



Development of the E-module with Project-Based Learning for the Flat Pattern Design Course

Pepi Resmanti¹, Anni Faridah^{1*}, Yusmerita¹, Yeka Hendriyani¹

¹Universitas Negeri Padang, Indonesia

*Correspondence to: faridah.anni@fpp.unp.ac.id

Abstract: This research was motivated by the disappointing results of student projects and the perceived lack of engagement with current instructional materials in flat pattern design courses. The aim was to create a project-based learning e-module designed specifically for this field of study. The study followed Borg and Gall's (1989) research and development (R&D) model. Participants consisted of three lecturers and 36 students. Data collection involved using questionnaires and evaluating student project outcomes. The results suggest that the project-based learning e-module is effective and practical in flat pattern design education, promising to improve student learning outcomes. The lecturer responses indicated a 91% rating in the "very practical" category for the e-module, while students similarly rated it at 89% in the same category. The control group showed a low N-gain value of 0.15, whereas the experimental group demonstrated a high N-gain value of 0.74. The e-modules, which employ project-based learning, effectively enhance students' psychomotor skills and engagement, aligning the curriculum with industry demands. Technology integration in the classroom paves the way for further advancements in fashion education and other fields.

Keywords: development, e-modules, flat pattern design, project-based learning

Recommended citation: Resmanti, P., Faridah, A., Yusmerita., & Hendriyani, Y. (2024). Development of the E-module with Project-Based Learning for the Flat Pattern Design Course. *Journal of Innovation in Educational and Cultural Research*, 5(3), 408-416.

INTRODUCTION

Technological advancements consistently drive efforts to improve educational quality, primarily through innovative learning methods (Budiman, 2017). Incorporating these advancements introduces new approaches to learning that promise enhanced outcomes and increased efficiency within higher education settings (Robinson, 2013; van Beurden et al., 2024). Adapting to the rapid pace of technological change requires flexibility and ongoing learning, which are crucial (Nascimento et al., 2024). Technology can significantly bolster inclusive education, improving educational achievements (Phulpoto, 2024). One such technological tool is the e-module, delivered digitally through computers, laptops, or smartphones, designed to cater to the specific needs of students. Implementing computer-assisted learning is strongly recommended to elevate academic performance across diverse subjects (Kareem, 2015).

As Rahmi (2019) described, an e-module is a digital medium for self-directed learning aimed at achieving educational goals and enhancing student interaction through applications. Typically, e-modules include educational videos, images, quizzes, links to resources, and audio components to create interactive learning environments that engage students (Shrestha et al., 2024). These modules promote independent and innovative learning approaches, allowing students to evaluate their understanding (Wulansari et al., 2018; Hasanah et al., 2023). Widely acknowledged as vital and effective educational tools, e-modules are crucial for providing convenient, autonomous access to learning materials from any location (Adrianus et al., 2023; Stumbrienė et al., 2024). In this research, the e-module utilizes the flipbook application. Given the current digital learning environment, digital flipbook e-modules effectively stimulate critical thinking and foster independent learning among students (Widiana & Rosy, 2021). E-modules employing the flipbookmaker application serve as dynamic learning tools that provide engaging educational experiences (Romayanti et al., 2020). Integrating the flipbook application into e-modules innovates the learning environment, aligning with models to enhance educational outcomes (Winatha, 2018). The project-based learning model applied in this study enhances student motivation (Oksa & Soenarto, 2020). Known as PjBL, project-based learning encourages students to develop knowledge and skills independently (Winatha, 2018). The project-based learning integrated within the e-module aims to improve students' psychomotor skills in creating intricate fashion patterns. Psychomotor skills entail performing practical tasks proficiently and accurately according to established standards (Komalaye, 2016).

According to research by Çelik et al. (2018), Project-based learning (PjBL) provides students with the advantage of broadening their perspectives. Multiple studies suggest that PjBL improves students' knowledge, skills, and academic motivation despite time constraints (Guo et al., 2020). PjBL, a constructivist approach widely applied across various contexts, is acknowledged for fostering 21st-century skills (Al-Ali, 2015; Liu, 2019). This approach positively influences students by enhancing their competencies aligned with modern educational

standards, including critical thinking, problem-solving, effective communication, collaborative abilities, and creativity (Megayanti et al., 2020).

E-modules serve as versatile tools applicable to both theoretical learning and practical applications. Within the realm of Fashion Management, the flat pattern design course holds a critical position in the curriculum of the IKK Department's Fashion Management concentration. This course is fundamental for aspiring designers as it integrates pattern-making seamlessly into the design process, fostering the creation of innovative structures (Burns et al., 2019). Despite its importance, student engagement with the course has been tepid, mainly due to encountered challenges (Ugwu et al., 2023). Proficiency in techniques like the pivot and cutting methods is indispensable in the flat pattern design course, empowering students to craft various fashion designs skillfully. Pattern drafting techniques include modeling, mock design, pattern grading (modification of patterns for different sizes), computer-aided pattern drafting, and flat pattern techniques (Igbo & Iloeje, 2003). Integrating digital technology into education is crucial to advance online learning development (Rodrigues, 2020). Incorporating project-based activities through diverse technologies requires adjusting the blend of direct interaction and independent study within the curriculum, a productive implementation approach in the learning process (Bazhenov et al., 2021).

Project-based learning (PjBL) involves students in designing, problem-solving, decision-making, and self-investigation to complete a project. The flat pattern design course entails creating scaled clothing patterns (1:6 ratio), emphasizing a practical understanding of design principles. The PjBL approach is ideal for this course, encouraging students to apply theoretical knowledge in real-world applications. According to Noviani and Widarwati (2019), PjBL improves students' skills in fashion pattern-making and enhances metacognitive abilities through hands-on product creation. Moreover, Project-based Learning (PjBL) enhances students' understanding of flat pattern design concepts and principles through hands-on product creation experience. Adopting PjBL significantly advances student development, stimulates learning motivation, and nurtures creativity (Guo et al., 2020; Shuhailo, 2021; Wijnia et al., 2024). Furthermore, Indriyani et al. (2023) endorse PjBL as a recommended approach in Indonesian university settings. PjBL e-modules are valuable educational tools encouraging active student participation (Ningtyas & Jati, 2018). Integrating e-modules enhances student engagement and improves educational outcomes (Siregar & Harahap, 2020; Budi et al., 2024). Using PjBL e-modules effectively enhances student academic performance (Rusmanto & Rukun, 2020).

In the interview, the lecturer revealed that the flat pattern design course consists of three sessions. Current instructional materials include handouts, PowerPoint slides, job sheets, and plywood slopers (master patterns). However, students have indicated challenges in fully expressing their creative ideas using these resources. As a result, there is a need to explore alternative approaches to stimulate creativity and boost student motivation (Puspitarini, 2019). The existing teaching materials have led to a repetitive learning experience, impacting students' grasp of flat pattern design principles. Consequently, there is a push to develop learning resources that feature challenging practice tasks and compelling multimedia elements, adhering to established criteria for media development (Rahim et al., 2022). The precise positioning of darts in basic pattern construction significantly influences the outcome of clothing designs (Rita, 2021; Ahmed et al., 2022).

During the course, instructors utilize lecture, discussion, and demonstration techniques. Lectures are employed to comprehensively present theoretical concepts, while demonstrations on the blackboard illustrate practical steps in flat pattern design. However, these methods are confined to classroom settings, limiting students' ability to revisit content outside scheduled sessions. Project-based E-Modules provide a remedy by allowing students to engage in self-directed learning at their convenience (Ningsih et al., 2019). Implementing the PjBL approach empowers students to assume responsibility for their learning journey quickly (Meier & Hendel, 2019). nurturing their academic and social skills through active participation (Shin, 2018). Building upon the established background, this study explores the development of e-modules using project-based learning for flat pattern design courses at FPP UNP. It seeks to innovate upon prior research by enhancing project-based learning through e-modules in flat pattern design, aiming to foster students' competence in their respective fields.

METHODS

This study utilized Borg and Gall (1989) research and development (R&D) model. Sugiyono (2013) explains that the R&D method designs and evaluates specific products. The chosen development model is the 4-D (four-D) model, which includes defining, designing, developing, and disseminating stages. The research encompassed participation from three lecturers and 36 students enrolled in the flat pattern design course, distributed across two separate classes. This research begins with the defining stage, encompassing five analytical phases: front-end analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. Information collected during this stage involves observing and investigating critical issues encountered in flat pattern design lectures and factors contributing to low creativity and student achievement

outcomes. In the subsequent design stage, several actions are undertaken. These include selecting appropriate media, writing scripts/materials, choosing images, music, and videos, and developing the e-modules. The e-module design features an opening/cover page, a commentary section, a table of contents, a material presentation page containing detailed descriptions (including explanations of materials, specific video tutorials, project assignments, formative quizzes/tests, and feedback), a glossary, and a bibliography.

The e-module design focuses on improving students' capacity for independent learning, featuring an introductory section with video tutorials to support autonomous study. In the third phase of this study, the development stage aims to produce e-module learning materials rooted in Project-based Learning that are reliable, feasible, and impactful. Validation during this phase is carried out by experts in media, content, and language. Practicality testing includes gathering feedback from course instructors and students regarding their experience with the e-module application. Effectiveness testing measures student learning achievements to assess the impact of the e-module. Three validators, lecturers from UNP's Fashion Management department, participated in the validation process. They evaluated the e-module based on three criteria: content quality, learning effectiveness, and visual presentation (Laili, 2019). After the e-module passed validation, a practicality test was conducted. This phase included input from two lecturers teaching the flat pattern design course and responses from a questionnaire completed by 36 enrolled students. The effectiveness test aimed to assess whether the developed e-module could effectively improve student learning outcomes as intended. It measured changes in the psychomotor domain by evaluating student performance in creating fashion patterns before and after using the e-module in the flat pattern design course. Below is a table evaluating student project assignments.

Table 1. Criteria for Assessing Student Projects.

Assessment Criteria	Weight (Percentage)	Rating Scale (1-5)	Total Score (Weight x Scale)
Performance Aspects	10%		
Preparation			
Process (Basic fashion pattern)			
Creativity in Design	20%		
Design manipulation			
Combination of design elements			
Uniqueness of design			
Accuracy and Precision	20%		
Measurement Accuracy			
Precision of pattern lines and shapes			
Conformity of Pattern Break with Design	30%		
Size suitability			
Accuracy in pattern development			
Dart line transfer technique			
Innovation in patterns			
Pattern making technique	20%		
Pattern line flexibility			
Accuracy and Quality of Pattern Cutting			
Total	100%		

Source: Course Lecturer

The effectiveness of e-modules utilizing project-based learning is assessed by evaluating individual students' achievement and the class's overall performance. An individual student is considered successful if they complete their learning or achieve a score of ≥ 69 , with the criterion that at least 85% of students meet this standard. Thus, an e-module is deemed effective if the pass rate reaches or surpasses 85%. The gain score method (Hake, 1999) was employed to measure the enhancement in student learning outcomes. Categories for gain scores can be found in Table 2.

Table 2. Gain Score Categories

Gain Score	Category
$g > 0,70$	High
$0,30 \leq g \leq 0,69$	Medium
$g < 0,29$	Low

RESULT AND DISCUSSION

The study's results demonstrate the feasibility and efficacy of creating project-based learning e-modules to improve student learning outcomes in flat pattern design courses. The practicality test outcomes gathered from feedback provided by both lecturers and students are depicted in the figure below:

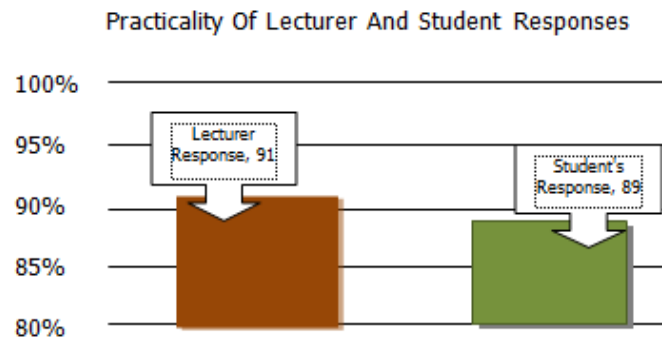


Figure 1. Feedback from both lecturers and students regarding the development of project-based learning e-modules.

The practicality of lecturers' response to the development of e-modules, at 91%, indicates a high level of engagement and acceptance towards integrating technology in learning. The data illustrates that most flat pattern design course lecturers have responded positively to the e-module development, likely recognizing its value in enhancing the teaching and learning processes. Similarly, students' response rate of 89% indicates a positive reception towards e-module usage. This suggests that e-modules have effectively provided students a practical and engaging learning experience, demonstrating a strong acceptance of technology-enhanced learning approaches. Data sets demonstrate favorable responses from lecturers and students regarding implementing e-modules, indicating robust support for their efficacy as a learning tool. According to the findings from the e-module trial, there was a noticeable improvement in learning outcomes as evidenced by the posttest results in the experimental class. The assessment of student projects was based on scores obtained from pretest and posttest evaluations, illustrated in the figure below.

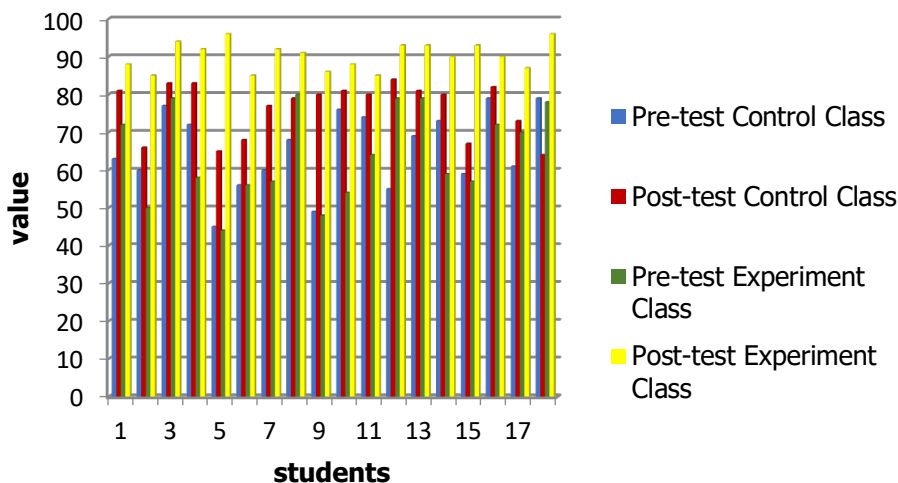


Figure 2. Results from the pretest and posttest assessments of both the control and experimental classes.

Figure 1 displays the pretest and posttest scores of two groups: the control and experimental classes. Each row represents a student, with columns indicating their pretest and posttest scores within each class. In the pretest of the control class, eight students scored incomplete on the project assignment. The highest pretest score achieved in the control class was 79 out of 100. Meanwhile, in the experimental class, ten students were incomplete in the pretest. The highest pretest score in the experimental class was 80 out of 100, achieved by only one student, while the others scored below 72. These results highlight that students' proficiency in independently completing project tasks remains relatively low. There were notable differences in posttest scores, with most students achieving satisfactory results. In the control class, posttest scores ranged from 64 to 81, with the highest score reaching 84 out of 100. Conversely, in the experimental class, most students scored

between 85 and 92, with the highest score being 96 out of 100. These posttest results indicate that a significant number of students successfully completed their project tasks. Below is a table showing the percentage of students achieving classical completeness.

Table 3. Pretest-Posttest Scores

Activities	Number of Students	Max Score	Min Score	Completed $\geq$ 85%	%	Description
Pretest Control Class	18	79	45	10	55%	Incomplete
Posttest Control Class	18	84	64	13	73%	Completed
Pretest Experiment Class	18	80	44	8	44%	Incomplete
Posttest Experiment Class	18	96	73	18	100%	Completed

Table 3 illustrates the evaluation of student learning outcomes in both the control and experimental classes. In the control class pretest, ten students (55%) achieved the completion criterion, categorized as "sufficient" in classical completeness. Following the assessment of student project results in the control class posttest, it was observed that 13 students (73%) reached the completion criterion, also categorized as "sufficient" in classical completeness. In the experimental class pretest, eight students (44%) completed the project assignment. In contrast, in the experimental class posttest, 18 students achieved a complete score (100%), indicating a significant improvement in student learning outcomes. [Rahmawati](#) (2023) finds that notable disparities between pretest and posttest outcomes indicate the effectiveness of e-modules grounded in project-based learning for enhancing student competence. Furthermore, [Puspitasari](#) (2019) underscores that electronic modules have successfully heightened student engagement in learning and led to improved academic performance. However, assessing the improvement in learning outcomes cannot rely solely on the data provided earlier. The N-Gain test is essential for evaluating the magnitude of improvement, necessitating data on student numbers and average pretest-posttest scores.

Table 4. N-Gain Score

Class	N-Gain Score	Classification	Interpretation
Control	0.15	Low	Ineffective
Experiment	0.74	High	Effective

As observed from the table, there is a notable disparity in the N-gain scores between the experimental and control classes. The experimental class achieved a high gain score of 0.74, whereas the control class scored a low 0.15. This stark difference underscores the practicality and effectiveness of the project-based learning e-module implemented in flat pattern design courses to improve student learning outcomes. Key contributing factors to its success include integrating electronic modules, adopting the Project Based Learning methodology, and carefully selecting learning topics.

Adopting e-modules in education fosters independent learning among students, empowering them to effectively manage and assess their comprehension, strengthening their grasp of concepts ([Nuraini & Muliawan, 2020](#); [Persa et al., 2023](#)). Introducing electronic instructional materials as an alternative in higher education can enhance academic achievement and enrich the learning experience ([Siregar & Harahap, 2020](#)). E-modules are versatile learning tools accessible anytime and anywhere, providing diverse media formats, including audio, video, animated images, and interactive presentations ([Widya et al., 2022](#); [Inanna et al., 2021](#)). Incorporating CAD applications within the e-module enables students to utilize them directly for their fashion pattern tasks, especially in rectifying damaged patterns. [Sawitri](#) (2023) highlights that CAD-based pattern-making significantly enhances student learning achievements. Additionally, the e-module features instructional video tutorials designed to aid students in mastering fashion pattern-making techniques. Teaching skills like pattern-breaking through online tutorials are deemed more effective than conventional approaches ([Mutia & Suprihatin, 2020](#); [Nuraini & Muliawan, 2020](#)).

Effective teaching involves robust strategies that offer students crucial learning opportunities to nurture their growth and adaptable learning skills. It also entails assisting educators in addressing individual differences, overcoming challenges, and strengthening student resilience ([Darling-Hammond et al., 2020](#)). The flat pattern design course is particularly suitable for project-based learning (PjBL) because it centers on creating fashion patterns. According to [Hsin and Wu](#) (2023), integrating PjBL-based e-modules can enhance practical outcomes for students. E-modules structured around project-based learning aim to boost student engagement and develop practical skills. This aligns with [Affandi et al.](#) (2021), who underscore that project-based learning encourages active student involvement in planning, problem-solving, decision-making, and setting learning objectives. This pedagogical approach ensures sustained student engagement throughout the learning process.

The development of e-modules aimed to enhance student engagement through project-based learning and foster skills relevant to employability. According to Onyeazor (2019), skills essential in Flat Pattern drafting include measuring, drawing, shaping, slitting, spreading, and drafting, which are fundamental in creating basic blocks like front bodice, back bodice, front skirt, back skirt, and sleeves. Using patterns in sewing is pivotal for achieving improved garment fit and optimal outcomes (Bans et al., 2024). Jack (2023) and Souza et al. (2019) emphasize the importance of teaching hand-cutting techniques in tailoring in schools and the need to be equipped with adequate training and practical experience in various skills, such as creativity and innovation. This study demonstrates significant differences in student learning outcomes in flat pattern design courses before and after implementing PjBL-based e-modules. According to Hany et al. (2024), PjBL-based e-modules effectively improve student learning outcomes. Additionally, integrating technology can enhance accuracy, efficiency, and productivity in fashion design education (Sindisiwe, 2024). This research has a significant impact on higher education, especially in the development of technology-based fashion design, which is crucial for improving curriculum and industry development in vocational schools (Tantawy et al., 2024).

CONCLUSION

This research and development endeavor creates project-based e-modules for flat pattern design courses, emphasizing learning through practical application. These e-modules possess appealing features that make them suitable for adoption in flat pattern design courses as innovative learning tools. They facilitate independent learning for students both inside and outside the classroom. Students can assess their comprehension levels through quizzes embedded within each learning topic. Additionally, instructional videos support practical tasks. The findings indicate that adopting the Project-Based Learning approach in the e-modules proved practical and effective in enhancing student learning outcomes in flat pattern design courses.

REFERENCES

- Adrianus, A., Astuti, I., & Enawaty, E. (2023). Hasil Analisis Kebutuhan Pengembangan E-Modul Berbasis Android Pada Pembelajaran IPA. *EDUKATIF: JURNAL ILMU PENDIDIKAN*, 5(3), 1434–1442.
- Ahmed, F., Nuruzzaman, M., & Mondal, M. I. H. (2022). Photo-responsive hydrogel-treated fabrics for smart drug delivery systems. In *Medical Textiles from Natural Resources* (pp. 315–338). Woodhead Publishing.
- Affandi, M., Mitsuru, T., Kamil, M., & Suryadi, A. (2021). The effect of project-based learning models on improving student learning results on entrepreneurship education. *First Transnational Webinar on Adult and Continuing Education (TRACED 2020)*, 122–128.
- Al-Ali, E. (2015). *The effect of Project-based Learning strategy on developing creative thinking skills, academic achievement, and attitudes toward science on third intermediate grade students in Tabuk* [Doctoral dissertation, Jordan University].
- Budiman, H. (2017). Peran teknologi informasi dan komunikasi dalam pendidikan. *Al-Tadzkiyyah: Jurnal Pendidikan Islam*, 8(1), 31–43.
- Budi, L., Widodo, A., Julianto, E. N., Kristianto, V. A., Mayasari, R., & Yuhana, N. (2024, February). The Effect of the Project-based Learning (PjBL) Model to Students' Learning Interests and Learning Outcomes in the Advanced Reinforced Concrete Structure Subject, Civil Engineering Department, Universitas Negeri Semarang. In *5th Vocational Education International Conference (VEIC-5 2023)* (pp. 511–517). Atlantis Press.
- Bazhenov, R., Sabirova, V., Samorukov, A., Berseneva, S., & Beknazarova, S. (2021). Technologies of embedded project-based learning for undergraduate engineering students. *Journal of Physics: Conference Series*, 2001(1), 12028.
- Bans-Akutey, M., Aboagyewaa-Ntiri, J., & Appiah, N. A. (2024). Usage of Free-Hand Cutting and Patterns in Garment Construction in Ghana. *Art and Design Review*, 12(2), 121–136.
- Borg, W. R., & Gall, M. D. (1989). *Educational research. An Introduction* (5th ed.). Longman.
- Burns, A., & Vuruşkan, A. (2019). Using origami for creative design and pattern development in fashion education. *Tekstil ve Mühendis*, 26(113), 86–96.
- Çelik, H. C., Ertas, H., & İlhan, A. (2018). The Impact of Project-Based Learning on Achievement and Student Views: The Case of AutoCAD Programming Course. *Journal of Education and Learning*, 7(6), 67–80.

- Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 24(2), 97–140.
- Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, 102, 101586.
- Hake, R. R. (1999). *Analyzing change/gain scores*.
- Hasanah, M., Supeno, S., & Wahyuni, D. (2023). Pengembangan E-Modul Berbasis Flip Pdf Professional untuk Meningkatkan Keterampilan Berpikir Kreatif Siswa pada Pembelajaran IPA. *Tarbiyah Wa Ta'lim: Jurnal Penelitian Pendidikan Dan Pembelajaran*, 10(1), 44–58.
- Hany, N. C., & Syafriani, D. (2024). Development of A Chemistry E-Module Based on Project-Based Learning Using the Flipbook Application to Improve Learning Outcomes and Train Collaboration on Acid-Base Material. *Jurnal Teknologi Pendidikan: Jurnal Penelitian dan Pengembangan Pembelajaran*, 9(2), 168-176.
- Hsin, C.-T., & Wu, H.-K. (2023). Implementing a project-based learning module in urban and indigenous areas to promote young children's scientific practices. *Research in Science Education*, 53(1), 37–57.
- Inanna, I., Ampa, A. T., & Nurdiana, N. (2021). Modul Elektronik (E-Modul) Sebagai Media Pembelajaran Jarak Jauh. *Seminar Nasional Hasil Penelitian*, 1232–1241.
- Indriyani, V., Jasmienti, J., & Ningsih, A. G. (2023). The Effect of PjBL with Copy The Master Method on the Skills of Writing Lesson Plans. *Journal of Innovation in Educational and Cultural Research*, 4(2), 271–279.
- Igbo, C. A., & Illoeje, C. I. (2003). The basics of dress pattern drafting. *Enugu: Inselberg Nigeria Ltd.*
- Jack, P. (2023). Freehand cutting technique in dressmaking as an entrepreneurial skill among secondary school students in Port Harcourt Metropolis. *International Journal of Home Economics, Hospitality and Allied Research*, 2(2), 229–237.
- Kareem, A. A. (2015). Effects of Computer-assisted instruction on students' academic achievement and attitude in biology in Osun State, Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies*, 6(1), 69–73.
- Komalaye, F. (2016). Reinforcing psychomotor skill of clothing and textile teachers in Nigerian Secondary School. *Multidisciplinary Journal of Research Development*, 25(1), 1–7.
- Laili, I. (2019). Efektivitas pengembangan e-modul project based learning pada mata pelajaran instalasi motor listrik. *Jurnal Ilmiah Pendidikan Dan Pembelajaran*, 3(3), 306–315.
- Liu, H. (2019). Barriers of project-based learning in teaching and learning of Chinese technical and vocational education and training (TVET): a review. *TVET@ Asia*, 12(1).
- Megayanti, T., Busono, T., & Maknun, J. (2020). Project-based learning efficacy in vocational education: A literature review. *IOP Conference Series: Materials Science and Engineering*, 830(4), 42075.
- Meier, R. M., & Hendel, S. A. (2019). A project-based learning unit plan: An inquiry into frogs. *Open Journal of Social Sciences*, 7(11), 70–78.
- Mutia, T., & Suprihatin, S. E. Y. (2020). Pengembangan Media Video Pembelajaran Pembuatan Pola Kemeja Lengan Panjang Dengan CAD Untuk Siswa Kelas XI SMK Tata Busana. *Jurnal Fesyen: Pendidikan Dan Teknologi*, 9(1).
- Nascimento, L., Correia, M. F., & O'Sullivan, G. (2024). The upside of teachers' technostress: Adaptation and validation of a techno-eustress scale. *International Journal of Instruction*, 17(4), 1-18.
- Ningsih, M. P., & Ruhidayati, C. (2019, February). The analysis of needs for e-job sheet development on children's attire based on tutorial model. *5th UPI International Conference on Technical and Vocational Education and Training (ICTVET 2018)* (pp. 389-391). Atlantis Press.
- Ningtyas, R. K., & Jati, H. (2018). Project-Based Electronic Module Development As A Supporting Learning Media For Basic Programming Learning. *Journal of Educational Science and Technology*, 4(3), 221–227.
- Noviani, R., & Widarwati, S. (2019). Penerapan Model Pembelajaran Project Based Learning Untuk Meningkatkan Kemampuan Pembuatan Pola Badan Sistem Soen Siswa Kelas X Busana 2 Smk Negeri 2 Godean. *Jurnal Fesyen: Pendidikan Dan Teknologi*, 8(2).
- Nuraini, & Muliawan, W. (2020). Development of Science Learning with Project Based Learning on Science Process Skill : A Needs Analysis Study. *Journal of Physics: Conference Series*, 1539(1), 1–5.

- Oksa, S., & Soenarto, S. (2020). Pengembangan e-modul berbasis proyek untuk memotivasi belajar siswa sekolah kejuruan. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 4(1), 99–111.
- Onyeazor, U. C. (2019). *Development of software package for teaching pattern drafting skills in tertiary institutions in South East Nigeria* [Thesis, University of Nigeria Nsukka].
- Persa, P., Putra, R. W. Y., & Komikesari, H. (2023). Pengembangan E-Modul Interaktif Menggunakan Berbasis Microsoft Office Sway Untuk Meningkatkan Pemahaman Konsep Peserta Didik. *Jurnal Pendidikan Indonesia Didaktika*, 1(1).
- Puspitarini, Y. D., & Hanif, M. (2019). Using Learning Media to Increase Learning Motivation in Elementary School. *Anatolian Journal of Education*, 4(2), 53-60.
- Puspitasari, A. D. (2019). Penerapan media pembelajaran fisika menggunakan modul cetak dan modul elektronik pada siswa SMA. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, 7(1), 17–25.
- Phulpoto, S. A. J., Oad, L., & Imran, M. (2024). Enhancing Teacher Performance in E-Learning: Addressing Barriers and Promoting Sustainable Education in Public Universities of Pakistan. *Pakistan Languages and Humanities Review*, 8(1), 418-429.
- Rahmawati, Y. (2023). Efektifitas Penggunaan E-Modul Berbasis Project Based Learning Terhadap Kompetensi Peserta Didik Pada Kurikulum Merdeka Belajar. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, 4(1), 293–300.
- Rahmi, L. (2019). Perancangan e-module perakitan dan instalasi personal komputer sebagai media pembelajaran siswa SMK. *Ta'dib*, 21(2), 105–112.
- Rahim, F. R., Sari, S. Y., Sundari, P. D., Aulia, F., & Fauza, N. (2022). Interactive design of physics learning media: The role of teachers and students in a teaching innovation. *Journal of Physics: Conference Series* (2309), No. 1, p. 012075). IOP Publishing.
- Robinson, J. K. (2013). *Project-based learning: improving student engagement and performance in the laboratory*. Springer.
- Romayanti, C., Sundaryono, A., & Handayani, D. (2020). Pengembangan e-modul kimia berbasis kemampuan berpikir kreatif dengan menggunakan Kvisoft Flipbook Maker. *Alotrop*, 4(1).
- Rodrigues, A. L. (2020). Digital technologies integration in teacher education: the active teacher training model. *Journal of E-learning and Knowledge Society*, 16(3), 24-33.
- Rusmanto, R., & Rukun, K. (2020). The Development of E-Learning Module Based on Project-Based Learning (PjBL) for Electric Motor Installation Course. *Journal of Education Research and Evaluation*, 4(2), 181–193.
- Rita, A. A. (2021). *Understanding the basic dress foundation of pattern making: A Complete study of darting and fitting of the garment*.
- Sawitri, E. (2023). *Pengembangan Sintaks Pembelajaran Pola Berbasis CAD untuk Meningkatkan Hasil Belajar Siswa pada Mata Pelajaran Pembuatan Busana Industri* [Doctoral Dissertation, Universitas Sebelas Maret].
- Shin, M.-H. (2018). Effects of Project-Based Learning on Students' Motivation and Self-Efficacy. *English Teaching*, 73(1), 95–114.
- Siregar, A. D., & Harahap, L. K. (2020). Pengembangan e-modul berbasis project based learning terintegrasi media komputasi hyperchem pada materi bentuk molekul. *JPPS (Jurnal Penelitian Pendidikan Sains)*, 10(1), 1925–1931.
- Sindisiwe, D., Felisia, C., & Chipso, C. (2024). An Analysis of the Textile Technology and Design Subject Operations for Secondary Schools in Zimbabwe. *Chitrolekha Journal*, 8(1).
- Sugiyono, D. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D*.
- Shuhailo, Y. V., & Derkach, T. M. (2021). Project-based learning for undergraduate engineering students minoring in textile technology and design. *Journal of Physics: Conference Series*, 1840(1), 12042.
- Shrestha, S., Dahlke, S., Butler, J. I., Hunter, K., Fox, M. T., Davidson, S., ... & Moody, E. (2024). Nursing Students' Perceptions on a Pain Management E-Learning Module: An Exploratory Quantitative Study. *Pain Management Nursing*, 25(2), e138-e143.

- Stumbrienė, D., Jevsikova, T., & Kontvainė, V. (2024). Key factors influencing teachers' motivation to transfer technology-enabled educational innovation. *Education and Information Technologies*, 29(2), 1697-1731.
- Souza, M., Moreira, R., & Figueiredo, E. (2019). Students' perception on the use of project-based learning in software engineering education. *Proceedings of the XXXIII Brazilian Symposium on Software Engineering*, 537–546.
- Tantawy, R. R., Muhammad, K., Farghaly, S. T., Alaswad, M. H., Fiad, N. S., & Hassabo, A. G. (2024). Advancements in 3d digital technology for virtual fashion design and education. *Journal of Textiles, Coloration and Polymer Science*.
- Ugwu, E. I., Ezeaku, M. N., Attah, B. I., Emeghebo, U. M., & Eze, E. C. (2023). Application of computer-aided design (CAD) and flat techniques in teaching pattern drafting by clothing lecturers in universities in South East Nigeria. *International Journal of Home Economics, Hospitality and Allied Research*, 2(1), 29–43.
- van Beurden, J., Borghouts, I., van den Groenendaal, S. M., & Freese, C. (2024). How Dutch higher HRM education prepares future HR professionals for the impact of technological developments. *The International Journal of Management Education*, 22(1), 100916.
- Widiana, F. H., & Rosy, B. (2021). Pengembangan e-modul berbasis flipbook maker pada mata pelajaran teknologi perkantoran. *Edukatif: Jurnal Ilmu Pendidikan*, 3(6), 3728–3739.
- Widya, W., Yusmanila, Y., Zaturrahmi, Z., & Ikhwan, K. (2022). Praktikalitas E-Module Berbasis Model Creative Problem Solving (CPS) untuk Materi Fluida Dinamis Terintegrasi Keterampilan Abad 21. *Edukatif: Jurnal Ilmu Pendidikan*, 4(4), 5700–5707.
- Winatha, K. R. (2018). Pengembangan e-modul interaktif berbasis proyek mata pelajaran simulasi digital. *Jurnal Pendidikan Teknologi Dan Kejuruan*, 15(2).
- Wulansari, E. W., Kantun, S., & Suharso, P. (2018). Pengembangan e-modul pembelajaran ekonomi materi pasar modal untuk siswa kelas XI IPS MAN 1 Jember tahun ajaran 2016/2017. *JURNAL PENDIDIKAN EKONOMI: Jurnal Ilmiah Ilmu Pendidikan, Ilmu Ekonomi Dan Ilmu Sosial*, 12(1), 1–7.
- Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M., & Loyens, S. M. (2024). The effects of problem-based, project-based, and case-based learning on students' motivation: A meta-analysis. *Educational Psychology Review*, 36(1), 29.