Proceedings of Science and Mathematics
Faculty of science, universiti teknologi malaysia
https://science.utm.my/procscimath/
Volume 26 (2024) 40-47

# Educational Board Games for Enhancing Money Calculation in 3rd Grade Students in Indonesia

**Karina Widya Ramadhani[1], Gantina Rachmaputri[2]**
[1]Bandung Institute of Technology, Jl. Ganesa No.10, Lb. Siliwangi, Bandung City, 40132, Indonesia
[2]Bandung Institute of Technology, Jl. Ganesa No.10, Lb. Siliwangi, Bandung City, 40132, Indonesia
[1]karinawidyaramadhani@gmail.com
[2]gantina.r@itb.ac.id

**Abstract**
Our project focuses on designing a math education board game centered on money-counting skills for 3rd-grade elementary school students in Indonesia. We chose this topic due to Indonesia's low ranking in the Programme for International Student Assessment (PISA) 2022 math skills assessment and the urgent need for innovative learning tools in elementary education.

We developed the board game using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) method, encompassing analysis, design, development, implementation, and evaluation. Validation by 3rd-grade teachers, game design experts, instructional designers, and subject matter experts confirmed its quality, the rating is scored 85%.

Furthermore, trials demonstrated the board game's effectiveness, significantly improving students' scores. Based on these results, we believe this educational tool is well-suited for classroom use.
**Keywords:** math education; educational game; board game; money counting; ADDIE

## Introduction

Worldwide research to assess the quality of education is called the Programme for International Student Assessment (PISA), and it involves 81 countries. A random sample of children is evaluated in science, math, and reading every three years. Indonesia's math ranking in PISA 2022 was 70th out of 81 nations (OECD, 2023), raising serious concerns.

There are several internal and external reasons that lead to Indonesian students' inadequate mathematical ability (Ayu et al., 2021). Low IQ, lack of enthusiasm in learning, and poor eyesight and hearing are examples of internal issues. Low parental participation, an unfavorable home environment, and the influence of the media are examples of external variables. If these issues are not resolved, they will make it more difficult to understand mathematics in everyday situations.

Money counting is a useful use of mathematics that is essential to economic existence. This ability is necessary for tasks like pricing calculations, bill payment, and vital purchases. Effective instruction in this area can start in the third grade (Soffa et al., 2023), fitting in with the curriculum's coverage of fundamental math concepts as well as real-world applications like purchasing and selling.

Third-grade children can be effectively engaged with instructional games, or edugames (Taylor, 2009). They facilitate children's effective absorption of knowledge and skills by making learning enjoyable and engaging. Edugames can be found on websites, in apps, on books, in toys, and even in board games.

Dice, cards, and boards are some of the components of board games, which provide a concrete and visible learning environment. Through practical application, they may make intricate ideas—like calculating money—more understandable. Board games can therefore be a useful training tool for this ability.

The goal of this project is to create a board game that will improve third graders' understanding of money calculations. The game is meant to be an entertaining and useful teaching tool that makes arithmetic fun and approachable.

## Materials and Methods

### Type of Research

The ADDIE model is the development model that was applied in this study. The ADDIE learning model is a framework for developing learning experiences that is built on an efficient, effective, interactive systems approach and evaluation that promotes learning (Sugihartini & Yudiana, 2018). The steps of research in this paradigm are called analysis, design, development, implementation, and evaluation, or ADDIE for short.

### Research Subjects

Third-grade elementary school kids from three distinct schools—SDN 001 Merdeka Kota Bandung, SDN 2 Lembang, and SD Cendekia Leadership School—are the focus of this study. Furthermore, there are validators who will be involved in this research process.

### Stages of the ADDIE Model

1. Analysis
   The history of the edugame's evolution as a board game is examined during the analysis phase. The first step in the study process is to observe the needs and circumstances of third-grade children. Curriculum analysis, the first step, entails looking at the current curriculum and establishing core competencies linked to basic arithmetic operations and money computations in thousands. The conduct of pupils about the current educational media used in the classroom is examined in the second step, needs analysis. The outcomes of this stage offer recommendations for the creation of the educational materials.
2. Design
   The development of the learning media's basic design takes place at this phase. Based on a review of the needs of the students, the design seeks to be entertaining, well-structured, and compliant with their needs. The learning media's initial product is the result of this phase.
3. Development
   Extending the outcomes from the design phase is the main goal of the development phase. Three crucial steps are involved in this process: The first step in the product design development stage is to make sure the first learning media product is up to the required standards by improving it. Second, the validation stage evaluates the validity of the learning materials and offers recommendations for enhancement based on assessments from subject matter experts, game designers, and design experts. Finally, before going on to the deployment step, the product is revised based on input from experts and validators to improve its quality.
4. Implementation
   In this phase, the learning media is implemented in the classroom. The outcome is an evaluation of the learning media based on student response questionnaires.
5. Evaluation
   Final improvements to the learning media are made based on student responses from the implementation phase.

### Data Collection Instruments

Pre-test and post-tests, questionnaires, interviews, and validation sheets are some of the data gathering tools employed in this study. Tests comprise a series of questions on subjects meant to gauge the respondents' level of knowledge. Using written responses to a series of statements or questions, respondents are asked to complete questionnaires as a method of gathering data. Through oral or written question-and-answer sessions, interviews collect data. Validators receive validation papers so they can get approval for the created educational resources.

The tests are used to determine the difference in student scores before and after using the learning media. Questionnaires collect assessment data from students, while interviews gather data from validators during the development phase, specifically 3rd-grade teachers. Validation sheets collect data from validators during the evaluation phase, including game design experts, subject matter experts, and design experts. The assessments in the questionnaires and validation sheets use a specific scale, while the assessments in the tests follow criteria designed for the study.

**Table 1:** Scale of Assessment for Pre-test and Post-test

| Number of Correct Answers | Score |
|---|---|
| 0 | 0 |
| 1 | 20 |
| 2 | 40 |
| 3 | 60 |
| 4 | 80 |
| 5 | 100 |

**Table 2:** Scale of Assessment for Questionnaires and Validation Sheets

| Category | Score |
|---|---|
| Very Agree (VA) | 5 |
| Agree (A) | 4 |
| Neutral (N) | 3 |
| Disagree (D) | 2 |
| Strongly Disagree (SD) | 1 |

## Results and Discussion

### Board Game Media Creation Process

1. Analysis
   The analysis stage is the first step conducted before designing the learning media. In this stage, information is gathered and recorded as a supporting basis for product creation. The collected information includes the curriculum and the need for learning media used at SDN 001 Merdeka Kota Bandung, SDN 2 Lembang, and SD Cendekia Leadership School. The information obtained indicates that the schools use an independent curriculum, require engaging learning media to help students better understand school lessons, utilize money counting materials with intervals from 1,000 to 10,000, and incorporate materials in the game aligned with the independent curriculum objectives.
2. Design
   In this stage, the researchers developed the initial concept of the game, including creating the storyline, designing game components, making flowcharts, drafting rules, and preparing questions for the game.
3. Development
   During this stage, a prototype of the game was created and presented to validators. The assessment instruments were developed, and the game's feasibility was validated by development stage validators. Revisions to the game components and design were made based on feedback.
4. Implementation
   At this stage, the board game was tested in two elementary schools in Bandung. This trial aimed to assess the feasibility of the learning media and gather student feedback for further evaluation and revision. Students tested the game using the physical prototype of the board game.
5. Evaluation
   Following the implementation stage, the learning media entered the evaluation phase. This phase aimed to determine the game's effectiveness in improving children's math skills and make further improvements. The evaluation steps included conducting pre-tests and post-tests for the trial students, interviewing 3rd-grade teachers to obtain post-trial evaluations, revising the game based on trial observations, interviewing the board game designer and board game enthusiasts, collecting validation sheets from validators, and revising the game components and design.

### Results of Board Game Assessment

1. Pre-test and Post-test Scores of Students
   Presented below is a summary of the pre-test scores obtained before the game trial and the post-test scores collected after the game trial:

**Table 3:** Pre-test and Post-test Results of Students

| Score | Number of Students | | | |
|---|---|---|---|---|
| | Pre-test | Post-test | Pre-test | Post-test |
| | SDN 2 Lembang | | SD Cendekia Leadership School | |
| 0 | 0 | 0 | 2 | 0 |
| 25 | 0 | 0 | 1 | 1 |
| 50 | 3 | 1 | 2 | 0 |
| 75 | 7 | 8 | 3 | 4 |
| 100 | 0 | 11 | 7 | 10 |
| **Average** | **83.75** | **87.5** | **70** | **88.33** |
| **Improvement** | **4.48%** | | **26.19%** | |

Here is the visualization of the pre-test and post-test scores of students

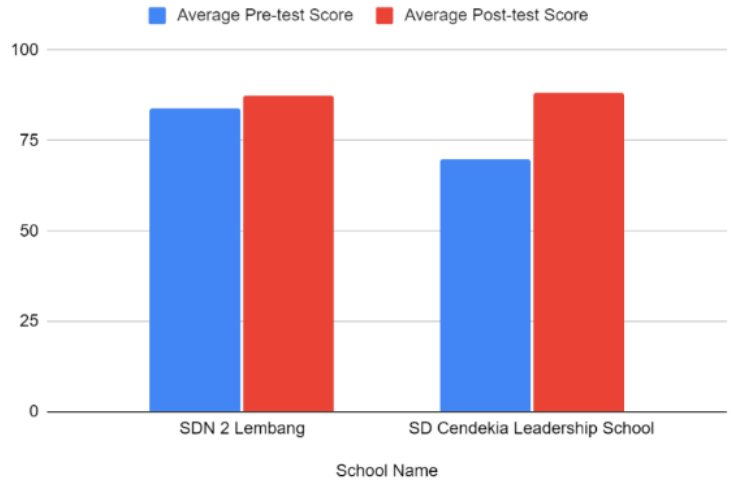


**Figure 1** Bar Chart of Pre-test and Post-test Scores of Students

Based on the results of the pre-test and post-test, it can be concluded that the Board Game improves students' understanding of the money counting material. The students' scores at SDN 2 Lembang and SD Cendekia Leadership School increased by 4.48% and 26.19%, respectively. The average score increase across the three schools was 12.84%.

2. Questionnaire for Students

This questionnaire is needed to measure the effectiveness of the board game across several aspects. The average scores per aspect are as follows:

**Table 4:** Pre-test and Post-test Results of Students

| Aspect | Average Score | Rating |
|---|---|---|
| Gameplay Aspect | 4.68 | 93.6% |
| Mathematics Content Aspect | 4.31 | 86.2% |
| Indonesian Cultural Content Aspect | 4.29 | 85.8% |
| **Overall Average** | 4.35 | 87% |

Based on the table, it is known that the board game scored an average of 93.6% for gameplay, 86.2% for mathematics content, and 85.8% for Indonesian cultural content. The overall average score is 87%.

3. Validation Sheet by Validator
   The validation sheet was completed based on assessments from the game design expert (Mathematics Lecturer from ITB), design expert (Design Lecturer from ITB), and subject matter expert (3rd Grade Teachers). The validation results from the validators are as follows:

**Table 5:** Summary of Validation Results by Evaluation Validator

| Aspect | Average Score | Rating |
|---|---|---|
| Game Design Expert | 4.05 | 81% |
| Design Expert | 4.1 | 82% |
| Subject Matter Expert | 4.4 | 88% |
| **Overall Average** | **4.23** | **85%** |

Based on the summary table, the average assessment result is 85%. Additionally, the validators provided comments and suggestions regarding the Board Game.

**Product**

The output of this research and development is an educational mathematics board game named Mantara. The name Mantara is an acronym of Matematika Nusantara. This game was designed with Indonesian cultural elements in the game design and gameplay materials. It covers material associated with counting money, which was based on integer-related operations of some basic arithmetic.

The storyline of the game is as follow: A group of children embark on an adventure in Indonesia. Their goal is to travel around the country, collecting souvenirs from various places. Each time they successfully help with adding up food ingredients, they earn a reward. The journey is not always easy as there will be various challenges along the way. The winner is the adventurer who collects the most souvenirs.

The rules of the game are as follows: Players can each take their token and start with 20,000 in initial funds. They take turns rolling the dice and moving on the map, choosing any interval from 1 up to the number shown on the dice for their steps. After completing a card, players will face its consequences and are not allowed to be on the same spot as another player. The game ends when a player reaches the “Finish” point, and the winner is the player who has collected the most souvenir cards.

Below are the designs for each component of the Mantara board game:


**Figure 2** Mantara game board

**Figure 3** Mantara Token


**Figure 4** Mantara Money


**Figure 5** Mantara Food Price List Card


**Figure 6** Mantara Market Cards, Souvenir Cards, Gift Cards, and Challenge Cards

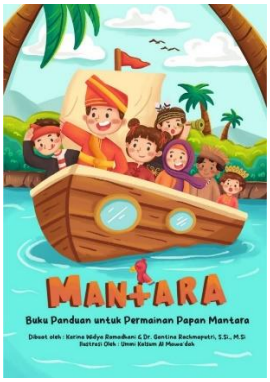


**Figure 7** Mantara Guidebook


**Figure 8** Mantara Box

**Figure 9** Mantara Hourglass

**Figure 10** Mantara Dice

## Conclusion

The educational board game named Mantara has been successfully designed and developed to enhance the money-counting skills of third-grade elementary school students using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The application of the ADDIE model ensured a systematic and comprehensive approach to creating an effective educational tool.

Based on the pre-test and post-test results of third-grade students at SDN 2 Lembang Bandung and SD Cendekia Leadership School, it was found that the Mantara board game significantly improved money-counting skills by 12.84%. The validity of this educational media scored 85%, indicating that the Mantara board game is suitable for use with third-grade students to improve their money-counting skills. Additionally, the effectiveness level of this educational media scored 87%, demonstrating that the Mantara board game is highly effective in several aspects.

## Acknowledgement

We would especially want to thank Ummi Kalsum Al Mawa'dah for her work as the illustrator on the final Mantara design.

## References

Ayu, S., Ardianti, S. D., & Wanabuliandari, S. (2021). Analisis Faktor Penyebab Kesulitan Belajar Matematika. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 10(3), 1611. https://doi.org/10.24127/ajpm.v10i3.3824

OECD. (n.d.). PISA 2022 Results. Accessed on June 12, 2024, from https://www.oecd.org/publication/pisa-2022-results

Soffa, F. M., Yuginanda, A. S., Saniyati, S. L., Tobia, M. I., & Pratama, H. Y. (2023). Implementasi pembelajaran bermuatan computational thinking Pada materi “Kegunaan Uang” kelas III sekolah

dasar. *Jurnal Penelitian, Pendidikan, dan Pengajaran: JPPP*, 4(1). https://doi.org/10.30596/jppp.v4i1.14697

Sugihartini, N., & Yudiana, K. (2018). ADDIE Sebagai Model Pengembangan Media Instruksional Edukatif (Mie) Mata Kuliah Kurikulum Dan Pengajaran. *JPTK (Jurnal Pendidikan Teknologi Dan Kejuruan)*, 15(2). https://doi.org/10.23887/jptk-undiksha.v15i2.14892

Taylor, L. N. (2009). Gaming Ethics, Rules, Etiquette, and Learning. In IGI Global eBooks (pp. 1057–1067). https://doi.org/10.4018/978-1-59904-808-6.ch061