data normal distribution and homogeneity, the next step is to do the calculation using parametric tests namely dependent t-tests to test the comparative hypothesis dependent samples. The results of t-test and the reason and mathematical communication students as follow

TABLE IV. TWO-SAMPLE T-TEST AND CI: SCORE; CLASS

Two-sample T for your score				
The class	N	Mean	St Dev	SE Mean
Post test	30	15.90	3.78	0.69
Pre test	30	5.50	3.12	0.57
Difference=Post test Pre test				
Estimate for difference: 10.4000				
95% lower bound for difference: 8.9034				
T-Test of difference = 0 (vs >): T-Value = 11.63 P-Value = 0.000 Indonesia Recorded Its 94 = 55				

From of Table IV, it conclude that there are differences in the ability to reasoning and mathematical communication before and after the learning using CTL assisted work sheets 21 century in aggregate materials in class VII 8 SMP 7 Padang. Then to determine the category of increased capacity of the reasoning and mathematical communication students performed the calculation of N-gain. The calculation of N-gain pretest and posttest data summarized in Table V below

TABLE V. RECAPITULATION OF N-GAIN

Statistics	Pre Test	Post Test	Gain Normalization
	Score	Score	
Mean	5.50	15.90	0.540
SD	3.12	3.78	

Based on the results obtained an average of the gain index is 0.54, means there is increased communication capabilities mathematically students after learning through assisted CTL approach work sheets 21 century with the category is medium.

#### IV. DISCUSSION

Based on the analysis of the data pretest scores and post test, obtained the average pretest and posttest score are 5.50 and 15.90. Then the analysis of the student data before and after the learning is done through assisted CTL approach work sheets 21 century. The results of the calculation of N-gain shows the category increased capacity of the logic and mathematical communication students is currently with an average of the gain index of 0.54.

From the analysis of the data above shows that there are increased capacity of the logic and mathematical communication students. Improving the mathematical communication skills students happens because in the teaching process used the characteristics of the CTL approach assisted work sheets 21 century. Through the skills of 4C (communication) 21 century gave an opportunity to the students to improve their mathematical communication capabilities. The students learn how to inquiry, ensnared, reason, and write mathematical ideas about the concepts of mathematics that they learn. Students are also trained to criticize the explanation of their friends.

Through learning activities designed in accordance with the principles and characteristics of this 21st century CTL that allows the stimulation of indicators of reasoning and mathematical communication. In this approach can be seen when students are working on worksheet based on 4C skills, so students will do inquiry, ask, reason and write mathematical ideas about the mathematical concepts they learn as characteristic of the CTL approach, as shown in Figure 5 below.



Fig. 5. The Students was Discussion

Based on Figure 5 shows the student activity in the CTL class being inquiry, questioning, reasoning, and writing down mathematical ideas about the mathematical concepts they studied. Improved reasoning ability and mathematical communication can also be seen from the ability to solve the problem of the worksheet. Figure 6 is one of the student's work in solving the problem of reasoning and mathematical communication below.

Suppose there is a variety of flowers in the store "Beautiful" which dahlia, mawar, melati, kamboja, matahari, kenanga, and anggrek. Alya wants to buy flowers in the store "Beautiful" mawar, melati, and lily, what is the universal set? Are all the flowers Alya is looking for in the "Beautiful" store? How do you think that if the type of interest that is not in the store is the same as the empty set? Explain your answer

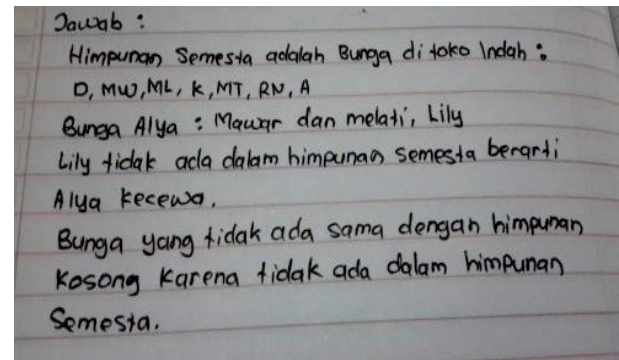


Fig. 6. The Students' Answer

Based on the answers given by students, can provide creative ideas, though still in a common way. Students can reason but are still limited in communicating. According to Tatang Yuli [13] Mathematical learning should be able to develop student's reasoning, creativity and personality. This means that to solve the problem in the given worksheet, the students should have the freedom to solve the contextual problems by using their own way based on the knowledge that they have before, but this is not in the worksheet made. In the student worksheet the student has been led to answer the problem in accordance with the steps of completion given. This caused the way students solve problems between groups with one another tend to be the same.

Based on the above exposure shows that in applying the approach CTL assisted 21 century worksheets need to pay attention to the mathematical capabilities of students and activeness and creativity of the students in learning. If the mathematical capabilities, activeness and creativity of

the students is low then learning will be impeded because in the CTL approach assisted work sheets 21 century students are required to find the concept of independent.

### V. CONCLUSION

Based on the findings that have been presented in the previous section, the conclusions can be take that of that there is a significant difference in the capacity of the logic and mathematical communication students before and after the learning using CTL Approach assisted work sheets 21 century. There is increased capacity of the logic and mathematical communication students after learning through assisted CTL approach work sheets 21 century in aggregate materials with an average of the index gain normalization namely 0.54 which means classified is medium.

Based on the conclusions put forward a number of recommendations to get more attention from all stakeholders on the use of assisted CTL approach work sheets 21 century in the process of learning mathematics especially on the level of basic education is in the CTL approach assisted work sheets 21 century, the teacher as a facilitator and moderator. Therefore, mathematics teacher who will apply the approach assisted CTL work sheets 21 century need to consider the following: (a) the availability of learning materials in the form of contextual issues (b) required consideration for teachers in the interventions so that their students independently and creative freedom to achieve the development of the mathematical knowledge of the more optimal.

### ACKNOWLEDGMENT

We thank to headmaster of SMP 7 Padang, and mathematics teachers had been supported by facilities and expertise the assisted in this research.

### REFERENCES

- [1] The National Council of Teacher of Mathematics, Principles and Standards for School Mathematics, VA: NCTM Reston, 2000.
- [2] The department of education, Regulation of the Minister of National Education No. 22. The year 2006 About Content standards for Elementary and secondary education units. Jakarta: Standard Agency The National Education, 2006.
- [3] The OECD, PISA. 2012. <http://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf> Accessed on 19 January 2016.
- [4] Mahmudi, Ali. 2009. *Develop Student Thinking Through Mathematics Teaching realistic*. (Online). : [http://sciencemathematicseducation.files.wordpress.com/2014/01/mpen\\_d5alimuddin.pdf](http://sciencemathematicseducation.files.wordpress.com/2014/01/mpen_d5alimuddin.pdf). (23 June 2015).
- [5] The Partnership for 21st Century Skills, 21st Century Skills Map: Math, Washington: P21.Org, 2011.
- [6] NEA, Preparing 21st Century Students for a Global Society: An Educator's Guide to The "Four Cs", Washington: NEA, 2011.

- [7] Pacific Policy Research Center, 21st Century Skills for Students and Class Teachers, Honolulu: Kameha Schools, Research & Evaluation Division, 2010.
- [8] Rusman, Model-Model Learning. Bandung : PT Raja Grafindo Persada, 2012.
- [9] Kemdikbud. Guide the implementation of the skills of the Twentieth Century 21 2013 Curriculum. The Directorate of PSMA Directorate General of Primary and Secondary Education, 2017.
- [10] Kaymakci, S, A Review of Studies on Worksheets in Turkey. US- China Education Review A1, 2012, pp. 57-64.
- [11] Sugiyono, Education Research Method (Quantitative approach, Qualitative, and R&D). Bandung : Alfabeta, 2014.
- [12] Meltzer, D. E, "The Relationship Between Mathematics Preparation And Conceptual Learning Gains In Physic: A Possible Hidden Variable In Diagnostic Pre-Test Score" The Journal of am J Phys, vol. 70 (12), 2002.
- [13] Tatang Yuli & Eko Siswono, PMRI: Mathematics lessons that develop the logic, creativity and Personality Students (paper delivered at a workshop in Mathematics Teaching at MI "Nurur Rohmah) Sidoarjo: UNESA, 2006.