JURNAL ABSIS
Jurnal Pendidikan Matematika dan Matematika
Vol. 8 No. 3, December 2025

PJBL-STEAM IMPLEMENTATION: CHALLENGES FOR PROSPECTIVE MATHEMATICS TEACHERS IN DEVELOPING ANDROID LEARNING MEDIA

Muh. Khaedir Lutfi[1], Fitri Anisa Kusumastuti[2], Nadya Amalia Juana[3], Ade Lukman Nulhakim[4], Ayathollah Khomeni[5], Roslian Lubis[6], Eka Santika[7]
[1-4,7] Universitas Tangerang Raya, Indonesia
[5,6] Institut Pendidikan Tapanuli Selatan
muh.khaedir.lutfi@gmail.com

ABSTRACT Technological developments demand adaptation in the world of education, particularly in the integration of technology into mathematics learning. Prospective student teachers need to possess the competencies to create innovative learning media that are not only content-accurate but also visually and technologically engaging. This study aims to describe the implementation of the Project-Based Learning (PjBL) model with STEAM (Science, Technology, Engineering, Art, and Mathematics) content in producing Android-based mathematics learning media. The method used was descriptive qualitative through triangulation of observation data, discussions, and analysis of the output product. The research subjects were 16 Mathematics Education students taking the IT-Based Mathematics Learning Media course in semester VI. The results showed that PjBL facilitated students in practicing the engineering cycle of media creation. However, obstacles were encountered in the Technology and Mathematics elements, where students experienced difficulty transforming textbook content into the system logic of an Android application. Furthermore, technical barriers to mastery of tools (Technology) such as iSpring Suite were a major challenge. Nevertheless, this approach successfully encouraged students to integrate art elements into interface design and mathematical logic within a single, integrated product. It was concluded that the implementation of PjBL with a STEAM framework effectively helped lecturers and students produce usable digital media products.

Keywords: android, learning media, project-based learning, prospective mathematics teachers, STEAM

ABSTRAK Perkembangan teknologi menuntut adanya adaptasi dalam dunia pendidikan, khususnya dalam integrasi teknologi ke dalam pembelajaran matematika. Calon guru matematika dituntut untuk memiliki kompetensi dalam mengembangkan media pembelajaran inovatif yang tidak hanya akurat secara konten, tetapi juga menarik secara

visual dan fungsional secara teknologi. Penelitian ini bertujuan untuk mendeskripsikan implementasi model *Project-Based Learning* (PjBL) bermuatan STEAM (*Science, Technology, Engineering, Art, and Mathematics*) dalam menghasilkan media pembelajaran matematika berbasis Android. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan teknik triangulasi melalui data observasi, diskusi, dan analisis terhadap produk media yang dihasilkan. Subjek penelitian terdiri atas 16 mahasiswa Program Studi Pendidikan Matematika yang mengikuti mata kuliah Media Pembelajaran Matematika Berbasis Teknologi Informasi pada semester VI. Hasil penelitian menunjukkan bahwa penerapan PjBL mampu memfasilitasi mahasiswa dalam mempraktikkan *engineering cycle* pada proses pengembangan media pembelajaran. Namun demikian, ditemukan beberapa kendala pada aspek *Technology* dan *Mathematics*, khususnya kesulitan mahasiswa dalam mentransformasikan materi buku teks ke dalam logika sistem aplikasi Android. Selain itu, keterbatasan penguasaan perangkat lunak pendukung, seperti *iSpring Suite*, menjadi hambatan teknis yang cukup signifikan. Meskipun demikian, pendekatan ini terbukti mampu mendorong mahasiswa untuk mengintegrasikan unsur seni dalam desain antarmuka serta logika matematika ke dalam satu produk media digital yang terpadu. Dengan demikian, dapat disimpulkan bahwa implementasi model PjBL berbasis kerangka STEAM efektif dalam membantu dosen dan mahasiswa menghasilkan produk media pembelajaran digital yang layak dan dapat digunakan.

Kata-kata kunci: Android, media pembelajaran, *project-based learning*, calon guru matematika, STEAM.

INTRODUCTION

The integration of technology in mathematics education is no longer merely an option, but rather a necessity to create a learning ecosystem relevant to the digital generation. Among the various technologies available, Android-based mobile devices have become the most dominant platform among students (Santos, 2017). This potential has driven a paradigm shift in the use of learning media, from static media to interactive multimedia capable of dynamically visualizing abstract mathematical concepts (Rolfes et al., 2020). Interactive multimedia has been proven to increase student cognitive engagement and facilitate the understanding of complex concepts through engaging visual representations (Agisni et al., 2023).

In line with these developments, the competency profile of prospective mathematics teachers in the Industrial Revolution 4.0 era has also changed. Prospective teachers are no longer limited to merely possessing pedagogical skills and content knowledge, they must also possess robust technological literacy. They are required to transform from mere technology consumers to technology creators capable of developing independent learning media. Therefore, the curriculum at Teacher Training Institutions (LPTK) needs to design courses that facilitate this role transition, one example of which is through courses on IT-based learning media development.

However, the reality on the ground shows that efforts to produce "creative teachers" face multidimensional challenges. Prospective teachers often experience a knowledge gap between their understanding of mathematics material and their

https://doi.org/10.30606/absis.v8i3.4066

technical programming skills (Broley et al., 2023; Lutfi & Kusumastuti, 2024). Developing Android applications requires mastery of technical authoring tools, aesthetically pleasing user interface design, and accurate pedagogical content. A study by Dockendorff & Zaccarelli, (2025) and Lee et al. (2023) highlighted that many prospective teachers struggle to translate pedagogical objectives into technological features, resulting in products often experiencing technical malfunctions or distorting mathematical concepts themselves.

Although the Project-Based Learning (PjBL) model has been widely recognized as effective in developing practical and collaborative skills (Rohmaniyah & Asih, 2024), pure PjBL implementation is often insufficient to address the complexities of digital application development. This is where a research gap lies that needs to be filled. Most previous research has focused solely on the validity of the final media product or its impact on school students, but there has been little in-depth study of the engineering process and the dynamics of the challenges faced by prospective teachers during the development process. How prospective teachers simultaneously "survive" system errors, design visuals, and maintain mathematical accuracy remains a black box that needs to be explored.

To address these complex challenges, PjBL needs to be strengthened with an interdisciplinary STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach. STEAM offers a holistic framework in which application development is viewed as an engineering process that integrates technology, design arts, and content (Mathematics) (Thang & Tho, 2024; Yun et al., 2024). The integration of PjBL-STEAM not only requires students to complete projects but also trains them in computational thinking and design aesthetics as a holistic competency for future teachers.

This research makes an important contribution to the literature on mathematics teacher education by offering a new perspective on learning media courses. It serves not simply as technical software training but as an incubator of STEAM skills. It also provides practical insights for educators at LPTK (Teachers' Training Institutions) regarding the crucial points where students require specific scaffolding, both technically and content-wise, when developing Android-based media.

Based on this background, this study aims to describe the implementation of the PjBL model with STEAM content in the IT-Based Mathematics Learning Media course. The main focus of the study is to analyze how the PjBL-STEAM stages help student teachers navigate technical and pedagogical obstacles to produce valid and innovative Android-based mathematics learning media outputs.

METHODS

This research employed a qualitative approach with descriptive methods. This design was chosen to in-depth explore phenomena occurring during the lecture process, specifically the dynamics of student experiences, technical challenges, and problem-

solving strategies in developing Android-based mathematics learning media. The descriptive approach was used to provide a factual overview of the implementation of the Project-Based Learning (PjBL) model, which incorporates STEAM (Science, Technology, Engineering, Arts, and Mathematics) elements.

The research subjects were 16 Mathematics Education students taking the IT-Based Mathematics Learning Media course in semester VI. Subject selection was based on purposive sampling, including students actively involved in all stages of the Android application development project, from design to the final product.

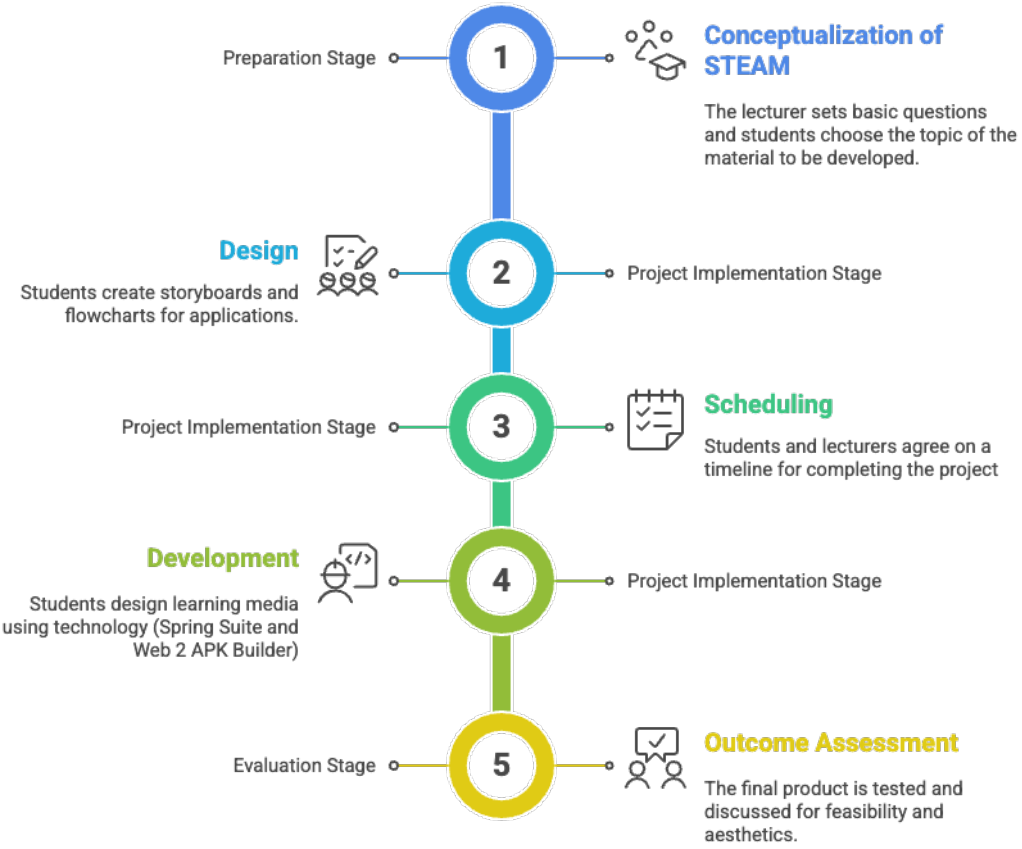


Figure 1. PjBL-STEAM Research Procedure

The research procedure adopted the Project-Based Learning (PjBL) model syntax based on Figure 1, from defining fundamental questions to evaluating the experience. In the initial phase, the lecturer posed a provocative question (Start with the Essential Question) regarding the urgency of digital media innovation, which students then responded to through the project planning phase (Design a Plan). In this planning phase, students identified a specific mathematics topic (Mathematics) and explored the context of a real-world problem or science (Science) that would be integrated into the media material. Once the topic was agreed upon, the students and the lecturer developed a project completion schedule (Create a Schedule) to ensure the media development targets were met on time.

https://doi.org/10.30606/absis.v8i3.4066

The next phase was implementation and monitoring (Monitor the Students and the Progress), which is the core of the STEAM activities in this research. Students began the systems engineering process (Engineering) by creating a storyboard and flowchart for the application, while designing a user interface (User Interface) that took into account aesthetic principles and visual communication (Arts). This conceptual design was then constructed into a concrete application using software such as iSpring Suite and Web 2 APK Builder, representing the strengthening of technological literacy (Technology). During the construction process, researchers conducted intensive participant observation to record the dynamics that occurred, including technical challenges (debugging) and strategies employed by students in solving programming problems.

The series of procedures concluded with the Assess the Outcome and Evaluate the Experience stages. At this stage, the resulting Android-based learning media product was tested to assess the feasibility of navigation functions, system responsiveness, and the accuracy of the content. The activity concluded with a reflective discussion between the lecturer and students to evaluate the overall learning process, identify key obstacles encountered during technology integration, and formulate suggestions for improvements for future media development.

Data collection was conducted using triangulation techniques, including participant observation, interviews, and documentation. Observations focused on directly observing student activities during the media engineering process, particularly when they interacted with the software (Technology) and developed system logic (Engineering). Furthermore, discussions and in-depth interviews were conducted to explore students' perceptions of the pedagogical challenges faced in transforming textbook material into digital content. As a complement, a documentation study was conducted by collecting project artifacts in the form of storyboards and application files (.apk) to analyze the quality of the integration of mathematical content (Mathematics) and visual design (Arts) in the final product.

Data analysis adopted the interactive model of (Miles et al., 2018), which consists of data reduction, data presentation, and conclusion drawing. In the reduction stage, raw field data was sorted and categorized based on STEAM component indicators, separating technical programming challenges from material mastery challenges. The structured data was then presented in a descriptive narrative supported by tabular visualizations and screenshots of student product progress. The final stage involved drawing conclusions to synthesize the effectiveness of the PjBL implementation in facilitating student teachers in producing valid Android-based learning media.

FINDING AND DISCUSSION

This research was conducted using the Project-Based Learning (PjBL) model in the IT-Based Mathematics Learning Media course. The data presented below are the results of observations, product documentation, and identification of obstacles during one semester (14 meetings).

Description of PjBL Implementation Stages

The learning implementation follows the six-step PjBL syntax that integrates the use of technology in the development of mathematics media. The process begins with an apperception regarding the urgency of transforming learning media in the digital era. Based on observation data, students respond by identifying the need for interactive media. At this stage, students select a mathematics topic to be developed. The topics selected include Geometry (Spatial and Planar Shapes), Algebra, and Basic Statistics. Topic selection is based on the level of difficulty of the material when taught without the aid of visualization.

In next stage, students develop a media design that encompasses two main aspects namely, students map the material from the textbook into a storyboard and prepare supporting software, namely Microsoft PowerPoint for interface design, iSpring Suite for conversion to HTML5 format, and Web 2 APK Builder for creating Android applications (.apk). Students also create a flowchart to define the application's navigation logic, from the main menu to the evaluation.

A project timeline is agreed upon, divided into two main terms, first one is seven initial meetings (pre-midterm exam), focus on finalizing the visual design and materials in PowerPoint format. And second one is 7 Final meetings (post-midterm exam), focus on technical conversion (HTML5 to APK), debugging, and finalizing the product.

Next stage is the production phase. Students translated their flowchart designs into tangible products. Based on lecturer monitoring, the activity was dominated by laptop use to design interactive slides and configure hyperlinks. Lecturers provided intensive guidance, especially as students progressed to the stage of using iSpring Suite and Web 2 APK Builder, which require specific technical specifications.

The final product was an application file with the .apk extension. Each student presented their work to the class. During this session, functional testing was conducted to ensure navigation buttons functioned, videos or animations ran smoothly, and quiz scores appeared automatically.

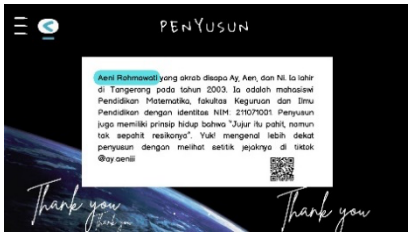
The final stage involved a reflective discussion. Students and lecturers evaluated the challenges encountered and provided feedback for improvements. Revisions were primarily focused on text readability (font size) and background color consistency.

Characteristics of Android Learning Media Products

The primary output of this research is an Android-based mathematics learning media application that can be installed on smartphones. In general, the structure of the media developed by students has uniform navigation characteristics, as presented in Table 1.

https://doi.org/10.30606/absis.v8i3.4066

Table 1. Description of Android-Based Mathematics Learning Media Outputs

Display	Mathematics Learning Media Display	Function Description
Home		Displays the media title, developer identity, and a "Mulai" button to access the main menu.
Main Menu		A navigation center connects users to all application features (Core Competencies, Materials, Videos, Quizzes).
Instructions		Contains icon and button function guides so users can operate the application independently.
Materials		Presents concise content on selected mathematics topics (text, images, and animations).
Evaluation/Quiz		Interactive features include multiple-choice questions or essays that provide immediate scoring feedback.
Profile		Displays student biodata as a media developer.

Identification of Obstacles in the Development Process

During the implementation of the PjBL (Project-Based Learning) program, several obstacles were encountered by students, both technical and pedagogical. Data on these obstacles was summarized based on field observations and interviews, as presented in Table 2.

Table 2. Summary of Student Obstacles in Media Development

Obstacle Categories	Types of Issues Encountered	Frequency of Findings
Technical (Technology)	Microsoft Office version incompatibility with iSpring Suite (iSpring menu not appearing). Failure to build (convert) from HTML5 to APK because the Java Development Kit (JDK) is not installed. Image/video file sizes are too large, causing the application to lag.	High
Content (Mathematics)	Difficulty summarizing lengthy textbook material into limited mobile slides. Mathematical symbols (equations) are sometimes messy when converted to mobile format.	Moderate
Design (Arts)	Poor contrast between background and text color combinations (difficult to read). Navigation buttons (hyperlinks) are too small or obscured by other elements.	Moderate

Technical challenges, particularly related to iSpring Suite installation, were the most significant obstacle. This was addressed through a peer-tutoring strategy, where students who successfully installed the software assisted their peers or borrowed compatible devices. Meanwhile, content and design challenges were addressed through an iterative revision process based on instructor feedback during the monitoring phase.

Based on the description of the process and product output above, it is clear that developing Android-based media poses unique challenges for prospective teachers. The data will then be analyzed using a STEAM perspective to understand how students navigate both technical and pedagogical aspects simultaneously. The following discussion outlines a synthesis of field findings with relevant theory.

This study aims to describe the implementation of a STEAM-based PjBL model in developing Android-based mathematics learning media. Based on the research

https://doi.org/10.30606/absis.v8i3.4066

results, the PjBL implementation not only functions as a project management framework but also as an incubator for students' techno-pedagogical competencies.

Dynamics of the Engineering Process in Mathematics Learning

Research findings indicate that the PjBL stages, particularly the design and implementation phases, effectively facilitate students' practice of the Engineering Design Process (EDP) cycle. The activity of creating flowcharts and storyboards is not merely an administrative activity, but rather a simultaneous manifestation of the Engineering and Mathematics components. Students are required to translate abstract mathematical logic into systematic application algorithmic logic.

This aligns with the view of Nurhamidah & Nurachadijat (2023) and Zhou (2023), who stated that PjBL encourages student independence and responsibility in designing solutions. In this context, the designed solutions serve as digital bridges for school students to understand mathematics. The students' iterative revisions when developing the application's navigation flow demonstrate a process of critical and reflective thinking, where they continually test the validity of the navigation logic to ensure user-friendliness. This integration demonstrates that the STEAM approach in PjBL can transform a theoretical mathematics classroom into a creative production space.

Technological Literacy Gap and Pedagogical Challenges

Although the final product was successfully created, an analysis of the field challenges (Table 2) revealed important facts regarding the technological readiness of prospective teachers. The predominance of technical challenges, such as difficulties installing the Java Development Kit (JDK) and iSpring Suite incompatibility, indicates that the prospective teachers' technological literacy remains at the operator level, not yet reaching the developer level.

This phenomenon confirms the study by Kaur (2023), Kusumastuti et al. (2025), Mat Yamin et al. (2023), which stated that although students are aware of the importance of ICT, their technical skills in using authoring tools are still limited. Beyond technical aspects, the biggest challenge in the Mathematics element is didactic transposition. Students struggle to transform static, text-heavy textbook material into concise visual content. This challenge is relevant to the findings of Darsih et al. (2025) and Yang et al. (2024) that prospective teachers often face pedagogical barriers when integrating technology, they know what to teach, but are unsure how to present it in a digital format without compromising the essence of the material.

The naturally emerging peer-tutoring strategy that emerges when overcoming technical challenges demonstrates that PjBL successfully creates a collaborative learning environment (Kim, 2024). More technically proficient students assist their peers, creating a communal learning ecosystem that complements individual competency gaps.

Identity Transformation: From Consumer to Media Creator

The students' success in producing an application with the .apk extension marks a significant achievement in the Arts and Technology elements. The resulting media product boasts interactivity advantages not found in conventional media, such as immediate feedback on the quiz feature. The presence of visual elements, button layout, and color composition in the application demonstrate the integration of Arts elements, which serve to reduce student anxiety about mathematics, which is often perceived as rigid.

The use of interactive media has the potential to increase student engagement and visualize abstract concepts, as stated by (Haerawan et al. (2024), Lutfi et al. (2023), and Wooten (2020). Furthermore, the ups and downs of developing this application have an impact on the formation of students' professional identities. Through PjBL-STEAM, students no longer see themselves merely as transmitters of knowledge, but as designers of learning experiences. This role transformation is crucial for preparing adaptive mathematics teachers to face the demands of future curricula (Makamure, 2025).

CONCLUSIONS AND RECOMMENDATIONS

This study presents the implementation of a STEAM-based Project-Based Learning (PjBL) model that effectively facilitates student mathematics teachers in developing Android-based learning media. Specifically, this approach successfully transforms students' roles from mere technology consumers to digital media creators. The integration of STEAM elements is evident in students' ability to apply the engineering cycle (Engineering) in designing application flows, balancing visual aesthetics (Arts) with navigation functions, and transforming material content (Mathematics) into a mobile format.

However, this study also uncovers fundamental challenges related to students' technological literacy readiness. It was found that technical mastery of software (authoring tools) remains the biggest obstacle compared to mastery of the mathematics material itself. The constraints of software incompatibility (Technology) and the difficulty of transposing didactic materials from textbooks to digital media indicate that teacher education curricula need to place greater emphasis on strengthening practical, rather than theoretical, technopedagogical aspects (TPACK).

ACKNOWLEDGMENT

The authors would like to thank Universitas Tangerang Raya, the host institution, for facilitating this research. They also appreciate the collaborative support from Institut Pendidikan Tapanuli Selatan in the data analysis and validation process. Special appreciation is extended to the prospective mathematics teacher students who

https://doi.org/10.30606/absis.v8i3.4066

demonstrated high dedication in completing the Android-based media development project.

REFERENCES

Agisni, A., Novari, D., Leander, G., Prawirawan, B. U., & Pohan, A. H. (2023). The effectiveness of multimedia learning: A study on student learning. Priviet Social Sciences Journal, 3(7). https://doi.org/10.55942/pssj.v3i7.215

Broley, L., Buteau, C., & Sardella, J. (2023). When preservice and inservice teachers join forces: A collaborative way to support the enactment of new coding curricula in mathematics classrooms. Journal of Pedagogical Research. https://doi.org/10.33902/jpr.202318636

Darsih, E., Agustiana, V., Hanggara, A., & Palmer, R. (2025). Insights on TPACK implementation by preservice English teachers: Challenges and solutions. Script Journal Journal of Linguistic and English Teaching, 10(1), 68–93. https://doi.org/10.24903/sj.v10i1.2000

Dockendorff, M., & Zaccarelli, F. G. (2025). Successfully preparing future mathematics teachers for digital technology integration: a literature review. International Journal of Mathematical Education in Science and Technology, 56(5), 948–979. https://doi.org/10.1080/0020739x.2024.2309273

Haerawan, H., Cale, W., & Barroso, U. (2024). The effectiveness of interactive videos in increasing student engagement in online learning. Journal of Computer Science Advancements, 2(5), 244–258. https://doi.org/10.70177/jsca.v2i5.1322

Kaur, K. (2023). Teaching and learning with ICT tools: Issues and challenges. International Journal on Cybernetics & Informatics, 12(3), 15–22. https://doi.org/10.5121/ijci.2023.120302

Kim, H.-J. (2024). Challenges and strategies for peer assessment in project-based learning. The Korea English Language Testing Association, 19(2), 11–30. https://doi.org/10.37244/ela.2024.19.2.11

Kusumastuti, F. A., Lutfi, M. K., & Junaedi, Y. (2025). Analisis Literasi Matematis Siswa dalam Pembelajaran Berbasis TPACK Berbantuan Media E-learning. Wilangan: Jurnal Inovasi Dan Riset Pendidikan Matematika, 6(1).

Lee, S. H., Kim, Y., Park, C., & Lee, K.-H. (2023). Difficulties of teachers in designing and implementing instruction using authoring tools for mathematics and science education: From the perspective of TPACK. Korean Association For Learner-Centered Curriculum And Instruction, 23(24), 585–601. https://doi.org/10.22251/jlcci.2023.23.24.585

Lutfi, M. K., Kusumastuti, F. A., Akib, I., & Rohmawati, A. (2023). Media E-Learning Bangun Ruang Sisi Datar: Kelayakan pada Pembelajaran Daring. Edu Komputika Journal, 9(2), 78–87. https://doi.org/10.15294/edukomputika.v9i2.54743

Lutfi, Muh. K., & Kusumastuti, F. A. (2024). Integrasi Augmented Reality berbantuan Geogebra sebagai Media Pembelajaran Interaktif dalam Pembelajaran Materi Bangun Ruang. Social, Humanities, and Educational Studies (SHES), 7(3).

Makamure, C. (2025). Project-based learning (PBL) for professional development of mathematics educators: Unlocking opportunities and navigating pitfalls and considerations. In Education and Human Development. IntechOpen. https://doi.org/10.5772/intechopen.1009552

Mat Yamin, F., Wan Ishak, W. H., & Husin, A. (2023). Assessing student ICT knowledge through survey and hands-on task. Data Science Insights, 1(1), 1–7. https://doi.org/10.63017/jdsi.v1i1.2

Yun, H., Zhang, Q., Chen, Y., & Chau, W. N. (2024). Incorporating mathematics into STEAM project-based learning activity: A pedagogical model. The Korean Society of Educational Studies in Mathematics - Journal of Educational Research in Mathematics, 34(4), 889–910. https://doi.org/10.29275/jerm.2024.34.4.889

Miles, M. B., Huberman, A. M., & Saldana, J. (2018). Qualitative Data Analysis: A Methods Sourcebook (4th ed.). Sage.

Nurhamidah, S., & Nurachadijat, K. (2023). Project Based Learning dalam Meningkatkan Kemandirian Belajar Siswa. Jurnal Inovasi, Evaluasi Dan Pengembangan Pembelajaran (JIEPP), 3(2), 42–50. https://doi.org/10.54371/jiepp.v3i2.272

Rohmaniyah, N., & Asih, S. W. (2024). Project-Based Learning design in secondary schools: Enhancing students' collaborative and creative skills. International Journal of Post Axial: Futuristic Teaching and Learning, 274–287. https://doi.org/10.59944/postaxial.v2i4.395

Rolfes, T., Roth, J., & Schnotz, W. (2020). Learning the concept of function with dynamic visualizations. Frontiers in Psychology, 11, 693. https://doi.org/10.3389/fpsyg.2020.00693

Santos, I. M. (2017). Using students' personal mobile devices in higher education. In Art and Technology (pp. 59–75). SensePublishers. https://doi.org/10.1007/978-94-6300-863-1_4

Thang, N.-M., & Tho, P.-D. (2024). Math learning application on mobile devices following the STEAM educational model. International Conference on Computers in Education. https://doi.org/10.58459/icce.2024.4977

https://doi.org/10.30606/absis.v8i3.4066

Wooten, J. J. (2020). Integrating discussion and digital media to increase classroom interaction. International Review of Economics Education, 33(100174), 100174. https://doi.org/10.1016/j.iree.2020.100174

Yang, T., Cheon, J., & Park, E. (2024). Investigating which challenges considered by pre-service teachers are reflected with their technology integration self-efficacy. The Journal of Applied Instructional Design. https://doi.org/10.59668/1269.15648

Zhou, C. (2023). The impact of the project-based learning method on students. BCP Education & Psychology, 9, 20–25. https://doi.org/10.54691/bcpep.v9i.4603