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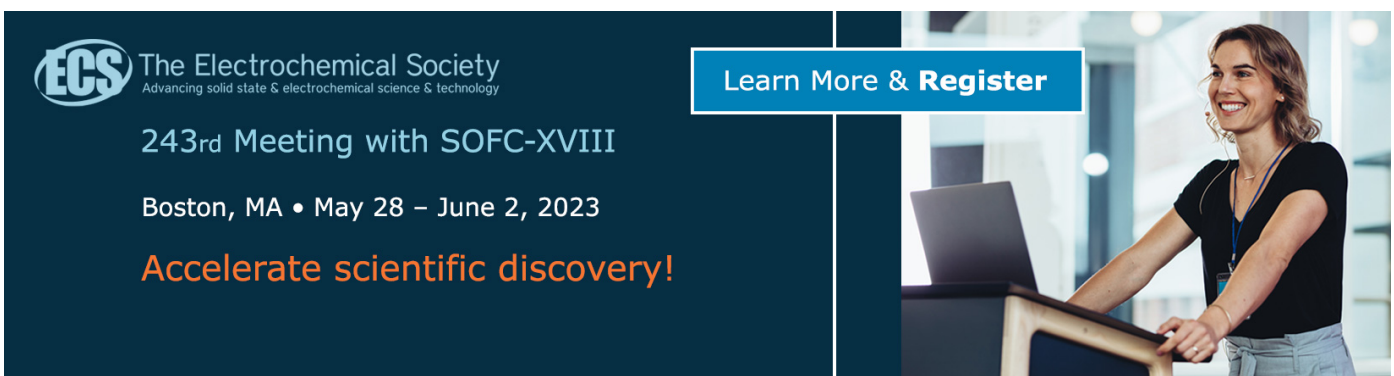
Enhancement of communication skills through physics learning with science, technology, engineering, and mathematics (stem) approach

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Enhancement of communication skills through physics learning with science, technology, engineering, and mathematics (stem) approach

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Abstract. This research aimed to determine the enhancement of communication skills on lightwave material physics learning with Science, Technology, Engineering, and Mathematics (STEM) approach. The benefit of this research is to train students to develop communication skills and as an innovation in learning physics in lightwave material. This research is Quasy Experimental research with Non-equivalent Control Group Design. XI IPA 7 as the experimental class and XI IPA 5 as the control class were recruited in this study as A subjects. The communication skills which are improved in this research include three indicators, including articulate thoughts and ideas, using communication for a range of purposes, and using several media and technology. Oral and written communication skills have improved from low to very high categories with high improvement criteria. The results of the questionnaire analysis showed that the application of physics learning with the STEM approach was effective in improving communication skills. Based on the results of this study, it can be concluded that learning physics with a STEM approach can improve communication skills from low to very high categories.

1. Introduction

United Nations (UN), through UNESCO, stated that 21st-century learning skills must learn 21st-century learning vision. The US-Based Partnership for 21st century that 21st-century learning or 4C skills consist of several skills, one of which is communication skills.

Communication skills are basic skills that are important as employability and to participate in society [1]. In a publication by [2] on several hundred interviews that have been conducted with business leaders, non-profits, and higher education officials, to survive in the 21st-century, students need some survival skills, one of which is oral communication and effective written communication.

The observation results of 16 high schools (SMA) in Semarang showed that physics learning had used the 2013 curriculum, but the learning process has not specifically improved communication skills. One of the efforts made to improve communication skills in the implementation of K-13 is to use an integrative approach. An integrative approach is a learning approach that is carried out using more than one scientific discipline, one of which is the STEM approach (Science, Technology, Engineering, and Mathematics) which integrates the basic themes and concepts of science, technology, engineering, and mathematics [3].

STEM is an approach to education with the aim of integrating four disciplines, namely science, technology, engineering, and mathematics [4]. The STEM approach not only focuses on

interdisciplinary integration of Science, Technology, Engineering, and Mathematics but also focuses on systematic thinking, openness to communication, ethical values, research, production, creativity, problems, intersections of knowledge and skills in science, technology, engineering, and mathematics [5].

The STEM approach is assessed as an appropriate approach applied in learning. Overall, the study of [6] highlights that the STEM approach has a positive impact on activities and learning outcomes in schools, including student academic success, interests and motivation, critical thinking skills, problem-solving skills, attitudes towards learning, and scientific process skills. In addition, STEM-based learning based on [7] research has proven to be effective in the learning process and helps students to develop 21st-century skills, including communication skills. Physics is the science that studies natural events and phenomena, which in the learning process can provide scientific experience to students, able to provide opportunities for cooperation, develop critical thinking skills, and solve problems to achieve good learning outcomes [8]. One of the subjects of physics is light waves, and this material is one of the basic competencies that students must master in the 2013 curriculum. In the learning process, lightwave material can also be integrated with technology, engineering, and mathematics. In STEM learning, STEM aspects such as science, technology, engineering, and mathematics are reflected in the learning tools. Each learning tool is consisting of lesson plans, discussion teaching, worksheets, and learning media that facilitate the improvement of communication skills. The purpose of this study was to determine the development of communication skills after participating in physics learning with the approach of Science, Technology, Engineering, and Mathematics (STEM).

2. Method

This study is Experimental Quasy research with a Non-equivalent Control Group Design. The random sampling technique is used in one of the state high schools in the city of Semarang. This research subject is XI IPA 7 as the experimental class and XI IPA 5 as the control class. In the experimental group with STEM learning was applied, while the usual learning control group was applied. Data collection methods include test methods and non-test methods, data collection techniques using tests and observations. The communication skill instrument consists of written and oral communication; the criteria categories are very high, high, medium, and low. Instrument analysis uses validity, suitability, differentiation, and reliability tests—initial data analysis using homogeneity test and normality test. Final data analysis uses the N-gain test, observation sheet analysis, and questionnaire analysis. Data analysis was performed with the help of IBM Statistics SPSS 22 and Microsoft Excel programs.

3. Result and Discussion

This research used the Problem Based Learning (PBL) learning model, and learning tools were arranged using the STEM approach. The use of the Problem Based Learning (PBL) learning model in the STEM approach is able to create dynamic learning, combine various stimuli, and enable students to gain valuable and widespread experience of its application in the real world [9]. The STEM aspect is integrated into student activities according to the learning tools with the STEM approach. The science aspect is the main subject of the material discussion, while the technology aspect is implemented in the concept of light diffraction, and engineering aspects are displayed in the form of making diffraction. Material related to the design of the technology is also displayed in this research, while the mathematical aspect is applied through mathematical equations in light diffraction material. The assignment to make diffraction grating as an embodiment of engineering aspects in this research is a place for students to channel their ideas according to the concepts of science and mathematics in light diffraction material. In the same vein as [10], who stated that the concepts of science and mathematics that students have received are the strongest foundation in engineering design related to the ideas and designs that students make. In addition, this research was conducted in accordance with the 2013 curriculum that integrates 21st-century learning skills so that it has a positive impact on improving students' communication skills

in speaking and writing. This is consistent with the findings of [11] that integrating 21st-century learning skills into learning can improve speaking and writing skills. Through STEM learning, students share solutions with their peers, thereby strengthening their ability to communicate. Similarly, [12] demonstrated that when students' oral communication skills were developed, vocabulary was internalized through the hands so that written communication skills developed.

Communication skills in this study were observed using observation sheets, including oral communication and written communication. The communication skills enhanced in this study include three indicators, namely articulating thoughts, and ideas, using communication for various purposes, and using several media and technology. The results of observing oral communication skills based on the analysis of the observation sheet are presented in Table 1 and improvement of oral communication skills between meetings through the N-gain test is presented in Table 2.

Table 1. Observation results of oral communication skills

Class	Meeting 1		Meeting 2		Meeting 3	
	Score (%)	Criteria	Score (%)	Criteria	Score (%)	Criteria
Experiment	49	Low	61	Medium	89	Very High
Control	26	Very Low	53	Medium	31	Very Low

Table 2. *N-gain* results of oral communication skills

Class	Meeting 1-2		Meeting 2-3		Meeting 1-3	
	< g >	Criteria	< g >	Criteria	< g >	Criteria
Experiment	0,24	Low	0,71	High	0,78	High
Control	0,36	Medium	-0,46	Decreasing	0,07	Low

Improvement of oral communication skills based on the results of observations in Table 1 and the N-gain test in Table 2 shows that the experimental class's oral communication skills are better than the control class. In the experimental class using learning with the STEM approach, students are required to be active in learning through problem-solving activities. Students solve the problems given through group discussion activities so that they will actively speak out for opinions, question, and answer, and explain the results of the discussion in front of the class. In line with these findings by [13], problem-based learning with the STEM approach can develop verbal communication skills in opinion and speaking in front of the class. The work of [14] showed that learning with the STEM approach is able to develop verbal communication skills up to standards categories and can increase if STEM approach learning is carried out in a continuous and sustainable manner. However, [15] said that in STEM approach learning, student activities are carried out in groups and guided by teachers so that oral communication skills can develop optimally. This is because guidance during group activities develops oral communication, such as speaking to answer teacher questions, and the courage to ask questions about material that is not yet understood can be achieved.

The improvement of oral communication skills in this research was made through STEM approach learning with problem-solving activities that are around students, in previous work by [16], which stated that raising issues or problems that exist around students can improve communication skills. In addition, [17] addressed that applying a transdisciplinary approach or approach that integrates more than one discipline to discuss issues or deal with problems can positively enhance verbal communication skills. In line with the results of the study, the STEM approach is an approach that integrates science, technology, engineering, and mathematics, so that it is proven to improve student communication skills better than the usual approach applied. At the same time, the result of the observation of oral communication skills on each indicator based on the observation sheet analysis is presented in Figure 1.
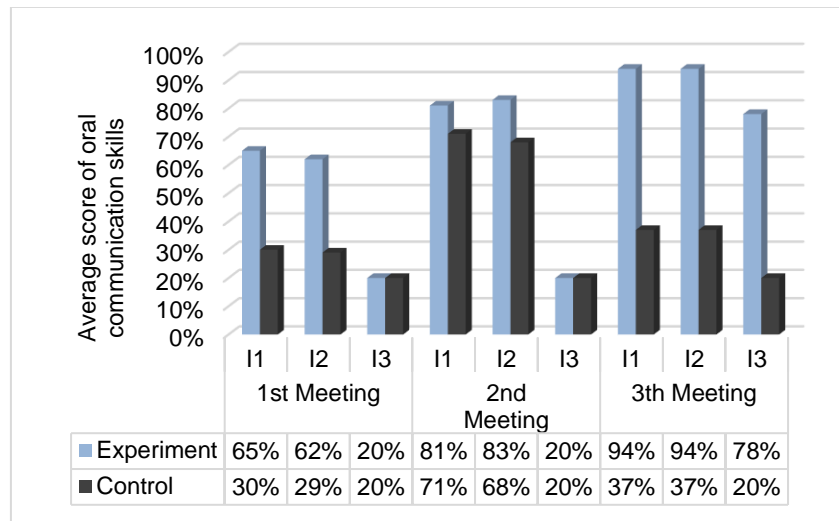
Figure 1. The average score of oral communication skills for each indicator

Information:
I1 (Indicator 1): articulate thoughts and ideas
I2 (Indicator 2): uses communication for various purposes
I3 (Indicator 3): uses several media and technology

Improved verbal communication skills on each indicator can be seen through the N-gain test. Based on the results of the N-gain test of oral communication skills, each indicator experiences a different increase at each meeting. The highest increase occurred in indicators using communication for various purposes. This is because, through STEM-based physics learning, students are accustomed to using communication to achieve a goal which is to solve the problems given related to learning material. Recent work of [18, 13] presents that problem-solving activities can improve communication skills, one of which is oral communication. In STEM-based learning, problem-solving activities are carried out through activities that require student activity, such as discussions, questions and answers, presentations, and practicum. Along the same lines [19, 20] argued that discussion and practical activities in problem-solving, which are then presented in front of the class, can improve communication skills. [21] also stressed that presentation activities could improve communication skills. Another view by [22] also claimed that by presenting their work, they were able to develop oral communication skills. At the same time, the indicators using media and technology experienced the lowest increase because these indicators could only be observed at the third meeting. Meanwhile, the results of the observation of written communication skills based on the analysis of the observation sheet are presented in Table 3, and an increase in written communication skills between meetings through the N-gain test is presented in Table 4.

Table 3. Observation results of written communication skills

Class	Meeting 1		Meeting 2		Meeting 3	
	Score (%)	Criteria	Score (%)	Criteria	Score (%)	Criteria
Experiment	42	Low	57	Medium	85	Very High
Control	39	Low	51	Low	50	Low

Table 4. *N-gain* results of written communication skills

Class	Meeting 1-2		Meeting 2-3		Meeting 1-3	
	< g >	Criteria	< g >	Criteria	< g >	Criteria
Experiment	0,26	Low	0,65	Medium	0,74	High
Control	0,20	Low	-0,02	Decreasing	0,18	Low

The improvement of written communication skills based on the results of observations in Table 3 and the *N-gain* test in Table 4 shows that the written communication skills of the experimental class are better than the control class. This is consistent with the research results by [13], that problem-based learning with STEM approach is able to develop written communication skills in writing reports of problem-solving results. The development of written communication skills in this study was carried out through learning activities that demanded student activity. [23] maintained that the use of learning strategies that make students more active and student-centered tends to improve their skills in shaping ideas and organizing ideas into written forms so that written communication skills increase. The written communication skills in this study were also developed through writing practicum reports. This is in line with [24] results that through the preparation of useful reports, it can develop written communication skills. The findings of [22] also stated that the report writing activities were able to develop written communication skills. At the same time, the results of observations of written communication skills on each indicator based on the analysis of the observation sheet are presented in Figure 2.
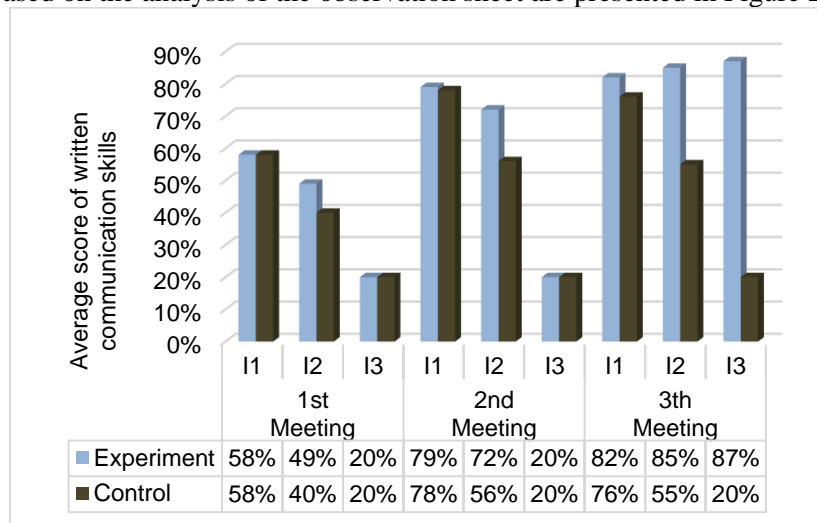
Figure 2. The average score of written communication skills for each indicator

Information:
I1 (Indicator 1): articulate thoughts and ideas
I2 (Indicator 2): uses communication for various purposes
I3 (Indicator 3): uses several media and technology

The indicators used in written communication skills are the same as the indicators in oral communication skills because both are part of general communication skills, and the indicators used are indicators of communication skills, according to [25]. The development of written communication skills on each indicator is seen through the improvement of written communication skills at each meeting

through the *N-gain* test. Based on the results of the N-gain written communication skills test, each indicator experienced a different increase at each meeting. As with oral communication, the greatest improvement in written communication skills occurs in indicators using communication for various purposes. This is because through STEM approach physics learning with problem-solving activities, students are accustomed to presenting problem-solving results written in the form of discussion reports, as well as practical reports, so written communication skills can develop. The study by [26, 27, 28] revealed that through problem-based learning, written communication skills could develop. At the same time, the indicators using media and technology experienced the lowest increase because these indicators could only be observed at the third meeting.

Based on the description above, it can be concluded that the improvement of each indicator of oral communication skills and written communication skills in STEM-related learning is better than using the usual approach applied. In addition, the results of the analysis of the questionnaire responses of students showed that communication skills could be improved through physics learning with STEM approach with an average score of 78.40% or effective criteria. This is consistent with the findings of [29], which stated that the STEM approach is positively able to develop students' skills, one of which is communication skills. In addition, the results of [30] said that the STEM approach in learning could develop students' communication skills in Thailand.

4. Conclusion

Based on the present research, it can be concluded that learning physics with a STEM approach can improve students' communication skills. Oral and written communication skills increase from low to very high, with the increase being in the high criteria. Indicators using communication for various purposes experienced the highest increase in both verbal and written communication skills. This is because the STEM approach in learning physics makes students accustomed to using communication to achieve a goal that is to solve the problems given related to learning material, such as discussing and delivering opinion. Then the results of the problem solving are presented in the form of reports, both discussion reports and practicum reports.

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