Enhancing basic computer network learning outcomes of vocational high school students by implementing a video-based learning model

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Abstract: Many students still achieved scores below the minimal completeness criteria when learning basic computer networks. This was because the teacher still uses traditional media, such as printed worksheets in the teaching process which made the learning boring and harder for students to comprehend what the teacher was teaching. Therefore, this study aimed to implement video-based learning within the educational process. This study employed a pre-experiment methodology by using a single pre- and post-test group. Thirty-three students majoring in computer and network engineering served as the research subjects. The paired sample t-test and N-gain score were the data analysis methods employed to examine the efficacy of the video-based instruction. The results demonstrated a significant improvement from students' knowledge before to that of after being engaged in video-based learning. Thus, it is possible to conclude that a video-based instruction can greatly enhance students' understanding on fundamental computer network science. According to the study's findings, the video-based learning ought to be incorporated into the curriculum of vocational education, particularly in the Department of Computer Network Engineering, to ensure that the students fully comprehend the subject matter and that the learning process runs smoothly.

Keywords: Technology media; Informatics engineering, Learning video; Vocational education

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1. Introduction

One education that is currently in high demand by students is vocational school. It is provided to students to improve their knowledge and abilities to compete in the world of work. With the rapid advancement of technology in the 21st century, the process of training students to be competent in their disciplines has significantly developed. In the 21st century, vocational education has progressed rapidly due to changes required by the world of work and technological advances in industry (Mukul & Büyüközkan, 2023; Quy et al., 2023). Technological developments in the 21st century have incorporated various technologies that aid learning. As a result, there is now a shift between conventional face-to-face learning to technology-based learning. This shift is known as digital transformation (Cattaneo et al., 2022; Wang et al., 2023). Using digital technology, learners will gain experiential learning about the skills and knowledge needed to work in the world of work. Technological advances make learning more flexible and enable students to learn for life, which is very important for modern students (Almaazmi et al., 2021; Jalinus et al., 2023). Leveraging digital transformation in education can drive innovation in education and accelerate the achievement of

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equitable, customized, and lifelong learning. Thus, introducing digital technologies to students is indispensable today.

Digital transformation in education refers to using digital technology in the classroom. By utilizing digital technology in the learning process, students are expected to master better the knowledge and skills they learn. Integrating digital technology into the learning process will also prepare students with the digital technology literacy competencies needed today. As new technologies such as artificial intelligence, electronic learning (e-learning), and the Internet of Things (IoT) emerge, digital learning will be greatly transformed (Fokides & Antonopoulos, 2024; Kumar et al., 2024). Digital transformation will transform conventional learning into technology-based learning and become an important approach to managing learning, human resources, and designing technology-enabled learning processes (Oliveira et al., 2024). One of the innovative learning tools used today is video-based learning. In this learning process, students will be guided to learn systematically to master certain material. So video-based learning can help the students' learning process (Mispandi et al., 2023). Network computer engineering is one of the majors in vocational schools, which aims to equip students with today's digital technology. In this department, students are equipped with computer programming skills, computer networks and the internet, and skills to create websites on the internet (Alghamdi et al., 2023; Shan, 2023). Through innovative learning by using learning videos, students will more easily understand basic computer and network material.

The support provided by the school to implement learning in the classroom is essential to the achievement of the learning that pupils accomplish. Generally, two types of influences affect students' learning outcomes: external and internal factors. Internal aspects, such as physical and mental (psychological), come from the individual concerned. On the other hand, external factors, also known as environmental factors, come from outside the individuals (Sukardi et al., 2020). One external factor affecting student learning outcomes is learning method implemented in the teaching process. Therefore, teachers should be able to choose an appropriate method that can improve student learning outcomes. However, teachers are less precise to do so (Sukardi et al., 2019).

In addition, teachers should be able to understand the situation and adjust to the students they will teach. Students have not been able to receive lessons well if the learning process is not meaningful. The factors include slow learning ability, the learning strategies used are not on target, and differences in the ability of students to catch. Therefore, a method that can adjust to the characteristics of students is needed. Based on the observation, the learning method used in the learning process is still ineffective because it is one-way, where students only hear what the teacher explains. The method will impact how well students receive the knowledge or skills they learn (Yanto et al., 2022).

Table 1. Learning results of daily test 1 odd semester of class X Network Computer Technology academic year 2023/2024

Class	Student Score				Total
	< 75	%	> 75	%	
X	26	67,70	10	32,3	33

Based on the observation done by the researchers on October 15, 2023, at SMKN 8 Padang Class X Network Computer Technology, it was found that student activity in communication and digital simulation subjects was still low and the learning strategies were not appropriate, which affected student learning outcomes. It was proven by the number of students' grades which were below the minimum completeness criteria. Each student has different capacity for comprehending lessons;

some quickly understand with one explanation, and some must be repeatedly explained to understand it. This often becomes a trigger for low student learning outcomes since the teacher does not adjust the learning method used to the student's ability to understand. The problem of learning outcomes that have been stated above is supported by data on the students' daily test scores of class X, majoring in Network Computer Technology of SMKN 8 Padang in the 2023-2024 academic year, which can be seen in table 1. There are 26 students whose scores are lower than 75 (< 75), with a percentage of 67.70%, and 10 students whose scores are greater than 75 (> 75), with a percentage of 32.30%. In short, there are many students' scores are lower than the minimum completeness criteria.

The low student learning outcomes are indicated by the fact that teachers only use worksheets in the learning process, which makes learning monotonous and one-way. As explained by previous research, the lack of variations in the learning methods, one-way delivery, unconducive learning atmospheres, and various other problems can affect student success in teaching and learning (Isabelle M. L. et al., 2019; Richardo et al., 2023). Thus, using the appropriate learning model during the learning process—one of which is a video-based learning model—is the way to solve the issues identified by this research. With video-based learning, students not only see and hear the explanation, but also read the text instructions. Four benefits of video-based learning to help students learn basic computers and networks, including its ability to load texts, images, sounds, and simulations to help students grasp what they are learning.

If the learning model selected is in line with the characteristics of the students and the learning environment, the teaching and learning process can proceed as planned and meet the goals of the national education system. In this context, the learning model offered as a solution is the video-based learning model. With this video-based learning paradigm, the teacher only acts as a tutor, facilitator, and mediator; the rest of the time, students are not used as objects of learning but as subjects of learning. Students are invited to answer the challenges that have been provided. In this way, students will become more active and focus on the problems to be solved. This model is effectively applied to basic network computer subjects because students will do the tasks given by the teacher, referring to the emancipated curriculum (Kurikulum Merdeka) at school, where the teacher is only as a facilitator, and students will be more active in learning. Thus, there are two objectives of this research on the implementation of video-based learning in the learning process of basic computers and networks:

1) How is the difference on students' learning outcome of basic computer and network subject before and after implementing the video-based learning?
2) To what extent can the video-based learning improve students' basic computer and network?

2. Methods

Design of research

Pre-experimental research with a one-group pre-test and post-test research design was the research approach utilized in the execution of this investigation, where this research method only uses one class (an experiment) as the research subject, and there is no control class (Aswardi et al., 2023). The pre-experimental research method consists of three main steps: the pre-test stage (O1), the treatment stage (X), and the post-test stage (O2). O1 is the initial value obtained from the test results for students before applying the video-based learning model. Variable X is the treatment given to the experimental class, where the treatment given is to apply video-based learning to the basic computer and network learning processes. Variable O2 is the final score obtained from the

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experimental class after the test; this score was taken after the treatment in the basic computer and network learning process (Jalinus et al., 2022). This method is suitable for research where the sample is limited to one class only.

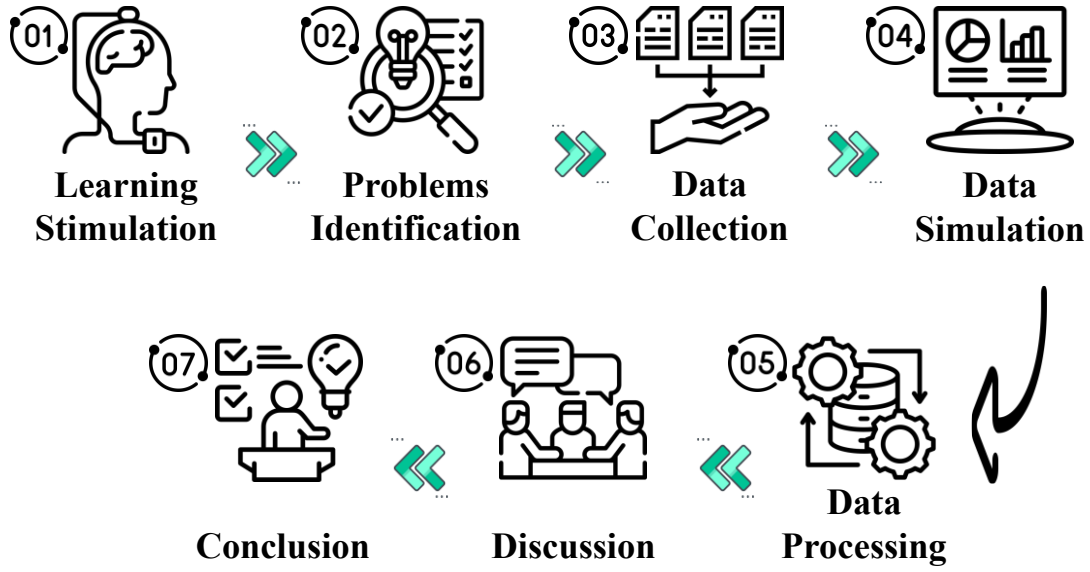


Figure 1. The learning syntax

The learning syntax consists of seven phases, as shown in Figure 1. The learning stimulation phase is conducted to provide initial questions to students regarding the learning material to be carried out. The problem identification phase directs students to identify the problems that students will study. In this study, the problem for learning is determined by setting the computer bios properly and correctly. In data collection phase, students are asked to collect information about what will be learned. During the data simulation phase, students are asked to test the material they learn directly by using practical equipment to find out the truth about the information they get. In the processing data phase, students are asked to record and collect all the information obtained from the results of trials and literature reviews. So, at the discussion phase, students are asked to share all the information obtained to their classmates. So, there is an interaction between students based on the data obtained from each of them. The last phase is the conclusion, where the teacher concludes the learning outcomes with students so that there is no misunderstanding the learning concept.

Research sample

In conducting this study, a sample of thirty-three students enrolled in Class X Network Computer Technology at SMK Negeri 8 Padang in academic year 2023-2024, was selected. They have stated their consent to this study which is in line with the Declaration of Helsinki. Furthermore, before and after the treatment was given, the students did an assessment of learning outcomes through objective tests.

Data collection instruments

Students' test results on their cognitive abilities after the treatment were the data for this investigation. The implementation of the research began in October 2023 and continued until November 2023. This study used objective assessment using multiple-choice questions as the instrument to test the students' knowledge abilities. Data on students' thinking skills were obtained

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by giving tests as an evaluation tool to students. The data of this study included three types: the pre-available data which were collected from the teacher based on the students' subject score, the initial data of the study (pre-test) by using worksheets, and the final test (post-test), which was conducted after the treatments were completed in the experimental class, which was implementing video-based learning. The tests given to students in the study were intended to determine the extent to which students mastered the subject matter after applying the video-based learning model. Table 2 is a grid of basic network computer knowledge tests given to the students (Fajrin et al., 2023; Moybeka et al., 2023).

Table 2. Assessment grid for student knowledge learning outcomes

Learning Outcomes	Course Content
Implementing Bios Configuration on a computer	1. Components – Bios components 2. Determining the appropriate Bios configuration
Setting the Bios	1. Bios as a condition for the initial installation of the operating system 2. Bios Test configuration results

Data analysis technique

The results of the student knowledge proficiency test further demonstrated the effectiveness of the video-based learning strategy. Three testing methods were used to determine the effectiveness: paired sample t-test, passing percentage, and N-Gain score calculation. The statistical technique called the paired sample t-test compared the means of two related or paired samples . This method is used when the data being analysed are paired, such as before and after intervention on the same subject. Pass percentage is a measure used to describe the number of individuals or students who successfully pass an examination, test, or educational program compared to the total number of individuals or students taking the examination or program. Meanwhile, the N-Gain score evaluates improvements or changes in student learning outcomes or skills after being given a certain treatment or method. It will lead to a conclusion if the treatment or method given is effective (Semathong, 2023; Yanto et al., 2023). Equations 1 and 2 provide the formulas for the paired sample t-test and pass percentage, respectively, while the N-Gain score formula is provided in Equations 3.

$$t = \frac{D}{\left(\frac{SD}{\sqrt{N}}\right)} \quad (1)$$

$$P = \frac{F}{N}\ x\ 100\% \quad (2)$$

$$N - gain = \frac{Spost - Spre}{Smaks - Spre} \quad (3)$$

The N-gain value obtained will be interpreted as stated in Table 3 so that the criteria for increasing the learning outcomes of students in class X Network Computer Technology in the Basic Network Computer subject can be known.

Table 3. N-gain score assessment criteria

No	N-gain value	Category
1	G > 0.7	High
2	0.3 < g ≤ 0.7	Medium
3	G ≤ 0.3	Low

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3. Results

Using instructional videos in the learning process is known as "video-based learning." In this study, a tutorial video for configuring computer BIOS is used to help students in learning basic computer networks. Applying a tutorial video with graphics, animations, music, and descriptive text makes it easier for students to comprehend and acquire the skills they need to be proficient. The tutorial video provides students with the steps of configuring the computer's BIOS from the beginning to the end, ensuring optimal functionality. Students majoring in Network Computer Technology are required to possess these fundamental competencies. Figure 2 illustrates the format of video-based learning used in the teaching and learning process.



Figure 2. A display of computer bios setup tutorial learning video

Two sets of data were collected for this study project: pre-test data on students' initial scores and post-test data on students' scores following the use of video in the learning process. Every piece of data acquired had its level of normality checked before any additional analysis was done. This is due to the fact that the data analysis method of the paired sample t-test is parametric, meaning that normally distributed data are required. Table 4 displays the outcomes of the data normality test.

Table 4. Results of data normality test by using One-Sample Kolmogorov-Smirnov test

Description		Pre-test	Post-test
N		33	33
Normal Parameters	Mean	66.061	81.121
	Std. Deviation	9.248	7.809
Most Extreme Differences	Absolute	.150	.153
	Positive	.106	.153
	Negative	-.150	-.120
Test Statistic		.150	.153
Asymp. Sig. (2-tailed)		.058	.050

The significance p-value from the pre-test data is 0.058, as observed from the data normality test results. The significance p-value for the post-test data normality test is 0.050. Thus, it can be inferred from the data that the obtained normality p-value (0.058 > 0.05) is higher than the normality p-value limit of 0.05. Thus, it may be said that there is a normal distribution of the pre-test data. Similarly, the post-test data's normality p-value (0.087 > 0.05) is higher than the p-value limit. Therefore, it may be said that the data from the post-test follow a normal distribution. It is evident from the findings of the Kolmogorov-Smirnov Z analysis technique's data normality test that the collected data are all normally distributed.

The first analysis technique used to evaluate the effectiveness of basic computer network learning

was a paired sample t-test. The data analysis was done to find out the student learning outcomes by calculating the pre-test and post-test scores that have been obtained. This test illustrated the difference in student learning outcomes between before and after being treated by using a tutorial video. The results of the paired sample t-test are shown in Table 5, where the 2-tailed significant p-value is 0.000, and the t-value is 20.721. This result demonstrates that the 2-tailed significance value achieved is less than 0.05 (0.000 < 0.05) and that the t-value obtained is more than the t-table value of 2.03693 (20.721 > 2.03693). These results show significant differences in the learning outcomes of students who used video-based learning to become proficient in computer network fundamentals.

Table 5. Results of paired sample t-test

Test	M	SD	SEM	CI = 95%		t	df	Sig. (2-tailed)
				LW	UP			
Post-test – Pre-test	15.061	4.175	0.726	13.580	16.541	20.721	32	.000

Note: M (mean), SD (standard deviation), SEM (standard error mean), LW (lower), UP (Upper)

The N-Gain Score test, the second statistical test in this study, was used to determine the extent of the gain in students' scores. To administer this test, the pre-test and post-test data were analysed by calculating the difference. Table 6 shows the result of the analysis. With a test result of 0.444 for the N-Gain Score, this result was classified as medium in improving student learning outcomes. It proves, then, that video-based learning in teaching students the fundamentals of computer networks could enhance their learning outcomes fairly. While some students struggled during the learning process, most students succeeded.

Table 6. Results of the N-gain score test

Treatment	N-Gain	Criteria
Video-based Learning	0.444	Medium

Based on the test results of the two analyses above, it did not show the percentage and number of students who passed the learning process. Therefore, the third analysis was carried out, which was percentage data analysis. This analysis determined the number and percentage of students who passed basic computer network learning. The number and percentage of students who passed and did not pass the learning process were determined by this analysis. The results of the data analysis on the passing percentage are shown in Table 7. It was known that many students failed in the pre-test as they scored below the minimum completion criteria of 75. It was found from the pre-test data that only nine students, or 27.2% of the total students, passed the test. An analysis was then conducted on the post-test results of 30 students who passed, with a passing percentage was 90.9. Thus, it indicates that incorporating video in teaching students about basic computer networking can improve their learning outcomes.

Table 7. Test result of passing percentage

Description	Pre-test		Post-test	
	NS	%	NS	%
Passed	9	27.2	30	90.9
Not passed	24	72.8	3	9.1

Note: NS (number of students)

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4. Discussion

This research was a pre-experimental research with one group pre-test and post-test design. It aimed to test the effectiveness of video-based learning in the learning process of basic computer networks. In addition, this study also revealed the difference in student learning outcomes before and after using learning video in the basic computer network learning process. The learning video used was an instructional tutorial video on how to set up a computer BIOS correctly. In addition to explaining the bios settings and their order, the instructional video also explained the issues came up from inappropriate setting the bios. The video used in the procedure also included BIOS configuration animations to further ease the students in understanding the materials during the learning process.

The first test result, paired sample t-test, shows that student learning outcomes before and after utilizing video-based learning differ significantly. These findings indicate that students can better comprehend basic computer network concepts through video-based learning. A previous study indicating that systematic learning videos may improve basic network computer skills also supports these results. Additionally, using worksheets, movies, and interactive learning materials in the basic network computer learning process will make instructional learning—like operating a computer—more effective (Maor et al., 2023; Medugu et al., 2023). The second analysis was the N-Gain Score analysis, where the results obtained in this study achieved an average score of 0.444. In addition, the passing percentage analysis result showed that about thirty students or 90.9% passed the post-test. All findings of the three statistical tests indicated that incorporating video into computer-based instruction can improve student learning outcomes.

The findings are corroborated by earlier studies that were carried out in the same field. According to (Badruttamam & Hadromi, 2021; Richardo et al., 2023), their research used video-based learning, which considerably boosted student learning outcomes because the video content included audio, text, and visuals of the learning material provided. Furthermore, prior research has demonstrated that using a tutorial video in the vocational education process has improved student learning outcomes. Prior research has produced videos limited to tutorial videos with no animation, textual, or voice explanation (Alghamdi et al., 2023; Hafis et al., 2023; Richardo et al., 2023). Therefore, this study benefits from earlier studies in that the application video includes animation, audio, and explanatory text in addition to tutorials on modifying the computer bios, making it easier for students to comprehend the course material (Lestari et al., 2023; Sansi et al., 2023). The findings of the collected research have demonstrated it.

Based on the research results, it is known that the basic network computer learning process is effective to be carried out by educators. To facilitate the learning of basic computer networking, teachers are expected to use worksheets and instructional films. Job sheets and films will be used to engage students in an active learning process. If student-centred learning involves active student participation, students will find it more engaging and meaningful. Furthermore, this learning approach must be incorporated into an independent curriculum. By research, we will provide a comprehensive picture for educators in applying worksheets and learning videos to the learning process of basic network computers.

5. Conclusion

Learning videos were used in this study to help students learn the fundamentals of network computing. Thus, the purpose of this study was to determine the effectiveness of video-based learning in the process of learning basic network computers using pre-experimental research

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approach. The findings of the paired sample t-test showed that using a tutorial video significantly altered the learning process. Additionally, the findings of the N-Gain score test demonstrated that a tutorial video was able to enhance student learning outcomes in the medium category. In order to support the analysis findings, the passing percentage was calculated. These findings also revealed encouraging outcomes, with 90.9% of students passed the course on fundamental computer networks. The use of a tutorial video in learning basic computer networks successfully increased student learning outcomes, as were inferred by the results of the three statistical tests. However, the video used as the research treatment can only be implemented in face-to-face learning process. In the 21st century, as educational technology advances, further research is expected to deal with an online learning platform which is able to load instructional films, embracing the digital and online learning process.

Author contribution

Herlin Setyawan and Sukardi conceptualized the research, analyzed the data and wrote the article. Yolanda Idha Fitri and Lili Safitri Diati acted as data collectors and statistical data processing. Ambyar were involved in collecting literature review, discussing the learning video and research results.

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Competing interest

The researchers have no conflict of interest from any party and agree for the review and publication process of the article.

References

Alghamdi, Fahad. A., Younes Hamed, A., Alghamdi, A. M., Salah, A. Ben, Farag, T. H., & Hassan, W. (2023). A genetic algorithm for shortest path with real constraints in computer networks. *International Journal of Electrical and Computer Engineering (IJECE)*, *13*(1), 435. https://doi.org/10.11591/ijece.v13i1.pp435-442

Almaazmi, J., Alshurideh, M., Al Kurdi, B., & Salloum, S. A. (2021). *The Effect of Digital Transformation on Product Innovation: A Critical Review* (pp. 731–741). https://doi.org/10.1007/978-3-030-58669-0_65

Aswardi, A., Putra Yanto, D. T., Dewi, C., Zaswita, H., Kabatiah, M., & Kurani, R. (2023). Human Machine Interface-Based Control Training Kit as Innovative Learning Media to Enhance Students' Automation Control Skills in the Industry 4.0 Era. *TEM Journal*, 2157–2165. https://doi.org/10.18421/TEM124-26

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Badruttamam, M., & Hadromi, H. (2021). Development Of Android-Based Interactive Jobsheet On Electrical Measuring Equipment Materials In Vocational School. *Journal of Educational Research and Evaluation*, *10*(1), 37–47. https://doi.org/10.15294/jere.v10i1.50048

Cattaneo, A. A. P., Antonietti, C., & Rauseo, M. (2022). How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors. *Computers & Education*, *176*, 104358. https://doi.org/10.1016/j.compedu.2021.104358

Fajrin, M., Purwantono, P., Irzal, I., Rahim, B., & Zaus, A. A. (2023). The effectiveness of the case method to improve student learning outcomes in the SMAW subject. *Jurnal Pendidikan Teknologi Kejuruan*, *6*(4), 270–277. https://doi.org/10.24036/jptk.v6i4.34723

Fokides, E., & Antonopoulos, P. (2024). Development and testing of a model for explaining learning and learning-related factors in immersive virtual reality. *Computers & Education: X Reality*, *4*, 100048. https://doi.org/10.1016/j.cexr.2023.100048

Hafis, M., Syahril, S., Refdinal, R., & Prasetya, F. (2023). Optimizing learning engagement and performance in technical education: Harnessing the power of video tutorials for enhanced motivation and skill development in Shield Metal Arc Welding Subject. *Journal of Engineering Researcher and Lecturer*, *2*(3), 120–128. https://doi.org/10.58712/jerel.v2i3.112

Kumar, P. K. N., Harish Kumar, B. T., & Bhuvanesh, A. (2024). Spectral clustering algorithm based web mining and quadratic support vector machine for learning style prediction in E-learning platform. *Measurement: Sensors*, *31*, 100962. https://doi.org/10.1016/j.measen.2023.100962

Isabelle M. L., S., Andrade, W. L., & Livia M. R., S. (2019). Analyzing the Effect of Computational Thinking on Mathematics through Educational Robotics. *2019 IEEE Frontiers in Education Conference (FIE)*, 1–7. https://doi.org/10.1109/FIE43999.2019.9028384

Jalinus, N., Ganefri, Zaus, M. A., Wulansari, R. E., Nabawi, R. A., & Hidayat, H. (2022). Hybrid and Collaborative Networks Approach: Online Learning Integrated Project and Kolb Learning Style in Mechanical Engineering Courses. *International Journal of Online and Biomedical Engineering (IJOE)*, *18*(15), 4–16. https://doi.org/10.3991/ijoe.v18i15.34333

Jalinus, N., Sukardi, S., Wulansari, R. E., Heong, Y. M., & Kiong, T. T. (2023). Teaching activities for supporting students' 4cs skills development in vocational education. *Journal of Engineering Researcher and Lecturer*, *2*(2), 28–37. https://doi.org/10.58712/jerel.v2i2.95

Lestari, S., Dayurni, P., Evasufi Widi Fajari, L., & Ya, K. Z. (2023). The impact of the removal of information and communication technology subjects on students' digital literacy. *Journal of Computer-Based Instructional Media*, *1*(1), 19–24. https://doi.org/10.58712/jcim.v1i1.17

Maor, R., Paz-Baruch, N., Grinshpan, N., Milman, A., Mevarech, Z., Levi, R., Shlomo, S., & Zion, M. (2023). Relationships between metacognition, creativity, and critical thinking in self-reported teaching performances in project-based learning settings. *Thinking Skills and Creativity*, *50*, 101425. https://doi.org/10.1016/j.tsc.2023.101425

Medugu, P. M., Pwalakino, C. B., Mutah, Y., & Gandada, D. (2023). An Empirical Comparison of Power of Two Independent Population Tests under Different Underlined Distributions. *Asian Journal of Probability and Statistics*, *24*(1), 10–21. https://doi.org/10.9734/ajpas/2023/v24i1514

Mispandi, M., Muh. Fahrurrozi, & Siti Mawaddah. (2023). The Effect Of Using The Flipped Classroom Learning Model Using Video Interactive Media On Learning Outcomes. *IJE : Interdisciplinary Journal of Education*, *1*(1), 24–37. https://doi.org/10.61277/ije.v1i1.4

Moybeka, A. M. S., Bosco, F. H., Apalem, C. R., Chandra, D. A., & Efendi, E. (2023). Developing EFL Students' Writing Ability Through Contextual Teaching and Learning (A Classroom Action Research Study). *Journal of English Culture, Language, Literature and Education*, *11*(1), 79–97. https://doi.org/10.53682/eclue.v11i1.6107

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Mukul, E., & Büyüközkan, G. (2023). Digital transformation in education: A systematic review of education 4.0. *Technological Forecasting and Social Change*, *194*, 122664. https://doi.org/10.1016/j.techfore.2023.122664

Quy, V. K., Thanh, B. T., Chehri, A., Linh, D. M., & Tuan, D. A. (2023). AI and Digital Transformation in Higher Education: Vision and Approach of a Specific University in Vietnam. *Sustainability*, *15*(14), 11093. https://doi.org/10.3390/su151411093

Richardo, R., Dwiningrum, S. I. A., Wijaya, A., Retnawati, H., Wahyudi, A., Sholihah, D. A., & Hidayah, K. N. (2023). The impact of STEM attitudes and computational thinking on 21st-century via structural equation modelling. *International Journal of Evaluation and Research in Education (IJERE)*, *12*(2), 571. https://doi.org/10.11591/ijere.v12i2.24232

Sansi, A. S., Rini, F., Mary, T., & Kiong, T. T. (2023). The Development of Android-based Computer and Basic Network Learning Media. *Journal of Computer-Based Instructional Media*, *1*(2), 44–56. https://doi.org/10.58712/jcim.v1i2.19

Semathong, S. (2023). Participatory Action Research to Develop the Teachers on Classroom Action Research. *Shanlax International Journal of Education*, *11*(3), 29–36. https://doi.org/10.34293/education.v11i3.6118

Shan, D. (2023). New Media Development Model Based on Computer Network Technology. *Procedia Computer Science*, *228*, 655–662. https://doi.org/10.1016/j.procs.2023.11.076

Sukardi, Giatman, M., Haq, S., Sarwandi, & Pratama, Y. F. (2019). Effectivity of Online Learning Teaching Materials Model on Innovation Course of Vocational and Technology Education. *Journal of Physics: Conference Series*, *1387*(1), 012131. https://doi.org/10.1088/1742-6596/1387/1/012131

Sukardi, Mayefis, R., & Usmeldi. (2020). Effectiveness of Mobile Learning Media on Computer Assembly at Vocational High School. *Journal of Physics: Conference Series*, *1594*(1), 012012. https://doi.org/10.1088/1742-6596/1594/1/012012

Oliveira, T, M., Maciel Santos, M., Lucas Mayara da Cruz Reis, K., Resende Oliveira, L., & DeSantana, J. M. (2024). Transcutaneous Electric Nerve Stimulation in Animal Model Studies: From Neural Mechanisms to Biological Effects for Analgesia. *Neuromodulation: Technology at the Neural Interface*, *27*(1), 13–21. https://doi.org/10.1016/j.neurom.2023.02.085

Wang, Y., Hong, D., & Huang, J. (2023). A Diffusion of Innovation Perspective for Digital Transformation on Education. *Procedia Computer Science*, *225*, 2439–2448. https://doi.org/10.1016/j.procs.2023.10.235

Yanto, D. T. P., Kabatiah, M., Zaswita, H., Jalinus, N., & Refdinal, R. (2022). Virtual Laboratory as A New Educational Trend Post Covid-19: An Effectiveness Study. *Mimbar Ilmu*, *27*(3), 501–510. https://doi.org/10.23887/mi.v27i3.53996

Yanto, R., Waskito, W., Effendi, H., & Purwanto, W. (2023). Development of Web-Based Learning Media Using Google Sites in Vocational High School Informatics Subjects. *Journal of Vocational Education Studies*, *6*(1), 11–24. https://doi.org/10.12928/joves.v6i1.8027

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