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The Effect of STEM Approach and Student's Collaboration Ability on Physics Problem Solving Skill

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ABSTRACT: This research is a True experimental study with a 2x2 factorial design aimed at finding the influence of the STEM approach and students' collaboration abilities on physics problem-solving skills. Sampling in this study used a simple random sampling technique with the class lottery, resulting in a sample of 31 students in the experimental class and 31 students in the control class. This study was executed by providing treatment as a STEM approach to fluid material. Data on students' collaboration abilities were collected using questionnaires, while data on physics problem-solving skills were collected using tests. The research data were analysed using Two-Way ANOVA statistical tests. The research results show that: (1) $Fcount$ (625.72) > $Ftable$ (3.33), meaning there are differences in physics problem-solving skills between students taught using the STEM approach and the scientific approach, (2) $Fcount$ (1,793.79) > $Ftable$ (3.33), meaning for high collaboration abilities, there are differences in physics problem-solving skills between students taught using the STEM approach and the scientific approach, (3) $Fcount$ (1,792.37) > $Ftable$ (3.33), meaning for low collaboration abilities, there are differences in physics problem-solving skills between students taught using the STEM approach and the scientific approach, (4) $Fcount$ (-34,125.75) < $Ftable$ (3.33), meaning there is no interaction between the STEM approach and students' collaboration abilities on physics problem-solving skills.

KEYWORDS: STEM Approach, Collaboration Ability, Physics Problem Solving Skill

INTRODUCTION

Education is a pivotal human need because education has the task of preparing human resources for nation-building. Therefore, education today is expected to produce critical resources capable of contributing to the construction of social orders and knowledge, just like global citizens produced by professionally managed institutions, yielding outstanding results, especially in physics learning. Physics learning presents challenges to be studied and often makes students complain. Physics learning still revolves around teachers and is unrelated to real life and technological developments. In physics learning, there are various theories or formulas only but various concept understandings. Physics learning facilitates students to develop 4C skills, namely critical thinking, creativity, collaboration, and communication. One of the core competencies developed in the 21st century is collaboration skills (Adhelacahya, 2023). Physics problem-solving skills and STEM approaches can be potential solutions to improve students' collaboration skills. Physics problem-solving skills involve a deep understanding of physics concepts and the ability to apply them in real-world situations. In the meanwhile, the STEM approach emphasizes the application of science and mathematics in practical contexts. Students must work together in teams to design and test concrete physics solutions. In this process, they will learn how to collaborate with team members to achieve common goals. The STEM approach is crucial because it requires students to solve problems that arise in everyday life by current job demands (Widya, 2019). It's expounded that through the STEM approach, students are sophisticated to be individuals who can handle problems and learn new things, capable of generating creative solutions, becoming self-reliant, able to think logically, and becoming literate in technology (technologically literate). Based on observations conducted at SMA Negeri 07 Kendari in physics subjects, the school implements the 2013 curriculum for class XI, but learning activities still revolve around the teacher. The implementation of education still uses methods where the teacher explains the material and students answer questions in the book. Students tend to be passive, and the role of students becomes very low. Learning methods based on teacher explanations and doing tasks in books are traditional approaches that can hinder active student interaction. In this context, students have disadvantaged access to develop collaborative skills and solve physics problems independently. Lack of active and collaborative interaction can result in low student engagement. Passive students do not develop problem-solving skills optimally because problem-solving time and again requires active involvement and creative thinking. STEM approach can be a solution because this approach often encourages students to be actively involved, especially in project and task contexts that require collaboration. Collaboration within teams can increase student participation, build physics problem-solving skills, and move learning from teacher-centered approaches to more student-centered approaches. One of the goals of physics learning is to help learners develop collaboration skills. The STEM approach has the potential to promote learners' collaboration skills. STEM learning can prepare learners to face the 21st century because it demands learners to reconstruct knowledge, collaborate, solve problems, learn through design, engage in construction, and utilize technology. According to Suwarma & Kumano (2019), the STEM approach aims to create STEM-literate learners by developing 21st-century skills. Other research suggests that STEM learning successfully trains 21st-century skills (Lou, Shih, Ray D., & Tseng, 2011; Tseng, Chang, Lou, & Chen, 2013). Research conducted by Kaniawati & Suwarma (2017) also indicates that implementing the STEM approach in experimental classes can enhance learners' problem-solving skills compared to control classes that do not implement the STEM approach. The treatment of STEM in learning can also improve problem-solving skills and help connect learners with contextual issues (Berry, 2012).

METHOD

The type of research used in this study is a True experimental design. This study applied at SMA Negeri 07 Kendari, Jl. Imam Bonjol No. 53A, Wawombalata, Mandonga District, Kendari City, Southeast Sulawesi, in the Odd Semester of the 2022/2023 Academic Year. While the primary focus of the study lay in analyzing the impact of the STEM approach, ancillary data on students' collaboration abilities we obtained from a collaboration ability questionnaire, which served to provide supplementary insights into the participants' interactive skills, and data on physics problem-solving skills acquired from a physics problem-solving skills test. The population in this study consists of eleventh-grade science students at SMAN 07 Kendari, totaling four classes with a total of 118 students, and the sampling is determined using a simple random sampling technique *(simple random sampling).* The results of the analysis among experts were analyzed using the formula:

$$V = \frac{\sum s}{n(C-1)} \qquad (1)$$

After testing, then analyzed using product-moment correlation equation below:

$$r_{xy} = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\{n\sum x^2 - (\sum x)^2\}\{n\sum y^2 - (\sum y)^2\}}} \qquad (2)$$

The instrument's reliability coefficient was determined using the Cronbach's alpha technique, namely:

$$r_{ii} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum S_i}{S_t}\right) \qquad (3)$$

Difficulty Index's *p* is determined by the formula:

$$T_k = \frac{S_A + S_B}{I_A + I_B} \qquad (4)$$

Table 1. Difficulty Index's Criteria

Difficulty Index	**Category**
$0{,}00 < T_k < 0{,}30$	Difficult
$0{,}31 < T_k < 0{,}70$	Moderate
$0{,}71 < T_k < 1{,}00$	Easy

Source: (Ali & Khaeruddin, 2012)

The discriminant power of an item indicates how well the item can differentiate between the group of proficient students and the group of less proficient students, calculated using the formula:

$$D = \frac{N_H - N_L}{N_T} \qquad (5)$$

Table 2. Differential Item Index

Differential Item Index	Classification
0,70 < D ≤ 1,00	Excellent
0,40 < D < 0,70	Good
0,20 < D < 0,40	Satisfactory
D < 0,20	Bad

Source: (Arikunto, 2018)

The normality test (Sudjana, 2005) uses the Lilliefors test because the data still falls within the small-scale category, with the formula as follows:

$$L_{count} = |F(z) - S(z)| \quad (6)$$

The homogeneity test using F_{max} with the following formula:

$$F_{count} = \frac{Biggest\ variance}{Smallest\ variance} \quad (7)$$

RESULT AND DISCUSSION

Descriptive analysis aims to describe the variation of data collected through research instruments in the form of a collaboration ability test for students. The data to be analyzed includes information on learning with STEM-based learning approaches and students' collaboration abilities in solving physics problems. Description of students' physics problem-solving scores is captured by conducting descriptive analysis of the scores obtained through physics problem-solving tests for students taught using the STEM approach in Class XI_2 and those taught using the scientific approach in Class XI_1. The description of students' physics problem-solving ability scores obtained after the implementation of the STEM approach and the scientific approach in the following Table 3:

Table 3. Statistics of Students' Physics Problem-Solving Ability Scores

Description	Physics Problem-Solving Ability Scores	
	STEM Approach	**Scientific Approach**
Sample Size	31	31
Highest Score	57	36
Lowest Score	30	12
Mean	39,19	25,42
Standard Deviation	5,96	5,71

Source: Processed Primary Data (2023)

Table 3 above shows that the average scores of classes using the STEM approach are higher than those among the groups using the scientific approach. Similarly, the highest and lowest scores indicate that experimental classes with the STEM approach are higher when contrasted with control classes with the scientific approach.

For the descriptive analysis of student collaboration abilities, the data is displayed in Table 4 below:

Table 4. Statistics of Students' Collaboration Ability Scores

Description	Students' Collaboration Ability Scores	
	STEM Approach	**Scientific Approach**
Sample Size	31	31
Highest Score	144	127
Lowest Score	80	74
Mean	113,42	96,48
Standard Deviation	17,46	14,94

Table 4 above indicates that the average scores for students' collaboration abilities show that in classes taught using the STEM approach, the average score obtained was 113.42, while for classes taught using the scientific approach, the average score obtained was 96.48. It means that the average score for students' collaboration abilities in classes taught using the STEM approach is higher than those taught using the scientific approach. Likewise, the highest and lowest scores show that classes taught using the STEM approach are higher than those taught using the scientific approach. The purpose of hypothesis testing is to analyze whether there is a difference in the influence of teaching approaches on students' collaboration abilities on students' physics problem-solving skills and the interaction between teaching approaches and students' physics problem-solving skills. The summary of the analysis of variance results is shown in Table 5 below:

Table 5. Summary of Analysis of Variance (ANOVA) Results

Variance Source	**JK**	**Db**	**RJK (S^2)**	**F_h**	**F_t** 0,05	**Test Decision**
Between Groups	37411,75	3	12.470,58	625,72	3,33	H_0 Rejected
Between A	35750,25	1	35750,25	1.793,79	3,33	H_0 Rejected
Between B	35721,88	1	35721,88	1.792,37	3,33	H_0 Rejected
Interaction A x B	-34.125,75	1	-27.889,00	-34.125,75	3,33	H_0 Accepted
Within Groups	306,25	28	19,93			
Total	**61972,63**	**35**				

Source: Processed Primary Data (2023)

The results of the descriptive analysis indicate that the average collaboration ability score of students taught using the STEM approach has increased compared to the average collaboration ability score of students taught using the scientific approach. Students taught using the STEM approach have an average score of 113.42, while students taught using the scientific approach have an average score of 96.48. Based on research by (Afriana, 2016; Adlim, Saminan, & Ariestia, 2015) which suggests that the implementation of the STEM learning approach is efficient in improving science abilities, where problem-solving skills are one aspect of science skills (Nugraheni & Suyanto, 2017). The STEM approach provides opportunities for teachers to instill concepts, principles, and techniques from science, technology, engineering, and mathematics in an integrated manner to develop a product for everyday life.

CONCLUSIONS

Based on the results of the analysis and discussion outlined in the previous chapter, the following observations can be inferred: (1) Overall, there is a significant difference in physics problem-solving skills between students taught using the STEM approach and those taught using the scientific approach in the 11th grade of SMA Negeri 07 Kendari. (2) For students with high collaboration abilities, there is a significant difference in physics problem-solving skills between students taught using the STEM approach and those taught using the scientific approach in the 11th grade of SMA Negeri 07 Kendari. (3) For students with low collaboration abilities, there is a significant difference in physics problem-solving skills between students taught using the STEM approach and those taught using the scientific approach in the 11th grade of SMA Negeri 07 Kendari. (4) There is no interaction between the STEM approach and physics problem-solving skills on the collaboration abilities of 11th-grade students at SMA Negeri 07 Kendari.

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