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The effect of SPADA-integrated electronic civic education teaching materials on improving students' STEM and communication skills

Lalu Sumardi[1] ✉
Adi Fadli[2]
Ahmad Fauzan[3]


(✉ Corresponding Author)

[1,3]*University of Mataram, West Nusa Tenggara, Indonesia.*
[1]*Email: lalusumardi.fkip@unram.ac.id*
[3]*Email: ahmadfauzan18@unram.ac.id*
[2]*Universitas Islam Negeri Mataram, West Nusa Tenggara, Indonesia.*
[2]*Email: adi.fadli@uinmataram.ac.id*

Abstract

This study aims to measure the effectiveness of electronic civic education teaching materials integrated into LMS-SPADA in improving students' STEM reasoning ability and communication skills. In addition, this study will also measure the effect of gender on their STEM reasoning ability and communication skills. The research design is a quasi-nonequivalent pre- and post-tests control group design. The sample size is 60 students consisting of 24 male and 36 female. An essay test was used to collect data on STEM reasoning skills. Meanwhile, communication skills were collected using a questionnaire. The data were analyzed descriptively and using a t-test. This study found that students' STEM reasoning and communication skills can be improved by using civic education electronic teaching materials integrated into LMS-SPADA (learning management system-SPADA). Another finding of this study is that gender significantly affects students' STEM and communication skills where male students are better at STEM reasoning than female students, while female students are better in the aspect of communication skills. Therefore, it is clear that electronic civic education materials integrated into LMS-SPAD are effective in improving students' STEM reasoning and communication skills.

Keywords: Civic education, Communication skill, Gender difference, LMS-SPADA, STEM reasoning, Teaching materials.

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Contents

Contribution of this paper to the literature

This research proves that information technology-integrated teaching materials are not only effective in improving students' STEM and communication skills in science subjects but also effective in social subjects especially in civic education. The findings of this study can be a strong basis for teachers in conducting teaching and learning to develop students' STEM and communication skills through the use of electronic teaching materials integrated with online platforms.

1. Introduction

Technology plays an important role in everyday life including in education. In today's digital era, technology is an important factor that determines the quality of learning (Ho et al., 2020; Kulturel-Konak, D'Allegro, & Dickinson, 2011; Pavlova, 2013). Learning must be transformed using technology and it is no longer a secondary factor but a primary need in carrying out learning activities at every level of education (Kelley, Knowles, Holland, & Han, 2020; Wahyudiati, 2023). Teaching materials are one of several ways technology may be used as an instrument. This research will measure the effectiveness of IT-based civic education teaching materials in improving the STEM reasoning ability and communication skills of students in universities because the STEM reasoning ability and communication skills of students in universities still need to be improved (Verawati, Ernita, & Prayogi, 2022; Wahyudiati, 2023).

Technology-based learning innovations can be practiced through the creation of educational media and teaching materials to help students acquire 21st-century skills. It is expected that students' skills will enable them to compete in their field of work (Castro, Tamayo Arias, Arango Serna, Branch Bedoya, & Burgos, 2020; Hai, Linh, & Bich, 2023; Kırkıç & Arıkan, 2023). STEM reasoning is related to the ability to think critically, systematically and logically. STEM reasoning and communication skills are 21st-century competencies that students should have (Ho et al., 2020; Reilly, Neumann, & Andrews, 2017). Students' hard and soft skills will improve with these two abilities (Kelley et al., 2020; Wahyudiati, 2023).

The main idea behind STEM-based learning is the optimal development of students' potential through the functionalization of technology. As a result, e-learning systems are the new way of education today (Krumsvik, 2014; Kulturel-Konak et al., 2011; Verawati et al., 2022). As a result, teachers are urged to use electronic-based teaching media and materials rather than traditional teaching materials or learning media to keep up with the rapid advancement of modern technology (Hai et al., 2023; Kiazai, Siddiqua, & Waheed, 2020; Wahyudiati, 2023). In addition, compatible and adaptive learning designs such as the availability of IT-based media, electronic teaching materials, and online learning systems (SPADA) are needed to strengthen the implementation of online learning. Thus, it can create more meaningful learning and encourage students to construct their knowledge and skills actively (Kong & Mohd Matore, 2021; Mechouat, 2017; Tandrayen-Ragoobur & Gokulsing, 2022; Verawati et al., 2022).

Learning Management System-SPADA is an online-based learning system under the name SPADA developed by the University of Mataram since the COVID-19 pandemic. This system was developed based on the Moodle learning platform which can be used by all lecturers in conducting learning. This system not only facilitates online face-to-face but also has a complete menu needed for learning. Therefore, all learning activities are carried out through this system. This system is still used as an option in conducting learning.

In particular, student interaction and engagement in the learning implementation is one of the determining factors in developing students' STEM and communication skills (Castro et al., 2020; Hai et al., 2023; Kırkıç & Arıkan, 2023). Since reasoning ability predicts student success in STEM fields, reasoning ability should be a concern (Ali, Bhadra, Siby, Ahmad, & Al-Thani, 2021; Verawati et al., 2022). According to Kong and Mohd Matore (2021) and according to Dwi Wahyudiati (2023) the indicators of STEM reasoning capacity are analysis, inference, judgment, and decision-making skills. All of these abilities will be successful factors in the 21st century.

Student interaction and involvement in learning are still the focus especially in developing STEM and communication skills (Castro et al., 2020; Kırkıç & Arıkan, 2023; Wahyudiati, 2023). The student skill that needs to be developed is reasoning ability because it is a predictor of STEM (Ali et al., 2021; Hai et al., 2023). STEM reasoning skills have several indicators such as analysis, evaluation, inference and decision-making skills (Ali et al., 2021; Kırkıç & Arıkan, 2023; Verawati et al., 2022; Wahyudiati, 2023). Therefore, it is expected that students' STEM reasoning and communication skills can be developed by implementing STEM-based learning in higher education.

However, previous research shows that the teaching materials that have been developed are still not sufficient to equip students with 21st-century skills especially in terms of STEM and communication skills (Qazi et al., 2022; Wahyudiati, Sutrisno, & Supiah, 2019; Yavuz & Güzel, 2020). In civic education courses, the availability of IT-based teaching materials is still limited (Japar, Hermanto, Muyaroah, Susila, & Alfani, 2023; Siddiq & Scherer, 2016). This leads to poor student reasoning and communication skills. It also has an impact on student motivation to learn abstract concepts (Sumardi, 2024). The results of interviews with civic education lecturers also show that students have difficulty developing their ability to understand concepts, analytical thinking skills and communication skills. On the other hand, the availability of supporting instruments such as appropriate teaching materials is still lacking. Therefore, IT-based civic education teaching materials are essential to be developed and implemented to accelerate concept understanding and develop STEM and communication abilities (Japar et al., 2023; Zorwick & Wade, 2016). In addition, research conducted by Ali et al. (2021); Jacoby (2022) and Wahyudiati (2023) shows that the use of IT-based teaching materials in the learning process can improve students' critical thinking, problem-solving and learning outcomes. Various research findings prove that IT-based teaching materials are effective in improving student learning outcomes.

There are two questions to be answered in this study, namely, (1) what is the effect of integrated civic education electronic teaching materials in LMS-SPADA on students' STEM reasoning and communication skills? (2) What is the effect of gender on these two abilities based on the above arguments? This kind of research is very

interesting and important to do because there are still few studies that examine these issues in the context of civic education subjects.

2. Literature Review

2.1. Electronic Teaching Materials

Electronic teaching materials are teaching materials designed in digital format. This teaching material can also be called IT-based teaching material because the design is not in printout but in digital form. This teaching material is very complex because its content does not only consist of text but is also accompanied by images, sound recordings, videos, and others that can attract students' learning interests (Klement, Dostál, & Marešová, 2014). This model is a new form of teaching material in education (Krumsvik, 2014; Kulturel-Konak et al., 2011; Verawati et al., 2022). In the current digital era, the model is very relevant because students are very familiar with technology and they have adequate access. They really like to surf with technology and match their style. They are very adept at operating it, especially gadgets. This is important because learning style is an important factor in the use of electronic teaching materials (Klement et al., 2014). Teachers must be able to revolutionize their teaching methods responding to technological developments and changes in the way students learn. They must be adaptive to technological developments in the preparation of media and learning resources (Hai et al., 2023; Kiazai et al., 2020; Wahyudiati, 2023) because it determines the quality of the learning process and outcomes. With IT-based learning resources, learning becomes more meaningful and encourages students to construct their knowledge independently and more easily (Kong & Mohd Matore, 2021; Mechouat, 2017; Tandrayen-Ragoobur & Gokulsing, 2022; Verawati et al., 2022). The use of IT-based teaching materials in learning not only has an impact on the process aspect but also has an impact on the results. This is illustrated by various opinions and research findings that have been conducted previously. The results of research conducted by Reilly et al. (2017); Kiazai et al. (2020); Ho et al. (2020); Kırkıç and Arıkan (2023); Verawati et al. (2022) and Wahyudiati (2023) showed that IT can increase student participation in learning, visual and spatial skills, self-confidence, learning independence, learning outcomes, digital literacy, and STEM abilities. IT-based teaching materials can also make it easier for students to understand concepts, improve reasoning skills, communication (Japar et al., 2023; Zorwick & Wade, 2016), critical thinking, problem solving, learning outcomes (Ali et al., 2021; Jacoby, 2022; Kurup, Li, Powell, & Brown, 2019; Wahyudiati, 2023) cooperation, and self-efficacy (Gardner, Glassmeyer, & Worthy, 2019; Hai et al., 2023; Kelley et al., 2020; Kırkıç & Arıkan, 2023). The research findings above prove that electronic teaching materials are very effective in improving the quality of learning.

2.2. STEM and Communication Skills

In 2016, the Ontorio discussion document (Sumardi, 2024) described 3 domains of 21st-century competencies that must be developed, namely, cognitive, interpersonal, and intrapersonal domains. The following three domains consist of 50 competencies: 13 competencies are in the cognitive domain circle, 15 competencies are in the interpersonal domain circle, and 22 competencies are in the intrapersonal domain circle. Of the many 21st-century competencies identified, one of the competencies that students must have is STEM reasoning ability and communication skills (Ho et al., 2020; Reilly et al., 2017). Both skills are very important for everyone to have because they are one of the determining factors for success (Wahyudiati, 2023). Therefore, learning should give more attention to the development of these competencies. The orientation of STEM-based learning is the development of students' reasoning skills based on the functionalization of technology. According to Castro et al. (2020); Kırkıç and Arıkan (2023) and Hai et al. (2023) the determining factor for the development of STEM reasoning ability and student communication skills is student interaction and participation in learning. Meanwhile, according to Sumardi (2024) the development of students' critical and analytical thinking skills can be done through teaching materials that contain tasks that require problem solving. Students' reasoning skills will develop well through these tasks. This opinion is in line with the opinion expressed by Kong and Mohd Matore (2021) and Wahyudiati (2023) who said that the development of STEM reasoning skills can be done through analytical activities. Meanwhile, communication skills can be developed through learning with the help of information technology (IT) learning resources (Yoon, Kim, & Lee, 2021).

According to Verawati et al. (2022); Ali et al. (2021) and Kırkıç and Arıkan (2023) there are 4 indicators of STEM reasoning skills, namely, analysis, evaluation, inference, and decision-making skills. These processes are all essentially based on logic. According to Ali et al. (2021) and Hai et al. (2023) reasoning skills are predictors of STEM. Communication skills are one of the fundamental skills in human life and social processes (Wahyudiati, 2023). Mahmud et al. (2023) said that these skills help students understand and communicate ideas effectively with others. There are 4 indicators that can be used, namely, articulating ideas effectively, listening effectively, communicating communicatively and using media and technology functionally to measure communication skills (Gustiani, Ratna, & Solihat, 2018).

3. Research Method

3.1. Research Design

A quasi- non-equivalent pre- and post-test control group design was employed in this research (Creswell, 2009). Random selection was used to establish the classes of experimental and control. The experimental class received instruction using electronic civic education teaching materials (a combination of the Canva application with the SPADA platform) while the control group employed a direct learning methodology using traditional media. Prior to starting treatment, a pre-test was administered to determine the student's baseline STEM reasoning ability and communication skill and this process was then repeated with a post-test. The design of this research is shown in Table 1.

Table 1. The design of research.

Classes	Pre-test	Treatment	Post-test
Experiment	D1, E1	X	D2, E2
Control	D1, E1	Y	D2, E2

Note: D1 = Communication skills (Pre-test).
D2 = Communication skills (Post-test).
E1 = STEM reasoning ability (Pre-test).
E2 = STEM reasoning ability (Post-test).
X = Learning with electronic civic education teaching materials.
Y = Learning with conventional teaching materials.

3.2. Research Sample

There were sixty students from the University of Mataram in Indonesia in the research sample: thirty-six females and twenty-four males. Using the cluster random sampling technique, a total of 30 students—12 males and 18 females—were allocated as the control group and another 30 students—11 males and 19 females—as the experimental group. The participants' average age was between 19 and 20 years old (see Table 2). Each of them participated willingly and is free to leave at any time. A lecturer with more than ten years of expertise in the classroom instructed them.

Table 2. Sample characteristics.

Categories		Experimental group, n = 30		Control group, n=30	
		Quantity	%	Quantity	%
Gender	Male	11	60%	12	64%
	Female	19	40%	18	36%
Age (Year)	19	11	44%	10	40%
	20	14	56%	15	60%

3.3. Research Instruments and Data Analysis

3.3.1. Research Instruments

STEM reasoning abilities and communication skills instruments were employed in this investigation. The analytical skills (A), inference skills (I), evaluation skills (E) and decision-making skills (D) are indications of the STEM reasoning ability instruments. The STEM reasoning ability instrument took the form of an essay with a total of 12 questions altogether, three questions for each indicator. Each item has a maximum score of +4 (descriptor: the answer is correct and the case for each indicator of reasoning using facts, concepts, and laws is compelling) and a minimum score of 0 (no response is provided). It was then transformed into an interval equation based on the scoring criteria (Verawati et al., 2022). STEM reasoning abilities were measured based on reasoning skill indicator (RSi) and individual ability (RSs) as shown in Table 3.

Table 3. Category of STEM abilities.

Categories	Score ranges	Score ranges
Very good	RSi > 3.21	RSs > 25.60
Good	2.40 < RSi ≤ 3.21	7.20 < RSs ≤ 25.60
Enough	1.60 < RSi ≤ 2.40	12.80 < RSs ≤ 19.20
Less	0.80 < RSi ≤ 1.60	6.41 < RSs ≤12.80
Bad	RSi ≤ 0.80	RSs ≤ 6.41

The communication skills questionnaire adopts an instrument developed by Bahtiar, Maimun, and Ibrahim (2023) which consists of 3 aspects, namely speaking ability (SA), listening ability (LA), and non-verbal communication ability (NVCA). Details for the communication skills instrument grid are illustrated in Table 4.

Table 4. Instrument grid for communication skills.

Indicators	Number of items
Speaking ability	11
Listening ability	12
Non-verbal communication ability	13
Total items	36

The questionnaire uses a Likert model with five ranges, namely: strongly agree, agree, slightly disagree, disagree, and strongly disagree. The highest score is 5 and the minimum score is 1 (applies to negative and positive statement items). These criteria were converted into interval equations (Iksan et al., 2012). Communication skill intervals are shown in Table 5.

Table 5. Reference criteria for student communication skills.

Communication skills criteria	Mean range
Good	3.35-5.00
Average	1.68-3.34
Low	0-1.67

3.3.2. Data Analysis

Data analysis of students' STEM abilities and communication skills descriptively relates to Tables 4 and 5 and the Hake formulation (Wahyudiati, 2023) is used to represent the increase in score (n-gain). Additionally, a test of differences between sample groups was performed using statistical analysis to see whether there was a difference ($p < 0.05$) in the development of students' STEM and communication skills. Previously, a normality test was carried

out ($p > 0.05$) with the Shapiro-Wilk test. Data analysis was carried out using the statistical package for the social sciences (SPSS) 24.0 program.

3.4. Research Procedure

The phases of creating electronic civic education teaching materials integrated with the SPADA (online learning system) and the phases of putting those teaching materials into practice in the experimental class comprise the two main stages of the research. The specifications of the electronic civic education teaching materials integrated with the SPADA application developed are a combination of the Canva application integrated with the SPADA application as a means of e-learning at the University of Mataram. The Canva application is used to design interactive learning videos and to select interesting features for displaying the developed material that aim to make learning more interesting and fun for students. Electronic civic education teaching materials were developed in their application using the SPADA application platform. This research was carried out in eight meetings (May–June 2023), and each meeting lasted for 100 minutes. In the experimental class, it was taught using electronic civic education teaching materials integrated into SPADA while in the control class, it was taught using non-electronic civic education teaching materials.

4. Results

4.1. STEM Reasoning Ability

Table 6 describes data about students' STEM reasoning abilities based on four indicators (RSi) and gender.

Table 6. Data of students' STEM reasoning abilities for each indicator.

Group	N	Score	Gender	STEM skill indicator				Average	Category
				A	I	E	D		
Experimental	30	Pre	M	1.22	1.18	1.18	1.17	1.19	Less
			F	1.32	1.14	1.31	1.42	1.3	Less
		Post	M	3.24	3.35	3.27	3.28	3.29	Good
			F	3.35	3.38	3.43	3.34	3.38	Good
		Score N-g	M	0.73	0.77	0.74	0.75	0.75	High
			F	0.76	0.78	0.79	0.74	0.77	High
Control	30	Pre	M	1.32	1.15	1.16	1.12	1.19	Less
			F	1.33	1.15	1.32	1.41	1.3	Less
		Post	M	1.68	1.58	1.57	1.57	1.6	Less
			F	1.62	1.73	1.75	1.88	1.75	Less
		Score N-g	M	0.13	0.15	0.14	0.16	0.2	Low
			F	0.11	0.2	0.16	0.18	0.16	Low

Table 6 shows that the RSi criteria for both research groups increased before and after treatment based on gender. Within the experimental group, the girls' E and I indicators showed the most improvement while the males' A indicator showed the lowest score. Similarly, the experimental class's male and female RSi scores for the rise in N-gain were classified as high at 0.75 and 0.77, respectively. With an n-gain of 0.16, the control group showed a little increase in RSi. In the meantime, the control group's female members have the lowest scores on the SA indication and the greatest scores on the D indicator. The differences in students' STEM reasoning abilities based on gender are presented in Figures 1 and 2.

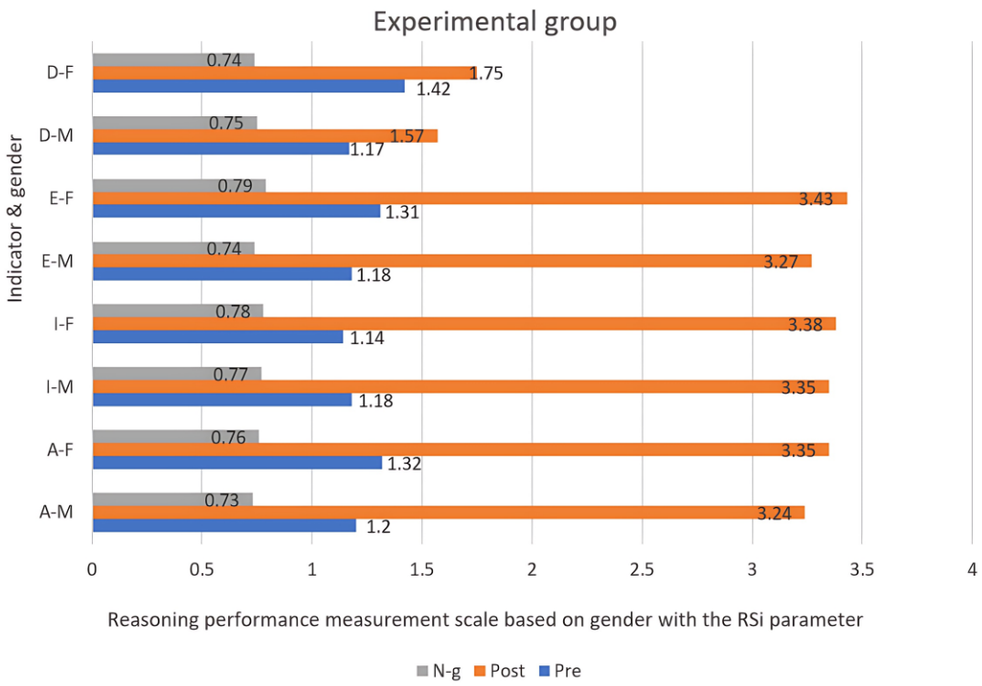

Figure 1. Experimental class.

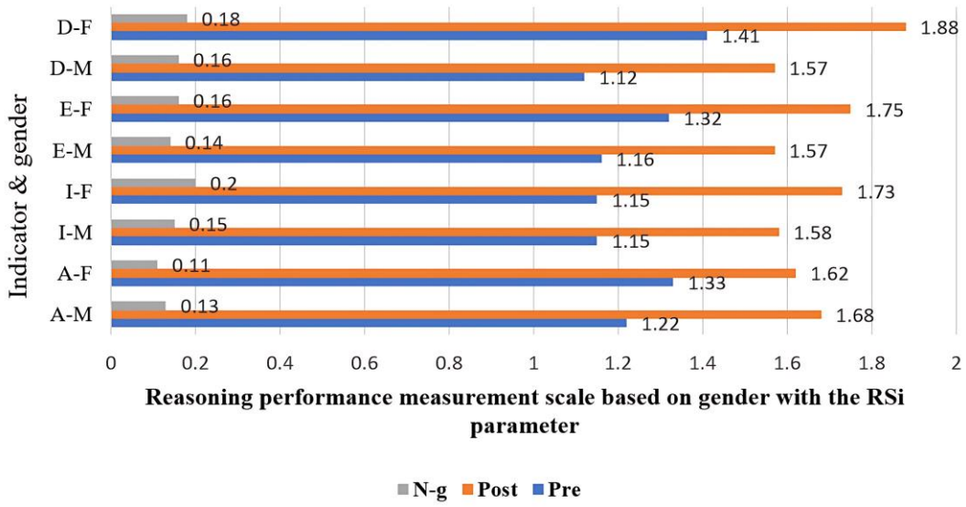

Figure 2. Control class.

Additionally, Table 7 summarizes each group's gender-based reasoning skills performance with regard to the RSs parameter.

Table 7. Data of students' STEM reasoning ability based on gender.

Classes	N	Gender	Score and criteria of students' STEM skills				N-gain	Category
			Pre-test	Category	Post-test	Category		
Experimental	60	F	9.40	Less	24.60	Good	0.80	High
		M	9.10	Less	24.40	Good	0.79	High
Control	60	F	9.40	Less	13.00	Less	0.16	Low
		M	9.20	Less	12.00	Less	0.12	Low

Table 7 shows that the control group's STEM reasoning abilities are in the low category. However, the N-gain score shows an increase in STEM reasoning abilities after the post-test. The STEM reasoning abilities in the experimental class are in the high category.

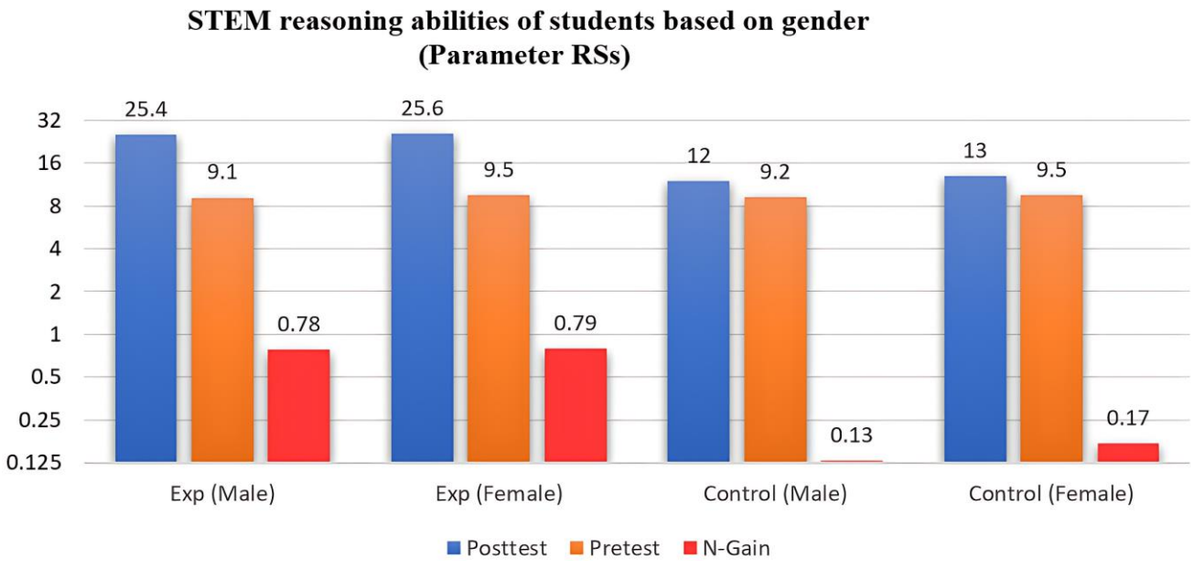

Figure 3. Student' STEM reasoning abilities based on gender.

Figure 3 illustrates the difference in students' STEM reasoning abilities between research groups. The experimental group's STEM reasoning ability increased from the low category to the high category while the control group did not increase remaining in the low category. In addition, the independent t-test result showed a sig. < p (0,05). This indicates a significant difference in students' STEM reasoning abilities based on gender between the two research groups. The results of the t-test can be seen in Table 8.

Table 8. Independent t-test results (p < 0.05).

Value	Student communication skills	T-test		
		T	Df	Sig 2-tailed
N-gain	Equal variances are not assumed.	14.312	34.365	0.000
	Equal variances are assumed.	14.312	58	0.000

4.2. Communication Skills

Table 9 presents gender-based research findings on students' communication skills. These findings are based on the criteria as stated by Iksan et al. (2012).

Table 9. Students' communication skills based on indicators.

Groups	N	Score	Gender	Indicator of communication skill			Mean range	Category
				SA	LA	NVCA		
Experimental	30	Pre	M	2.15	2.35	2.23	2.24	Average
			F	2.73	2.53	2.52	2.59	Average
		Post	M	4.24	4.27	4.26	4.26	Good
			F	4.43	4.35	4.32	4.37	Good
		N-Gain	M	0.73	0.72	0.73	0.73	High
			F	0.75	0.74	0.73	0.74	High
Control	30	Pre	M	2.14	2.18	2.19	2.17	Average
			F	2.3	2.25	2.35	2.3	Average
		Post	M	2.87	2.75	2.86	2.83	Average
			F	2.96	2.98	2.97	2.97	Average
		N-Gain	M	0.26	0.21	0.24	0.23	Low
			F	0.24	0.27	0.23	0.25	Low

Table 9 illustrates that the communication skills of the experimental and control groups improved after being given treatment. Females' SA indicator score is 0.75 and their LA indicator score is 0.74 in the high category. The data above shows that there has been an improvement in the average N-gain score in the experimental class. The control group experienced an improvement in the average N-gain score of 0.27 for the female LA indicator and 0.26 for the male SA indicator. Both are in the low category. Figures 4 and 5 visualize students' communication skills in terms of gender in the experimental and control classes.

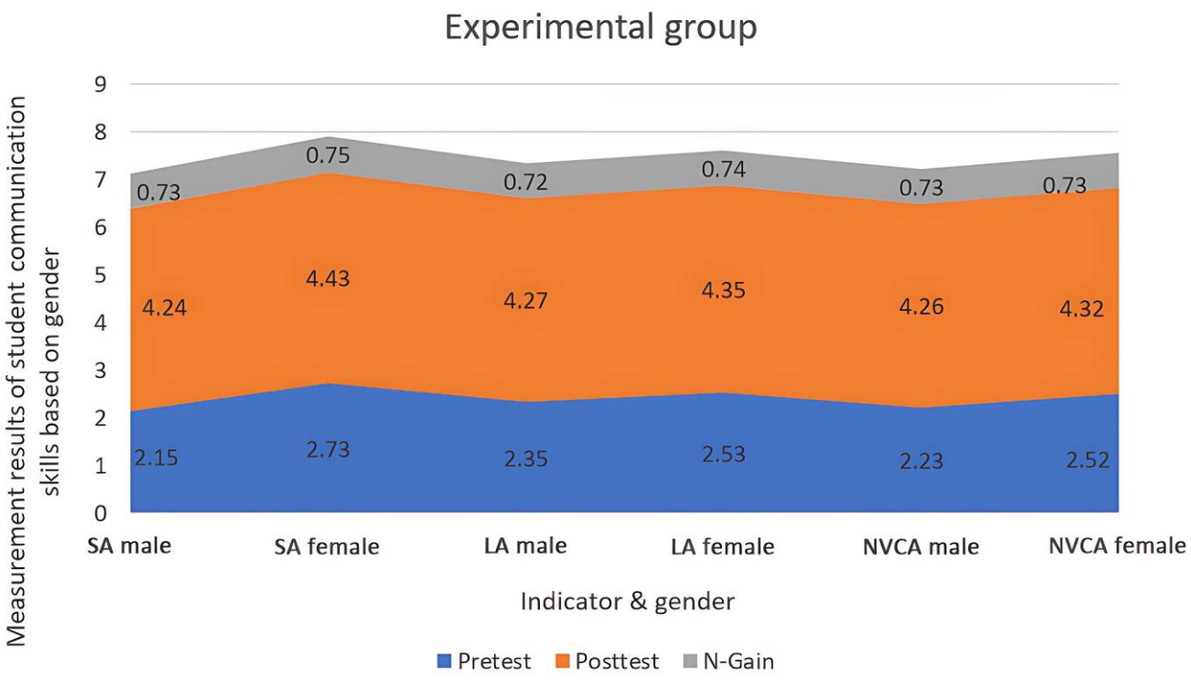

Figure 4. Student communication skills based on gender and indicators in experimental classes.

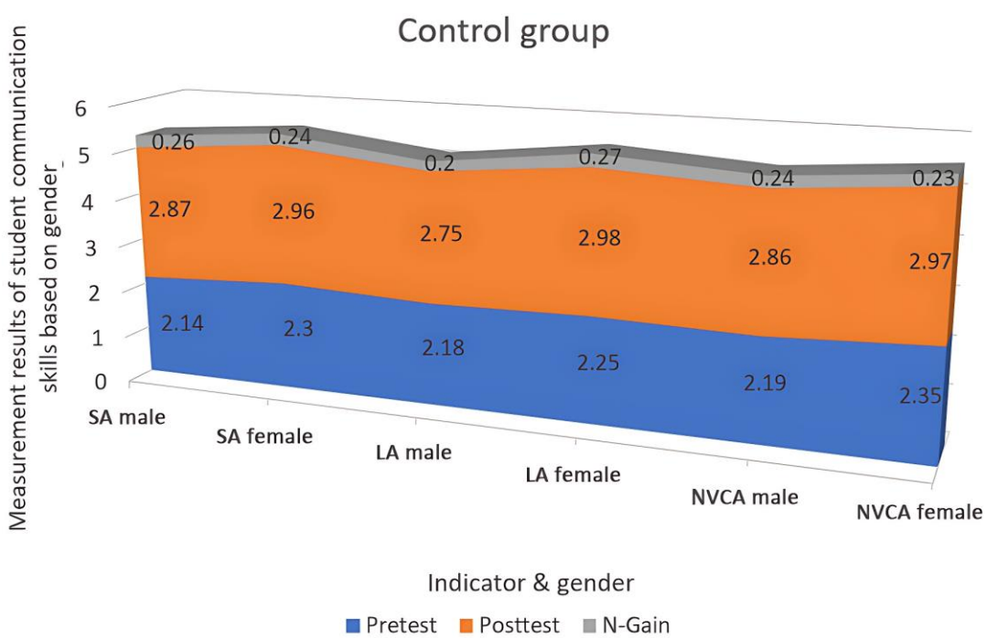

Figure 5. Student communication skills in terms of gender and indicators in the control class

The information presented in Figures 4 and 5 shows the differences in students' communication skills in the experimental and control groups. Students in the experimental group had their communication skills improve from the average category to the good category but in the control group, the students' communication skills remained in the average category. In addition, the independent sample t-test data shows that the communication skills of the two research groups have significant differences. This is known from the output of the sample data t-test which shows that sig. < p (0.05) (see Table 10).

Table 10. Independent test results t-test sample (p < 0.05).

Value	Skills of communication	Test t		
		t	Df	Sig. 2 tailed
N-Gain	Equal variances are not assumed.	12.059	28.055	0.000
	Equal variances are assumed.	12.059	47	0.000

5. Discussion

5.1. STEM Reasoning Abilities

This study found that electronic teaching materials for civic education subjects integrated with LMS-SPADA effectively influenced their STEM reasoning abilities compared to conventional teaching materials in relation to students' STEM reasoning abilities. The findings of this study are in line with the results of previously conducted studies that show that the use of IT in learning can improve students' reasoning skills (Verawati et al., 2022) problem solving, critical thinking, communication (Kurup et al., 2019) cooperation skills, the ability to communicate cooperation, concept understanding and self-efficacy (Gardner et al., 2019; Hai et al., 2023; Kelley et al., 2020; Kırkıç & Arıkan, 2023). The ability of the teaching material model to improve students' STEM reasoning abilities is because electronic teaching materials can drive students to learn and complete each task gradually (Sumardi, 2024). This method forces students to master the material thoroughly and trains them to reason. In addition, the integration of teaching materials in the LMS-SPAD not only makes it easier for students to access learning resources but also improves their technological skills.

Another finding of this study related to STEM reasoning abilities is that gender differences have a significant effect on students' reasoning skills where male students have better reasoning skills than female students. This finding is in line with the results of research conducted by Ho et al. (2020) and Bowman et al. (2022) who found that gender differences have a significant effect on students' STEM reasoning abilities where male students have better STEM reasoning abilities than female students. In addition, previous research findings show that male students have better decision-making, problem-solving and probabilistic reasoning skills than female students (Wahyudiati, 2023; Zhang, 2019). Similarly, male students are better than female students with teamwork and decision-making skills (Adeduntan & Adetayo, 2022). The findings of the above studies confirm that gender convincingly influences students' STEM reasoning abilities.

Theoretically, IT-based teaching materials can encourage students to more actively participate in learning, improve visual and spatial skills, self-confidence, learning independence, learning outcomes, digital literacy, and STEM abilities in addition to the above findings (Ho et al., 2020; Kiazai et al., 2020; Kırkıç & Arıkan, 2023; Reilly et al., 2017; Verawati et al., 2022; Wahyudiati, 2023). All of these learning processes have a direct impact on improving students' STEM reasoning skills. Therefore, IT-based civic education teaching materials integrated in LMS-SPADA can convincingly improve various student skills, especially their STEM reasoning ability based on these arguments.

5.2. Communication Skills

Electronic teaching materials for civic education subjects integrated into LMS-SPADA were effective in improving students' communication skills as for the aspect of communication skills. Its ability to improve students' communication skills is much better than traditional teaching materials. The findings of this study are in line with the results of research conducted by Yoon et al. (2021) which revealed that learning using IT-based learning resources can improve students' communication skills. In addition, IT-based learning resources are also able to improve their digital literacy skills.

Another finding of this study is that there are differences in the effect of IT-based teaching materials on male and female students where female students' communication skills are better than male students. The difference was not only seen in the experimental class but also occurred in the control class. This is clearly seen in the NVCA indicators for male students and the SA and LA indicators for females. The findings of this study are in line with the results of previous studies conducted by Mechouat (2017) and Qazi et al. (2022) which revealed that students' communication skills are influenced by gender. Therefore, it can be inferred that female students' communication skills develop better than male students in both oral communication and written communication based on these research findings. According to the results of Adeduntan and Adetayo (2022) and Rahmah, Mawadah, and Stibudi (2022) female students' communication is more accurate and detailed. The same opinion was also expressed by Siddiq and Scherer (2016); Yavuz and Güzel (2020) and Wahyudiati (2023) that female students have better communication skills than male students. According to Nugraha and Pujiastuti (2019) and Qazi et al. (2022) this condition is caused by female students having enthusiasm and being more active in the learning process.

The improvement of students' communication skills in the experimental class as described above was due to the teaching materials used, IT-based civic education teaching materials integrated in LMS-SPADA. These teaching materials make learning more interesting and motivate students to be actively involved. Learning activities that contribute to improve students' communication skills are the facilitation provided by teaching materials for students to be active in class discussions, record relevant information, ask questions, and respond to other students' questions. This is in accordance with the opinion expressed by Siddiq and Scherer (2016) who revealed that electronic teaching materials can increase active participation in communicating ideas responding to questions, providing arguments, and improving students' visual skills. These conditions can automatically improve students'

verbal communication skills, listening, and social competence. According to Verawati et al. (2022) and Purwanto, Faridi, and Rozi (2022) these academic activities had a significant impact on improving their learning outcomes.

6. Conclusion

It can be concluded that the use of electronic civic education teaching materials integrated with LMS-SPADA is effective in improving students' STEM reasoning ability and communication skills based on the findings and discussion above. In addition, it can be concluded that the gender factor has a significant effect on both abilities, where male students are more progressive in STEM reasoning skills while female students are more advanced in communication skills. It is recommended for civic education lecturers to use electronic teaching materials and integrate them with the MS to improve students' STEM reasoning ability and communication skills based on the above conclusions.

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