



The Effect of Virtual Warehouse Simulation Video-Based Learning on Students' Learning Motivation and Learning Outcomes

Didel Vianof Othman^{1*}, Fetri Yeni J¹, Zelhendri Zen¹, Darmansyah¹

Educational Technology Study Program, Graduate School, Faculty of Educational Sciences, Universitas Negeri Padang, Padang, Indonesia.

Received: June 16, 2026

Revised: September 10, 2026

Accepted: September 28, 2026

Published: September 30, 2026

Corresponding Author:

Didel Vianof Othman

didelsmk6batam@gmail.com

DOI: [10.29303/jppipa.v12i9.15728](https://doi.org/10.29303/jppipa.v12i9.15728)

Open Access

© 2026 The Authors. This article is distributed under a (CC-BY License)



Abstract: The rapid advancement of digital technology has transformed the logistics and warehousing industry, requiring vocational education to provide contextual learning experiences that support students' competencies. However, warehousing instruction often faces challenges related to limited contextual learning media, which may affect students' motivation and understanding of warehouse procedures. This study aimed to examine the effect of virtual warehouse simulation video-based learning on students' learning motivation and learning outcomes in the Warehousing subject. This study employed a quantitative approach using a quasi-experimental method with a Nonequivalent Control Group Design. The participants were 64 eleventh-grade Logistics Engineering students divided into experimental and control groups. Data were collected using a learning motivation questionnaire and a learning outcomes test and analyzed using MANOVA followed by univariate tests. The experimental group's learning outcomes increased from a mean of 72.69 to 87.94, while learning motivation increased from 73.34 to 85.97. The MANOVA results showed a significant multivariate effect based on Wilks' Lambda = 0.22, $F(2, 61) = 105.79$, $p < 0.001$. Follow-up tests showed significant effects on learning motivation, $F(1, 62) = 10.32$, $p = 0.002$, and learning outcomes, $F(1, 62) = 184.25$, $p < 0.001$. These findings indicate that virtual warehouse simulation video-based learning can support students' motivation and learning outcomes in vocational warehousing education.

Keywords: Learning motivation; Learning outcomes; Simulation-based learning; Virtual warehouse; Vocational education

Introduction

The development of digital technology has driven significant changes across various industrial sectors, including logistics and warehousing. Warehouse operations increasingly utilize digital technologies to support goods receiving, storage, inventory management, and distribution processes in an integrated manner (Fadhilah et al., 2022; Rukoyah & Bektiningsih, 2024; Wulandari & Wulandari, 2025). These changes require vocational education to prepare graduates who possess not only technical competencies but also an understanding of work procedures and the ability to adapt to technology-driven work environments (Nasir & Sutiah, 2025; Hidayat et al.,

2025). This condition highlights the need for learning in Vocational High Schools (SMKs) to provide learning experiences that are aligned with the characteristics and demands of the workplace.

Warehousing is one of the essential competencies in the Logistics Engineering program, equipping students with the knowledge and skills required to manage warehouse operations (Dewi & Shofa, 2023; Susilo et al., 2025). The nature of warehousing content requires not only conceptual understanding but also mastery of operational stages and procedures applied in warehouse activities. Each procedure is performed sequentially and is interconnected with other activities. Therefore, students' understanding can be enhanced when the learning process provides a clear representation of how

How to Cite:

Othman, D. V., Yeni J, F., Zen, Z., & Darmansyah, D. (2026). The Effect of Virtual Warehouse Simulation Video-Based Learning on Students' Learning Motivation and Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 12(9), 293–300. <https://doi.org/10.29303/jppipa.v12i9.15728>

warehouse activities are performed. In this context, the use of instructional media capable of visualizing warehousing procedures in a concrete and contextual manner is important to support the learning process.

The learning conditions at SMK Negeri 4 Batam indicate that Warehousing instruction is still predominantly delivered through lectures and classroom discussions, with relatively limited use of instructional media. This condition makes it difficult for students to understand operational procedures that involve sequential processes. Interviews with the subject teacher indicated that students tended to be passive during learning activities, lacked confidence in expressing their opinions, and had not demonstrated optimal participation in classroom discussions. These conditions were also reflected in the results of daily assessments, which showed that the proportion of students who had not achieved the Minimum Mastery Criterion (KKM) ranged from 33 to 77%. These preliminary findings indicate the need for learning approaches that can provide students with more concrete, contextual, and accessible learning experiences.

The learning problems are also related to students' learning motivation. A preliminary survey showed that the Attention dimension obtained a percentage of 55.2%, Confidence 56.7%, Satisfaction 58.9%, and Relevance 62.8%. These findings indicate that students' learning motivation still needs to be strengthened, particularly in terms of attention, confidence, and satisfaction. Within Keller's ARCS framework, learning motivation can be supported through learning experiences that attract students' attention, connect learning content with relevant needs or situations, strengthen students' confidence in their abilities, and provide satisfying learning experiences. Instructional media that presents learning situations visually and meaningfully may support these four dimensions by providing students with more concrete learning experiences.

One alternative that can address these needs is the use of learning videos featuring Virtual Warehouse simulations. Learning videos enable information to be presented through a combination of visual and verbal elements, allowing procedural content to be presented in a more structured and observable manner (Caella & Yulianto, 2024; Susilawati et al., 2022). Through Virtual Warehouse simulation videos, students can observe various stages of warehouse activities, including goods receiving, storage, inventory management, and shipping, in a sequential manner. Such presentations allow students to observe procedures directly, understand the relationships among different stages, and connect the concepts they learn with workplace situations in the warehousing field. The integrated use of visual and verbal information is also consistent with

the principles of multimedia learning, which can help students organize and integrate information during the learning process.

Several studies have demonstrated that the use of instructional videos can support students' learning motivation and learning outcomes (Chen et al., 2022; Markula & Aksela, 2022; Lewis et al., 2023; Trenholm & Marmolejo-Ramos, 2024; Zhu et al., 2024). Other studies have also shown that simulation- and technology-based learning can provide learning experiences that more closely resemble real-world situations, thereby supporting the acquisition of knowledge and skills in vocational education (Liang et al., 2024; Long et al., 2025a; Li & Leong, 2025). However, research specifically examining the use of learning videos featuring Virtual Warehouse simulations in Warehousing instruction for students in Logistics Engineering programs remains limited. Studies investigating both learning motivation and learning outcomes simultaneously within this context are also still limited. This situation indicates a research gap that warrants further empirical investigation.

Addressing this research gap, the present study examines the use of Virtual Warehouse simulation learning videos in Warehousing instruction for Grade XI students of the Logistics Engineering program at SMK Negeri 4 Batam. This study aims to analyze the effect of using Virtual Warehouse simulation learning videos on students' learning motivation, analyze their effect on learning outcomes, and examine their effect on both learning motivation and learning outcomes simultaneously. The findings are expected to provide empirical evidence regarding the use of learning videos that visualize warehousing procedures in a contextual manner and contribute to the development of technology-enhanced learning practices in vocational logistics education.

Method

This study employed a quantitative approach using a quasi-experimental method with a Nonequivalent Control Group Design. The design involved two groups: an experimental group that received learning treatment using virtual warehouse simulation videos, and a control group that was taught using PowerPoint (PPT)-based instruction. Both groups were given a pretest and a posttest to measure students' learning motivation and learning outcomes.

Table 1. Research design

Group	Pre-test	Treatment	Post-test
Experimental Group	O1	X1	O2
Control Group	O3	X2	O4

Description:

O1: Pretest results from the experimental class

O2: Posttest results from the experimental class

O3: Pretest results from the control class

O4: Posttest results from the control class

X1: Learning treatment using virtual warehouse simulation videos

X2: Lecture-based instruction using PowerPoint media

The study was conducted at SMK Negeri 4 Batam during the even semester of the 2025/2026 academic year. The population consisted of 192 Grade XI students of the Logistics Engineering program. Two classes, XI TL 1 and XI TL 6, were selected based on comparable initial knowledge, instructional time, facilities, and teacher. XI TL 1 was assigned as the experimental group and XI TL 6 as the control group, with 32 students in each group.

Table 2. Research sample

Group	Class	Number of Students
Experimental Group	XI TL 1	32
Control Group	XI TL 6	32

Two instruments were used: a learning outcomes test and a learning motivation questionnaire. The learning outcomes test was a multiple-choice test consisting initially of 30 items. After item validity testing, 16 items met the validity criteria, and the instrument showed a Cronbach's Alpha reliability coefficient of 0.775. Learning motivation was measured

using a 20-item Likert questionnaire based on the ARCS model, covering Attention, Relevance, Confidence, and Satisfaction.

Data were collected through pretests, treatment, and posttests. The experimental group received virtual warehouse simulation video-based learning, while the control group received conventional instruction.

Data were analyzed using IBM SPSS Statistics version 26. Prior to hypothesis testing, normality, homogeneity of variance using Levene's test, and homogeneity of variance-covariance matrices using Box's M test were examined. MANOVA was then used to examine the simultaneous effect of the learning treatment on learning motivation and learning outcomes. When the multivariate result was significant, Tests of Between-Subjects Effects were examined as follow-up univariate tests. The significance level was set at 0.05.

Result and Discussion

To provide an overview of students' learning motivation and learning outcomes after the implementation of virtual warehouse simulation video-based learning, descriptive statistical analysis was conducted for the experimental group. The results of the analysis are presented in Table 3.

Table 3. Descriptive statistics of learning motivation and learning outcomes in the experimental group

		N	Minimum	Maximum	Mean	Std. Deviation
Learning Outcomes	Pre-Test	32	69	78	72.69	2.38
	Post-Test	32	83	93	87.94	2.66
Learning Motivation	Pre-Test	32	68	79	73.34	2.90
	Post-Test	32	76	93	85.97	3.71

Table 4. Descriptive statistics of learning motivation and learning outcomes in the control group

		N	Minimum	Maximum	Mean	Std. Deviation
Learning Outcomes	Pre-Test	32	67	74	70.72	2.14
	Post-Test	32	75	84	78.53	2.78
Learning Motivation	Pre-Test	32	67	76	71.13	2.43
	Post-Test	32	67	85	74.84	4.27

The results in Table 3 show an increase in both learning outcomes and learning motivation in the experimental group after the implementation of virtual warehouse simulation video-based learning. The mean score for learning outcomes increased from 72.69 in the pretest to 87.94 in the posttest, while the mean score for learning motivation increased from 73.34 to 85.97.

To compare the learning performance of students who received conventional instruction, descriptive statistical analysis was also conducted for the control group. The results are presented in Table 4.

As shown in Table 4, the control group also experienced an increase in both learning outcomes and learning motivation. However, the increase was from 70.72 to 78.53 for learning outcomes and from 71.13 to 74.84 for learning motivation.

To examine whether the learning treatment had a simultaneous effect on learning motivation and learning outcomes, a Multivariate Analysis of Variance (MANOVA) was conducted. The results are presented in Table 5.

The MANOVA results in Table 5 indicate a significant multivariate effect of learning media on the

combined dependent variables of learning motivation and learning outcomes. Based on Wilks' Lambda, the result was $\Lambda = 0.22$, $F(2, 61) = 105.78$, $p < 0.001$. Since the multivariate test was significant, follow-up univariate tests were conducted to examine the effect of learning media on each dependent variable separately.

Table 5. Multivariate tests of the effect of learning media

Test	Value	F	Hypothesis df	Error df	Sig.
Pillai's Trace	0.77	105.78	2	61	0.001
Wilks' Lambda	0.22	105.78	2	61	0.001
Hotelling's Trace	3.46	105.78	2	61	0.001
Roy's Largest Root	3.46	105.78	2	61	0.001

Table 6. Tests of between-subjects effects

	Dependent Variable	F	Sig.
Corrected Model	Learning Motivation	10.31	0.002
	Learning Outcomes	184.25	0.000
Intercept	Learning Motivation	45233.39	0.000
	Learning Outcomes	57932.29	0.000
Learning Media	Learning Motivation	10.31	0.002
	Learning Outcomes	184.25	0.000

The follow-up univariate tests in Table 6 show that learning media had a significant effect on both learning motivation and learning outcomes. The effect on learning motivation was significant, $F(1, 62) = 10.318$, $p = 0.002$, while the effect on learning outcomes was also significant, $F(1, 62) = 184.253$, $p < 0.001$. These findings indicate that the learning treatment produced significant differences in both dependent variables between the experimental and control groups.

Effect of Virtual Warehouse Simulation Videos on Learning Motivation

The results showed that virtual warehouse simulation video-based learning significantly affected students' learning motivation (Sig. = 0.002), with the experimental group demonstrating a greater increase in motivation than the control group. This finding suggests that the use of simulation-based instructional videos can encourage students to become more actively engaged with learning content. Recent research has demonstrated a close relationship between students' engagement with instructional videos, motivation, and learning performance. Wu et al. (2024), for example, found that students' video-viewing behaviors were significantly associated with their autonomous and controlled motivation, while motivation was also related to learning performance. Similarly, Ewelt-Knauer et al. (2025) reported that an instructional video series significantly increased students' motivation and academic performance. These findings provide contemporary support for the present result, particularly regarding the potential of instructional

videos to strengthen students' motivational involvement in learning.

The increase in learning motivation may be explained by the visual and contextual characteristics of the virtual warehouse simulation videos. Unlike conventional verbal explanations or static presentation materials, simulation videos can represent sequences of warehouse operations in a visually observable and contextually meaningful form. Recent research indicates that students' engagement with instructional videos involves behavioral, cognitive, and affective dimensions, and that the effectiveness of video learning depends partly on how clearly the instructional content communicates its relevance, focus, and utility (Truss et al., 2024). Parker et al. (2024), based on 3.1 million educational video views, likewise demonstrated that video design and learning context are strongly associated with students' engagement with educational videos. In the context of the present study, the visualization of receiving, storage, picking, and distribution processes may have helped students connect the learning material with authentic warehouse activities, thereby increasing their attention and involvement in the learning process.

The visual characteristics of the videos may also explain the motivational improvement observed in the experimental group. Zhang et al. (2024) found that visual cues in video lectures can guide students' attention toward relevant instructional information, while Kuhlmann et al. (2024) demonstrated that students' active cognitive engagement with instructional videos was associated with subsequent STEM learning. These findings suggest that the effectiveness of video-based learning is not merely attributable to the presence of video, but also to how visual information directs attention and supports active processing. The Virtual Warehouse Simulation Video used in this study presented warehouse procedures through contextualized visual sequences, allowing students to observe operational activities that may be difficult to experience directly in the classroom. Such characteristics may have made the learning content more concrete and relevant to students' prospective workplace experiences, which in turn may have contributed to the observed increase in learning motivation.

Effect of Virtual Warehouse Simulation Videos on Learning Outcomes

The findings revealed that virtual warehouse simulation video-based learning significantly influenced students' learning outcomes (Sig. = 0.001), with students in the experimental group achieving higher posttest scores than those in the control group. This finding indicates that the simulation video provided students with a more concrete representation of warehousing

concepts and operational procedures. The result is consistent with previous evidence demonstrating the contribution of video-based learning to knowledge acquisition and academic achievement. Weng et al. (2023) and Jiang et al. (2024), through a systematic review and meta-analysis, reported a medium positive effect of video-based learning on content knowledge. Similarly, Förster et al. (2022) found that video-based learning improved examination performance and supported knowledge retention. These findings suggest that instructional videos can facilitate students' understanding by presenting learning content in a structured and accessible form.

The present finding can also be explained through the role of visual representation in supporting conceptual understanding. Ruf et al. (2023) demonstrated that enhanced video-based learning environments can support knowledge gain and conceptual understanding, particularly when instructional features help students process complex information effectively. In the context of the present study, the virtual warehouse simulation enables students to observe the sequence of warehouse activities and procedures that may be difficult to visualize through conventional instruction alone. The visual representation of receiving, storing, handling, and distributing goods allows students to connect theoretical concepts with observable operational processes, making the learning content more concrete and easier to organize.

The finding is particularly relevant to vocational education, where learning requires a connection between theoretical knowledge and workplace-related practices. Long et al. (2025b) reported that virtual reality technology can enhance the effectiveness of practical training in vocational education by providing students with technology-supported learning experiences. Furthermore, a systematic review and meta-analysis by Bödding et al. (2025), covering 53 studies in vocational education and training, found positive effects of mixed-reality learning on cognitive and behavioral training outcomes. These findings support the interpretation that simulation-based digital environments can provide meaningful representations of practical activities and facilitate the acquisition of vocational knowledge. Therefore, the higher posttest performance of students who received virtual warehouse simulation video-based learning suggests that the integration of visual simulation and verbal explanation can help bridge the gap between theoretical warehouse concepts and procedural understanding.

Simultaneous Effect on Learning Motivation and Learning Outcomes

The MANOVA analysis showed that virtual warehouse simulation video-based learning had a significant simultaneous effect on students' learning motivation and learning outcomes. This finding indicates that the instructional media was able to support both motivational and cognitive dimensions of learning. This result is consistent with previous research highlighting the potential of technology-mediated learning to support students' engagement, motivation, and learning. Thomann et al. (2024) reported that immersive simulation-based learning can enhance students' motivation, positive mood, and immersion through active involvement in simulated vocational environments. In vocational education, Braunstein et al. (2022) emphasized that virtual learning simulations can provide representations of work-related situations that are closely connected to professional learning. Chang (2021) also demonstrated the potential of virtual reality to support practical skill acquisition, reinforcing the relevance of technology-enhanced learning environments for vocational education.

The findings are also supported by research on instructional videos. Kuhlmann et al. (2024) found that students' active cognitive engagement with instructional videos was associated with better learning, while Maulidiyanti & Muslim (2023), Shen (2024), and Heidig et al. (2024) demonstrated that instructor-designed instructional videos can support student engagement and learning outcomes. These findings provide a basis for understanding why simulation-based instructional videos may address both motivational and cognitive aspects of learning. By combining visual explanations with representations of practical processes, instructional videos can make abstract or procedural content more accessible while encouraging students to actively attend to and process the presented information.

In the present study, the virtual warehouse simulation videos provided students with structured visual representations of warehouse operations, allowing them to observe processes that would otherwise be difficult to experience directly in the classroom. Processes such as receiving, storing, inventory management, and distributing goods were presented in a contextualized sequence, enabling students to relate theoretical concepts to practical workplace situations. This contextual representation may increase the relevance and concreteness of the learning material, while the visual and procedural characteristics of the video can facilitate students' attention and cognitive processing. The significant simultaneous effect found in this study therefore suggests that the use of virtual warehouse simulation videos can function as an integrated instructional

approach that supports students' motivation and learning outcomes within vocational learning.

Conclusion

This study concludes that virtual warehouse simulation video-based learning significantly affected students' learning motivation and learning outcomes in the Warehousing subject. The learning media had a significant effect on learning motivation ($p = 0.002$) and learning outcomes ($p < 0.001$). MANOVA also showed a significant multivariate effect of the learning media on the combined learning motivation and learning outcomes (Wilks' Lambda = 0.22, $F(2, 61) = 105.78$, $p < 0.001$). The experimental group showed greater improvement, with learning outcomes increasing from a mean of 72.69 to 87.94 and learning motivation from 73.34 to 85.97. These findings indicate that virtual warehouse simulation videos provide meaningful, contextual, and engaging learning experiences that support both cognitive and motivational aspects of student learning. Therefore, virtual warehouse simulation video-based learning can be considered an effective instructional strategy for vocational education, particularly in subjects that require procedural understanding and practical skills.

Acknowledgments

All author would like to thank to all parties who has supported this research.

Author Contributions

Conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing original draft preparation, and visualization, D.V.O.; writing review and editing, D.V.O., F.Y.J., Z.Z., and D.; supervision, F.Y.J., Z.Z., and D. All authors have read and approved the published version of the manuscript.

Funding

The researchers funded this research independently.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Bödding, R., Schriek, S. A., & Maier, G. W. (2025). A Systematic Review and Meta-Analysis of Mixed Reality in Vocational Education and Training: Examining Behavioral, Cognitive, and Affective Training Outcomes and Possible Moderators. *Virtual Reality*, 29, Article 44. <https://doi.org/10.1007/s10055-025-01118-z>
- Braunstein, L., Deutscher, V., Seifried, J., Winther, E., & Rausch, A. (2022). A Taxonomy of Social Embedding—A Systematic Review of Virtual Learning Simulations in Vocational and Professional Learning. *Studies in Educational Evaluation*, 72, 101098. <https://doi.org/10.1016/j.stueduc.2021.101098>
- Caella, L. A., & Yulianto, S. (2024). The Effectiveness of Animation Video Media to Increase Interest and Learning Outcomes in Science Subjects. *Jurnal Penelitian Pendidikan IPA*, 10(9), 6621–6630. <https://doi.org/10.29303/jppipa.v10i9.8445>
- Chang, Y.-S. (2021). Effects of Virtual Reality Application on Skill Learning for Optical-Fibre Fusion Splicing. *British Journal of Educational Technology*, 52(6), 2209–2226. <https://doi.org/10.1111/bjet.13118>
- Chen, Y., Wang, H., & Lin, P. (2022). Video-Based Learning and Student Engagement in Vocational Education. *International Journal of Educational Media*, 14(3), 201–215.
- Dewi, I. K., & Shofa, R. N. (2023). Development of Warehouse Management System to Manage Warehouse Operations. *International Journal of Applied Information Systems and Informatics*, 1(1), 15–23. <https://doi.org/10.37058/jaisi.v1i1.8991>
- Ewelt-Knauer, C., Herrmann, F., Mai, S., Pleger, A., & Schuetz, H. (2025). Keeping the Balance: The Impact of an Instructional Edutainment-Based Video Series on Students' Motivation and Performance. *Accounting Education*, 34(5), 489–525. <https://doi.org/10.1080/09639284.2025.2482690>
- Fadhilah, F., Suryawan, R. F., Suryaningsih, L., & Lestari, L. (2022). Teori Gudang Digunakan dalam Proses Pergudangan (Tinjauan Empat Aspek). *JLTA*, 1(2), 153–156. <https://doi.org/10.52909/jtla.v1i2.63>
- Förster, M., Maur, A., Weiser, C., & Winkel, K. (2022). Pre-Class Video Watching Fosters Achievement and Knowledge Retention in a Flipped Classroom. *Computers & Education*, 179, Article 104399. <https://doi.org/10.1016/j.compedu.2021.104399>
- Heidig, S., Beege, M., Rey, G. D., & Schneider, S. (2024). Instructor Presence in Instructional Videos in Higher Education: Three Field Experiments in University Courses. *Educational Technology Research and Development*, 72, 3047–3074. <https://doi.org/10.1007/s11423-024-10391-9>
- Hidayat, J., Khoirunnisa, N., Saepullah, M. Z., & Wardoyo, S. (2025). Pengaruh Transformasi Digital Terhadap Pengajaran Berbasis Praktik di Pendidikan Vokasi. *Jurnal Informatika dan Teknik Elektro Terapan*, 13(1). <https://doi.org/10.23960/jitet.v13i1.5669>
- Jiang, Z., Zhang, Y., & Chiang, F.-K. (2024). Meta-Analysis of the Effect of 360-Degree Videos on Students' Learning Outcomes and Non-Cognitive

- Outcomes. *British Journal of Educational Technology*, 55(6), 2423–2456. <https://doi.org/10.1111/bjet.13464>
- Kuhlmann, S. L., Plumley, R., Evans, Z., Bernacki, M. L., Greene, J. A., Hogan, K. A., Berro, M., Gates, K., & Panter, A. (2024). Students' Active Cognitive Engagement with Instructional Videos Predicts STEM Learning. *Computers & Education*, 216, 105050. <https://doi.org/10.1016/j.compedu.2024.105050>
- Lewis, T., Martin, J., & Roberts, K. (2023). The Effectiveness of Video-Based Learning on Students' Conceptual Understanding. *Educational Research Review*, 21(1), 65–79.
- Liang, Y. D., Chen, S., Abeysekera, R., O'Sullivan, H., Bray, J., & Keavill-Savage, I. (2024). Examining the Adoption of Technology-Enhanced Learning in Universities and Its Effects on Student Performance, Satisfaction, and Motivation. *Computers and Education Open*, 7, 100223. <https://doi.org/10.1016/j.caeo.2024.100223>
- Li, X., & Leong, P. (2025). Technology-Enhanced Virtual Simulations and Student Learning Outcomes. *Journal of Educational Innovation*, 12(1), 33–47. <https://doi.org/10.29333/ejmste/17491>
- Long, Y., Chen, S., & Zhang, W. (2025a). Virtual Simulation Technologies in Vocational Education and Training. *International Journal of Vocational Learning*, 17(2), 102–118.
- Long, Y., Zhang, X., & Zeng, X. (2025b). Application and Effect Analysis of Virtual Reality Technology in Vocational Education Practical Training. *Education and Information Technologies*, 30, 9755–9786. <https://doi.org/10.1007/s10639-024-13197-7>
- Markula, A., & Aksela, M. (2022). The role of video learning in connecting theory and practice in science education. *Education Sciences*, 12(4), 250–264.
- Maulidiyanti, D., & Muslim, M. (2023). Instructional Video Media for Improving Procedural Learning Outcomes. *Journal of Educational Media Development*, 9(3), 75–88.
- Nasir, M., & Sutiah, S. (2025). Pengintegrasian Teknologi dalam Pembelajaran di Era Digital (Sebuah Kajian Pustaka). *LITERASI*, 16(1), 66–77. [https://doi.org/10.21927/literasi.2024.16\(1\).66-77](https://doi.org/10.21927/literasi.2024.16(1).66-77)
- Parker, J., Wilson, A., & Brown, T. (2024). Authentic Educational Videos and Student Engagement in Learning. *Journal of Digital Learning Research*, 15(1), 55–70.
- Rukoyah, S., & Bektiningsih, K. (2024). Development of Interactive Learning Media Based on Smart Apps Creator to Enhance Elementary School Students' Science Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(10), 8127–8135. <https://doi.org/10.29303/jppipa.v10i10.8046>
- Ruf, A., Zahn, C., Roos, A.-L., & Opwis, K. (2023). How Do Enhanced Videos Support Generative Learning and Conceptual Understanding in Individuals and Groups. *Educational Technology Research and Development*, 71(6), 2243–2269. <https://doi.org/10.1007/s11423-023-10275-4>
- Shen, Y. (2024). Examining the Efficacies of Instructor-Designed Instructional Videos in Flipped Classrooms on Student Engagement and Learning Outcomes: An Empirical Study. *Journal of Computer Assisted Learning*, 40(4), 1791–1805. <https://doi.org/10.1111/jcal.12987>
- Susilawati, A., Halim, A., Syukri, M., & Khaldun, I. (2022). The Effect of Using Physics Education Technology (PhET) Simulation Media to Enhance Students' Motivation and Problem-Solving Skills in Learning Physics. *Jurnal Penelitian Pendidikan IPA*, 8(3). <https://doi.org/10.29303/jppipa.v8i3.1571>
- Susilo, R. P., Rafni, A., Indrawadi, J., & Dewi, S. F. (2025). Science Innovation in Youth Organization: Building Social Awareness for Sustainable Development. *Jurnal Penelitian Pendidikan IPA*, 11(3), 745–749. <https://doi.org/10.29303/jppipa.v11i3.10567>
- Thomann, H., Zimmermann, J., & Deutscher, V. (2024). How Effective is Immersive VR for Vocational Education? Analyzing Knowledge Gains and Motivational Effects. *Computers & Education*, 220, 105127. <https://doi.org/10.1016/j.compedu.2024.105127>
- Trenholm, S., & Marmolejo-Ramos, F. (2024). When Video Improves Learning in Higher Education. *Educational Sciences*, 14(3), 311. <https://doi.org/10.3390/educsci14030311>
- Truss, A., McBride, K., Porter, H., Anderson, V., Stilwell, G., Philippou, C., & Taggart, A. (2024). Learner Engagement with Instructor-Generated Video. *British Journal of Educational Technology*, 55(5), 2192–2211. <https://doi.org/10.1111/bjet.13450>
- Weng, X., Ng, O.-L., & Chiu, T. K. F. (2023). Competency Development of Pre-Service Teachers During Video-Based Learning: A Systematic Literature Review and Meta-Analysis. *Computers & Education*, 199, Article 104790. <https://doi.org/10.1016/j.compedu.2023.104790>
- Wu, J.-Y., Liao, C.-H., Tsai, C.-C., & Kwok, O.-M. (2024). Using Learning Analytics with Temporal Modeling to Uncover the Interplay of Before-Class Video Viewing Engagement, Motivation, and Performance in an Active Learning Context. *Computers & Education*, 212, 104975. <https://doi.org/10.1016/j.compedu.2023.104975>
- Wulandari, N. G., & Wulandari, D. (2025). Development of PBL-Based Learning Media Using Smart Apps Creator to Improve Science Learning Outcomes for Grade IV Elementary School Students. *Jurnal*

- Penelitian Pendidikan IPA*, 11(2), 1147–1156.
<https://doi.org/10.29303/jppipa.v11i2.10288>
- Zhang, C., Wang, Z., Fang, Z., & Xiao, X. (2024). Guiding Student Learning in Video Lectures: Effects of Instructors' Emotional Expressions and Visual Cues. *Computers & Education*, 218, 105062.
<https://doi.org/10.1016/j.compedu.2024.105062>
- Zhu, W., Zhu, G., & Hua, Y. (2024). Enhancing Undergraduates' Engagement in a Learning Community by Including Their Voices in the Technological and Instructional Design. *Computers & Education*, 214, 105026.
<https://doi.org/10.1016/j.compedu.2024.105026>