The effect of science technology engineering mathematics (STEM) learning on respiratory system topic on students' numerical ability

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ABSTRACT

The purpose of this study was to analyze the effect of STEM learning on students' numeracy skills. STEM learning was carried out through the activity of making a UV sterilizer prototype in one class with six groups in it. Data collection was carried out before, during, and after learning. The instruments used were written tests of numeracy skills, observation sheets, and students' questionnaires response. The effect of learning was tested through paired sample t-test and N-gain. Data collection was carried out in one class of XI IPA at Senior High School in Bandung with 21 participating students. The results showed that STEM learning had an effect on numeracy skills, with significant results (t (21) = -5.87, p = 0.00), and moderate increase (N-gain = 0.46).

INTRODUCTION

The awareness of the importance of numeracy needed in various disciplines is felt by various groups (Prince & Frith, 2017), one of which is in schools (Botts et al., 2018). The 2013 curriculum implemented in Indonesia has one of the abilities demands that are entrusted to the learning process, namely the use of data based on quantitative observations. This numeracy activity is a problem-solving skill needed to solve numeracy problems in everyday life (Rakhmawati et al., 2022). Through biology learning, it is expected to develop a learning process with a more quantitative science tendency (Apriyani & Suhartini, 2019). The process is assessed through an assessment to assess fundamental competencies, namely the minimum competency assessment (AKM). One focus of the fundamental competencies tested is numeracy skills or mathematical literacy (Yamtinah et al., 2022).

The low numeracy literacy skills are thought to occur because learning activities have not been maximized to support the development of students' numeracy literacy. Students are not familiar with mathematical applications in learning other fields (Aisyah et al., 2017). Conventional learning is considered unable to facilitate students' needs, until finally a learning model that collaborates mathematics becomes one of its main components.

Science Technology Engineering Mathematics (STEM) is learning that focuses on the innovation that students provide and the applied process to design a solution to today's complex contextual problems using sophisticated tools and technology and mathematical applications in the process (Kennedy & Odell, 2014). Research conducted by Lestari et al. (2021) on STEM learning, proved that there was a significant increase in science literacy skills, which included indicators of problem-solving using numeracy skills and drawing conclusions based on quantitative data. Problem-based STEM learning can also help improve mathematical communication because students gain learning experience through realistic problems related to technology and engineering in the form of Natural Science and Mathematics content (Asikin et al., 2021). The research encourages further research that focuses on STEM learning on student numeracy, where numeracy in this era is a very important and useful skill demand.

The global problem of the Covid-19 pandemic is also felt by all levels of society, including high school students in the learning process. Learning during the pandemic sometimes cannot meet the demands of today's competencies, one of which is numeracy (Laksana, 2020). STEM learning with a mathematics component in it provides hope for improving mathematical abilities for students. Based on the problems described and the hope of solutions that can overcome them, research on the effect of STEM learning on numeracy skills can provide one of the choices of learning strategies in the classroom in making efforts to improve students' numeracy skills.

METHODS

The research was conducted as a pre-experiment by taking data on one experimental group using a one group pre-test post-test research design. There is only one experimental group that runs the test by giving a pre-test then given STEM learning and conducting a post test. The experimental group will conduct Science Technology Engineering Mathematics (STEM) learning with UV sterilizer prototyping activities.

The research was conducted at one of the Bandung City State Senior High Schools with a population of numeracy skills of grade 11 high school students with a sample of numeracy skills of 1 class total 21 students selected using purposive sampling technique. Data collection was carried out with three research instruments, namely numeracy questions total 14 essay questions, student response questionnaires, and observation sheets.

In this study, the first data is in the form of student scores on numeracy literacy (14) given on human respiratory system material. This test was given before (pretest) and after (posttest)

STEM learning was conducted. Data taken in this study are student responses after doing STEM learning and observations by observers during the Teaching and Learning Activities (KBM) process. The implementation of this research went through several stages which included the stages before, during and after the implementation of learning. The stage before learning is the preparation stage before research such as preparing proposals and research instruments. The stage during the research is divided into two learning meetings. The first meeting, students received an explanation of the respiratory system material through STEM learning and designed a prototype. The second meeting, students conducted in-class trials and evaluations. The post-learning stage is the data processing and report preparation stage.

The research data obtained is then processed, scoring the test results on the numeracy test. After getting the score, it is continued with the N-gain test and statistical testing by calculating the paired sample t-test. Student response questionnaire data and observation sheets are processed with percentages and then matched with predetermined categories.

RESULTS AND DISCUSSION

Implementation of learning

STEM learning is carried out in several stages, namely problem analysis, solution proposal, analysis of tool and material requirements, product design, producing and testing UV sterilizer prototype products. All stages must be carried out fully and sequentially so that the learning objectives that have been designed can be fulfilled. However, if there are still parts that must be improved at one stage, students can return to that stage and continue the next stage until the designed solution is perfect.

Observations made by observers showed the results that most STEM learning activities were implemented (87.5%). This shows that students perform all stages of STEM learning and fulfil every demand in all stages. The implementation of STEM learning can be seen from the observations made by the observer. The implementation data obtained is as in Table 1 below.

Table 1. Percentage of implementation of STEM learning stages

No	Learning Syntax	Percentage (%)	
1	Analyze the problem	91	
2	Propose a solution	75	87,5%
3	Analyze tool and material requirements	91	(Most of the
4	Design a product	83	activities were
5	Produce the product	91	carried out)
6	Conduct practical trials	91	

Students' numeracy ability

The results of the improvement and significance tests on all numeracy indicators are presented in Table 2 and Table 3.

Table 2. Recapitulation of pretest and posttest data

Data Type	Pretest	Posttest
Number of learners	21	21
Average	61,5	82,3
Max score	85,7	89,3
Min Score	19,6	71,4
Standard deviation	16,2	5,3
Percentage of learners > KKM (75)	23,8	90,4

Table 3. Numeracy pretest and posttest data collection

Test	Significance	Interpretation
Normality Test (Kolmogorof Smirnov)	0,20	Normal
Homogeneity Test (Levene's Test)	0,28	Homogenous
Hypothesis Test (Paired Sample Test)	0,00	Significance

Based on Table 2, the results of the research focused on students' numeracy skills in general are an increase in students' abilities before and after the STEM learning treatment. The improvement occurred in all indicators. This is in accordance with the research findings of Khaeroningtyas et al. (2016) that there is a better effect on mathematical literacy skills with learning using STEM than non-STEM because students can increase their sensitivity to real-world problems and provide solutions that refer to the concept of mathematical literacy.

Based on Table 3, the STEM learning provided a significant improvement for students' numeracy skills (t(21) = -5.87, p = 0.00). This is in line with research findings which state that project-based learning is effective in facilitating students' reasoning skills (Abidin et al., 2020). STEM learning that begins with the identification of problems or obstacles exist in the surrounding environment is shown by students through problem identification on LKPD. Some studies show that students who get problem-based learning can have better mathematical reasoning skills compared to conventional learning carried out on other students (Pramestika et al., 2020; Putra et al., 2019). The implementation of the first STEM stage, namely problem identification, was 91% and occurred in almost all groups in the class.

Students' response to STEM learning

Student responses strongly agreed that the concepts being learnt were useful (95.7%) and very much related to the current situation (92.8%). Students responded positively to the interest (85.7%) and usefulness (84.2%) of the STEM learning provided. Students felt interested, excited and curious when doing STEM learning. This is supported by the findings of research conducted by Struyf et al. (2019) that students in schools have an interest in STEM learning because they can explore knowledge in groups. Students who do learning feel the benefits of the activities carried out because STEM learning can help solve problems much more comprehensively (Yang et al., 2021), the knowledge gained becomes more meaningful (Lestari, 2019), and find solutions related to the surrounding environment by utilizing technology (Kelley & Knowles, 2016). Details of student responses are outlined in Table 4.

Table 4. Percentage of students' response to STEM learning on human respiratory system

No	Indicators	Average (%)	Conclusion
1	Student response on the usefulness of the material concept	95,7	Strongly agree
2	Student responses on the interest of STEM learning	85,7	Strongly agree
3	Student responses on the usefulness of STEM learning	84,2	Strongly agree
4	Students' responses on the relevance of learning to the present situation	92,8	Strongly agree
5	Students' response on understanding the material	82,3	Strongly agree

CONCLUSION

STEM learning with UV sterilizer prototyping activities can improve students' numeracy skills significantly with a moderate improvement category. Students who do the learning argue that the material learned has benefits especially in accordance with the current situation. Most of the STEM learning stages were successfully carried out and in accordance with the designed learning stages.

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Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

How to Cite this Article

Rahmawati, A. L. L., Nuraeni, E., & Wulan. A. R. (2022). The effect of science technology engineering mathematics (STEM) learning on respiratory system topic on students' numerical ability. *Assimilation: Indonesian Journal of Biology Education, 5*(2), 135-140.