THE INFLUENCE OF STEM-BASED TEXTBOOKS (SCIENCE, TECHNOLOGY, ENGINEERING AND MATH) ON IMPROVING STUDENTS' CRITICAL THINKING ON LIFE ORGANIZATIONAL SYSTEM MATERIAL IN THE IMPLEMENTATION OF SCIENCE LEARNING IN MIDDLE SCHOOL

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ABSTRACT

This research is a type of quantitative qualitative research using STEM-based textbooks on the life organization system material to improve critical thinking of science students in junior high schools. The purpose of this study was to determine the effect of STEM-based textbooks on the level of critical thinking of students in junior high school. The method in this research uses village control group design research steps. The subjects of this study were 12 class VII students at the Mts Al-fatah Sragi Banyuwangi school on a small scale trial, whereas on a large scale trial consisting of 64 students divided into 32 control class students and 32 experimental class students in two schools namely SMP N 1 Songgon and MTs Al-Fatah Sragi Banyuwangi district. The results of this study through a small group test showed that STEM-based textbooks can improve students' critical thinking with N-gain values taken from the pretest and posttest results showed a value of 0.70 in the high category. The results of large group tests show that STEM-based textbooks can improve students' critical thinking with an N-gain value in the Al-Fatah Sragi MTs school of 0.75 in the high category and an N-gain value in Songgon 1 Middle School getting an N-gain value of 0.84. Based on the results of these studies indicate that STEM-based textbooks can improve students' critical thinking on the material system of life organization in junior high schools.

Keyword: - *Textbooks, science, critical thinking, STEM*

1. INTRODUCTION

The problems that occur in education today are very related to student achievement in certain subjects, namely in analyzing and applying to real life. Research conducted by PISA in 2015 published in 2016 shows that Indonesia has an average value of 403 from the international average of 500 and 501 (OECD, 2016). In addition, in 2015 TIMSS research data it is known that Indonesia ranks 69 out of 76 countries involved (TIMSS, 2015). Textbooks are learning media that are used in SMP / MTS schools in the learning process. A textbook is a handbook

for a subject written and compiled by experts in related fields and fulfilling the rules of the book and officially published and distributed (Minister of National Education, 2006).

STEM is an interdisciplinary approach to learning where rigorous academic concepts are combined with real-world learning when students apply science, technology, engineering, and mathematics in contexts that make connections between schools, communities, jobs, and global companies that enable the development of STEMs to be able to compete in a new economy (Southwest Regional STEM Network, 2009).

The learning process at the junior hisg school level is directed to develop students' critical thinking skills within the framework of scientific development (Mana and Titik, 2016). The STEM approach can increase students' level of critical thinking. Critical thinking is reflective thinking that focuses on making decisions about what to do next (Ennis, 2011). Natural science is one of the subjects looking for the relationship of nature with mathematical concepts as a discovery of concepts or facts that exist (Suhandi and Wibowo, 2012). Life organization system is one of the natural sciences in the scope of biology that explains cells, tissues, organs, organ systems and organisms.

STEM based textbooks are textbooks that are prepared based on STEM aspects. The components in the book are the same as the current textbook. In the contents of this textbook described in each sub-chapter of the material system of life organization, which includes cells, tissues, organs, organ systems and organisms. In each material sub-chapter there are problems that must be solved by students by finding the right solution. The evaluation form in this book uses bloom C4 and C5 taxonomies, while the activities in this book are in accordance with bloom C6 taxonomy, which is producing products.

Based on the description related to the current educational problems described above, it is necessary to conduct research on "the effect of STEM-based textbooks (science, technology, engineering and math) on the improvement of students' critical thinking on the material system of life organization in learning natural science in junior high school.

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2. METHODOLOGY

The method in this study uses a village control group method through two stages, namely the initial field test and the main field test. The field of study in this research is integrated natural science in the material systems of living organizations. In this research, it is divided into the control class and the experimental class with the following designs:

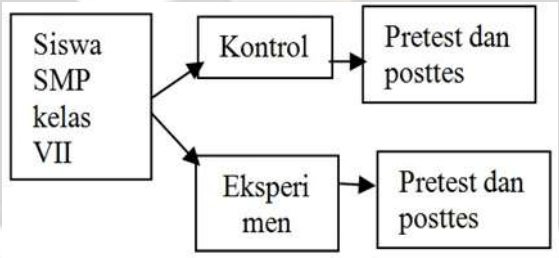

Fig-1: Research design

2.1 Small Group Test

The small group test aims to get an initial qualitative and quantitative evaluation of the use of STEM-based textbooks on the level of students' critical thinking. Following are the steps done in the small group test:

a. Taken 12 students from class VII C of Al-Fatah Banyuwangi where afterwards they were given STEM based textbooks.
b. At the first meeting, it was explained about STEMto students, which then will be discussed in the contents of the book. Then students are given an evaluation in the form of pre-test related to the material system of life organization.
c. At the second meeting, students are explained cell and tissue material. Then they are given a student analysis questionnaire of the material.
d. At the third meeting, students are explained the material of organs, organ systems and organisms briefly, after which they will be given a questionnaire analyzing student responses to determine their responses to the material.
e. At the fourth meeting, students are given a post-test.

2.2 Large group test

The next research phase is the large group test phase which is conducted at two SMP / MTS schools in Banyuwangi. Stages of large group tests are as follows:

a. Two classes were taken from each VII grade junior high school in Banyuwangi Regency, consisting of 32 control classes and 32 experimental classes.
b. At the beginning of learning in the experimental class, students are given an evaluation in the form of a pretest.
c. Students are given STEM based textbooks.
d. At the second meeting, students are explained cell and tissue material.e) At the third meeting, students explained the material of the organ and organ system.
e. At the fourth meeting, students are explained about the material of organisms.
f. At the end of learning, students in the control and experiment class are given a post-test to test their critical thinking skills after using STEM-based textbooks.

2.3 Effectiveness Test

The effectiveness test is carried out to find out whether STEM based textbooks are really effective to be used as learning media with the following steps:

a. Gives score of answers on each item obtained by students based on the assessment rubric that has been made.
b. Add up the scores obtained by students.
c. Calculate the value obtained by each student.
d. Categorize student learning test results based on the standart score determined by the school concerned, which is 70.
e. Tabulate student test results
f. Calculate the percentage of students' test completeness, using the following formula:

$$X = \frac{Number\ students\ who\ completed}{Number\ of\ students}\ x\ 100\%$$

g. Categorize the percentage of completeness with the interval criteria for completeness of student learning outcomes test results as follows (Widoyoko, 2009: 238).

Table-1: Criteria for completeness of student learning outcomes test results

Percentage of Implementation	Category
$x \geq 80\%$	Very Effective
$60\% \leq x < 80\ \%$	Effective
$40\% \leq x < 60\%$	Quite Effective
$20\% \leq x < 40\%$	Less Effective
$x \leq 20\%$	Ineffective

Based on the effectiveness analysis above, the resulting textbooks are said to be effective if the completeness of the students' posttest results in the experimental class meets the minimum criteria of 65%.

2.4 Practicality test

Practicality test is carried out to test STEM based textbooks whether it is really practical with the following steps:

a) Tabulate the score data of learning observation results by giving a score of 1 for "Yes" and 0 for "No".
b) Calculate the percentage using the following formula:

$$p = \frac{The\ number\ of\ "Yes"\ answers}{The\ number\ of\ aspects\ observed}\ x\ 100\%$$

Table-2: Criteria of Questionnaire Results

Percentage of Implementation	Category
$x \geq 80\%$	Very Practical
$60\% \leq x < 80\ \%$	Practical
$40\% \leq x < 60\%$	Quite Practical
$20\% \leq x < 40\%$	Less Practical
$x \leq 20\%$	Not Practical

2.5 *N-gain* analysis

N-gain Analysis is an analysis of learning outcomes tests which usually have pretest and posttest scores. The difference in value can indicate students' critical thinking skills after using the book. The *N-gain* formula is as follows:

$$N - Gain = \frac{score\ of\ posttes - score\ of\ pretest}{maximum\ score\ - score\ of\ pretest}$$

Table-3: *N-gain* Interpretation Criteria

N-Gain	Criteria of Interpretation
N-Gain>0,7	High
0,3≤*N-Gain*≤0,7	Medium
N-Gain<0,3	Low

(Hake,2002)

3. RESULT

The results of this study are based on the results of small group tests and large groups of STEM-based textbook tests effective and practical for improving students' critical thinking which can be seen through the *N-gain* values in the high category. The following are the results of small group tests and large group tests:

3.1 Small group test

Data on the results of the effectiveness test and practicality test from the small group test are described as follows:

a. The results of small group effectiveness

Data from the results of small group studies are described in chart 1 as follows:

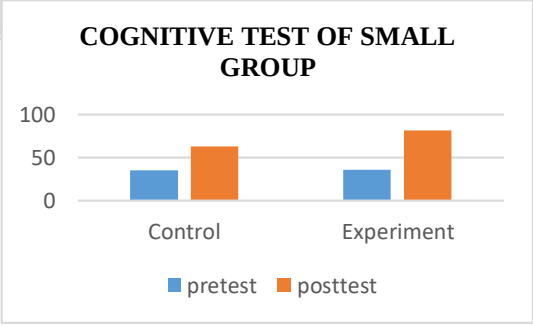

Chart-1: Small group pre-test and post-test results

Based on the chart 1 of the small group test, the posttest value in the control class is 62.91 while the experimental class is 81.25. The effectiveness value of small groups is described in chart 2 as follows:

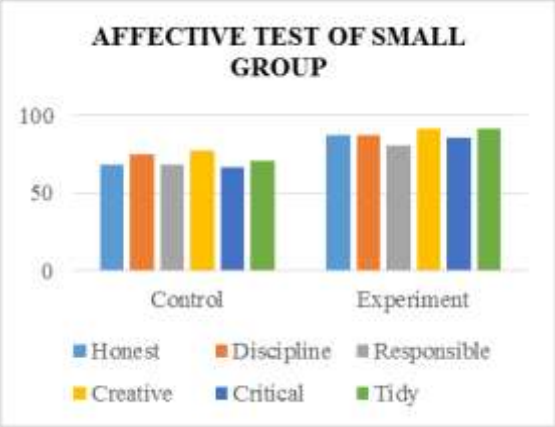

Chart-2: Affective Test of Small Group

Based on chart 2 about the results of skills, it is known that the score on the effectiveness test of the small group of the control class is 71.17% while the experimental class is 88.88%.

b. The practicality result of small group tests

Practicality test on small groups of data which obtained from the results of the feasibility of learning asessment done by the observer and the results of the analysis of student responses are described in chart 3 as follows:

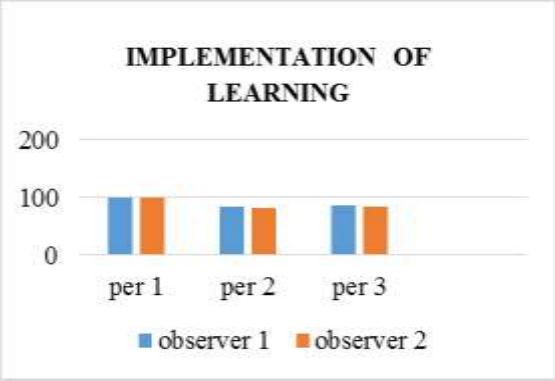

Chart-3: Learning implementation data

Based on chart 3 about the practicality test for small groups at the O1 firsst meeting is 100% and 100% for O2. At the second meeting, O1 85% and O2 82.3% and the third meeting O1 85.7% and O2 85% or overall is 89.66%. Data from the results of the questionnaire analysis of student responses are described in chart.4 as follows:

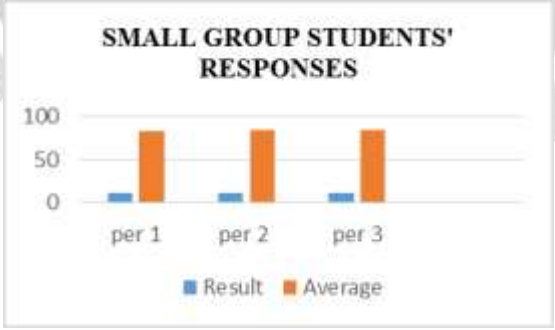

Chart-4: Results of questionnaire analysis of student response to practicality testing in small groups

Based on the graph 4.4 practicality test chart in the small group at first meeting, it is known the score is 83.28%, the score at the secod meeting is 84.5%, the score at the third meeting amounted to 85.07% or all in total is 84.28%.

c. *N-gain* analysis of small group tests

The *N-gain* analysis in the small group test is used to determine the level of critical thinking of students described in table 4 as follows:

Table-4: results of the *N-gain* analysis in the small group test

No	School	N-Gain	Category
1.	MTS	0,70 ≥ 0,7	High

3.2 Large group test

Large group test were conducted at two SMP / MTs schools in Banyuwangi regency, namely MTs Al-Fatah Sragi and Songgon 1 Junior High School. Large group test data are described as follows:

a. Effectiveness Result of large groups

Data collected includes knowledge and skills described in chart 5:

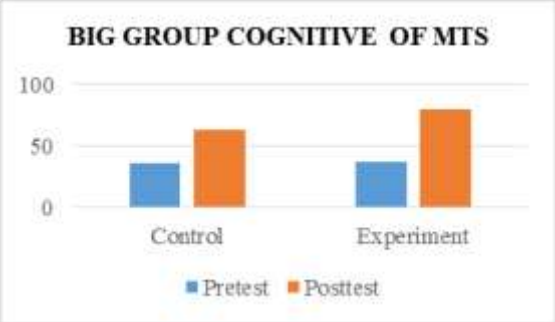

Chart-5: Value of MTs knowledge

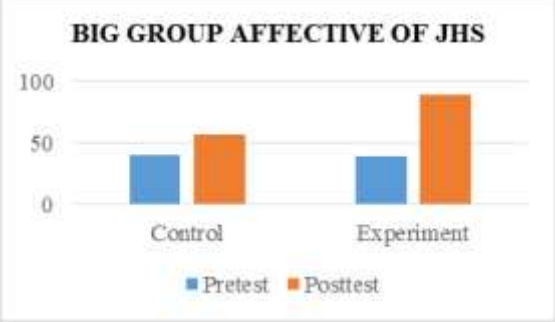

Chart-6: Value of junior high school knowledge

Based on chart 5, it can be seen that the posttests score of class control in MTs is 63.12, while the experimental class is 80.62. In the Songgon 1 Junior High School, the posttest score obtained by control class is 57.28 while the experimental class is 84.53. The skill scores are described in chart 7 as follows:

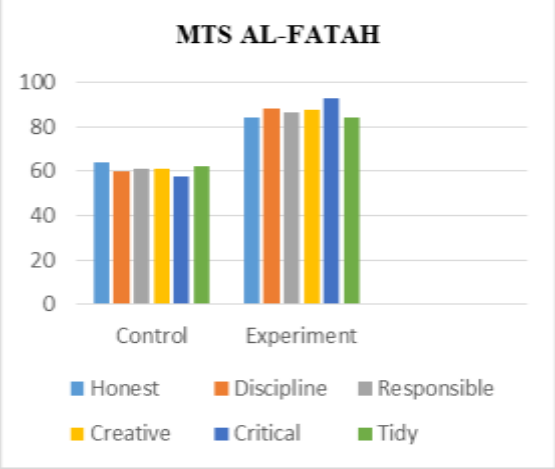

Chart-7: Results of skills scores on the effectiveness test of large groups in MTs

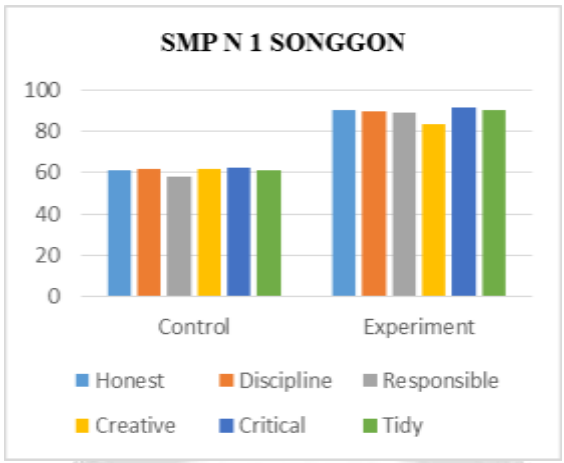

Chart-8: Results of skills scores on the effectiveness test of large groups in junior high school (SMP)

Based on chart 7, the score at the control class in MTs is 60.89% while the experimental class is 87.36%. In Songgon 1 Junior High School according to chart 8, it is known that the score in the control class is 60.93% while the experimental class is 89.18%.

b. The results of the practicality in large group test

Practicality test for large groups of data obtained from the results of the feasibility of learning assessment done by the observer and the results of the analysis of student responses. It is described in chart.9 as follows:

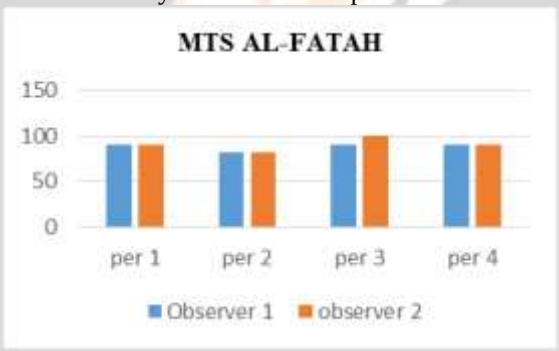

Chart-9: Data of the learning implementation on practicality test in large groups of MTs

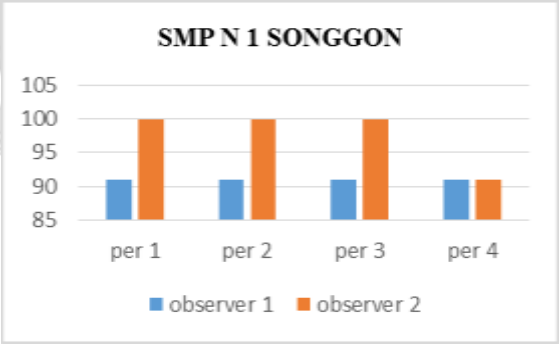

Chart-10: Data of the learning implementation on practicality test in large groups of SMP

Based on the chart 9 about the learning outcomes of MTs Al-Fatah Sragi, at the first meeting it is found that the average O1 was 90.9% and O2 was 81.81%, the second meeting O1 is 81.81% and O2 is 81.81%. At the third meeting, the O1 value is 90.9% and O2 is 100%. Then at the fourth meeting, O1 is 90.9% and O2 is 90.9%. As per graph 4.10, the percentage of Songgon 1 Junior High School at the first meeting, obtained an average O1 of 90.9% and O2 of 90.9%. At the second meeting, O1 is 90.9% and O2 is 100%, the third meeting O1 is 90.9% and O2 is 100%. The last is at the fourth meeting, the O1 value is 90.9% and O2 is 90.9% where overall 91.46. The results of the student response analysis questionnaire are described in chart 11 as follows:

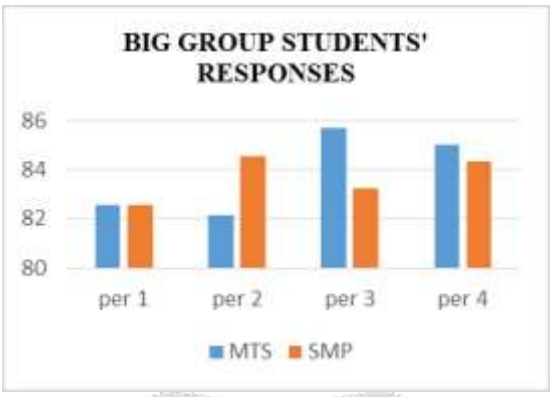

Chart-11: Big Group Students' Responses

Based on chart 11, MTs Al-Fatah Sragi at the first meeting is 82.58%, the second meeting is 82.14%, the third meeting is 85.71% and the fourth meeting is 85.04%. In 1 Songgon Junior High School, the score at the first meeting is 82.57%, the second meeting is 84.57%, the third meeting is 83.25% and at the fourth meeting is 84.37%, overall from all meetings is 83.77%.

c. *N-gain* analysis of large group tests

The data is taken from the results of the pretest average value. It is described in table 5 as follows:

Table-5: Results of the *N-gain* analysis in the large group test

No	School	N-Gain	Category
1.	SMP	0,84 ≥ 0,7	High
2.	MTS	0,75 ≥ 0,7	High

Based on the results of the *N-gain* analysis in table 5, it shows that *N-gain* is categorized high which means that there is an influence on students 'critical thinking where students' critical thinking is higher after using STEM-based textbooks.

4. DISCUSSION

Qualitative-quantitative research gets results in accordance with research objectives namely STEM-based textbooks can improve students' critical thinking in junior high school. The learning method used in this study is the STEM approach. The STEM approach consists of orienting students to problems and finding solutions from those problems by thinking critically according to real daily life. The learning media used are STEM-based textbooks which are textbooks that are arranged according to the STEM (Science, technology, engineering and math) aspects.

Based on chart 1, the post-test value in the control class is 62.91 and the experimental class is 81.25. Based on the 4.2 graph about the results of skills in the effectiveness test of small groups, the control class obtained a percentage of 71.17% and 88.88% in the experimental class. Based on chart 4, overall a percentage of 84.28% is obtained with a very practical category. Based on table 4.4, it shows that *N-gain* is categorized high.

Based on chart 5 about the results of quantitative data posttest in the control class and the experimental class in MTs Al-Fatah Sragi, the control class obtained a value of 63.12 and an experimental class is 80.62. While in SMPN 1 Songgon, according to chart 6, the value obtained in the control class is 57.28 and the experimental class is 84.53.

Based on the chart 9 on the practicality test of a large group of MTs Al-Fatah Sragi, the first meeting obtained an average O1 of 90.9% and O2 of 81.81%. At the second meeting the O1 value is 81.81% and O2 is 81.81%. At the third meeting, O1 values of 90.9% and O2 of 100% are obtained. Whereas at the fourth meeting, O1 values are 90.9% and O2 90.9%. At SMPN 1 Songgon as chart 10, it is known that at the first meeting, an average O1 of 90.9% and O2 of 90.9% is obtained. At the second meeting, an O1 value of 90.9% and O2 of 100% is obtained. At the third meeting, O1 values of 90.9% and O2 of 100% are obtained, O1 meetings of 90.9% and O2 of 90.9% with a total of 91.46%.

Based on chart 11 about the results of the questionnaire analysis of the response of practicality test students in a large group of MTs Al-Fatah Sragi schools, the first meeting obtained a percentage of 82.58% with a practical category. The second meeting showed an average of 82.14%, the third meeting 85.71%, and the fourth meeting

85.04%. At SMPN 1 Songgon, the percentage at the first meeting is 82.57% with the practical category. Then at the second meeting, the percentage obtained is 84.57%, at the third meeting is 83.25% in the practical category and at the fourth meeting is 84.37% with the overall percentage showing an average of 83.77%. Based on the results of the *N-gain* analysis in table 5, it shows that the *N-gain* is categorized high.

5. CONCLUSIONS

This research is a qualitative research using a STEM based textbook material for life organization system to improve students' critical thinking in science learning in junior high school. In this study shows that STEM-based textbooks are effective and practical for science learning in junior high schools. This STEM-based science textbook can improve students' critical thinking which is shown from the results of N-Gain in the high category taken from the difference between the pretest and posttest values.

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