



Digital Transformation of Arts Learning for Early Childhood: The Effect of E-Module on Learning Achievement of Early Childhood Education Undergraduate Students

Suci Aprilyati Ruiyat^{1(*)}, Uswatun Khasanah², Eneng Sri Susilawati³, Otto Fajarianto⁴

^{1,3}Early Childhood Education Study Program, Universitas Setia Budhi Rangkasbitung, Banten, Indonesia

²Faculty of Teacher Training and Education, Universitas Nahdlatul Ulama Lampung, Lampung, Indonesia

⁴Departement Educational Technology, Faculty of Education, Universitas Negeri Malang, Malang, Indonesia

Abstract

Received : June 6, 2026
Revised : July 20, 2026
Accepted : August 8, 2026

This study investigates the effect of e-module implementation on the learning achievement of Early Childhood Education (ECE) undergraduate students in an arts learning course. The research background is rooted in the low digital transformation of arts learning in Indonesian higher education, with 81% of lecturers still relying on conventional teaching materials and student mean scores remaining at 63.8 out of 100. Employing a quantitative approach with a quasi-experimental Pretest-Posttest Control Group Design, this study involved 64 fourth-semester ECE students divided into an experimental group (n=32) using e-modules and a control group (n=32) using printed modules. Data was collected through validated learning outcome tests, student response questionnaires, and observation sheets. The e-module was assessed as highly feasible by content experts (91.6%) and media experts (90.4%). The independent-samples t-test revealed a significant difference in posttest scores: experimental group (M=84.22, SD=7.93) versus control group (M=70.47, SD=9.18), $t(62) = 6.74$, $p < 0.001$, with Cohen's $d = 1.67$ indicating a very large effect size. These findings confirm that e-module-based digital transformation significantly enhances ECE students' arts learning achievement and supports the advancement of 21st-century pedagogical practice in higher education.

Keywords:

digital transformation; e-module; arts learning; early childhood education; learning achievement

(*) Corresponding Author: suciruihyat01@gmail.com

How to Cite: Ruiyat, S. A., Khasanah, U., Susilawati, E. S., & Fajarianto, O. (2026). Digital Transformation of Arts Learning for Early Childhood: The Effect of E-Module on Learning Achievement of Early Childhood Education Undergraduate Students. *JTP - Jurnal Teknologi Pendidikan*, 28(2), 540–549. <https://doi.org/10.21009/jtp.v28i2.69258>

INTRODUCTION

The digital transformation era fundamentally reshapes pedagogical paradigms across all educational levels, including higher education programs dedicated to Early Childhood Education (ECE). The integration of digital learning resources is no longer optional but constitutes a professional imperative for educators tasked with preparing future PAUD teachers who are competent in both arts' pedagogy and technology-integrated instruction (Basilotta, Gomez, Pablos et al., 2022). Arts learning for early childhood encompassing visual arts, music,



movement, and drama play a vital role in children's holistic development, stimulating cognitive flexibility, socio-emotional competence, and creative expression (Hagood, 2021; Trimis & Savva, 2022).

The ideal condition for arts learning in ECE undergraduate programs demands that prospective teachers master not only the theoretical foundations of child art development but also practical skills in designing, demonstrating, and assessing arts activities appropriate for young children aged 0–6 years (Listiana et al., 2022). According to Smaldino et al. (2023), effective higher education teaching materials must be multi-representational, learner-centred, and capable of facilitating active knowledge construction. Electronic modules (e-modules), as interactive digital teaching materials, have been shown to meet these criteria by integrating text, images, instructional video, animations, and formative quizzes within a single accessible platform (Mayer, 2021; Suartama et al., 2021).

However, field evidence reveals a stark contrast to this ideal. A preliminary needs analysis conducted across four Indonesian universities offering ECE programmes found that 81% of arts learning lecturers still rely exclusively on printed modules or photocopied handouts as their primary teaching resource, while only 12% have developed any form of digital learning material (Hidayati et al., 2023). Consequently, students' mean learning achievement in arts courses stagnated at 63.8 out of 100, significantly below the minimum mastery criterion of 75 set by the Indonesian National Standards of Higher Education (Sari & Kusumawati, 2022). Furthermore, student engagement surveys indicated that 76.4% of ECE students felt that conventional arts learning materials failed to adequately represent movement, rhythm, and visual arts processes that are inherently dynamic in nature (Rahmawati et al., 2023).

Research consistently affirms that e-module adoption constitutes a viable and evidence-based solution to these challenges. Jayawardana (2021) demonstrated that e-module integration produced statistically significant improvements in higher education students' conceptual understanding across multiple disciplines. Wulandari et al. (2022) specifically found that multimedia-enhanced e-modules elevated arts-related learning outcomes by 26.3% compared to conventional instruction. Setiawan et al. (2023) further established that digital interactive e-modules for ECE contexts positively influenced both cognitive and affective learning domains. In the context of arts learning, the capacity of e-modules to embed instructional videos of artistic processes including dance demonstrations, painting techniques, and musical performances provides an irreplaceable representational advantage over static printed materials (Asyhari & Silvia, 2023; Mayer, 2021).

Despite this growing evidence base, a critical research gap persists: no published study has systematically investigated the effect of e-module-mediated digital transformation specifically within ECE arts learning courses in Indonesian higher education, nor has any study measured its practical significance through effect size analysis in this context. This constitutes the primary novelty of the present study: it moves beyond feasibility assessment to rigorously quantify both the statistical and practical magnitude of e-module effects on ECE students' arts learning achievement using Cohen's *d* effect size, thereby providing actionable

evidence for curriculum digitalisation policy in ECE higher education (Nurhasanah et al., 2023; Prasetyo & Harjanta, 2022).

Accordingly, this study addresses the following primary research question: To what extent does the implementation of the developed e-module significantly improve the arts learning achievement of ECE undergraduate students compared to conventional printed modules

METHODS

Research Design

This study employed a quantitative approach with a quasi-experimental Pretest-Posttest Control Group Design (Creswell & Creswell, 2022). The design was selected to rigorously examine causal relationships between e-module use and learning achievement while accounting for pre-existing group differences through pretest administration. Two intact classes were randomly assigned as the experimental group (e-module instruction) and the control group (conventional printed module instruction). Prior to the main experiment, the e-module was developed and validated using an iterative expert review process aligned with systematic instructional design principles (Smaldino et al., 2023; Tegeh et al., 2022).

Research Subjects

Research subjects comprised 64 fourth-semester ECE undergraduate students at Universitas Setia Budhi Rangkasbitung Indonesia, enrolled in the Arts Learning for Early Childhood course during the 2024/2025 academic year. Purposive sampling criteria were: (1) active enrollment in the target course, (2) no prior formal digital arts learning experience, and (3) informed consent to participate. Class A (n = 32) served as the experimental group; Class B (n = 32) served as the control group. Preliminary equivalence between groups was confirmed by the absence of significant differences in pretest scores ($t(62) = 0.18$, $p = 0.86$) and prior academic GPA (Fraenkel et al., 2023). Expert validation panels comprised two content experts (senior arts education lecturers holding doctoral qualifications) and two media experts (educational technology lecturers holding doctoral qualifications with e-learning design experience).

Research Instruments

Five instruments were employed: (1) E-module content expert validation sheet: 28 items across content accuracy, pedagogical alignment, and presentation quality sub-scales ($\alpha=0.91$); (2) E-module media expert validation sheet: 32 items covering interface design, interactivity, navigation, and technical performance sub-scales ($\alpha=0.89$); (3) Student response questionnaire: 22 Likert-scale items (1–5) measuring perceived usability, visual appeal, content relevance, and learning support ($\alpha=0.87$); (4) Arts learning achievement test: 45 multiple-choice items and 5 performance-based essay items assessing cognitive competencies (C1–C4) and applied pedagogical knowledge ($\alpha=0.86$); and (5) Structured observation checklist for monitoring instructional process fidelity in both groups (Nurhasanah et al.,

2023; Sugiyono, 2023). All test instruments underwent item analysis using SPSS 26.0; items with corrected item-total correlation $r < 0.30$ were revised or removed prior to administration.

Data Collection Procedures

Data collection proceeded in four sequential phases. First, expert validation: completed through two rounds of structured panel reviews, with revisions implemented between rounds until consensus scores exceeded the 80% feasibility threshold. Second, small-group trial ($n=10$): student response questionnaires administered following a two-week e-module trial, with findings informing final revisions. Third, field trial: the finalised e-module was deployed to the experimental group across eight instructional weeks; the control group received equivalent content via conventional printed modules under identical weekly schedules. Fourth, outcome measurement: standardized pretest administered in Week 1 and posttest in Week 8 to both groups under supervised conditions (Creswell & Creswell, 2022; Bellefroid et al., 2022).

Data Analysis Techniques

Expert validation data were analysed using the feasibility percentage formula: $P = (\Sigma \text{ obtained score} / \Sigma \text{ maximum score}) \times 100\%$, classified as: $\geq 81\%$ (very valid), 61–80% (valid), 41–60% (valid), 40–20% (fairly valid), $\leq 20\%$ (invalid) (Akbar, 2020). Student response data were summarised using descriptive statistics. For learning achievement analysis, normality was assessed with the Shapiro–Wilk test and homogeneity with Levene’s Test. Where assumptions were met, independent-samples t-tests were conducted (significance level $\alpha=0.05$). Normalised gain scores (N-gain) were calculated per Hake’s formula to measure learning improvement magnitude. Practical significance was quantified using Cohen’s d, interpreted as: $d < 0.2$ (negligible), 0.2–0.5 (small), 0.5–0.8 (medium), 0.8–1.2 (large), > 1.2 (very large) (Creswell & Creswell, 2022).

RESULTS & DISCUSSION

E-Module Feasibility: Expert Validation

Two rounds of expert panel review produced validation scores summarised in Table 1 below. Revision implementation between rounds elevated scores by an average of 4.3 percentage points, reflecting the iterative quality assurance process inherent in systematic instructional design (Tegeh et al., 2022; Hanafi, 2021).

Table 1. Expert Validation Results of the Arts Learning E-Module

Validation Aspect	Score (%)	Category	Expert Notes	Decision
Content	92.1%	Very Valid	Add video diversity	Approved
Accuracy – Material Expert				
Pedagogical	91.4%	Very Valid	Minor language edit	Approved
Relevance – Material Expert				

Content	91.3%	Very Valid	—	Approved
Presentation – Material Expert				
Overall Material Validation	91.6%	Very Valid	—	Approved
Visual Display – Media Expert	91.8%	Very Valid	—	Approved
Interactivity – Media Expert	92.3%	Very Valid	Improve feedback speed	Approved
Navigation & Accessibility – Media Expert	87.2%	Very Valid	Minor revision	Approved
Overall Media Validation	90.4%	Very Valid	—	Approved

Source: Primary Data (2024)

As shown in Table 1, the overall content validation score of 91.6% and media validation score of 90.4% both fall within the ‘Very Valid’ category, satisfying the minimum feasibility threshold of $\geq 81\%$ required for instructional materials in Indonesian higher education (Akbar, 2020). Content experts particularly commended the e-module’s pedagogical sequencing, which progressed systematically from arts theory to guided practice and reflective application, consistent with constructivist learning design principles (Mayer, 2021). Media experts highlighted the high interactivity score (92.3%) as the module’s strongest technical feature, attributed to its embedded H5P interactive exercises providing immediate corrective feedback, a feature identified by Lee et al. (2022) as critical for sustaining learner engagement in digital learning environments.

Student Response Results

Small-group trial (n=10) yielded a student response score of 88.4% (very positive). The full field-trial cohort (n=32) produced a response score of 92.7% (very positive). The highest-rated dimensions were visual attractiveness (94.1%), content relevance to future teaching practice (93.6%), and navigational ease (92.3%). The lowest-rated dimension, though still in the very positive range, was video streaming stability (88.9%), reflecting infrastructure heterogeneity across students’ internet connectivity environments a limitation consistent with findings by Dhawan (2020) and Widiyono (2021) in Indonesian online learning contexts. Open-ended qualitative responses indicated that students most valued the ability to re-watch arts demonstration videos at their own pace, corroborating Almusharraf and Bailey’s (2021) finding that asynchronous multimedia access significantly boosts learner engagement in higher education.

Learning Achievement: Pretest-Posttest Comparison

Shapiro–Wilk test confirmed normal data distribution for both groups ($p>0.05$). Levene’s Test confirmed variance homogeneity ($p=0.31$). Table 2 presents normalised gain scores, and Table 3 presents independent-samples t-test results.

Table 2. Normalised Gain (N-Gain) Scores by Group

Group	Pretest Mean	Posttest Mean	N-Gain	Category	SD (Post)
Experimental (E-Module)	62.31	84.22	0.58	Medium-High	7.93
Control (Printed Module)	61.94	70.47	0.22	Low	9.18

Source: Primary Data (2024)

As shown in Table 2, the experimental group achieved an N-gain of 0.58 (medium-high category), substantially exceeding the control group's N-gain of 0.22 (low category). This differential gain of 0.36 points indicates that e-module use produced markedly stronger learning trajectory improvement, even given near-identical pretest baselines (Hake, 1998, as cited in Creswell & Creswell, 2022).

Table 3. Independent-Samples T-Test Results of Arts Learning Achievement

Group	N	Mean	SD	t-value	p-value & Cohen's d
Experimental	32	84.22	7.93	6.74	p<0.001; d=1.67
Control	32	70.47	9.18	—	—

Source: Primary Data (2024)

Table 3 confirms a statistically significant difference in posttest means between the experimental and control groups: $t(62) = 6.74$, $p < 0.001$. The Cohen's d of 1.67 represents a very large practical effect size, indicating that the e-module produced improvements substantially exceeding what would be expected from sampling variability alone. This effect size considerably surpasses the large-effect benchmark ($d > 0.8$) established by Cohen (1988, as cited in Fraenkel et al., 2023), and exceeds comparable e-module studies in arts education that reported d values between 0.87 and 1.12 (Wulandari et al., 2022; Fausih & Danang, 2021).

Discussion

The convergence of very high expert validation scores, very positive student responses, and a very large effect size collectively establishes the e-module's status as both a technically sound and educationally powerful instructional tool. The theoretical basis for these outcomes is best understood through Mayer's (2021) Cognitive Theory of Multimedia Learning (CTML), which posits that dual-channel processing of visual and verbal information precisely as enabled by the e-module's video-text integration reduces extraneous cognitive load and deepens schema formation. For arts content specifically, where aesthetic processes are inherently visual and kinaesthetic, the representational affordances of multimedia e-modules are qualitatively irreplaceable by static text (Hagood, 2021; Trimis & Savva, 2022).

The very large Cohen's d effect (1.67) also supports Vygotsky's (1978) constructivist framework regarding the Zone of Proximal Development (ZPD). The e-module's built-in adaptive scaffolding through immediate quiz feedback, progressive difficulty sequencing, and on-demand video re-access effectively operationalised digital ZPD support, enabling students to advance competencies beyond what self-study with static printed materials could achieve (Andriani &

Fatmawati, 2023; Chen & Su, 2021). This finding aligns with Setiawan et al. (2023), who reported that digital interactive ECE materials consistently outperform printed equivalents in fostering higher-order pedagogical thinking among prospective ECE teachers.

From a digital transformation policy perspective, this study contributes empirical justification for institutional digitalisation of arts learning curricula in ECE higher education programmes. Basilotta, Gomez, Pablos et al. (2022) established that lecturers' digital competence is the primary bottleneck in higher education digitalisation; accordingly, the present findings imply that providing ready to deploy validated e-modules, rather than expecting individual lecturers to develop digital materials independently, represents the most strategically efficient path to sustainable digital transformation in ECE arts education (Nouri et al., 2020; Huang et al., 2021).

Several limitations warrant acknowledgement. First, the study was conducted in a single institution, restricting generalizability to other ECE programme contexts. Second, the eight-week treatment period, while sufficient to detect achievement differences, does not capture longer-term retention effects. Third, the study did not examine whether e-module-enhanced learning achievement transferred to students' actual classroom arts teaching performance during field placement. Future research should employ multi-site, longitudinal designs and incorporate teaching performance assessments to more comprehensively evaluate the downstream benefits of e-module-mediated digital transformation in ECE arts education (Mardiana & Kuswanto, 2023; Paristiowati et al., 2022).

CONCLUSION

This study demonstrates that the implementation of the developed interactive e-module significantly enhances the arts learning achievement of ECE undergraduate students compared to conventional printed modules. The quasi-experimental evaluation confirms a statistically significant superiority in posttest performance for students using the e-module. These empirical findings establish that e-module-mediated digital transformation effectively addresses the representational limitations of static printed media in arts education, offering a highly potent and actionable strategy for elevating instructional quality and student competency in higher childhood teacher education programs

Theoretically, these findings reinforce the applicability of Mayer's CTML to arts education contexts in higher education and extend its evidence base to ECE teacher preparation specifically. Practically, this study recommends that ECE programme administrators institutionalise e-module adoption for all arts learning courses, invest in lecturer digital competence development, and establish infrastructure support to address connectivity inequities identified in student response data. Future research should explore the integration of artificial intelligence and augmented reality within ECE arts e-modules to further personalise instructional scaffolding and bridge the gap between digital learning and embodied arts practice.

REFERENCES

- Akbar, S. A. (2020). Instrumen perangkat pembelajaran. Remaja Rosdakarya.
- Almusharraf, N., & Bailey, D. (2021). Online learning environments and EFL learner engagement during an emergency remote teaching context. *Journal of Computer Assisted Learning*, 37(6), 1709–1722. <https://doi.org/10.1111/jcal.12589>
- Andriani, D., & Fatmawati, L. (2023). Pengembangan e-modul interaktif berbasis konstruktivisme untuk meningkatkan hasil belajar mahasiswa PAUD. *Jurnal Pendidikan Anak Usia Dini*, 17(1), 45–62. <https://doi.org/10.21009/JPUD.171.04>
- Asyhari, A., & Silvia, H. (2023). Pengembangan media pembelajaran berupa buletin dalam bentuk buku saku untuk pembelajaran IPA terpadu. *Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi*, 5(1), 1–13. <https://doi.org/10.24042/jpifalbiruni.v5i1.100>
- Basilotta-Gomez-Pablos, V., Matarranz, M., Casado-Aranda, L.-A., & Otto, A. (2022). Teachers' digital competencies in higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, 19(1), 1–16. <https://doi.org/10.1186/s41239-021-00286-7>
- Bellefroid, B., Deroover, K., & Leclercq, D. (2022). Interactive digital textbooks in higher education: Acceptance and effectiveness. *Computers & Education*, 182, 104472. <https://doi.org/10.1016/j.compedu.2022.104472>
- Basilotta-Gomez-Pablos, V., & Matarranz, M. (2020). Project-based learning (PBL) through the incorporation of digital technologies: An evaluation based on the experience of serving teachers. *Digital Education Review*, 37, 53–68. <https://doi.org/10.1344/der.2020.37.53-68>
- Chen, C. M., & Su, Y. N. (2021). Developing a personalized e-learning system based on an intelligent agent and semantic web technology. *Computers & Education*, 149, 103801. <https://doi.org/10.1016/j.compedu.2019.103801>
- Cheng, L., Ritzhaupt, A. D., & Antonenko, P. (2022). Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. *Educational Technology Research and Development*, 67(4), 793–824. <https://doi.org/10.1007/s11423-018-9633-7>
- Creswell, J. W., & Creswell, J. D. (2022). *Research design: Qualitative, quantitative, and mixed methods approach* (6th ed.). SAGE Publications.
- Crompton, H., & Burke, D. (2020). Mobile learning and pedagogical opportunities: A configurative systematic review of PreK–12 research using the SAMR framework. *Computers & Education*, 156, 103945. <https://doi.org/10.1016/j.compedu.2020.103945>
- Damanik, B. E. (2021). Pengembangan e-modul berbasis proyek untuk meningkatkan keterampilan berpikir kreatif mahasiswa. *Jurnal Teknologi Pendidikan*, 23(3), 211–224. <https://doi.org/10.21009/jtp.v23i3.21874>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>
- Fausih, M., & Danang, T. (2021). Pengembangan media e-modul mata pelajaran produktif pokok bahasan instalasi jaringan LAN. *Jurnal UNESA*, 1(1), 1–9.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2023). *How to design and evaluate research in education* (10th ed.). McGraw-Hill.
- Hagood, T. K. (2021). *Dance arts education: Curriculum design and pedagogy for early childhood*. Routledge.
- Hanafi. (2021). Konsep penelitian R&D dalam bidang pendidikan. *Jurnal Kajian Keislaman*, 4(2), 129–150. <https://doi.org/10.31538/kajian.v4i2.54>

- Hidayati, N., Suparno, S., & Wulandari, D. (2023). Analisis kebutuhan pengembangan bahan ajar digital seni tari untuk mahasiswa PAUD. *Jurnal Teknologi Pendidikan*, 25(2), 112–125. <https://doi.org/10.21009/jtp.v25i2.32011>
- Huang, R., Tlili, A., Chang, T.-W., Zhang, X., Nascimbeni, F., & Burgos, D. (2021). Disrupted classes, undisrupted learning during COVID-19 outbreak in China: Application of open educational practices and resources. *Smart Learning Environments*, 7(1), 19. <https://doi.org/10.1186/s40561-020-00125-8>
- Jayawardana, H. B. A. (2021). Paradigm shift in science education: The role of e-modules in enhancing students' conceptual understanding. *International Journal of Emerging Technologies in Learning (iJET)*, 16(6), 21–35. <https://doi.org/10.3991/ijet.v16i06.18389>
- Lee, J., Lim, C., & Kim, H. (2022). Development of an AI-based adaptive learning content recommendation system for personalized learning in higher education. *Education and Information Technologies*, 27(2), 1567–1590. <https://doi.org/10.1007/s10639-021-10680-9>
- Listiana, A., Maryati, S., & Novianti, R. (2022). Pengembangan bahan ajar berbasis ADDIE pada mata kuliah seni dan budaya anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 6(3), 1812–1823. <https://doi.org/10.31004/obsesi.v6i3.1754>
- Mardiana, T., & Kuswanto, H. (2023). Development of physics e-module based on augmented reality to improve students' learning outcomes and motivation. *Journal of Science Education and Technology*, 32(1), 84–97. <https://doi.org/10.1007/s10956-022-09999-2>
- Mayer, R. E. (2021). *Multimedia learning* (3rd ed.). Cambridge University Press. <https://doi.org/10.1017/9781108894333>
- Nouri, J., Zhang, L., Mannila, L., & Norén, E. (2020). Development of computational thinking, digital competence and 21st century skills when learning programming in K–9. *Education Inquiry*, 11(1), 1–17. <https://doi.org/10.1080/20004508.2019.1627831>
- Nurhasanah, S., Sobandi, A., & Kardinata, R. (2023). Developing interactive e-module for early childhood education: A systematic design approach. *Journal of Physics: Conference Series*, 2049(1), 012077. <https://doi.org/10.1088/1742-6596/2049/1/012077>
- Paristiowati, M., Fitriani, E., Aldi, N. H., & Fahroji, A. (2022). The effect of project-based learning–flipped classroom model on student academic achievement in chemistry. *Journal of Physics: Conference Series*, 2155(1), 012007. <https://doi.org/10.1088/1742-6596/2155/1/012007>
- Prasetyo, Z. K., & Harjanta, A. T. J. (2022). Pengembangan e-modul berbasis web dengan model pembelajaran inkuiri. *Jurnal Teknologi Pendidikan*, 24(1), 78–90. <https://doi.org/10.21009/jtp.v24i1.25411>
- Rahmawati, F., Widodo, A., & Suherman, A. (2023). Pengaruh e-modul interaktif berbasis multimedia terhadap hasil belajar dan motivasi mahasiswa pendidikan jasmani. *Jurnal Keolahragaan*, 11(1), 43–55. <https://doi.org/10.21831/jk.v11i1.48721>
- Sari, D. P., & Kusumawati, E. (2022). Evaluasi hasil belajar mahasiswa PAUD pada mata kuliah seni dan kreativitas anak. *Jurnal Pendidikan Anak*, 11(2), 89–100. <https://doi.org/10.21831/jpa.v11i2.42178>
- Setiawan, B., Rachmadtullah, R., Iasha, V., & Rasmitadila, R. (2023). Digital interactive e-modules for early childhood education: Development and implementation. *International Journal of Early Childhood*, 55(2), 123–141. <https://doi.org/10.1007/s13158-022-00342-z>

- Smaldino, S. E., Lowther, D. L., Mims, C., & Russell, J. D. (2023). *Instructional technology and media for learning* (13th ed.). Pearson.
- Suartama, I. K., Setyosari, P., Sulthoni, & Ulfa, S. (2021). Development of ubiquitous learning-based e-module using project-based learning in polytechnic. *Journal of Technology and Science Education*, 11(2), 419–440. <https://doi.org/10.3926/jotse.1095>
- Sugiyono. (2023). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D* (Edisi ke-3). Alfabeta.
- Tegeh, I. M., Jampel, I. N., & Pudjawan, K. (2022). *Model penelitian pengembangan* (2nd ed.). Graha Ilmu.
- Trimis, E., & Savva, A. (2022). Pedagogical documentation and arts-based inquiry in early childhood: Rethinking creative learning environments. *International Journal of Early Childhood*, 54(1), 55–74. <https://doi.org/10.1007/s13158-021-00304-4>
- Umar, M., & Ko, I. (2023). The relationship between ICT is used for learning and student academic achievement: A meta-analysis of selected countries in Asia. *SAGE Open*, 13(1), 1–15. <https://doi.org/10.1177/21582440221149740>
- Widiyono, A. (2021). Efektifitas perkuliahan daring (online) pada mahasiswa PGSD di masa pandemi Covid-19. *Jurnal Pendidikan*, 22(2), 169–177. <https://doi.org/10.33830/jp.v22i2.1915.2021>
- Wulandari, B., Surjono, H. D., & Priyanto. (2022). Pengaruh e-modul multimedia interaktif terhadap hasil belajar ditinjau dari motivasi belajar. *Jurnal Pendidikan Vokasi*, 12(2), 159–172. <https://doi.org/10.21831/jpv.v12i2.42851>
- Yarmi, G., Suntari, Y., Usman, H., & Yesi, Y. (2024). Need analysis of mobile learning based on problem-based learning in social studies at elementary schools. *Jurnal Teknologi Pendidikan*, 26(2), 507–516. <https://doi.org/10.21009/jtp.v26i2.47170>