

Development of RPG educational game Mathvestor for vocational high school mathematics learning

Kholif Al Hamdhany^{1*}, Aan Nur Irsyad¹, Ira Evikasari²

¹Department of Mathematics Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

²Madrasah Ibtidaiyah Awaliyah Kedungharjo, Ngawi, Indonesia

*Correspondence: kholifal.2021@student.uny.ac.id

Abstract: Problem-solving ability is a key competency in mathematics education, yet studies indicate that this skill remains low among vocational high school students. This study aims to develop and evaluate the feasibility of an educational RPG game, “Mathvestor,” designed using the Contextual Teaching and Learning (CTL) approach and Polya’s problem-solving stages for teaching simple and compound interest. The research employed an R&D method using the ADDIE model. Media validity was assessed by material and media experts, while practicality was evaluated through student questionnaires, teacher responses, and classroom implementation observations. The validation results indicated a “very valid” category, with scores of 94% for material and 91% for media. Practicality tests also showed a “very practical” category based on student responses (88%), teacher responses (94%), and implementation observations (88.8%). These findings demonstrate that Mathvestor is feasible and effective as an interactive and contextual learning medium to support students’ mathematical problem-solving skills.

Keywords:

CTL, Compound Interest, Educational Game, Problem-solving, Polya

How to Cite: Hamdhany, K. A., Irsyad, A. N., & Evikasari, I. (2025). Development of RPG educational game Mathvestor for vocational high school mathematics learning. *Instructional Media for Mathematics*, 3(1), 1-14. <https://doi.org/10.66161/708479>

1. Introduction

Mathematics education is a crucial foundation for the development of logical and systematic thinking skills. Problem-solving ability is often referred to as the core of mathematics learning (Nugroho et al., 2025; Rahmadi et al., 2024; Wahyuni et al., 2024). As the core of mathematics learning, Problem Solving Ability is the most important skill, enabling learners to identify, analyze, and solve non-routine or contextual problems. As emphasized by Polya (1977), problem-solving involves four important stages: understanding the problem, devising a plan, carrying out the plan, and looking back.

However, this ability remains a major challenge in Indonesia's education system. Various studies report that students' mathematical problem-solving abilities are still far from expected and are categorized as low (Asnawi et al., 2022; Nursyahidah et al., 2018; Simamora et al., 2018). This finding is reinforced by the results of the Program for International Student

Assessment (PISA), which shows that the mathematical literacy of Indonesian students ranks 73rd out of 81 (OECD, 2003). This low ability is caused by learning practices that tend to be teacher-centered and focus on solving routine problems, without connecting mathematical concepts to real-life applications (contextual) (Ramadhani et al., 2023; Reyes et al., 2019; Wijaya et al., 2018). This certainly has a significant impact on Vocational High School (SMK) students, where students require contextual understanding because it is closely related to the world of work.

To bridge this gap, learning innovations are needed that can create a relevant and active learning environment. Contextual Teaching and Learning (CTL) is a highly relevant approach, where students are helped to connect new knowledge with real experiences and their life contexts (Nguh et al., 2024; Van Oers, 1998). According to Van Oers (1998), CTL involves seven main components (constructivism, inquiry, questioning, learning community, modeling, reflection, and authentic assessment) that collectively encourage students to build their own understanding rather than merely receive information.

In line with the demands of digital innovation, this research focuses on the development of an RPG (Role-Playing Game) Educational Game design named "Mathvestor". The RPG genre was chosen because it inherently presents complex, continuous problems through narrative simulations, which is highly effective for realizing CTL principles (Chiu & Hsieh, 2017; Wang et al., 2018). In this game, students are forced to take on the role of an investor, managing capital, and making strategic decisions, which directly train them through Polya's four problem-solving stages. Through this innovative design, "Mathvestor" theoretically aims to overcome the main problem of problem-solving by transforming abstract questions into contextual simulation challenges.

Therefore, this article aims to: (1) Explain the development model (ADDIE) and the design philosophy of the RPG Educational Game "Mathvestor", and (2) Analyze and present the quality of the product in terms of validity and practicality aspects, with a focus on an in-depth discussion of how the integration of CTL and RPG mechanics in game design is able to create an effective environment to train students' mathematical problem-solving abilities.

2. Methods

This study focuses on developing a mathematics learning medium in the form of a game. The research method used is Research and Development (R&D), which, according to Sugiyono (2016), is a method to produce a certain product and test its effectiveness. The development model applied in this study is the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation.

Subjects and Research Location The subjects of the research were Grade XI students majoring in Digital Business at SMK Negeri 1 Depok, Yogyakarta, who were selected because the material on simple and compound interest is included in the Grade XI curriculum and is relevant to the economic context taught in that major. The research was conducted in the odd semester of the 2025/2026 academic year. The research stages refer to the five steps of the ADDIE model.

2.1 Research Procedure

Analysis

The analysis stage was carried out to determine needs, actual conditions, and available resources so that the product developed is aligned with learning problems. This analysis covers four aspects: (1) needs analysis, to identify the importance of decision-making skills in SMK mathematics learning through curriculum studies, literature, and school observations; (2) material analysis, which examines basic competencies on the topic of simple and compound interest and their relevance to the context of the world of work; (3) condition analysis, which includes observation of learning facilities and student characteristics; and (4) software analysis, namely the determination of software that supports game-based media development.

Design

This stage involved designing storyboards, game flow, compiling visual and audio assets, and evaluation instruments in the form of missions and interactive quizzes. The game design was arranged to integrate learning content with RPG elements that stimulate students' thinking and decision-making abilities.

Development

The design was then implemented in a real product using Software. At this stage, the integration of visual assets, sound, and simple and compound interest material into the RPG game mechanics was carried out. Initial testing was done to ensure every element functions according to the design.

Implementation

This stage is a product trial on SMK students through giving a pretest, "Mathvestor" game playing session, and posttest to measure the improvement of decision-making abilities. After the playing session, students also completed a questionnaire to assess the media's quality and attractiveness.

Evaluation

The evaluation stage focused on the media's validity and practicality. Validity was established through assessments by material and media experts of the suitability of content, appearance, and integration of learning elements. Practicality was measured through user responses (teachers and students) to ease of use, clarity of instructions, and media attractiveness. These evaluation criteria are based on the learning media quality assessment model described by Nieveen (1999).

2.2 Data Analysis

According to Sugiyono (2016), data analysis is the process of systematically arranging and processing data to draw meaningful conclusions. This research used a quantitative approach

focusing on two aspects of media quality, namely validity and practicality. Implementation, and Evaluation.

Validity Analysis

Validity analysis was conducted to assess the extent to which the developed media and learning materials align with the learning objectives and content. Validity was assessed using validation sheets from media and material experts, rated on a 1–5 Likert scale. The validation result data were analyzed using the Equation (1).

$$P = \frac{\sum x}{n} \times 100\% \quad (1)$$

Where P represents the percentage rating, $\sum x$ denotes the total score obtained from all statement items, and n refers to the total number of statement items. The average percentage results were then categorized according to the criteria outlined by Arikunto (2013) (see Table 1).

Table 1. Media Expert Validation Results

Achievement Level	Interpretation
81% – 100%	Very Valid
61% – 80%	Valid
41% – 60%	Quite Valid
21% – 40%	Less Valid
0% – 20%	Very Less Valid

The media is declared valid if the average result is in the valid or very valid category.

Practicality Analysis

Practicality was analyzed to assess the extent to which the media can be easily used by teachers and students. This aspect was measured through student and teacher response questionnaires, as well as observation of learning implementation in class. The questionnaire used a 1–5 Likert scale, with the same analysis as in the validity test. Meanwhile, the analysis of implementation observation used Equation (2) from Arikunto (2013).

$$x = \frac{f}{n} \times 100\% \quad (2)$$

Where x represents the implementation percentage, f denotes the number of activities implemented, and n refers to the total number of activities. The average percentage results were then categorized according to the criteria outlined by Arikunto (2013) (see Table 2). The media is considered practical if the percentage result falls within the practical or very practical category.

Table 2. Media Expert Validation Results

Achievement Level	Interpretation
81% – 100%	Very Practical
61% – 80%	Practical
41% – 60%	Quite Practical
21% – 40%	Less Practical
0% – 20%	Very Less Practical

3. Results and Discussion

3.1 Analysis Stage

The initial stage was carried out through needs, material, student condition, and software analysis. The analysis results showed that SMK students still experience difficulties understanding mathematical word problems and tend to be passive during learning, especially with material on simple and compound interest, which demands problem-solving and decision-making abilities. Based on the Phase F SMK Mathematics curriculum, this material must be mastered because it is relevant to real-life contexts such as savings and investments, yet student learning outcomes remain below expectations. In addition, school conditions support the use of digital media, as most students own Android smartphones and are enthusiastic about game-based learning. To accommodate this, GDevelop 5 was chosen because it is user-friendly, free, supports animation and learning logic, and can produce lightweight, cross-platform games. Based on this, the development of the "Mathvestor" media was aimed at presenting contextual, interactive learning suitable for SMK students' characteristics.

3.2 Design and Development Stage

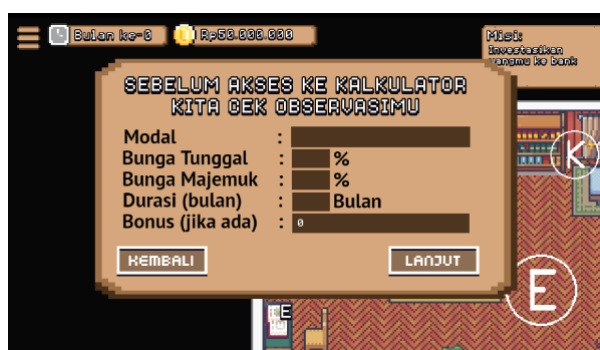
The design of the Mathvestor educational game was developed based on Contextual Teaching and Learning (CTL) principles combined with Polya's problem-solving stages with the aim of presenting a meaningful learning experience so that students not only memorize formulas but are also able to apply these concepts to make real financial decisions. CTL is applied in this game design through six main components: constructivism, inquiry, modeling, learning community, reflection, and authentic assessment. Each component is translated into game mechanics and activities that require players to think critically and make decisions independently.

The main problem this design seeks to address is the low level of mathematical problem-solving ability among SMK students. The Mathvestor game is designed to shift the student's role from a passive information receiver to an active decision-maker; by presenting challenges that resemble the real world, it is expected to train their thinking processes naturally.

Table 3. Implementation of CTL in the Game

TL Component	Implementation in Game
Constructivism	Players build understanding by trying investment options (compound or simple bank) and observing the results.
Inquiry	Players explore information menus and simulations to find out the most profitable financial products.
Questioning	Interactive dialogue with NPCs (bankers, successful investors) provokes players to analyze risks and benefits.
Learning Community	Interaction with other NPCs creates a mini financial community that mimics the real socio-economic environment.
Modeling	The "Financial Advisor" NPC gives an example of compound interest calculation steps at the beginning of the game.
Reflection	The portfolio recap screen at the end of every game "year" asks players to review the decisions made.
Authentic Assessment	Player performance is assessed from total assets and investment strategy success, not traditional test scores.

The first stage, understanding the problem, is taught through tutorial sessions and analysis panels at the beginning of the period (before access to the calculator). The game displays data such as initial capital, simple and compound interest rates, and bonus opportunities for each game phase. Players must identify relevant information and understand their financial condition before making a decision (see Figure 1).

**Figure 1.** Analysis Stage during Tutorial Phase**Figure 2.** Analysis Stage at the Beginning of Period

The second stage, devising a plan, is realized with in-game calculator features and investment simulation menus (see Figures 2 and 3). Players can compare two banks and estimate investment results for the coming period. These mechanics demand that players think critically when designing the most profitable strategy. The absence of explicit answers encourages players to test various possibilities and relate simulation results to learned mathematical concepts.



Figure 3. In-game Calculator

The third stage, carrying out the plan, occurs when players choose to execute their analysis results (see Figure 4). In the game, players interact directly with bank tellers to deposit capital at their discretion. After the decision is made, players press the "sleep" button to pass five months of in-game time. This mechanic illustrates the process of applying plans as concrete actions, while emphasizing that mathematical strategies do not stop at calculations but must be realized through measured decisions.



Figure 4. Bank Teller NPC Confirming

The final stage, evaluation (looking back), is carried out through two forms of feedback: micro and macro. Micro feedback appears every time a player completes a five-month period, in the form of an investment results report that shows capital growth and compares it with the previous period. This encourages players to review the effectiveness of their decisions and improve their strategies in the next period. Macro feedback is given at the end of the game after 30 in-game months, in the form of a total asset recapitulation and a ranking system (D–S) reflecting the player's success in managing financial decisions. This stage emphasizes reflection and authentic assessment in line with CTL principles, which assess learning through real performance rather than test scores (see Figures 5 and 6).

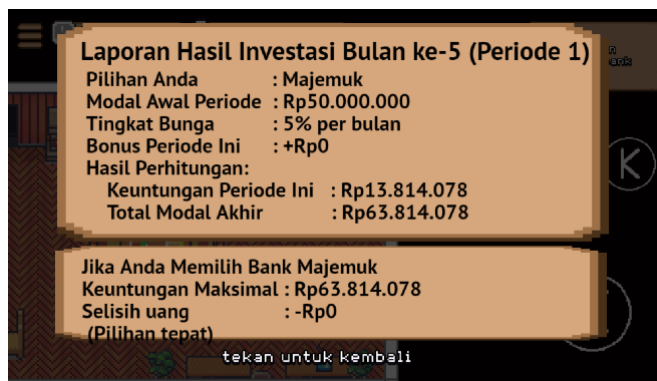


Figure 5. Report at the End of Every Period

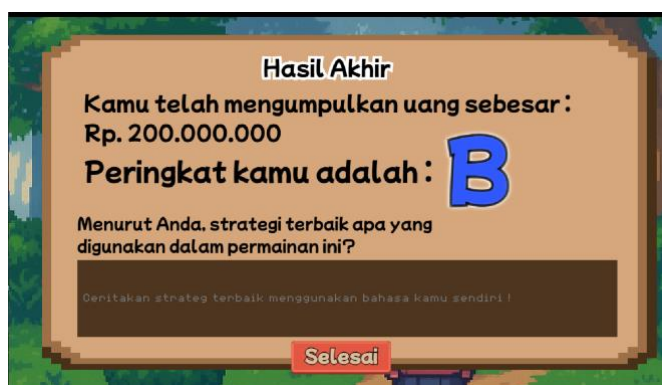


Figure 6. Final Ranking Assignment

3.3 Implementation and Evaluation Stage

After being tested in class, the quality of the learning media was measured through validity and practicality tests. This comprehensive evaluation aims to ensure that the developed product is not only theoretically sound according to experts but also usable and effective in a real classroom setting.

Media Validity Result

The validity test was conducted by two validators: a materials expert and a media expert. The assessment results showed that both aspects obtained average scores in the "very valid" category. This indicates that the learning content and the media's appearance align with basic competencies, learner characteristics, and educational game development objectives. Material Validity The material expert assessed aspects of content suitability, accuracy of simple and compound interest concepts, and clarity of presentation of missions based on financial contexts. The material expert validation results are shown in Table 4.

Table 4. Material Expert Validation Results

Assessed Aspects	Average Score	Category
Technical Quality	93%	Very Valid
Instructional Quality	100%	Very Valid
Overall Average	94%	Very Valid

The average percentage of validation results obtained was 94% (very valid), indicating that the material content in the Mathvestor game is in accordance with curriculum demands and the context of SMK mathematics learning.

Table 5. Media Expert Validation Results

Assessed Aspects	Average Score	Category
Content Quality	90%	Very Valid
Instructional Quality	93%	Very Valid
Overall Average	91%	Very Valid

The average validation result is 91% (very valid). This means that the visual design, user interaction, and game flow effectively support an interactive learning process. Based on these results, it can be concluded that the Mathvestor learning media is feasible for use in the class trial stage. High validity also strengthens the argument that integrating Contextual Teaching and Learning (CTL) with RPG mechanics is pedagogically and technically appropriate.

Media Practicality Test Result

Practicality was assessed through student and teacher response questionnaires and observations of learning implementation. Student Response to Media Questionnaires were completed by students after the Mathvestor game was tested during implementation. Based on the questionnaire results from all respondents, a total of 29 students gave a positive assessment of the media with an average percentage of 88% (very practical). The questionnaire covered aspects of ease of use, relevance to learning, and the game's visuals. The majority of students stated that the game was easy to use, interesting, and helped understand compound interest concepts through contextual simulation.

Teacher Response to Media

Questionnaires were filled out by the subject teacher. Statements in the questionnaire covered aspects of the game's ease of use and visuals. Based on the questionnaire results from all respondents, the data summary is shown in Table 6.

Table 6. Teacher Response Results

Assessed Aspects	Average Score	Category
Ease of Access and Use	93%	Very Practical
Interface Clarity	80%	Very Practical
Readability and Instructions	92%	Very Practical
Overall Average	94%	Very Practical

The mathematics subject teacher gave an average score of 94% (Very Practical). The teacher assessed that the Mathvestor game could be integrated into classroom learning because it has a mission flow aligned with learning objectives and can increase students'

motivation to learn.

Learning Implementation Observation

Observation results showed an implementation rate of 88.8% (very practical). All steps of learning activities using the media could be carried out according to plan, showing that the game is easy to operate and supports active learning processes. This result aligns with Nieveen's (1999) view that a learning medium is practical if it can be used efficiently and easily by users without requiring special training. High practicality also indicates that the gameplay mechanism and mission-based interactions in Mathvestor have successfully created an intuitive and enjoyable learning experience. After being tested in class, the learning media was evaluated for validity and practicality. This comprehensive evaluation aims to ensure that the developed product is not only theoretically sound according to experts but also usable and effective in a real classroom setting.

The results of this study indicate that the Mathvestor educational game meets high standards of validity and practicality, demonstrating its feasibility as an innovative mathematics learning medium. The high validity scores from both material and media experts confirm that the content, instructional design, and technical aspects are well aligned with curriculum demands and student characteristics. This finding is consistent with previous studies that emphasize the importance of expert validation in ensuring the quality of educational media, particularly in game-based learning environments where both pedagogical and technical elements must be integrated effectively (Andriyani, 2023; Dia et al., 2024; Indah Wulandari et al., 2025).

Furthermore, the practicality results indicate that Mathvestor is highly usable and well-received by both students and teachers. The high percentage of positive responses reflects that the game is easy to operate, engaging, and relevant to learning objectives. This aligns with prior research indicating that game-based learning can increase student motivation, participation, and engagement when the media is designed to be interactive and contextual (Andriyani, 2023; Chiu & Hsieh, 2017; Fernández-Oliveras et al., 2021). In addition, the use of RPG elements in this study supports active learning by placing students in meaningful roles, encouraging exploration and decision-making, consistent with findings from other studies on digital game-based learning.

In terms of instructional design, integrating Contextual Teaching and Learning (CTL) with Polya's problem-solving stages provides a strong pedagogical foundation for improving students' mathematical problem-solving abilities. The game mechanics, which simulate real-life financial decision-making, enable students to connect abstract mathematical concepts with practical applications. This is in line with previous research highlighting that contextual and problem-based approaches are effective in enhancing higher-order thinking skills and supporting meaningful learning experiences (Hoogland et al., 2018; Nurhayati et al., 2021; Samo et al., 2018; Suryawati & Osman, 2018). Compared to conventional instruction, this approach offers a more dynamic and student-centered learning environment (Nugroho et al., 2025, 2026).

However, this study has several limitations that should be considered. The implementation was conducted in a single class with a relatively small sample size, which may limit the generalizability of the findings. Additionally, the evaluation focused primarily on validity and practicality, without deeply examining long-term effectiveness on students' problem-solving abilities. Future research is recommended to involve larger and more diverse samples, include experimental designs to measure effectiveness, and explore the integration of similar game-based approaches in different mathematical topics and educational levels.

4. Conclusion

Based on the development, validation, and implementation processes carried out, this study concludes that the RPG Educational Game "Mathvestor" developed through the ADDIE model successfully meets the criteria for valid and practical learning media on simple and compound interest material in SMK. Validation results from material experts and media experts showed percentages of 94% and 91% respectively, which are included in the very valid category. These findings confirm that the content, mission flow, mathematical concept accuracy, and technical aspects are in accordance with curriculum standards and learner needs.

Furthermore, practicality test results from student responses (88%), teacher responses (94%), and learning implementation observations (88.8%) showed that Mathvestor is easy to operate, has clear instructions, and supports learning activities without requiring additional training. The integration of the Contextual Teaching and Learning (CTL) approach and Polya's problem-solving stages into RPG mechanics proved effective in creating a contextual, interactive learning experience, and encouraging students to understand problems, devise strategies, make decisions, and evaluate independently. With these high validity and practicality achievements, Mathvestor is feasible to be used as an alternative mathematics learning medium that can increase student motivation, engagement, and critical thinking skills in financial contexts closely related to the world of work.

Acknowledgments

The authors would like to thank Universitas Negeri Yogyakarta 2025 for its support of this study. The authors also express their sincere gratitude to SMK Negeri 1 Depok for their cooperation and support during the research implementation.

Declarations

- Author Contribution : KAH: Conceptualization, Methodology, Software Development, Writing – Original Draft, Visualization, Data Curation; ANI: Supervision, Validation, Writing – Review & Editing, Formal Analysis; IE: Project Administration, Investigation, Resources, Writing – Review & Editing.
- Funding Statement : The authors received no financial support for the research, authorship, and/or publication of this article

Conflict of Interest : The authors declare no conflict of interest.
Additional Information : -

References

- Andriyani. (2023). Stimulation of Cognitive and Psychomotor Capability by Game-Based Learning with Computational Thinking Core. *Mathematics Teaching-Research Journal*, 15(5), 76–104. <https://mtrj.commons.gc.cuny.edu/volume-15-n-5/>
- Arikunto, S. (2013). *Prosedur Penelitian: Suatu Pendekatan Praktik [Research Procedures: A Practical Approach]*. Bumi Aksara.
- Asnawi, M. H., Annisa, H., Ulum, Moh. M., Arofah, N. L., & Hendrawati, N. E. (2022). Ethnomathematic Exploration At Agung Jami' Malang Mosque In Improving Students' Mathematic Problem Solving Ability. *IndoMath: Indonesia Mathematics Education*, 5(1), 13. <https://doi.org/10.30738/indomath.v5i1.13>
- Chiu, F.-Y., & Hsieh, M.-L. (2017). Role-Playing Game Based Assessment to Fractional Concept in Second Grade Mathematics. *EURASIA Journal of Mathematics, Science and Technology Education*, 13(4), 1–15. <https://doi.org/10.12973/eurasia.2017.00659a>
- Dia, I. O., Putra, Z. H., Witri, G., Dahnilyah, & Aljarrah, A. (2024). Development of a Traditional Game-Based Computational Thinking Supplementary Textbook for Elementary School Students. *Mathematics Teaching-Research Journal*, 16(2), 185–206. <https://mtrj.commons.gc.cuny.edu/volume-16-n2/>
- Fernández-Oliveras, A., Espigares-Gámez, M. J., & Oliveras, M. L. (2021). Implementation of a playful microproject based on traditional games for working on mathematical and scientific content. *Education Sciences*, 11(10). <https://doi.org/10.3390/educsci11100624>
- Hoogland, K., de Koning, J., Bakker, A., Pepin, B. E. U., & Gravemeijer, K. (2018). Changing representation in contextual mathematical problems from descriptive to depictive: The effect on students' performance. *Studies in Educational Evaluation*, 58(April), 122–131. <https://doi.org/10.1016/j.stueduc.2018.06.004>
- Indah Wulandari, S., Widiyatmoko, A., & Dwi Wulandari, T. (2025). Development of E-Module Based on Game-Based Learning to Enhance Students' Conceptual Understanding and Interest in Vibration and Wave Concept. *Journal of Educational Technology Development and Exchange*, 18(4), 117–139. <https://doi.org/10.18785/jetde.1804.06>
- Ngurah, A., Cintyawati, T., & Suniasih, N. W. (2024). Contextual-based Open-Ended Model Improves Numeracy Skills of Grade IV Elementary School Students. *Thinking Skills and Creativity Journal*, 7(1), 175–181. <https://doi.org/10.23887/tscj.v7i1.78228>

- Nieveen, N. (1999). Prototyping to Reach Product Quality. In *Design Approaches and Tools in Education and Training* (pp. 125–135). Springer Netherlands. https://doi.org/10.1007/978-94-011-4255-7_10
- Nugroho, H., Arliana, E., & Sugiman, S. (2026). Integrating Realistic Mathematics Education Approach into Instructional Websites to Improve Students' Computational Thinking Skills in Mathematics. *Mathematics Teaching-Research Journal*, 18(1), 178–233. http://files.commons.gc.cuny.edu.s3.amazonaws.com/wp-content/blogs.dir/34462/files/2026/03/007_Nugroho-Arliana-and-Sugiman-18no1.pdf
- Nugroho, H., Desti, D., Kismiantini, K., & Setyaningrum, L. (2025). Integrating GeoGebra into Project-Based Learning to Improve Students' Problem-Solving Skill on Circle Topic. *Proceedings of the 8th International Symposium on Mathematics Education and Innovation (ISMEI 2024)*, 35–54. <https://doi.org/10.2991/978-2-38476-434-1>
- Nurhayati, R., Waluya, S. B., Sri, T., & Asih, N. (2021). Development of Web-Based Interactive Learning Multimedia with Contextual Approach to Facilitate Mathematical Critical Thinking Ability. *Unnes Journal of Mathematics Education Research*, 12(1), 50–57. <https://journal.unnes.ac.id/sju/ujmer/article/view/44459>
- Nursyahidah, F., Saputro, B. A., & Rubowo, M. R. (2018). A Secondary Student's Problem Solving Ability in Learning Based on Realistic Mathematics with Ethnomathematics. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 3(1), 13. <https://doi.org/10.23917/jramathedu.v3i1.5607>
- OECD. (2003). *The PISA 2003 Assessment Framework: Mathematics, Reading, Science and Problem Solving Knowledge and Skills*. OECD.
- Polya, G. (1977). *Mathematical methods in science*. Cambridge University Press. <https://doi.org/10.5948/UPO9780883859414>
- Rahmadi, J., Wahyu, Y., & Oktari, V. (2024). Implementation of creative problem-solving model with RME approach on mathematics problem-solving ability. *Jurnal Elemen*, 10(1), 43–54. <https://doi.org/10.29408/jel.v10i1.19788>
- Ramadhani, R., Syahputra, E., & Simamora, E. (2023). Ethnomathematics approach integrated flipped classroom model: Culturally contextualized meaningful learning and flexibility. *Jurnal Elemen*, 9(2), 371–387. <https://doi.org/10.29408/jel.v9i2.7871>
- Reyes, J. D., Insorio, A. O., Ingreso, M. L. V, Hilario, F. F., & Gutierrez, C. R. (2019). Conception and Application of Contextualization in Mathematics Education. *International Journal of Education Studies in Mathematics*, 6(1), 1–18. <https://dergipark.org.tr/en/pub/ijesim/issue/43715/454218>
- Samo, D. D., Darhim, & Kartasmita, B. G. (2018). Culture-based contextual learning to increase problem-solving ability of first year university student. *Journal on Mathematics Education*, 9(1), 81–93. <https://doi.org/10.22342/jme.9.1.4125.81-94>

- Simamora, R. E., Saragih, S., & Hasratuddin, H. (2018). Improving Students' Mathematical Problem Solving Ability and Self-Efficacy through Guided Discovery Learning in Local Culture Context. *International Electronic Journal of Mathematics Education*, 14(1), 61–72. <https://doi.org/10.12973/iejme/3966>
- Sugiyono. (2016). *Metode Penelitian Kualitatif, Kuantitatif dan R&D*. Alfabeta.
- Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 61–76. <https://doi.org/10.12973/ejmste/79329>
- Van Oers, B. (1998). From context to contextualizing. *Learning and Instruction*, 8(6), 473–488. [https://doi.org/10.1016/S0959-4752\(98\)00031-0](https://doi.org/10.1016/S0959-4752(98)00031-0)
- Wahyuni, R., Juniati, D., & Wijayanti, P. (2024). How do Math Anxiety and Self-Confidence Affect Mathematical Problem Solving? *TEM Journal*, 13(1), 550–560. <https://doi.org/10.18421/TEM131-58>
- Wang, S.-Y., Chang, S.-C., Hwang, G.-J., & Chen, P.-Y. (2018). A microworld-based role-playing game development approach to engaging students in interactive, enjoyable, and effective mathematics learning. *Interactive Learning Environments*, 26(3), 411–423. <https://doi.org/10.1080/10494820.2017.1337038>
- Wijaya, A., Van den Heuvel-Panhuizen, M., Doorman, M., & Veldhuis, M. (2018). Opportunity-to-learn to solve context-based mathematics tasks and students' performance in solving these tasks - Lessons from Indonesia. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(10). <https://doi.org/10.29333/ejmste/93420>