

Development of a Student-Centered Digital Mathematics Learning Prototype Using the ADDIE Model to Improve Conceptual Understanding

Ita Margaretta Br Tarigan^{1)*}

¹⁾Teknik Informatika, Institut Teknologi dan Bisnis Indonesia, Deli Serdang, Sumatera Utara, Indonesia

¹⁾itamargaretta1997@gmail.com

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Abstract: Mathematics learning in higher education still faces challenges in the form of low student conceptual understanding due to the dominance of procedural approaches and the suboptimal use of digital technology. Furthermore, there are still gaps in the development of structured, student-centered, and integrated learning designs in the form of prototype-based digital learning systems. This research aims to develop a student-centered digital mathematics learning prototype using the ADDIE model to improve conceptual understanding. This research employed a Research and Development (R&D) method with Analysis and Design stages. The results are a learning prototype design that includes learning objectives, material structure, student-centered learning strategies, digital media, student activities, and an evaluation system. The prototype is designed to support concept visualization, learning interactions, and exploration and problem-solving activities. The results indicate that the developed prototype has the potential to systematically and interactively improve the effectiveness of mathematics learning. In conclusion, this prototype can serve as the basis for developing innovative digital mathematics learning. The novelty of this research lies in the integration of the ADDIE model with a student-centered approach in the design of a comprehensive digital learning prototype.

Keywords: Digital Prototype; ADDIE; Mathematics Learning; Student-Centered; Conceptual Understanding.

INTRODUCTION

Mathematics plays a fundamental role in the development of science, technology, and modern society. In higher education, mathematics learning is expected not only to develop procedural skills but also to foster students' conceptual understanding, critical thinking, and problem-solving abilities. These competencies are essential in addressing complex challenges in the digital era. However, in practice, mathematics learning at the university level often remains dominated by procedural approaches, where students are able to perform calculations but lack a deep understanding of underlying concepts (Tarigan et al., 2024). This condition indicates a misalignment between expected learning outcomes and the actual learning process, particularly in developing higher-order thinking skills.

The rapid advancement of information and communication technology has significantly transformed educational practices, shifting the paradigm from teacher-centered learning to student-centered learning (Tarigan et al., 2022). This transformation emphasizes active student engagement in constructing knowledge through exploration, discussion, and problem-solving. Digital technologies, such as simulations, animations, and interactive platforms, have been widely recognized for their potential to support the visualization of abstract mathematical concepts and enhance students' learning experiences (Swist et al., 2024). Furthermore, the integration of technology in education has been shown to improve students' digital literacy and learning outcomes, which are essential competencies in the context of the digital economy (Fawns et al., 2023).

Despite these advancements, the implementation of technology in mathematics learning still faces critical challenges. One major issue is the lack of systematic instructional design that effectively integrates technology with pedagogical and content knowledge. In many cases, digital tools are used merely as supplementary media

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rather than as integral components of the learning process. As a result, the potential of technology to enhance conceptual understanding and student engagement is not fully optimized (Gourlay et al., 2021). Additionally, conventional instructional practices continue to contribute to low levels of student participation and engagement, further limiting the effectiveness of learning (Anisa Ulva Wahyuni & Hasanuddin, 2025).

Although numerous studies have examined the use of digital technology in mathematics learning, most of them focus on specific aspects, such as the development of digital media, the implementation of particular learning models, or the evaluation of learning outcomes (I Gusti Agung Trisna Jayantika & Gaudensia Namur, 2022). However, there is still a limited number of studies that integrate these components into a comprehensive and systematic learning design. In particular, the development of a structured, student-centered digital learning prototype that combines instructional design, technology integration, and conceptual learning processes remains underexplored. Previous research tends to treat technology as an independent variable rather than embedding it within a holistic instructional framework. Therefore, there is a need for a research approach that not only utilizes technology but also systematically integrates it into a coherent learning design that supports conceptual understanding and active student engagement.

To address this gap, this study proposes the development of a mathematics learning design prototype using a systematic approach. A prototype serves as an initial model that allows the visualization, testing, and refinement of a learning design before its full implementation (Kaban et al., 2023). Through the prototyping process, lecturers can design learning more effectively by integrating key components such as learning objectives, content structure, instructional strategies, digital media, student activities, and evaluation systems into a unified framework. This approach also enables iterative improvements based on feedback, ensuring that the resulting design is both functional and pedagogically sound.

The novelty of this research lies in the integration of student-centered learning principles with digital technology within a structured prototype design framework. Unlike previous studies that focus on isolated elements, this research develops a comprehensive learning prototype that emphasizes conceptual understanding, interactive learning activities, and problem-solving processes supported by digital media. Furthermore, this study aligns with the demands of the Society 5.0 era, where education must not only transfer knowledge but also develop critical, adaptive, and technologically literate individuals,

Therefore, this research aims to develop a mathematics learning design prototype that is systematic, interactive, and technology-integrated to enhance students' conceptual understanding. The resulting prototype is expected to contribute to the development of more innovative, adaptive, and effective mathematics learning models in higher education. In addition, this study provides a practical framework for integrating technology into mathematics learning in a way that is pedagogically meaningful and aligned with the needs of modern education.

LITERATURE REVIEW

Developing a student-centered digital mathematics learning prototype is becoming an increasingly relevant approach to addressing learning needs in the digital age. Prototyping is the initial stage in learning system development, aiming to visualize the design before full implementation. This approach provides developers with the opportunity to test the system's structure, learning flow, and user interactions early on, allowing for early improvements. This aligns with research showing that the use of prototypes can improve the quality of system design by enabling evaluation early in development (Cevikbas et al., 2023). In addition, the prototyping approach is flexible and iterative so that it can adapt the design to user needs more optimally (Hafidz et al., 2024).

Compared to conventional approaches, the prototype method has advantages in terms of design visualization and validation. This approach tends to jump straight to the implementation stage without thorough design evaluation, potentially resulting in conventional systems that are less suited to user needs. In contrast, prototypes allow for early interaction between developers and users to understand the system being developed. Research shows that in the development of digital learning systems, particularly Learning Management Systems (LMS), the use of prototypes can improve the quality of user interactions and ensure the system's suitability to the needs of lecturers and students (Soomro et al., 2021). Thus, the prototype serves not only as an initial model, but also as a strategic design evaluation tool.

Several previous studies have confirmed that effective learning focuses not only on procedural skills but also on developing critical thinking, analytical skills, and problem-solving. The integration of technology into mathematics learning has been shown to increase students' motivation to learn and critical thinking skills (Salinas et al., 2023). Furthermore, the use of technology can also help students understand abstract mathematical concepts through clearer visualizations (Syafri et al., 2021). However, most previous studies still position technology as a learning aid, rather than an integral part of the learning design. Therefore, an approach that systematically integrates technology into the overall learning design is needed to improve students' conceptual understanding.

* Ita Margaretta Br Tarigan



The use of learning websites as a learning medium has also shown significant development. Learning websites allow students to access learning materials, activities, and evaluations flexibly, without the constraints of space and time. Research shows that using websites in learning can increase the effectiveness of the learning process because they can integrate various types of media, such as text, video, and interactive simulations (Sa'dijah et al., 2024)

In addition, learning websites can also increase student engagement through various interactive activities provided (Neef et al., 2024). Compared to traditional learning media, learning websites offer advantages in terms of accessibility and engagement. Furthermore, the use of a web-based LMS has also been shown to help lecturers manage learning more systematically, from delivering material to evaluating learning (Taufikurrahman et al., 2021).

Digital learning media utilizes digital technology to deliver learning materials more interactively. This media can take the form of learning applications, learning videos, interactive simulations, or web-based learning platforms. Research shows that the use of digital learning media can increase student motivation and learning outcomes in mathematics. Furthermore, digital learning media can also help students understand complex mathematical concepts through visualization and simulation (Perez et al., 2025). Several studies have shown that digital learning media can enhance students' creativity in solving mathematical problems. Furthermore, the use of digital learning media can also improve students' understanding of mathematical concepts and their motivation to learn. Therefore, the use of digital learning media is a crucial strategy for improving the quality of mathematics learning in the digital age.

Based on the explanation above, it can be concluded that although there has been a lot of research discussing learning prototypes, mathematics learning, learning websites, and digital media separately, there are still limitations in integrating all these components into a complete learning design. Most previous research tends to focus on a particular aspect without linking them comprehensively. Therefore, this study explains various concepts by developing a structured, student-centered, website-based digital mathematics learning prototype that optimally utilizes digital media. This integration is a novelty in this research that distinguishes it from previous research, particularly in presenting a learning design that is not only technologically innovative but also pedagogically robust.

METHOD

Research Type and Approach

This research uses a research and development (R&D) approach, which aims to produce a product in the form of a prototype mathematics learning design for students. The research and development approach was used because this research focuses not only on testing theory but also on the process of designing a learning model or product that can be used in academic activities. In educational research, development methods are often used to design innovative and systematic learning models, learning tools, and learning systems. Research and development allows researchers to carry out the design process in stages through needs analysis, design preparation, and development of a learning prototype.

Research and Development Model

The development model used in this research refers to the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. However, in this study, the development process only goes up to the design stage without conducting implementation and field evaluation. This is because the focus of the research is to produce a mathematics learning prototype design as a conceptual model that can be used as a basis for further learning development. The ADDIE model is one of the learning design models widely used in educational research because it has systematic and structured stages in developing a learning product. The research flow in developing a mathematics learning prototype can be described as follows:

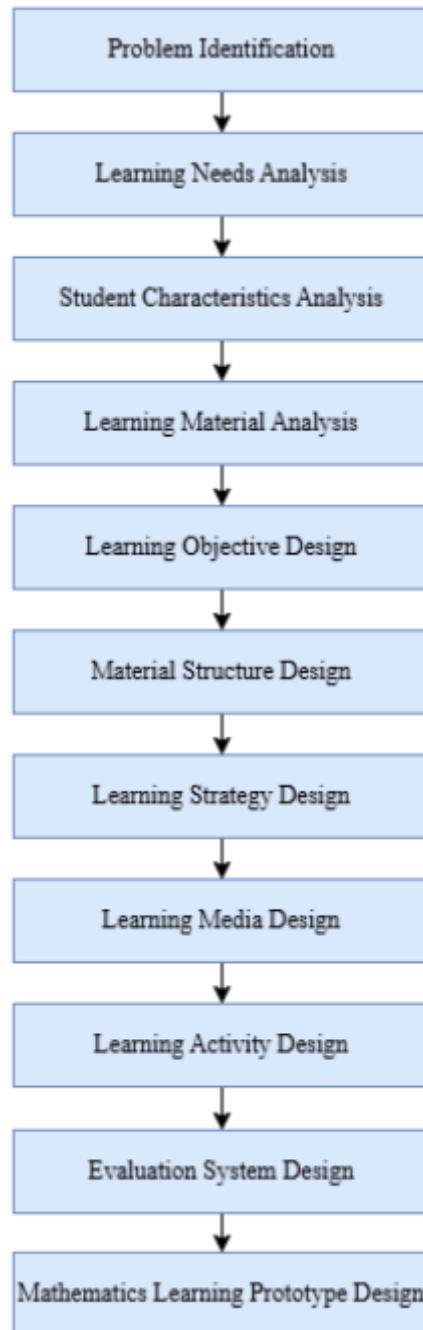


Fig 1. Research Flowchart

Analysis Stage

The analysis stage is the initial stage in the learning prototype development process. This stage identifies various aspects related to mathematics learning in higher education. This analysis aims to identify learning needs and any problems that arise in the mathematics learning process. Some activities carried out in the analysis stage include:

a. Learning Needs Analysis

This analysis is conducted to identify students' needs for more effective and innovative mathematics learning.

b. Student Characteristics Analysis

This analysis aims to determine students' academic backgrounds, initial abilities, and learning styles in learning mathematics.

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c. Learning Materials Analysis

This analysis is conducted to determine the mathematical concepts to be included in the learning design.

d. Learning Media and Technology Analysis

This analysis aims to determine appropriate learning media to support the understanding of mathematical concepts. The results of this analysis stage serve as the basis for designing a mathematics learning prototype that meets students' needs.

Design Stage

The design stage is the stage of preparing the initial design for the mathematics learning prototype to be developed. At this stage, various learning components that will be used in the mathematics learning process are developed. Some activities carried out in the design stage include:

a. Formulating learning objectives

Learning objectives are formulated based on the learning outcomes of the mathematics course that students must achieve.

b. Designing the structure of learning materials

Learning materials are systematically structured, starting from basic concepts to more complex concepts, so that students can gradually understand the material.

c. Designing learning strategies

Learning strategies are designed using a student-centered learning approach, such as group discussions, problem-solving, and exploration of mathematical concepts.

d. Designing learning media

Learning media used in this prototype design include digital media, visualizations of mathematical concepts, and technology-based learning tools.

e. Designing student learning activities

Learning activities are designed to enable students to play an active role in the learning process through concept exploration, discussions, and solving mathematical problems.

f. Designing learning evaluation systems

Learning evaluations are designed to measure students' understanding of mathematical concepts through various forms of assessment, such as assignments, quizzes, and conceptual tests.

RESULT

Based on the results of the needs analysis and design phase, this research produced a prototype mathematics learning design for students, systematically designed by integrating several key learning components. This prototype was designed to provide a structured learning framework to facilitate more effective mathematics learning and support students' conceptual understanding. The main components of this prototype design include learning objectives, learning material structure, learning strategies, learning media, student activities, and a learning evaluation system.

The learning objectives in this prototype emphasize students' ability to conceptually understand mathematical concepts, think logically and analytically, and apply mathematical concepts to solve various problems. The learning materials are systematically structured from basic concepts to more complex concepts to enable students to grasp mathematical concepts gradually. The learning strategy employed is oriented toward student-centered learning through discussion activities, concept exploration, and mathematical problem-solving.

Furthermore, this prototype utilizes digital technology-based learning media to facilitate the visualization of abstract mathematical concepts. Learning activities are designed to encourage active student involvement through group discussions, problem-solving, and presentations of learning outcomes. Learning evaluation is conducted comprehensively through various assessment methods, such as quizzes, individual assignments, group assignments, and presentations, to measure students' understanding of mathematical concepts. The following is a system for designing mathematics learning outcomes for students:

Login Display

The login page is a crucial part of a website, serving as a gateway for users to access the system using a specific identity. This screen uses the user name and password, as shown in Figure 2 below.

Silahkan Login	
user name	:
password	:

Masuk

Fig. 2 Login Display

Lecturer Dashboard Display

The Lecturer dashboard display is the main page that appears after a user successfully logs into a website or application. The dashboard serves as an information center, displaying various features, menus, and activity summaries accessible to lecturers, including: Student List, Course List, Learning Objectives, Learning Materials, Learning Models/Technologies, Lecturer Activities, Learning Outcomes, and Learning Evaluation. This can be seen in Figure 3 below.


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Evaluasi Pembelajaran			
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Fig. 3 Lecturer Dashboard Display

Figure 3 above shows the Student List page, which displays a list of students enrolled in each course. Next, there is the Course List page, which lists the mathematics courses offered at the university for each semester. Next, there is the Learning Objectives page, which displays information about the competencies students must achieve after completing the course. This page serves as an introduction so students understand the direction and focus of the learning they will be studying. Next, there is the Learning Materials page, which contains systematic explanations of mathematical concepts. The material is presented in the form of text, illustrations, and conceptual visualizations to help students understand abstract mathematical concepts more easily. This section can also include example questions and explanations of how to solve them. The next section is the student learning activity page, which contains various learning activities such as percentages, group discussions, concept exploration, and math problem-solving exercises. At this stage, students are encouraged to actively participate in the learning process through problem analysis, group work, and presentations of discussion results. The prototype also features a discussion or concept exploration page, which allows students to express opinions, ask questions, and exchange ideas regarding the math concepts being studied. These discussion activities aim to deepen conceptual understanding through interaction between students. Finally, there is a learning evaluation page, which is used to measure students' level of understanding of the material they have learned. Evaluations can take the form of quizzes, practice questions, or math problem-solving assignments designed to assess comprehensive conceptual understanding.

Student Dashboard Display

The Student Dashboard is the main page that appears after a user successfully logs in to a website or application. The dashboard serves as an information center, displaying various features, menus, and activity

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summaries accessible to students, including: Course List, Learning Objectives, Learning Materials, Learning Models/Technologies, Student Activities, and Learning Evaluations. This can be seen in Figure 4 below.



Fig. 4 Student Dashboard Display

Figure 4 above shows the Course List page, which contains information about the various mathematics courses offered at the university for a specific term or semester. This page serves as the main menu, helping students select the courses they wish to study. Next, there are Learning Objectives, which explain the competencies or abilities students are expected to achieve after completing the learning process. This information helps students understand the direction of their learning and the focus of the material to be studied. Furthermore, there is the Learning Materials page, which presents structured explanations of mathematical concepts. The material is structured in stages, from basic concepts to more in-depth discussions, so that students can systematically understand the material. The presentation of material can be supplemented with text, images, illustrations, or conceptual visualizations to facilitate understanding of abstract mathematical concepts. The next section is the student learning activities page, which contains various activities designed to support active learning. These activities can include presentations, group discussions, concept explorations, and mathematical problem-solving exercises. At the end of the section is the learning evaluation page, which is used to assess students' understanding of the material. Evaluation can be conducted through various forms of assessment, such as quizzes, practice problems, or problem-solving assignments. Through this evaluation process, lecturers can determine students' level of mastery of mathematical concepts and provide feedback to improve the quality of the learning process.

The results of the mathematics learning prototype design demonstrate that learning can be designed more systematically through the integration of various learning components. The resulting prototype emphasizes not only the delivery of material but also the development of students' conceptual understanding and critical thinking skills.

A student-centered learning approach is a crucial aspect of this prototype because it provides opportunities for students to actively participate in the learning process through discussion, concept exploration, and problem-solving. This active involvement can help students understand mathematical concepts more deeply.

Overall, the mathematics learning prototype produced in this study provides an overview of a structured learning design oriented toward conceptual understanding. This prototype can serve as a basis for developing more innovative mathematics learning models to improve the quality of learning in higher education.

DISCUSSIONS

The results of this study indicate that the development of a student-centered digital mathematics learning prototype using the ADDIE model (Analysis and Design stages) contributes to designing more structured learning that is oriented toward conceptual understanding. This finding aligns with various previous studies that emphasize the importance of technology integration in mathematics learning to improve student understanding. However, this study offers a more systematic approach because it focuses not only on the use of technology but also on the comprehensive integration of objectives, materials, strategies, activities, and evaluation within a single, cohesive prototype design.

Previous research generally indicates that the use of digital media in mathematics learning can improve student motivation and learning outcomes, but often remains partial, such as only developing specific media or teaching tools without integrating them into a comprehensive learning system. In this context, the strength of this study lies in the development of a prototype that not only displays the learning media but also designs the complete learning

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flow from the initial stages to evaluation. This addresses a gap in previous research that has not yet developed a holistic learning design.

Furthermore, the student-centered learning approach used in this study reinforces previous research findings that suggest that active student involvement significantly influences the understanding of mathematical concepts. However, this study makes a further contribution by explicitly integrating student activities into the prototype design, such as discussions, concept exploration, and structured problem-solving within the digital learning system. Thus, students' roles are not merely as media users, but as active subjects in the learning process.

From a material structure perspective, the results of this study also indicate that the gradual arrangement of the material, from basic to complex concepts, facilitates students' understanding of the relationships between mathematical concepts. This reinforces previous research findings regarding the importance of scaffolding in mathematics learning. However, the strength of this study lies in the integration of the material structure into a digital system that supports visualization and interactivity, thus enhancing the process of conceptual understanding.

The use of digital learning media in this prototype also provides added value compared to previous research. While previous research has emphasized the use of technology as an aid, this study positions technology as an integral part of the learning system. Digital media functions not only as a source of information but also as a means of interaction, exploration, and evaluation of learning. This demonstrates a shift from using technology as a supplement to a foundation in learning design.

However, this study still has limitations because it has not yet conducted the implementation phase and direct evaluation with users. Therefore, the prototype's effectiveness in improving students' conceptual understanding has not been empirically proven. Nevertheless, the resulting prototype meets the principles of effective learning and has the potential for further development during the implementation phase.

Overall, this research provides a novel contribution to the development of digital mathematics learning by presenting an integrated, systematic, and student-centered prototype. The main advantage of this research compared to previous research lies in the comprehensive integration of learning components within a single ADDIE-based prototype design, thus providing a foundation for developing a more innovative and relevant mathematics learning system to meet the needs of education in the digital age.

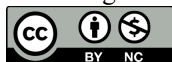
CONCLUSION

Based on the research results, it can be concluded that the development of a student-centered digital mathematics learning prototype using the ADDIE model (Analysis and Design stages) resulted in a systematic and integrated learning design. The developed prototype included key components: learning objectives, material structure, learning strategies, digital media, student activities, and an evaluation system that mutually supported conceptual understanding. The resulting learning design emphasized a student-centered learning approach that encouraged active student involvement through discussion, concept exploration, and problem-solving. Furthermore, the use of digital media in the prototype facilitated the visualization of abstract mathematical concepts, making them easier for students to understand. The material's gradual structure, from basic to complex concepts, also helped students understand the interrelationships between concepts more systematically. The design results indicate that the developed prototype has the potential to improve students' conceptual understanding in mathematics learning. Therefore, this prototype can serve as a basis for developing a more innovative, interactive digital mathematics learning model that meets the needs of learning in the technological era. The novelty of this research lies in the integration of the ADDIE model with a student-centered approach in the form of a comprehensive digital learning prototype design.

REFERENCES

- Anisa Ulva Wahyuni & Hasanuddin. (2025). Teknologi Digital dalam pembelajaran Matematika: Tinjauan Bibliometrik terhadap Dampaknya pada Pemahaman Konsep Matematis Siswa. *Buana Matematika : Jurnal Ilmiah Matematika Dan Pendidikan Matematika*, 15(1), 41–56. <https://doi.org/10.36456/buanamatematika.v15i1.10341>
- Cevikbas, M., Greefrath, G., & Siller, H.-S. (2023). Advantages and challenges of using digital technologies in mathematical modelling education – a descriptive systematic literature review. *Frontiers in Education*, 8, 1142556. <https://doi.org/10.3389/educ.2023.1142556>
- Fawns, T., Ross, J., Carbonel, H., Noteboom, J., Finnegan-Dehn, S., & Raver, M. (2023). Mapping and Tracing the Postdigital: Approaches and Parameters of Postdigital Research. *Postdigital Science and Education*, 5(3), 623–642. <https://doi.org/10.1007/s42438-023-00391-y>

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- Gourlay, L., Rodríguez-Illera, J. L., Barberà, E., Bali, M., Gachago, D., Pallitt, N., Jones, C., Bayne, S., Hansen, S. B., Hrastinski, S., Jaldemark, J., Themelis, C., Pischetola, M., Dirckinck-Holmfeld, L., Matthews, A., Gulson, K. N., Lee, K., Bligh, B., Thibaut, P., ... Knox, J. (2021). Networked Learning in 2021: A Community Definition. *Postdigital Science and Education*, 3(2), 326–369. <https://doi.org/10.1007/s42438-021-00222-y>
- Hafidz, M. A., Herlambang Cahya Pratama, Y., & Maulidya Effendi, P. (2024). Design Thinking: Pengembangan UI/UX Aplikasi Evaluasi Pembelajaran Mata Kuliah Berbasis Web. *Jurnal Informatika Polinema*, 10(3), 413–420. <https://doi.org/10.33795/jip.v10i3.5176>
- I Gusti Agung Trisna Jayantika & Gaudensia Namur. (2022). *PERAN TEKNOLOGI PEMBELAJARAN DALAM MENINGKATKAN LITERASI DIGITAL MATEMATIKA*. <https://doi.org/10.5281/ZENODO.7033331>
- Kaban, R., Sembiring, D. J., & Tarigan, I. M. B. (2023). *Monitoring System for Student Internships Using the Rapid Application Development (RAD) Method*. 15(02).
- Neef, T., Müller, S., & Mechtcherine, V. (2024). Integrating continuous mineral-impregnated carbon fibers into digital fabrication with concrete. *Materials & Design*, 239, 112794. <https://doi.org/10.1016/j.matdes.2024.112794>
- Perez, A. S., Nieto-Jalil, J. M., Chim, A. I. T., Huerta, J. M. M., & Cavazos, L. L. (2025). Scientific Research Model Applied to Mathematical Modeling and Prototype Construction. *2025 IEEE Global Engineering Education Conference (EDUCON)*, 1–7. <https://doi.org/10.1109/EDUCON62633.2025.11016324>
- Sa'dijah, C., Anwar, L., Hidayah, I. R., Abdullah, A. H., & Cahyowati, E. T. D. (2024). *Mathematics learning models based on local wisdom of Malang to support critical and creative thinking of secondary school students*. 030025. <https://doi.org/10.1063/5.0234944>
- Salinas, P., González-Mendivil, E., Quintero, E., Ríos, H., Ramírez, H., & Morales, S. (2013). The Development of a Didactic Prototype for the Learning of Mathematics through Augmented Reality. *Procedia Computer Science*, 25, 62–70. <https://doi.org/10.1016/j.procs.2013.11.008>
- Soomro, S. A., Casakin, H., & Georgiev, G. V. (2021). Sustainable Design and Prototyping Using Digital Fabrication Tools for Education. *Sustainability*, 13(3), 1196. <https://doi.org/10.3390/su13031196>
- Swist, T., Gulson, K. N., & Thompson, G. (2024). Education Prototyping: A Methodological Device for Technical Democracy. *Postdigital Science and Education*, 6(1), 342–359. <https://doi.org/10.1007/s42438-023-00426-4>
- Syafril, S., Asril, Z., Engkizar, E., Zafirah, A., Agusti, F. A., & Sugiharta, I. (2021). Designing prototype model of virtual geometry in mathematics learning using augmented reality. *Journal of Physics: Conference Series*, 1796(1), 012035. <https://doi.org/10.1088/1742-6596/1796/1/012035>
- Tarigan, I. M. B., Tarigan, S. J. B., & Ginting, R. B. (2024). *Optimalisasi Efektivitas Program MBKM: Sistem Monitoring Berbasis Lokasi dan Analisis aktivitas dengan TF-IDF*. 6(1).
- Tarigan, I. M., Simanjorang, M. M., & Siagian, P. (2022). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Ditinjau dari Perbedaan Gender di SMP N 1 Kuta Buluh. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 6(3), 2984–2998. <https://doi.org/10.31004/cendekia.v6i3.1791>
- Taufikurrahman, Budiyo, & Slamet, I. (2021). *Development of mathematics module based on meaningful learning*. 040032. <https://doi.org/10.1063/5.0043239>