Improving the ability of Miftahul Huda Islamic elementary school students to face the 21st century with the application of STEM in learning curriculum 2013

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Abstract. This paper aims to determine the effect of the application of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum learning to improve students' abilities in facing century skills at Miftahul Huda Islamic Elementary School, Siwatu, Watumalang, Wonosobo-Central Java. The target of this research is students of grade VI (six) at Miftahul Huda Islamic Elementary School. The problem is solved in five stages of activities, namely preparation, pre-test, implementation, post-test, and evaluation. Preparation is done by compiling the instruments that will be given to students and testing the validity and reliability of the instruments. The pre-test is carried out by distributing instruments according to the topic without the application of STEM (Science, Technology, Engineering, and Mathematics) in learning. Implementation is done by applying STEM (Science, Technology, Engineering, and Mathematics) in learning. The Post Test is carried out after the implementation of STEM (Science, Technology, Engineering, and Mathematics) learning. Based on the data obtained in the research, the application of STEM (Science, Technology, Engineering, and Mathematics) in the learning is effective in improving 21st century skills at Miftahul Huda Islamic Elementary School. STEM (Science, Technology, Engineering, and Mathematics) will teach critical, creative, communicative, and collaborative thinking from an early age.

1. Introduction

In the 21st century science and technology are developing rapidly, as evidenced by the emergence of the industrial revolution 4.0 in this era. 21st century skills are needed to face the industrial revolution 4.0. One way that can be done to improve 21st century skills is by implementing STEM (Science, Technology, Engineering, and Mathematics) in the 2013 Curriculum learning [1].

The 2013 curriculum is a curriculum that prioritizes character education specifically at the basic level which will be the provision for continuing the next level, with the hope that through the development of the 2013 curriculum which is based on character and competence, this nation will become a nation that is has a selling value that can be offered to other nations in the world [2]. In Law Number 20 of 2003 concerning the National Education System article 1 number 19 explains that the curriculum is a set of plans and arrangements regarding the objectives, content and learning materials as well as the methods used as guidelines in carrying out learning activities to achieve certain goals. The 2013 curriculum is here to replace the previous education unit level curriculum set in 2006. In the 2013 Curriculum there are several differences from the previous curriculum, namely the 2013 curriculum emphasizes...
understanding, skills, and character education, students are required to understand the material, be active in discussions and presentations, and have high discipline politeness. The 2013 curriculum requires that all subjects be studied by students at the education level or one educational unit.

STEM (Science, Technology, Engineering, and Mathematics) integration in learning is an interdisciplinary learning approach that connects student learning activities with real life, namely connecting schools, the world of work and the global world, thus developing STEM (Science, Technology, Engineering and Mathematics) literacy students to compete in the new economic era [3].

STEM (Science, Technology, Engineering and Mathematics) is an approach from two or more of one of the STEM (Science, Technology, Engineering and Mathematics) fields that is integrated and practiced directly to connect each field in STEM which is useful for improving student learning. So science and technology, engineering and mathematics can be integrated using STEM (Science, Technology, Engineering and Mathematics) in it so that through the problem solving process will develop students' creative attitudes [4,5].

The 21st century learning is demanded to be technology-based to balance the demands of the millennial era with the aim that students will get to know the life skills of the 21st century. In line with this opinion [3] states that students living in the 21st century must master science, have metacognitive skills, be able to think critically and creative, and able to communicate or collaborate effectively, this situation illustrates the gap between expectations and reality. Therefore, the government designed 21st century learning through student-based curriculum in 2013. Teachers as an extension of the government in schools carry out 21st century learning. In formal schools, learning is required to apply 4C (Critical Thinking, Communication, Collaboration, Creativity) abilities. This can be realized quickly, not only the demands of teacher performance in changing teaching methods, but also the roles and responsibilities of non-formal educators in getting children to apply 4C in their daily life [6,7]. To achieve ideal learning conditions, the quality of teaching is always related to the use of optimal learning models, meaning that to achieve quality learning, each subject must be arranged with the right organizational model and then conveyed to students with the right model. Also 4C skills must be mastered and possessed by every student to face the challenges of the 21st century [2].

Miftahul Huda Islamic Elementary School is a religious-based elementary school, which implements a boarding school system. The application of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum learning at Miftahul Huda Islamic Elementary School aims to increase student motivation and interest in participating in the learning process to improve student learning outcomes and student learning outcomes. It is hoped that the application of STEM (Science, Technology, Engineering, and Mathematics) can improve the skills and abilities of students (critical, creative, communicative, and collaborative) needed to face the 21st century. Where in the 21st century various kinds of skills and abilities must be possessed by students.

2. Method
This research was conducted in the even semester of the 2017/2018 school year at Miftahul Huda Islamic Elementary School, Siwatu, Watumalang, Wonosobo-Central Java, with a total population of 30 students.

This research is a quantitative study using a pre-experimental design (pre-experimental design). The pre-experimental design form has no control group. In this study, researchers studied one group (one-group-pretest-posttest) and provided interventions during the experiment. The model used can be seen in the following graph.
The instrument used in this study was a critical thinking skills test which contained several aspects and indicators to collect data on students' ability to think critically. The test of critical thinking skills of students has used as a description test that is limited to a certain time. The choice of test in the form of a description is intended to show the ability to analyze arguments and the ability to carry out and consider induction in the answer process and is also intended to minimize the element of guesswork. The instrument used in this study was a contained ability tests on several aspects and indicators to collect data on students' ability to think critically and creatively.

This test is carried out on students to see the results of tests of critical and creative thinking skills in the implementation of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum learning. In the preparation of the instruments before making the questions, they are made lattice as follows:

| No. | Critical Thinking Indicators / Measured Aspects | No. Question |
|-----|-----------------------------------------------|--------------|
| 1   | Identify / justify concepts                    | 1, 2,3,4,5,6, 7,8,9, |
| 2   | Solve the problem                              | 10,11,12,13,14,15,16 , |
| 3   | Analyze algorithms                             | 17,18,19,20,21,22,23 |
| 4   | Generalizing                                   | 24,25,26,27,28,29,30 |

Total questions = 30 questions
Number of test questions = 25 pieces

Observations are also carried out with the help of a camcorder which functions to record the 2013 curriculum learning process that has been implemented with STEM (Science, Technology, Engineering, and Mathematics). Validity test can be obtained by connecting the overall score of each item (X) with the overall score obtained by all students (Y) through the Pearson product-moment correlation technique with the following formula:

The product-moment formula between X and Y:

\[ r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{(N \sum X^2 - (\sum X)^2)(N \sum Y^2 - (\sum Y)^2)}} \]

Information:
- \( r_{xy} \): coefficient correlation
- \( N \): Number of test takers
- \( X \): score of each item
- \( Y \): total score

According to [8], an item is said to be valid if it has great support for the total score. The interpretation of the magnitude of the correlation coefficient is as follows:

| Correlation coefficient | Interpretation       |
|-------------------------|----------------------|
| 0, 800 - 1, 000         | the highest validity |
| 0, 600 - 0, 800         | high validity        |
| 0, 400 - 0, 600         | moderate validity    |
| 0, 200 - 0, 400         | low validity         |
| 0, 000 - 0, 200         | the lowest validity   |

Reliability Test
Reliability tests for essay data types use the Alpha Cronbach technique [6]. The reliability coefficient formula is as follows:

\[ r_1 = \frac{k}{k-1} \left(1 - \frac{\sum S_i}{S_t}\right) \]

Information:
- \( r_1 \): Instrument reliability
- \( k \): Mean Squares between Subjects
- \( \sum S_i \): Mean squared of error
- \( S_t \): Total Variation

The formulas for total variation and item variation are:

\[ S_t = \frac{\sum X^2}{n} - \frac{(\sum X)^2}{n^2} \]
\[ S_t = \frac{\sum_{ijkl} g}{n} - \frac{\sum_{ij} g}{n^2} \]
Where:
\( J_{ki} \) : the sum of squares of the entire item score
\( h_{kg} \) : the sum of the squares of the subject
criteria for reliable test instruments, namely:
if \( r > r_{table} \) then the item is declared reliable
if \( r \leq r_{table} \) then the item is declared unreliable

From the test of students, the scores achieved by students in tests of critical thinking and creative
thinking abilities will be obtained. The score calculation is done for each question using each question
is scored according to the aspect of critical thinking and creative thinking skills, as well as the
predetermined assessment criteria. The data that has been obtained is then processed using the SPSS
program in the following steps:

- **Normality test.** This test aims to assess the distribution of data in a group of data or variables,
whether the distribution of the data is normally distributed or not.

- **Paired Sample t-test.** Paired T-Test or Paired T-Test is used as a comparative or difference test
if the data scale of the two variables is quantitative (Interval or Ratio). This test is also known
as the pairing T-Test. The parametric difference test on two paired data is called the paired t-
test. That is the meaning of the paired t test by statistical. We make an understanding for the
reader so that the reader can understand what the actual function or use of the tests is.

- **Research Hypothesis Formulation.**

  Ho: There are no effect of STEM (Science, Technology, Engineering, and Mathematics)
  learning strategies on the 2013 curriculum in improving 21st century skills (critical thinking,
  creative, communicative and collaborative thinking) at SD Islam Miftahul Huda

  Ha: There is an effect of STEM (Science, Technology, Engineering and Mathematics) learning
  strategies in the 2013 curriculum in improving 21st century skills (critical thinking, creative,
  communicative, and collaborative thinking) at Miftahul Huda Islamic Elementary School. The
  significance value (sig.) Is the basis for decision making in the paired sample t-test [9], namely
  Ha is accepted if the value is sig. (2-tailed) < 0.05, while Ho is accepted if the value is sig. (2-
tailed) > 0.05 N-Gain test

  Normalized gain or N-Gain aims to determine the effectiveness of using a particular method or
  treatment in a one-group pre-test post-test design study (experimental design or pre-experimental
design) or research using a control group.

  The normalized gain or N-Gain can be calculated by the formula:

- \( N - Gain = \frac{Points \ Post \ Test - Points \ Pre \ Test}{Points \ Ideal - Points \ Pre \ Test} \)

  Where, the Ideal Score is the highest score that can be obtained. The categorization of the acquisition
  of N-Gain values can be determined based on the N-Gain value or the N-Gain value in the form of a
  percentage. We can see the distribution of categories for the N-gain value in the following table:

**Table 5. Categories of Interpretation of N-Gain Effectiveness**

| Percentage (%) | Interpretation     |
|----------------|-------------------|
| <40            | Ineffective       |
| 40 – 55        | Less effective    |
| 56 – 75        | Effective enough  |
| >76            | Effective         |
As for the communication and collaboration of students, data were obtained from visual observations during teaching and learning activities and on video teaching and learning activities.

3. Result and Discussion

3.1. Before Research.

Results achieved before conducting the research, first carried out testing the validity and reliability of the instruments that will be used in the study. The validity test is carried out to determine whether the instrument used is feasible or not. A reliability test is used to find out whether the instrument is consistent if the questions are reused. Instrument testing is carried out outside of the research sample. The instrument tested was an instrument of critical and creative thinking.

3.1.1. Testing results from data critical thinking instruments

3.1.1.1. Instruments Validity Test. Analysis of the validity of critical thinking questions using the Excel program. The instrument of the questions tested consisted of two questions for critical thinking problems. With N = 30 and α = 0.05, the table r is 0.30. The data for all items have Pearson Correlation > 0.30 so that all items are valid.

| Aspects measured       | Question items | r-count          | r-table | Information |
|------------------------|----------------|------------------|---------|-------------|
| Identify/justify concepts | 1-9            | 0.315-0.634      |         | Valid       |
| Solve the problem      | 10 -16         | 0.326 - 0.620    | 0.3     | Valid       |
| Analyze algorithms     | 17-23          | 0.306 - 0.505    |         | Valid       |
| Generalizing           | 24 -30         | 0.326 - 0.620    |         | Valid       |

3.1.1.2. Reliability Test. The instrument reliability test was taken from 30 students with a total of two critical thinking questions. The results of the reliability of the instrument for critical thinking have Cronbach's Alpha for critical thinking skills of 0.50 which means that the critical thinking instrument is reliable.

3.1.1.3. Instrument Validity Test. Analysis of the validity of critical thinking questions using the Excel program. The question instrument being tested consists of two questions for critical thinking questions. With N = 30 and α = 0.05, the table r is 0.30. From the data, all items have Pearson Correlation > 0.30 so that all items are valid.

| Aspects measured                                | Question items | r-count          | r-table | Information |
|------------------------------------------------|----------------|------------------|---------|-------------|
| Describe the possibilities that will occur in an event | 3,8,9,10,24,25 | 0.367076-0.834599 |         | Valid       |
| Ask as many questions as you can                | 1,6,11,12,13   | 0.540574-0.834599 | 0.3     | Valid       |
| Describe the function of an object              | 5,14,15,16,17  | 0.356513-0.834599 |         | Valid       |
| Explain cause and effect                        | 2,4,18,19,20,21| 0.335772-0.834599 |         | Valid       |
3.1.1.4. **Reliability Test.** The results of the calculation of the reliability of the creative thinking ability test obtained a value of \( r_{11} \) of 0.794 which is greater than the \( r \) table (0, 30) so that it can be concluded that the 8 test questions to be tested on students in the study have a high level of reliability. This means that the consistency (consistency) of the subjects in answering the creative thinking ability test questions is reliable (reliable).

3.2. **Research Result Data**

3.2.1 **Critical Thinking Data**

3.2.1.1. **Normality Test.** Based on normality test results obtained significance value pre-Shapiro-Wilk test = 0.0445 and post-test = 0.0623. Both are greater than 0.05, so it can be concluded that the variables are normally distributed.

3.2.1.2. **Paired Sample Test**

| Table 8. Data of Paired Sample Correlation Results |
|-----------------------------------------------|
| N     | Cor. | Sig. |
|---|---|---|
| Pair 1. Pre Test and Post Test | 30 | .939 | .000 |

Data from the correlation test or the relationship between the two data or variables pre-test and post-test. From the above values, it is known that the correlation coefficient (Correlation) is = 0.939, with a significance value (Sig) = 0.000. Because the Sig value is 0.000 <0.05 probability, it can be said that there is a relationship between the pre-test and post-test variables.

Based on the "Paired Sample Test" table, it is known that the Sig. (2-tailed) is 0.000 <0.05. So Ho was rejected and Ha accepted. So it can be concluded that there is a difference between the pre-test and post-test mean scores, this means that there is an effect of using STEM (Science, Technology, Engineering, and Mathematics) learning strategies in the 2013 curriculum in improving 21st century skills (critical thinking) at Miftahul Huda Islamic Elementary School.

After knowing the effect of STEM (Science, Technology, Engineering, and Mathematics) learning strategies on the 2013 curriculum in improving 21st century skills (critical thinking) at Miftahul Huda Islamic Elementary School, the next question is how much influence is the STEM (Science, Technology, Engineering, and Mathematics) learning strategy in the 2013 curriculum in improving 21st century skills (critical thinking)?

3.2.1.3. **N-Gain Test.** Furthermore, the N-gain test was carried out to determine the effectiveness of STEM (Science, Technology, Engineering, and Mathematics) learning strategies in the 2013 curriculum in improving 21st century skills (critical thinking) at Miftahul Huda Islamic Elementary School.

Based on the results of the N-gain score test, it shows that the average N-gain score = 84.7675 is included in the effective category. With a minimum N-gain value of 76.06% and a maximum N-gain value of 100%. Thus, it can be concluded that the use of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum is very effective in improving 21stCentury skills (critical thinking) at Miftahul Huda Islamic Elementary School.
3.2.2. Creative Thinking Data Result

3.2.2.1. Normality Test. Based on the results of the normality test, the Shapiro-Wilk significance value pre-test = 0.077 and the post-test = 0.027. Both are greater than 0.05, so it can be concluded that the variables are normally distributed.

3.2.2.2. Paired Sample Test

| Table 9. Data of Paired Sample Correlation Results |
| --- | --- | --- |
| Pair 1. Pre Test and Post Test | N | Cor. | Sig. |
| 30 | .869 | .000 |

The output above shows the results of the correlation test or the relationship between the two data or variables pre-test and post-test. From the value above, it is known that the correlation coefficient (Correlation) is = 0.869, with a significance value (Sig) = 0.000. Because the Sig value is 0.000 < 0.05 probability, it can be said that there is a relationship between the pre-test and post-test variables. Based on the "Paired Sample Test" table, it is known that the Sig. (2-tailed) is 0.000 < 0.05. So Ho was rejected and Ha accepted. So it can be concluded that there are differences in the average pre-test and post-test mean scores, this means that there is an effect of the use of STEM (Science, Technology, Engineering, and Mathematics) learning strategies in the 2013 curriculum in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School.

After knowing the effect of STEM (Science, Technology, Engineering, and Mathematics) learning strategies on the 2013 curriculum in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School, the next question is how much influence is the STEM (Science, Technology, Engineering, and Mathematics) learning strategy in the 2013 curriculum in improving 21st century skills (creative thinking)?

3.2.2.3. N-Gain Test. Furthermore, the N-gain test was carried out to determine the effectiveness of STEM (Science, Technology, Engineering, and Mathematics) learning strategies in the 2013 curriculum in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School.

Based on the results of the N-gain score test above, it shows that the average N-gain score = 68.4983 is in the quite effective category. With a minimum N-gain value of 39.39% and a maximum N-gain value of 100%. Thus, it can be concluded that the use of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum is quite effective in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School.

![Figure 1. Frequency distribution of the N-Gain value](image)
From the figure 1 above, you can see the distribution of the frequency distribution of the N-Gain value with a total of 30 students as respondents. And the highest score was >76%, which was 13 students. Thus it can be concluded that the use of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum is quite effective in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School.

3.3. Discussion
In this variable, data is obtained from observations during learning and obtained from observations of learning video recordings. It can be seen that when learning is carried out and STEM (Science, Technology, Engineering, and Mathematics) has been implemented in the 2013 curriculum learning. In the observations, it was seen that students worked together and communicated well during the learning process. Help each other in completing work and do not hesitate to ask for help from fellow friends. More courageous in expressing opinions because they feel more confident about their work. From the observations, it was also seen that among the members of the student group, there was a division of roles. This proves that the implementation of STEM (Science, Technology, Engineering, and Mathematics) in curriculum 2013 learning can improve students' abilities in communication and collaboration.

The 21st century is marked by the rapid flow of globalization and the rapid development of technology. The various divides that separate geographical boundaries are now easily removed by various advances in information and communication technology. New information and knowledge are not difficult to obtain and collect in this era. This has led to the emergence of a new economic era based on knowledge and technology in which individuals who can obtain, process, and interpret various information and knowledge will be able to succeed in responding to various challenges in the global society. This shows that the necessary learning concepts must be able to build.

The implementation of the 2013 curriculum will depend on the implementer in the field, be it educators, school principals, or supervisors of education units and subject supervisors. No less important is the education office at the district/city level and other positions related to education policy issues, because when all the elements involved are unable to commit and be consistent in their implementation, again this 2013 curriculum will return as a document only. Hopefully that doesn't happen in the 2013 curriculum.

The Project-Based Learning (PBL) model is the recommended model for implementing the 2013 Curriculum, while STEM (Science, Technology, Engineering, and Mathematics) is a learning strategy. The characteristic of STEM (Science, Technology, Engineering, and Mathematics) is that it emphasizes the process of designing, engineering, or engineering. According to [7] Design Process is a systematic approach in developing solutions to problems with well-defined outcomes, namely determining the best solution/process from emerging ideas.

By implementing STEM (Science, Technology, Engineering, and Mathematics) into the 2013 Curriculum learning, it becomes very effective considering that 2013 curriculum learning is not subject-based, but rather learning that has been integrated between one subject matter and another.

4. Conclusions
After analysing the data obtained during the study, the following conclusions were obtained: Based on the research results, the use of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum is very effective in improving 21st century skills (critical thinking) at Miftahul Huda Islamic Elementary School, this is because with STEM (Science, Technology, Engineering, and Mathematics) implementation students are easier and quicker to understand learning.

The use of STEM (Science, Technology, Engineering, and Mathematics) in the 2013 curriculum is quite effective in improving 21st century skills (creative thinking) at Miftahul Huda Islamic Elementary School, this is because with the implementation of STEM (Science, Technology, Engineering, and Mathematics) students are happier in participating in learning.
Based on the data obtained, the implementation of STEM (Science, Technology, Engineering, and Mathematics) in 2013 Curriculum learning is effective in improving 21st century skills (critical, creative, communicative and collaborative thinking) at SD Islam Miftahul Huda.

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