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Research Article

Design of a Financial Saving Challenge to Enhance Saving Interest Using the Reinforcement Learning Method

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Abstract: This study aims to develop a financial saving application to improve the saving habits of students, particularly in Islamic boarding schools, through an adaptive challenge approach. The system integrates a mobile iOS application with a backend service and Large Language Model (LLM) processing via Ollama. Transaction data entered by users is processed by the backend to generate contextual and personalized saving challenges, applying Reinforcement Learning concepts in an adaptive and data-driven manner. The research adopts a descriptive quantitative method using surveys and system testing with 50 respondents. Results indicate that the application functions as designed, with no significant bugs detected. User evaluation shows high satisfaction, with an average score of 4.3 out of 5, covering ease of use, interface design, and increased awareness of saving. The combination of gamification, reward systems, and adaptive personalization successfully motivates users to save regularly. This system demonstrates the potential of integrating AI-driven personalization to strengthen financial literacy and healthy financial habits among students in a fun and interactive way.methods, and a summary of the results. The abstract should end with a comment about the significance of the results or conclusions brief.

Keywords: Educational App; Financial Literacy; Reinforcement Learning; Santri; Saving Challenge.

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1. Introduction

Saving habits are one of the essential foundations of healthy financial management (Rafli et al., 2025) However, among adolescents, including Islamic boarding school students (santri), awareness and saving habits remain relatively low. Many teenagers still lack sufficient understanding of the importance of managing finances from an early age, leading them to spend money without considering the long-term consequences.

The low level of saving habits among santri can be attributed to several factors, including the lack of practical financial education, the absence of supportive systems or facilities, and the limited availability of methods capable of attracting their interest in saving. To date, efforts to instill financial awareness among santri have primarily been conducted through conventional approaches such as lectures and counseling sessions, without incorporating interactive methods that are relevant to the interests and lifestyles of modern adolescents. This situation indicates that financial literacy remains inadequately understood among students.

The importance of financial literacy from an early school age cannot be overlooked. Learning how to manage money, create budgets, and distinguish between needs and wants should begin early to foster positive habits that continue into adulthood. In this context, educational institutions play a crucial role in shaping students' character and promoting positive habits, including sound financial management practices.

Islamic boarding schools (pesantren), as educational institutions grounded in religious and moral values, provide a highly conducive environment for character development among students. Skill Village Islamic School Vocational High School (SMK Skill Village Islamic School), for example, fosters discipline, responsibility, and independence among its students. However, despite the emphasis on these values, saving has not yet become a firmly established routine in the daily lives of many santri. One contributing factor is the lack of motivation and engaging methods to encourage such behavior.

In the modern era, conventional approaches to teaching saving habits need to be complemented by more interactive and motivating methods. One promising approach is technology-based learning that utilizes a reward system to reinforce positive behavior. Through this mechanism, individuals are encouraged to repeat actions that produce positive outcomes, such as saving money.

Based on this approach, a program called the Financial Saving Challenge was designed using Reinforcement Learning. This innovative and interactive solution aims to increase students' interest in saving and strengthen their saving habits. The program combines elements of gamification and technology with a reward-based system, creating an enjoyable learning experience that promotes positive financial behavior (Hariyani, 2024).

Through this approach, students are not merely encouraged to save because they are instructed to do so; instead, they become naturally motivated through a sense of achievement, challenge, and recognition (Tetty Rimenda et al., 2022). Reinforcement Learning enables the system to adapt challenges and rewards dynamically, ensuring that students feel appreciated for every effort they make toward saving, regardless of how small the contribution may be (Ayuni P. Anggraeni et al., 2021).

Through the Financial Saving Challenge, students are expected not only to be motivated to save but also to develop the habit of managing their finances wisely. This habit is expected to continue in their daily lives even after graduating from the boarding school. Consequently, the program aims not only to establish positive financial habits but also to support the development of independent individuals who are prepared to face future life challenges.

Based on the identified problems, the objectives of this study are as follows: (1) to analyze the factors influencing saving interest among santri in a boarding school environment, including both internal factors (financial awareness and financial knowledge) and external factors (facilities, support from teachers, and social environment); (2) to identify relevant and practical financial literacy approaches and strategies suitable for implementation in Islamic boarding schools; (3) to design an educational technology-based saving system that aligns with the characteristics and needs of santri; and (4) to design and develop an adaptive and personalized saving challenge system based on Reinforcement Learning.

The proposed system utilizes a Reinforcement Learning (RL) approach, a machine learning method that enables the system to learn from user behavior patterns by continuously providing challenges and feedback.

The RL approach was selected due to several advantages: (a) its ability to adapt challenge strategies according to users' financial behavior patterns; (b) its capacity to provide personalized experiences in which challenges are tailored to each user's financial condition and capabilities; and (c) its support for the development of sustainable saving habits through dynamic and context-aware reward mechanisms.

2. Literature Review

Saving Behavior and Financial Literacy

Saving behavior is one of the essential aspects of financial behavior that plays a significant role in achieving long-term financial stability. Saving habits are influenced by various economic, social, and psychological factors, including income level, social environment, self-control, and individuals' time preferences in making financial decisions (Pant, 2024). In addition, low financial literacy is one of the primary causes of the lack of awareness, particularly among adolescents, regarding prudent financial management (Iskurniawan, 2024).

From the perspective of behavioral finance, financial decisions are not always based on rational considerations. Emotional factors, life experiences, and cognitive biases often influence individuals' financial management and saving behavior (Housel, 2020). Kubińska et al. (2023) explained that behavioral biases such as overconfidence, loss aversion, and short-termism may lead individuals to prioritize short-term satisfaction over long-term financial goals.

Hariyani (2024) found that students' financial behavior is significantly influenced by their locus of control. Meanwhile, Prinsloo (2015) emphasized that low saving rates may limit both individual and societal capacity to build economic resilience. Similarly, Rodriguez Palenzuela and Dees (2016) argued that saving behavior plays an important role in maintaining financial balance and supporting sustainable investment.

Gamification in Financial Management

Gamification refers to the application of game elements in non-game contexts to enhance user motivation, engagement, and behavioral change. In the financial sector, gamification is utilized to encourage individuals to become more actively involved in managing their finances and achieving predetermined savings goals.

Bitrián et al. (2021) explained that implementing gamification in personal financial management applications can increase user motivation by fulfilling needs for competence, autonomy, and achievement. Elements such as points, badges, levels, progress bars, and leaderboards have been shown to effectively improve user engagement in financial activities.

Rimenda et al. (2022) demonstrated that badges and levels positively influence users' intentions to save in digital banking services. Furthermore, Zhang et al. (2021) found that leaderboards can enhance saving intentions through social competition mechanisms that motivate users to achieve better financial targets.

Pal et al. (2021) also revealed that gamification elements strengthen the relationship between financial planning activities and individual financial management behavior. In addition, Rafiuddin et al. (2024) proved that the implementation of daily challenges, savings goal visualization, and reward systems significantly increases users' saving rates in mobile banking applications.

Gamification for Enhancing Motivation and Financial Literacy

The application of gamification extends beyond the financial sector and has also been widely adopted in education to improve student motivation and engagement. Gadea et al. (2020) explained that challenge-based gamification can enhance learning motivation through structured challenges and clear reward systems.

Through a systematic review, Sal-de-Rellán et al. (2025) found that gamification has a positive impact on adolescents' motivation across various learning activities. This finding was further supported by Mohammed et al. (2024), who demonstrated that the use of badges and leaderboards significantly increases student motivation.

In the context of financial literacy, Sumathy (2024) stated that integrating gamification into financial education can enhance learner engagement and improve learning outcomes. Similarly, Supathanarangsri et al. (2021) found that game-based financial learning applications improve financial understanding and foster positive attitudes toward financial management among young adults.

Furthermore, Hayes (2024) explained that combining financial literacy education with gamification-based persuasive technology can help establish better financial habits. Grobbelaar and Alsemgeest (2024) also demonstrated that gamification serves as an effective educational tool for long-term financial planning.

Financial Saving Challenge

A Financial Saving Challenge is an approach that combines saving activities with challenge-based mechanisms designed to enhance users' motivation in achieving specific financial goals. This concept incorporates various gamification elements such as rewards, badges, leaderboards, progress tracking, and daily challenges.

Hashim (2022) explained that providing psychological rewards through gamification systems can help individuals achieve their savings goals more consistently. Prasetyaningrum et al. (2024) further highlighted that challenge personalization is a crucial factor in increasing user engagement, as it allows the difficulty level to be adjusted according to individual characteristics.

Through a systematic literature review, Prasetyo et al. (2022) concluded that integrating gamification into financial management has the potential to improve positive financial behavior and strengthen users' commitment to their financial objectives. Therefore, the

Financial Saving Challenge concept is considered highly relevant for implementation in Islamic boarding schools to foster sustainable saving habits among students.

Reinforcement Learning in Financial Systems

Reinforcement Learning (RL) is a branch of machine learning that enables an agent to learn through interactions with its environment in order to maximize rewards obtained from its actions. The agent continuously evaluates the outcomes of previous actions and refines its strategy to achieve specific objectives (Nazaruddin & Mardhatillah, 2025).

In economics and finance, reinforcement learning has increasingly been utilized to support adaptive and dynamic decision-making processes. Charpentier et al. (2024) explained that RL has significant potential for solving various financial problems because it can continuously adjust strategies based on evolving user behavior patterns.

Artificial intelligence technologies have also been applied to financial decision-making through AI-based financial advisory systems. Anggraeni and Nugroho (2021) reported that Artificial Intelligence for Financial Advisor (AIFA) systems can support more effective financial decision-making processes. However, Rafli et al. (2025) emphasized that AI systems still require transparency and human oversight to ensure that the recommendations generated remain accurate and aligned with users' needs.

In this study, the reinforcement learning concept is employed to generate adaptive saving challenges based on user behavior, enabling the system to provide a more personalized experience than conventional approaches.

iOS Platform

iOS is a mobile operating system developed by Apple specifically for mobile devices. It is not only used on the iPhone but also on other Apple mobile devices, including the iPad and iPod. As a mobile operating system, iOS provides functionality similar to Android, which is developed by Google. The platform offers a wide range of frameworks, development tools, and security features that support the creation of high-performance mobile applications with a consistent user experience.

Ollama

Ollama is an open-source tool that enables users to run Large Language Models (LLMs) locally on their computers. This capability allows artificial intelligence applications to operate without relying on cloud-based services, thereby improving data privacy and reducing latency. Ollama provides a command-line interface for downloading, running, and managing various LLMs.

In this study, Ollama is utilized to generate personalized saving challenges based on students' daily transaction data. Although it does not directly implement reinforcement learning algorithms, adaptive RL-inspired logic is incorporated through behavior-responsive prompts, allowing the generated challenges to be more personalized and contextually relevant to each user.

Docker

Docker is an open-source software platform that enables developers to build, deploy, and distribute applications within containers. Containers package applications together with all necessary dependencies, including code, runtime environments, system tools, and libraries, ensuring consistent operation across different environments such as development, testing, and production. By utilizing containerization technology, Docker enhances application portability, scalability, and deployment efficiency.

3. Materials and Method

Research Design

This study employed a quantitative descriptive approach combined with a system development methodology to design and evaluate a Financial Saving Challenge application supported by adaptive artificial intelligence. The research was conducted to identify students' saving behavior, financial literacy levels, and preferences regarding gamification features, which were subsequently used as the basis for designing a personalized saving challenge system.

Data Collection

Data were collected from two primary sources: questionnaire data and transaction data. Questionnaire data were obtained from vocational high school students living in an Islamic boarding school environment in West Java, Indonesia. The respondents were aged between 15 and 17 years and had experience managing their daily allowances independently. The questionnaire gathered information regarding demographic characteristics, saving behavior,

financial literacy, technology acceptance, and gamification preferences. The responses were analyzed descriptively to identify behavioral patterns and user requirements for the proposed system.

Transaction data were collected through the mobile application and included records of daily income, expenditures, saving activities, and user interactions with challenge features. These data served as the primary input for generating personalized saving challenges.

System Architecture

The proposed system was designed using a three-layer architecture consisting of a mobile application, a backend service, and an artificial intelligence module. The mobile application was developed using Swift on the iOS platform and provided functionalities for recording expenses, monitoring financial statistics, tracking savings progress, and receiving personalized challenges. The backend service was implemented using Java Spring Boot and deployed through Docker containers on Amazon Web Services (AWS). This component was responsible for storing transaction data, processing user information, and managing communication between the application and the artificial intelligence module through RESTful APIs.

The artificial intelligence module utilized Ollama as a Large Language Model (LLM) execution platform. Weekly transaction histories were analyzed to generate personalized saving challenges tailored to each user's spending behavior. Although conventional Reinforcement Learning algorithms were not directly implemented, reinforcement learning principles were adopted through adaptive behavior-based prompting, enabling the system to generate contextual and personalized challenge recommendations.

Adaptive Challenge Generation

The adaptive challenge generation mechanism was designed to transform users' financial transaction histories into personalized saving recommendations. Daily transaction records submitted through the mobile application were transmitted to the backend server, where they were processed and organized into structured prompts. These prompts were subsequently analyzed by Ollama to generate saving challenges based on users' spending patterns and financial behavior.

The generated challenges were then delivered back to the mobile application and presented to users. Upon successfully completing a challenge, users received digital badges as rewards, creating a gamified saving experience intended to increase motivation and engagement.

Application Features

The developed application consists of three primary modules. The Home module allows users to record expenses and monitor their financial balance and expenditure history. The Statistics module provides visual representations of weekly spending patterns through charts and categorized expenditure summaries. The Challenge module displays AI-generated saving challenges based on users' transaction histories and manages the reward mechanism associated with challenge completion.

System Evaluation

System evaluation was conducted through functional testing and user evaluation. Functional testing employed a black-box testing approach to verify the correctness of core functionalities, including expense recording, statistical visualization, data transmission, challenge generation, and reward allocation.

User evaluation involved students using the application for seven consecutive days. The evaluation focused on saving motivation, financial literacy awareness, challenge completion rates, user satisfaction, and perceptions regarding the usefulness of personalized challenges. Pre-test and post-test questionnaires were administered before and after application usage to assess changes in saving behavior and financial awareness.

Success Indicators

The effectiveness of the proposed system was assessed using several performance indicators. These indicators included improvements in saving motivation, increased consistency in recording financial transactions, positive user perceptions regarding the relevance and realism of generated challenges, challenge completion rates exceeding 70%, and overall user satisfaction levels above 75%. These measurements were used to evaluate the capability of the proposed Financial Saving Challenge system to encourage sustainable saving behavior among students.

4. Results and Discussion

System Implementation

System Workflow

a) Transaction Data Transmission to the Backend

After users perform daily transactions, the transaction data are transmitted from the application to the backend server. The transmitted data include the transaction amount, transaction category, transaction timestamp, and a brief description of the transaction.

b) Data Processing and Prompt Generation by the Backend

The backend receives transaction data and formats them into a prompt that will be sent to the Large Language Model (LLM). The prompt is structured to enable the LLM to understand the user's financial behavior and generate an appropriate saving challenge. An example prompt is shown below:

"The user spent IDR 25,000 on coffee. Create a relevant and creative saving challenge for today."

Figure 1. Prompt Generation in the Backend.

c) Processing by Ollama (Local LLM Server)

The generated prompt is sent to Ollama, which runs the LLM locally. Ollama processes the prompt and produces a personalized, contextual, and engaging saving challenge for the user. An example output is:

"Today, challenge yourself to save IDR 25,000. Pretend you did not buy coffee and instead save the money for a long-term purpose."

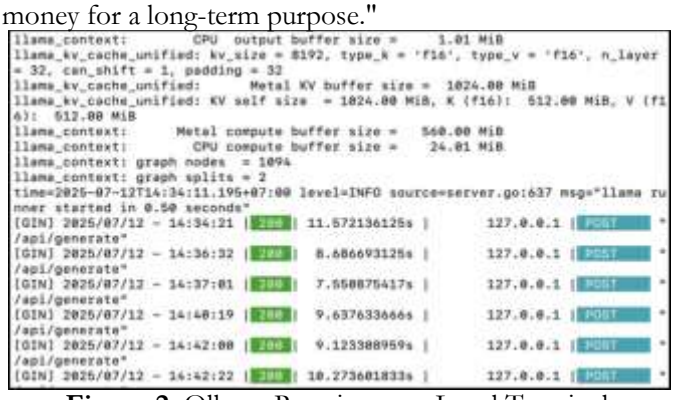
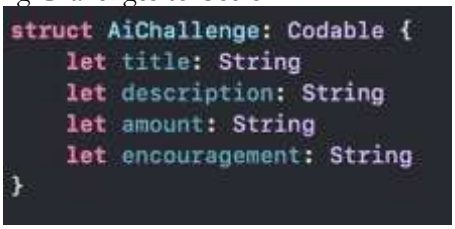


Figure 2. Ollama Running on a Local Terminal.

d) Delivering and Displaying Challenges to Users



```
struct AiChallenge: Codable {
    let title: String
    let description: String
    let amount: String
    let encouragement: String
}
```

Figure 3. Model Implementation in Swift.

The following figure shows the output generated by Ollama after being displayed on the Swift frontend.

Figure 4. Displayed Prompt Result.

Table 1 summarizes the implementation process of the saving application developed for students.

Table 1. Summary of the Implementation Process.

Stage	Input	Process	Output
Data Collection	User transactions	Sent to backend	Raw transaction data
Prompt Builder	Transaction data	Formatted into prompts	Instruction text for the LLM
LLM Processing (Ollama)	Prompt	Processed by the LLM	Personalized saving challenge
User Display	Challenge output	Displayed in the iOS application	Motivational text and suggested action

Application Interface

Before discussing the application testing process, the user interface of the developed application is presented, starting from the wireframe design to the final implementation.

a) Home Page

This page allows users to record their expenses, which are automatically categorized according to expenditure type. Available categories include Food, Daily, Communication, Transport, Medical, and School. This categorization helps users organize and monitor their expenses more effectively.

Figure 5. Home Page Wireframe.

The final implementation of the Home page is shown below.

Figure 6. Home Page Interface.

b) Statistics Page

This page groups and visualizes users' expenditures using statistical representations based on spending categories.

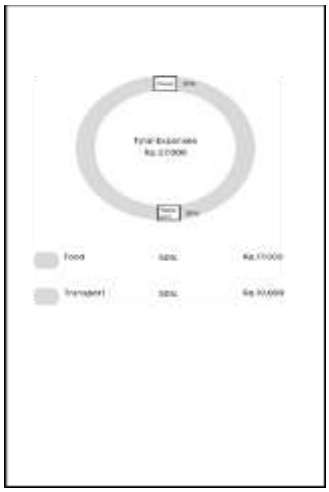


Figure 7. Statistics Page Wireframe.

The final implementation of the Statistics page is presented below.

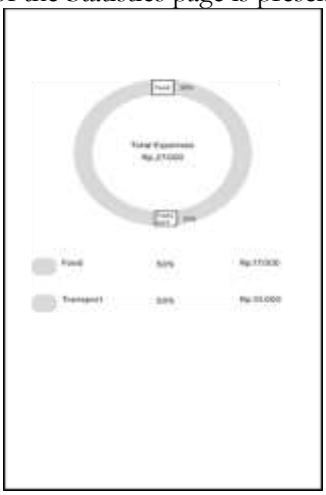


Figure 8. Statistics Page Interface.

c) Challenge Page

This page represents the core feature of the application. Users can view their achievements and complete saving challenges generated by the AI system.

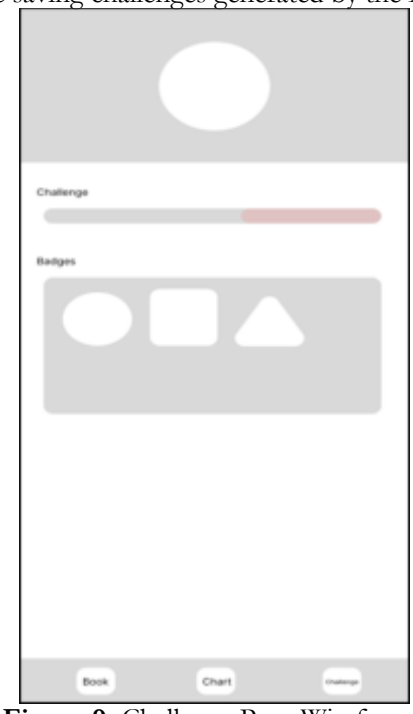


Figure 9. Challenge Page Wireframe.

The final implementation of the Challenge page is shown below.

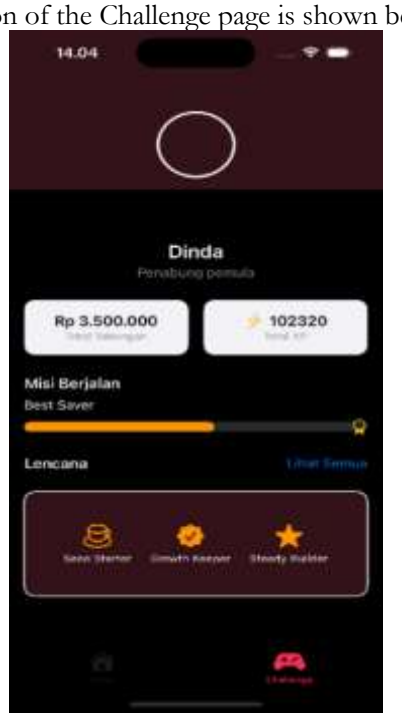


Figure 10. Challenge Page Interface.

System Testing

a) Pre-Test Evaluation

The pre-test evaluation was conducted by distributing questionnaires to 50 students. The survey aimed to assess financial literacy, saving interest, expenditure-recording habits, and interest in the proposed application.

Table 2. Financial Literacy.

No	Question	Response	Frequency	Percentage
1	Have you ever heard the term "financial literacy"?	Yes	38	76%
		No	12	24%
2	Do you save money regularly?	Yes, daily/weekly	20	40%
		Sometimes	15	30%
		Rarely	10	20%
		Never	5	10%
3	Where do you usually save money?	Personal piggy bank	30	60%
		Bank account	10	20%
		Boarding school cooperative	6	12%
		Others	4	8%
4	Reason for saving (multiple choice)	Buying desired items	22	44%
		Emergency needs	36	72%
		Having savings	30	60%
		Parents' suggestion	18	36%

Table 3. Expenditure Patterns and Financial Recording.

No	Question	Response	Frequency	Percentage
1	Have you ever recorded your expenses?	Regularly	8	16%
		Sometimes	20	40%
		Never	22	44%
2	How important is expense recording?	Very important	18	36%
		Important	20	40%
		Neutral	9	18%
		Not important	3	6%
3	Would you be willing to use a savings and expense-tracking application?	Very willing	22	44%
		Maybe	20	40%
		Not interested	8	16%

Table 4. Interest in Gamification.

No	Question	Response	Frequency	Percentage
1	Do you like challenge-based concepts?	Yes	35	70%
		No	10	20%
		Not sure	5	10%
2	Are you motivated by rewards after completing challenges?	Highly motivated	20	40%
		Moderately motivated	15	30%
		Neutral	10	20%
		Not motivated	5	10%
3	Are you interested in an automated saving challenge system?	Very interested	25	50%
		Interested	15	30%
		Neutral	7	14%
		Not interested	3	6%

b) Post-Test Evaluation

Based on the questionnaire results from 50 respondents, the overall average score was 4.3 on a 5-point scale. This indicates that the developed application achieved a good to excellent level in terms of usability, interface design, and functionality. The highest score was obtained for ease of use (4.6), while challenge relevance (4.0) was identified as an aspect requiring further improvement.

Table 5. Summary of Evaluation Results.

No	Evaluation Aspect	Score (1–5)	Interpretation
1	Ease of application use	4.6	Excellent
2	Application interface and design	4.5	Excellent
3	Clarity of saving challenges	4.2	Good
4	Relevance of challenges to spending habits	4.0	Good
5	Application usefulness for saving activities	4.4	Excellent
6	Application responsiveness	4.3	Good
7	Availability of required features	4.1	Good

Discussion of Research Questions

a) How can saving interest among students be improved?

Saving interest can be enhanced through a gamification approach that combines challenges and rewards. Features such as points, badges, and levels encourage students to save consistently by making the process more engaging and enjoyable. Furthermore, practical financial education delivered through the application helps users understand the long-term benefits of saving.

b) What are the characteristics of students' financial behavior, particularly regarding saving habits and allowance management in a boarding school environment?

The system was designed with simplicity, ease of use, and the boarding school context in mind. Features include expense tracking, statistical visualization, adaptive saving challenges, and achievement-based rewards. This design accommodates students' lifestyles by providing quick access, simple language, and motivating interactions.

c) How can Reinforcement Learning be applied to develop saving habits among students?

Reinforcement Learning is utilized to analyze students' spending and saving patterns and subsequently adjust challenges according to their habits. For example, if users frequently fail to achieve their targets, the system provides easier challenges while still offering rewards. Conversely, if users consistently achieve their targets, the system increases the difficulty level. This adaptive mechanism helps users gradually establish sustainable saving habits.

Final Testing Results

Based on both technical testing and questionnaire responses from 50 participants, the application performed successfully without significant bugs. Core functionalities, including transaction data collection, challenge generation through the Ollama LLM, and challenge presentation to users, operated according to the system design.

From the user perspective, the questionnaire results indicate that the application is easy to use (average score 4.6), visually appealing (4.5), and capable of increasing awareness of saving behavior (4.3). The overall average score was 4.34, which falls within the Excellent category.

The testing results also provide answers to the proposed research questions. First, regarding strategies for increasing students' interest in saving, the findings demonstrate that challenge-based gamification has a positive impact. A total of 70% of respondents expressed interest in challenge-based activities, while 40% reported being highly motivated by rewards received after completing saving challenges. These results indicate that interactive technology-based approaches are more effective than conventional methods such as lectures or financial counseling.

Second, concerning the characteristics of students' financial behavior, the questionnaire data reveal that although most students are familiar with the concept of financial literacy (76%), only a small proportion regularly record their expenses (16%) and save consistently (40%). Most students save money using personal piggy banks (60%) rather than formal financial institutions such as cooperatives or banks. These findings suggest that students' financial habits remain relatively simple and require accessible and relevant solutions such as the proposed application.

Third, regarding the implementation of Reinforcement Learning, the system successfully utilized a local LLM (Ollama) to generate personalized and adaptive saving challenges. These challenges were tailored to users' daily spending patterns, making them relevant and realistic. This approach enables the system to learn from user behavior and provide feedback in the form of challenges and rewards, thereby reinforcing sustainable saving habits. Consequently, Reinforcement Learning demonstrates strong potential for application in financial education and positive behavioral change among students.

Overall, the developed application can be considered suitable for supporting personalized saving education and motivation, particularly among students living in Islamic boarding school environments. Future developments may include reminder features, detailed saving reports, and integration with digital wallet services.

5. Conclusion and Recommendations

Conclusion

Based on the results of the design, implementation, and testing conducted on this savings application, it can be concluded that the system was successfully developed in accordance with its initial objective, namely to assist users, particularly students in Islamic boarding schools, in recording expenses and developing regular saving habits through an adaptive and engaging challenge-based approach. This system utilizes Large Language Model (LLM) technology through Ollama and applies a Reinforcement Learning approach to transform daily expenditure data into personalized and contextual saving challenges. This feature proved effective based on testing results involving 50 students, where the application achieved an average score of 4.3 out of 5, with the highest scores obtained in ease of use (4.6) and attractive interface design (4.5).

The application successfully increased students' interest in saving through a gamification and reward-based approach. This is reflected in the data showing that 70% of users liked the challenge concept, and the majority felt motivated by rewards such as points or badges. The questionnaire results indicate that students' financial behavior characteristics tend to be relatively undisciplined. Many students were not accustomed to recording their expenses (only 16%), and most still preferred informal saving methods such as personal piggy banks. This finding suggests that a digital application-based approach can serve as an educational solution that is relevant to their needs and habits.

The implementation of Reinforcement Learning within the system proved capable of adapting challenges based on user behavior, making the challenges feel relevant to the users' financial conditions. The system helps establish sustainable saving habits by utilizing positive reinforcement principles based on data collected in real time. Through a gamification approach and data-driven adaptation, the application is able to improve users' motivation, awareness, and consistency in saving and recording their finances regularly, particularly within boarding school-based Islamic boarding school environments. With a gamification approach and data-driven adaptation, the application is able to increase users' motivation to save and record their finances more consistently.

Recommendations

To further improve the application in the future, the following recommendations are proposed: a) Making the Application Publicly Available: Currently, the application operates locally on the developer's device. In the future, it is expected that the application can be made publicly available and distributed through the App Store. b) Financial Reports and Visual Analysis: Providing financial visualizations such as expenditure charts or weekly savings trends would help users better understand their financial conditions. c) Further Personalization: Saving challenges can be made more personalized by considering long-term user behavior rather than relying solely on daily transaction data. d) Digital Wallet Integration: To make the application more practical and relevant, integration with e-wallets or digital bank accounts should be considered. e) Long-Term Testing: Testing over a longer period (more than one week) would provide more comprehensive data regarding the effectiveness of the challenge feature in influencing changes in saving behavior.

With further development, this application is expected to become a practical solution for improving financial literacy among students and the general public through an engaging and user-friendly technological approach.

References

Anggraeni, A. P., & Nugroho, A. A. (2021). Strategi pengambilan keputusan keuangan berkelanjutan dengan artificial intelligence for financial advisor (AIFA). *Jurnal Administrasi Publik & Kebijakan*.

Bitrián, P., Buil, I., & Catalán, S. (2021). Making finance fun: The gamification of personal financial management apps. *International Journal of Bank Marketing*. https://doi.org/10.1108/IJBM-02-2021-0074

Charpentier, A., et al. (2024). *Reinforcement learning in economics and finance: A survey* (arXiv:2411.12746). arXiv. https://arxiv.org/abs/2411.12746

Gadea, et al. (2020). The effect of challenge-based gamification on learning. *Educational Technology & Society*. https://doi.org/10.1007/s10639-023-11585-z

Grobbelaar, C., & Alsemgeest, L. (2024). Gamification as an educational tool for retirement planning. https://doi.org/10.1177/10451595241286913

Hariyani, R. (2024). Pengaruh financial technology, locus of control, dan literasi keuangan terhadap perilaku keuangan mahasiswa. *Jurnal Ekonomi & Manajemen, 22*(1). https://doi.org/10.31294/jp.v22i1.20297

Hashim. (2022). *Gamification can help consumers reach their saving goals*. CEPR Policy Insight.

Hayes, C. (2024). *Using gamification to influence user success in personal finance applications* (Master's thesis, Toronto Metropolitan University). https://doi.org/10.32920/25164623.v1

Housel, M. (2020). *The psychology of money*. Harriman House.

Iskurniawan. (2024). *Literasi finansial siswa: Mengelola uang saku dengan bijak—Panduan bagi siswa SMA dan SMK*. Asadel Publisher.

Kubińska, E., Adamczyk-Kowalczuk, M., & Macko, A. (2023). *Behavioral finance in digital era*. Routledge. https://doi.org/10.4324/9781003400066

Mohammed, et al. (2024). Effects of gamification on motivations of elementary school students: An action research field experiment. *Simulation & Gaming*. https://doi.org/10.1177/10468781241237389

Nazaruddin, Y. Y., & Mardhatillah, I. (2025). *Memahami reinforcement learning: Dari teori ke implementasi*. ITB Press.

Pal, A., Indapurkar, K., & Gupta, K. P. (2021). Gamification of financial applications and financial behavior of young investors. *Young Consumers, 22*(3), 503–519. https://doi.org/10.1108/YC-10-2020-1240

Pant, D. K. (2024). Factors affecting the saving behaviour of individuals. *Researcher CAB, 3*(1). https://doi.org/10.3126/rcab.v3i1.68429

Prasetyaningrum, A., et al. (2024). Enhancing user engagement in mobile banking through personalized gamification. *International Journal of Intelligent Engineering and Systems*. https://doi.org/10.22266/IJIES2024.0831.60

Prasetyo, et al. (2022). Integrating financial management and gamification: A systematic literature review and future research agenda. *The Indonesian Journal of Computer Science*. https://doi.org/10.33022/ijcs.v12i3.3244

Prinsloo, J. W. (2015). *The saving behaviour of the South African economy*. South African Reserve Bank.

Rafiuddin, T. W., Lutfiani, N., Rizky, A., & Cesna, G. P. (2024). Evaluating the effectiveness of gamification in mobile banking to increase savings rates. In *2024 2nd International Conference on Technology Innovation and Its Applications (ICTIIA)*. IEEE. https://doi.org/10.1109/ICTIIA61827.2024.10761169

Rafli, M. R., Claudia, M., Rahadhian, L. N. R., Syahputra, M. D., & Wahyudi, M. H. (2025). Generative artificial intelligence sebagai penasihat keuangan pribadi. *Kindai, 21*(1). https://doi.org/10.35972/kindai.v21i1.2072

Rimenda, T., Aulia, M. R., Listiawati, R., & Marbun, J. (2022). Gamification: Saving in digital banking is like playing a game. *ASEAN Marketing Journal, 14*(2), 211–220. https://doi.org/10.21002/amj.v14i2.1206

Rodriguez Palenzuela, D., & Dees, S. (2016). *Savings and investment behaviour in the euro area* (Occasional Paper No. 167). European Central Bank. https://doi.org/10.2139/ssrn.2729234

Sal-de-Rellán, Y., et al. (2025). Gamification and motivation in adolescents: A systematic review. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2025.1575104

Sumathy. (2024). The role of gamification in enhancing financial literacy education. *Journal of the Oriental Institute*. https://doi.org/10.8224/journaloi.v72i2.20

Supathanarangsri, et al. (2021). Development of financial learning mobile game application for young adult learners. *Psychology and Education Journal.*

Zhang, Y., & van Horen, F. (2021). Increasing saving intentions through leaderboards: A gamification approach. *PLOS ONE, 16*(4). https://doi.org/10.1371/journal.pone.0249283