



Effectiveness of Using E-learning at STEM-based Physics Learning to Improve Communication Skills of High School Students

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Abstract

This study aims to determine the effectiveness of e-learning in STEM-based physics instruction on students' communication abilities. This research is a continuation of development research using the Allesi and Trollip model, which three experts have validated to make STEM-based e-learning to improve students' communication skills feasibly. The pre-experimental pretest-posttest design was used in this study's methodology. Thirty-one students from class XI MIPA Senior High Schools made up the sample for this study. The instrument used is a communication skill observation sheet with three observers to compare the impact before-after intervention, this study employed SPSS 25 to conduct a t-test and n-Gain. The results of the t-test and n-gain calculations show that STEM-based physics learning e-learning can significantly improve students' communication skills with an average n-gain score of 0.62 in the medium category. The highest increase was in oral communication (n-gain: 0.74), and the lowest was in student presentation skills (n-gain: 0.51). Furthermore, given the value of the t-count < t-table is $29.75 < 1.70$, the analysis utilizing the t-test yields H_1 being accepted so that the developed e-learning can be used as a medium for learning physics in the revolutionary era 4.0 in order to be able to face the demands of 21st-century learning.

Keywords: Communication Skills; E-Learning; Physics Learning; STEM

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INTRODUCTION

Information technology and science are the fields that have advanced the most as we move towards the fourth industrial revolution (Syafei et al., 2020). Because of advances in science and technology, we must constantly be prepared to learn new skills, solve issues, and create (Slavinec et al., 2019). Each educational process must

use information technology in a useful and digital way in the age of the fourth industrial revolution when access to information is not constrained by time or geography (Sugiharni & Setiasih, 2018).

Using information technology in the classroom prepares students for the fourth industrial revolution, namely by using learning resources that use the



digital environment (Wiyono & Zakiyah, 2019). E-learning is one option for learning media that uses the digital environment (Wahyuaji & Suparman, 2018). E-learning, often known as electronic learning, is a method of education that makes use of electronic devices on a network or online (Wahyudi, 2017)

Through e-learning, anyone, anyone can complete their education. Distance and time are no longer barriers to carrying out activities, including learning, thanks to the same principles that apply to other online activities (Azlan et al., 2020). E-learning is typically delivered through websites and online media. The information provided through e-learning might be in the form of learning, videos, learning materials, or even live-streaming YouTube videos (Umiyatun et al., 2020). A website provides access to these educational resources, including notes, tests, discussions, and exams (Elcullada Encarnacion et al., 2020). By using e-learning, students can be more independent in learning, and e-learning can increase student activity in the learning process (Wahyudi, 2017).

To conduct learning more effectively, e-learning is required (Bada & Jita, 2021). E-learning can be applied to traditional and distance learning systems. Mobile phones are the media that are frequently utilized in daily activities, according to the results of the analysis of the demands of Senior High Schools 2 Palembang pupils. Opening social network profiles on mobile devices is preferred to accessing educational materials. Student achievement will be impacted if the internet is exclusively utilized to create social media profiles.

Therefore, to reduce the negative impact of using the internet is to use e-learning to support learning in schools. Study (Hartanto et al., 2021; Marnita et al., 2021; Sukma & Halim, 2022) and (Sutriyono & Wiyono, 2022), stated that the application of learning using e-learning

affected student learning outcomes. Strategies in learning are needed to encourage students' knowledge and abilities by combining e-learning with a STEM approach (Fariyani & Kusuma, 2021; Sunarti & Rusilowati, 2020). In line with the results of the needs analysis that researchers have carried out, 96.3% of students want the use of e-learning accompanied by a STEM approach. Applying STEM-based learning will motivate students to excel and get the best grades and can motivate students to be more active in discussions (Syafei et al., 2020; Wahyuni, 2019).

STEM is an approach used by integrating Science, Technology, Engineering, and Mathematics in learning activities. Learning using STEM is an alternative to facing a challenge in the 21st century (Sunarti & Rusilowati, 2020). Students are led to become problem solvers, inventors, and innovators, build independence, think logically, and are technology literate (Ridwan et al., 2020). In addition, STEM-based learning can also support an independent learning curriculum that has anticipated the development of life and science to meet the 21st century (Batubara et al., 2022). Marked by the acceleration of the implementation of digital transformation in learning innovations that can produce students who think critically, creatively, communicatively, and collaboratively or commonly referred to as 4C (critical thinking, creativity, collaboration, and communication) (Bao & Koenig, 2019).

In order to manage learning that can affect the 4C abilities needed in the 21st century, teachers must control the importance of the 4C part of learning innovation. In order for pupils to directly apply what they have learnt when they have learned it. In order to mould the character, abilities, and skills of the 21st century, learning activities are created to be collaborative. One of the essential talents in the twenty-first century is

communication. When students explain the outcomes of the scientific method, either directly or indirectly, individually and in groups, communication skills are required (Redhana, 2019). Thus, communication abilities impact pupils' easier assimilation of the teacher's material (Marfuah, 2017).

The accomplishment of student learning outcomes and the efficiency of learning can be supported by students' communication abilities (Makiyah et al., 2021). According to the findings of teacher interviews, there are a variety of reasons students' communication skills are poor when learning online, including using instructional tools that are not fully exploited. The results of previous studies have shown that implementing continuous learning using a STEM approach can improve students' communication skills (Haryanti & Suwarma, 2018; Mulyani, 2019). One example of learning using STEM and its relationship with communication skills is that when students are given project assignments, indirectly, the communication skills of students are trained. In addition, students' oral communication skills are also trained when they convey the results of their projects through presentations in front of an audience; moreover, when students are made to request a project creation report, the students' receptive communication skills will also be trained. Learning so far is more about working on the practice questions in the student's book to better train students' communication skills (Taryono et al., 2019). Thus, this study was conducted to determine the effectiveness of using e-learning at STEM-based physics learning to improve the communication skills of high school students.

METHOD

The pre-experimental pretest-posttest design was used in this study's methodology. This research is part of research on the development of STEM-based e-learning to improve students' communication skills using the Alessi and Trollip development model. The

following in Figure 1 is a diagram of the stages of development based on the Alessi and Trollip models (Alessi & Trollip, 2001).

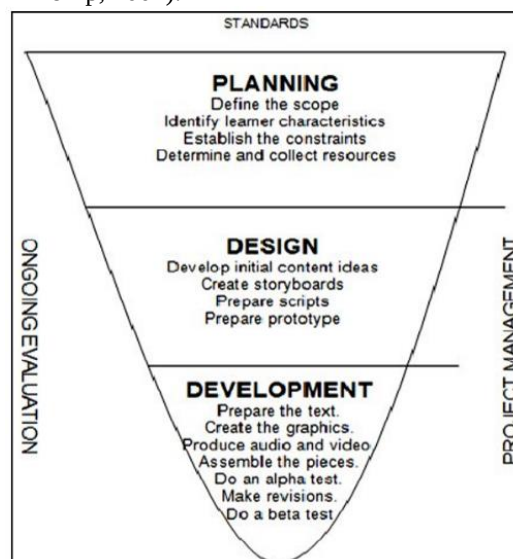


Figure 1 Alessi and Trollip's Development Stages

Three validators were selected to test the feasibility of e-learning during the alpha test, which resulted in e-learning being feasible to use. A trial method of STEM-based physics learning e-learning goods to improve students' communication abilities is conducted after initial observations by three observers chosen to assess students' communication skills before receiving treatment or taking a pretest. Continued with the trial process of STEM-based physics learning e-learning products to improve the communication skills that have been developed, and ended with the observation of students' communication skills after being treated as a post-test 31 students from class XI of MIPA 2 Senior High Schools 2 Palembang made up the sample for this study.

Purposive sampling technique is used in this study. The communication skills instruments used have been developed (Redhana, 2019) include aspects of oral communication, receptive communication, understanding communication intentions/ objectives,

muse communication strategies, and communication clearly to achieve a goal. This study aims to examine the improvement in high school students' communication abilities that occurs in a class as a result of the therapy delivered without a control or comparison group using research methodologies that have been chosen based on the research objective. This study employed a one-group pretest-posttest design using a t-test and N-gain to examine the impact of treatment on communication skills both before and after it was administered. Table 1 displays the research strategy. The research design can be seen in table 1; t-test and N-gain were used in this study using SPSS 25 to see the effect before and after being given treatment on improving communication skills with a one-group pretest-posttest design. This study used an instrument in the form of an observation sheet consisting of 6 indicators of communication skills. The several hypotheses developed in this study are as follows:

H_0 : There is no significant difference before and after the effectiveness of using e-learning at STEM-based physics learning to improve the communication skills of high school students.

H_1 : There is a significant difference before and after the effectiveness of using e-learning at STEM-based physics learning to improve the communication skills of high school students.

Furthermore, the increase in students' communication skills is obtained by calculating the magnitude of the n-gain score from each skill indicator and based on the n-gain categorization as in Table 1 (Hake, 1998).

Table 1 Categorization of N-Gain Values

N-gain value criteria	Category
$Ngain \geq 0.7$	High
$0.7 > Ngain \geq 0.3$	Medium
$Ngain < 0.3$	Low

RESULTS AND DISCUSSION

The research conducted in class XI MIPA 2 at Senior High Schools 2 Palembang is a study of the application of physics learning using STEM-based e-learning to improve students' communication skills that have been developed. To get accurate research results, researchers have carried out all stages, starting from data collection, processing data in the form of statistics using SPSS, namely looking for the n-gain value and paired sample t-test with the prerequisites of normality test using Kolmogorov-Smirnov (Arikunto, 2018). Researchers used the observation sheet to see students' communication skills during the pretest and post-test stages. The results of the initial and final analysis of the abilities of students who have been taught using STEM-based e-learning to show significant differences can be seen in Table 2.

Table 2 Description of Pretest and Posttest Values

Stages	Minimum Score	Maximum Score	Average
Pretest	51	75	59.48
Posttest	76	94	84.68

According to table 2's statistics, there were variations between the pre-and post-test periods regarding students' communication skills. The fact that the average score has risen 25,2% suggests that students can benefit significantly from the learning process when adopting

STEM-based e-learning. By examining the n-gain, the data from the following study are analyzed. The normality test is performed before the researcher analyzes the n-gain statistical data and the t-test since it is one of the conditions that must be met when carrying out

statistical analysis calculations (Widana & Muliani, 2020).

Furthermore, the normality test using

is carried out using SPSS 25. The results of the normality test can be seen in the following Table 3.

Table 3 Kolmogorof-Smirnov Normality Test Results

Group	Statistics	df	Sig
Pretest	0.15	31	0.07
Post-test	0.14	31	0.13

Table 3 shows the results of the normality test using Kolmogorov-Smirnov with a pretest group with a significance level of 0.07 and a post-test of 0.13, both of which have $\alpha > 0.05$ means the data is normally distributed.

Data analysis on applying physics learning using STEM-based e-learning is based on the acquisition of the n-gain value per communication skill indicator in Table 4.

Table 4 Analysis of N-Gain Value

Indicator	Pretest	Posttest	N-Gain Score	Category
Oral communication	58.33	89.24	0.74	High
Receptive communication	62.90	86.83	0.65	Medium
Understand the purpose/purpose of communication	59.14	81.45	0.55	Medium
Using communication strategies	55.38	84.68	0.66	Medium
Communicate clearly to achieve a goal	56.18	83.06	0.61	Medium
Presentation skills	64.78	82.80	0.51	Medium

Based on Table 4 shows the difference between the pretest and posttest values. A significant improvement was seen from the pretest-posttest results for all indicators of communication skills. The first indicator, namely oral communication, increased by 30.91%. The second indicator, namely receptive communication, increased by 23.93%. The third indicator, understanding the purpose of communication, increased by 22.31%. The fourth indicator, using a communication strategy, increased by 29.30%. The fifth indicator, communicating clearly to achieve a goal, increased by 26.88%. Finally, the sixth indicator, presentation skills, has increased by 18.02%. Furthermore, the representation of the n-gain score can be

seen in the following Figure 2.

The results of the overall n-gain calculation show good results. To see an increase in the n-gain score, it is presented in Figure 1. Each indicator of communication skills has a significant improvement. Communication skills improved after treatment using e-learning by implementing pre-developed STEM. The oral communication indicator has an n-gain score in the high category of $n\text{-gain} \geq 0.7$. While the indicators of receptive communication, understanding communication objectives, using communication strategies, communicating clearly to achieve a goal and students' presentation ability are in the range of $0.7 > n\text{-gain} \geq 0.3$, which means it is in the medium category.

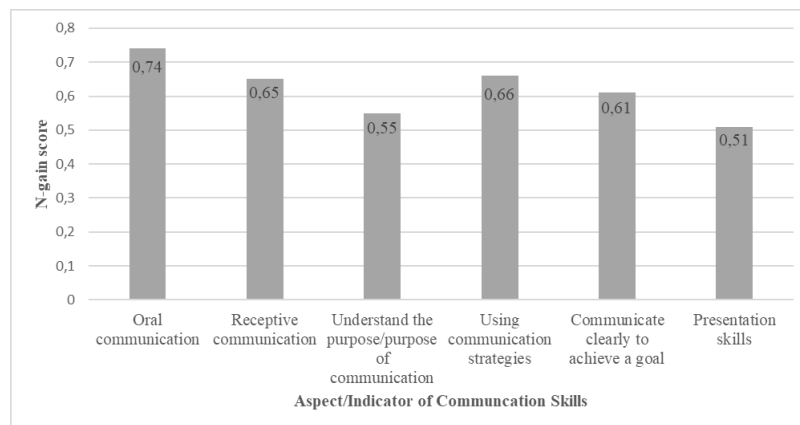


Figure 2 Graph of N-gain per-Indicator

The significant increase in the value of n-gain in both categories was due to the application of learning using interesting e-learning, making students curious about what they saw so that the enthusiasm of students to express opinions orally was very large and communication between students and students as well as students and teachers was very clear. (Maulida et al., 2021) conflicts created by teachers in e-learning require students to be active in communicating orally and in writing so that the effectiveness of learning using e-learning can improve students' communication skills (Jufriadi et al., 2022). The division of small groups at the time of class can also help to create more effective communication patterns; thus students feel more comfortable expressing their opinions and thoughts in the group (Septikasari & Frasandy, 2018).

Figure 1 also shows that the indicator of students' presentation skills is the lowest skill. Some of the causes of these indicators could be higher because they are not used to making presentations at learning time. Judging from the students when presenting the project results, some are still reading the notes, and their voice needs to be clearer. This is the same as

previous research: students' presentation skills are low because they are not used to it, so they seem to be in a hurry and not calm when presenting. This is because students are nervous about public speaking (Taryono et al., 2019). The solution to improve students' communication skills is to train students. The application of learning using e-learning has a positive impact on student learning outcomes (Haruna et al., 2021). In addition to e-learning, the application of learning by implementing STEM can improve students' communication skills (Wisnu Wibowo, 2018). STEM has the most significant contribution to improving students' communication skills. Solving the difficulties of STEM-based learning can be used as an innovative method to be creative, act actively, exchange ideas, express opinions, ask questions, discuss, argue, exchange information, and solve problems that exist together with the discussion group (Wahyuni, 2019). This is what can make students' communication skills improve. A paired t-sample test was carried out to strengthen the findings further, the results of which can be seen in Table 5.

Table 5 The Results of The Paired Sample T-Test

Group	t-count	t-table	Sig. (2-tailed)
Pretest-Posttest	29,75	1.70	0.00

Furthermore, an analysis using a t-test was conducted to determine whether there was an effect of STEM-based learning at the time of learning. The t-count test uses a statistical formula with a significance level of 0.05. The test criteria reject H_0 if $t\text{-count} > t\text{-table}$ and accept H_1 if $t\text{-count} < t\text{-table}$. The following are the results obtained by the t-test value of 29.75 while the t-table value is 1.70 with a significance level of 0.05. So it can be concluded that the value of $t\text{-count} < t\text{-table}$ is $29.75 < 1.70$. Thus, hypothesis testing shows H_1 is accepted. Namely, the application of learning-learning STEM-based can improve students' communication skills. It also shows that the use of STEM-based learning has a positive impact on increasing learning motivation and student learning outcomes. The results of this study are supported by previous research on e-learning using a STEM approach that can improve 21 st-century skills (Suwardi, 2021). The availability of discussion forums on e-learning provides opportunities for students to give opinions so that students' communication skills can improve.

The success of implementing learning using STEM-based learning because the learning process taught with the right pattern is packaged to be more attractive; the use of pictures, videos, animations, and virtual laboratories can help students understand the learning material (Hartanto et al., 2021; Wiyono et al., 2020). E-learning can also make it easier for students to find out learning content because it is already structured in one e-learning system (Wati et al., 2021). In addition, e-learning is more student-centred so students are more interactive (Wiyono et al., 2019). This is in line with what was stated by (Alyoussef, 2021), that e-learning is very exciting for students because learning becomes more interactive and can be accessed easily anytime and anywhere.

CONCLUSION

The improvement of students' communication skills can be seen through the average score of students before and after learning, namely before learning 59.48 and after learning 84.68, which means there is an increase. The application of physics learning using STEM-based e-learning that has been developed can improve the communication skills of high school students so that it is proven effective. E-learning that has been developed can be a reference to be used as a medium for learning physics in the 4.0 revolution era to face the demands of 21 st-century learning. Moodle is very suitable to be developed for researchers or teachers who already understand programming languages, complete features are the advantages of moodle, but if you are still a beginner, you should use e-learning that has been developed, for example, Schoology. For those STEM approaches, you should analyze the material to be taught first because learning by integrating the STEM approach must relate to four science disciplines: science, engineering and mathematics.

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