# Integrating Image Recognition and Board Games into Financial Education⋆

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## Abstract

As financial products diversify and market structures become more complex, promoting financial education has become increasingly important. Given that the foundation of financial literacy should be established from childhood, how to cultivate students' correct financial management concepts from a young age has become a significant issue in modern society. Considering the substantial advantages of game-based learning in providing high interactivity and real-world scenario simulations, this paper aims to develop an innovative financial education board game that incorporates elements of risk assessment and insurance planning, and digitalizes it. With the assistance of an app and the application of image recognition technology, we could enhance the convenience and fun of the gameplay. Research results show that integrating digital apps into board games as a game-based learning strategy significantly improves the learning outcomes and motivation of upper elementary school students in the areas of risk and insurance knowledge, compared to traditional lecture methods. It also enhances their understanding and application abilities. Students hold a positive attitude toward this teaching approach, demonstrating its potential and advantages in financial education.

## Keywords

image recognition, game-based learning, board games, financial education

## 1. Introduction

With the diversification of financial products and the increasing complexity of market structures, popularizing financial literacy has become particularly important. According to a survey by the Taiwan Academy of Banking and Finance, individuals aged 20 to 29 show a deficiency in financial and risk-related awareness. Thus, improving students' grasp of financial and risk-related concepts has become a critical educational goal. Given the close connection between financial risk management and daily life, game-based learning is more effective than traditional lecture-based learning in enhancing students' knowledge of risk management and sparking their interest. In their study, Subhash and Cudney [1] explored the application and future trends of game-based learning in higher education, noting that the widespread adoption of technology has driven a shift from traditional classroom lectures to integrated digital learning environments. Hui and Mahmud [2] demonstrated that game-based learning not only boosts students' confidence in learning mathematics but also enhances their ability to apply the acquired knowledge to real-world problems. According to Videnovik and colleagues [3], game-based learning significantly aids learners in grasping complex concepts in computer science, such as algorithms and data structures.

In their 2016 study, Fabris and Luburić [4] pointed out that a lack of financial knowledge has led an increasing number of people to face serious debt issues, also affecting their ability to manage personal finances. They emphasized the necessity of enhancing children's financial knowledge to prevent excessive debt and difficulties in financial management. The United States, the United Kingdom, and Taiwan each have different approaches to financial education. The U.S. promotes financial education through the Financial Literacy and Education Commission of the Treasury Department, focusing on building core financial skills and providing online resources. In the U.K., financial education is incorporated into school curricula through the Money Advice Service, which also provides financial advisory services for citizens. In Taiwan, the financial knowledge

that should be taught at the elementary school level includes the following four topics:

(1) Saving and Spending: Needs vs. wants, the rationale behind spending choices, methods and importance of bookkeeping, and the concept of income minus savings equals expenditure.

(2) Borrowing and Credit: Principles and attitudes towards borrowing, credit, and its value.

(3) Risk and Risk Management: Risk and methods of risk management, risks in daily life, and insurance.

(4) Investment: Saving and investing, and investing in oneself.

Game-Based Learning (GBL) refers to the use of game elements in the educational process to promote learning. This approach can enhance students' engagement and interest through visual and interactive methods, thereby improving learning outcomes. Game-based learning is not limited to digital games but can include any form of game activity, such as role-playing, simulation games, competitions, and puzzle-solving activities [5]. Moreover, game-based learning provides immediate feedback, allowing students to see their learning results in real time, which is crucial for learning motivation and self-regulated learning behaviors. When implementing game-based learning, educators need to carefully design the game environment and rules to ensure learning [6]. Game-based learning should also be personalized based on students' prior knowledge and learning needs to achieve optimal learning outcomes.

GBL has become an important trend in contemporary educational environments, enhancing learning outcomes and student engagement by introducing game mechanics. Research has shown that GBL can effectively boost students' motivation, participation, and memory, while also helping to develop critical thinking and problem-solving skills [7]. The significance of GBL lies mainly in how it makes the learning process more engaging and interactive. Through games, students can learn in a more challenging and enjoyable environment, which helps increase their motivation to learn. For example, when students solve problems through games while learning math, they not only acquire math skills but also practice them unconsciously, achieving better learning results. Such games can have high educational value, especially for students aged 10 to 15 [8].

Current trends in GBL include the integration of technology and the exploration of personalized learning paths. With technological advancements, digital games have become an essential component of GBL. These games not only support visual and auditory learning but also provide personalized learning experiences through data tracking [9]. Additionally, the incorporation of augmented reality (AR) and virtual reality (VR) technologies has opened new possibilities for GBL, allowing students to explore complex academic concepts through more immersive learning activities [10].

Based on the conclusions of the studies above, our research combines the idea of game-based learning to develop a financial literacy board game integrated with digital technology (Fig. 1).
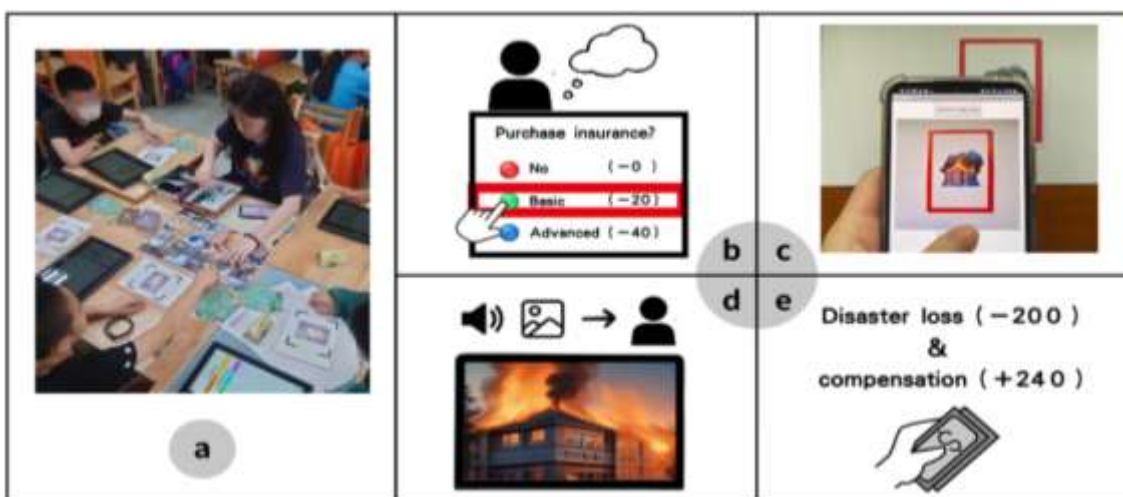


Figure 1: (a) Students play the board game and earn personal wealth during the game. (b) During the disaster phase, they choose whether to purchase insurance. (c) Card identification using image recognition. (d) Identify whether a disaster has occurred and display the corresponding animation. (e) Loss of wealth and receiving compensation according to the chosen insurance plan.

This research incorporates elements of risk assessment and insurance planning, using app assistance and image recognition technology to give students practical experience in deciding when to purchase insurance to mitigate risks, integrating it into their lives.

## 2. Design and Implementation

As shown in Figure 1, the game process starts with accumulating wealth (points) through the board game (Incan Gold). During the next phase called the disaster phase, players can mitigate the risk through an insurance mechanism. The player who accumulates the most wealth (points) after ten rounds is the winner. Each round starts with students playing the board game and collecting personal wealth. Following this, the game enters the disaster phase, allowing students to alleviate financial losses from disasters by opting to purchase insurance. This phase of the financial literacy board game includes physical cards (ten disaster cards and "non-disaster" cards), an image recognition area, and a custom-designed app (Fig. 2). In the game, each round features one type of disaster, with ten rounds in total. The occurrence probability, damage amount, and insurance costs for each type of disaster are based on real-life scenarios, resulting in unique settings for each. At the beginning of the game, each player must decide whether to buy insurance and, if so, whether to opt for basic or advanced coverage. These two insurance plans differ significantly in insurance costs and disaster compensation amounts. The basic plan has lower premiums, making it suitable for those with limited budgets or lower protection needs, but it offers a smaller compensation amount. On the other hand, the advanced plan requires higher premium payments but provides greater compensation coverage. This mechanism is designed to help students learn risk assessment and make wise decisions about insurance purchasing.

Each round of the disaster phase has ten cards on the field, including disaster cards and "non-disaster" cards (Fig. 2). Then, students draw a card, place it in the recognition area, and use a mobile device to scan it. The card's information is identified using the image recognition technology in the app, trained with MIT App Inventor's Personal Image Classifier (PIC) Tools, a custom neural network-based visual recognition system. The neural network parameters, such as learning rate, epochs, training data fraction, and optimizer, are adjusted based on the training results. This allows the trained model to identify the contents of the images accurately. After completing the recognition, a corresponding animation is displayed (Figs. 3-4). The system then modifies the scores according to whether the player purchased insurance and encountered a disaster, recording the progress in a Google Spreadsheet.

The player with the highest score at the end of the game is the winner.



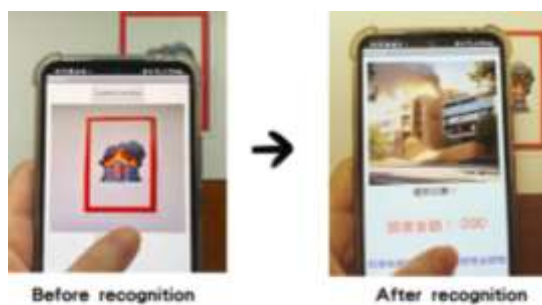Figure 2: Financial literacy board game components.



Figure 3: The process of image recognition.



Figure 4: The corresponding animation after recognition.

## 3. Research Method

This study focuses on sixth-grade students from a primary school in Taiwan. There are three classes in the sixth grade, and two of them were selected as the research subjects. These two classes were divided into an experimental group and a control group, maintaining their original class composition. The teaching strategy for the experimental group involved incorporating game-based learning with board games and app assistance, while the control group used traditional lecture-based teaching. During the teaching experiment, both groups received the same course instruction. After the teaching experiment concluded, both groups were tested with a risk and insurance test and a financial literacy learning motivation questionnaire as post-test results. Additionally, a semi-open questionnaire was used to gather feedback from the research subjects regarding their experience with digital board games during the teaching experiment, aiming to understand their attitudes toward using digital board games.

This study adopts a quasi-experimental research design, with 34 learners from two of the three sixth-

grade classes participating in the experimental process. Each class, consisting of 17 students, was assigned to one of two groups using purposive sampling. The experimental group had 17 students, and the control group also had 17 students. The total number of research subjects was 34, with 21 boys (approximately 62%) and 13 girls (approximately 38%), as shown in Table 1.

Table 1
Statistical Table of Participants for Two Different Teaching Strategies

|  | #Boys | #Girls | #Total |
|---|---|---|---|
| Experimental Group (Game-Based Learning with Board Games and App Assistance) | 10 | 7 | 17 |
| Control Group (Traditional Lecture-Based) | 11 | 6 | 17 |

This study divided the teaching experiment process into four stages, which are explained as follows:

(1) Pre-test of the Teaching Experiment: Before the experimental teaching began, a pre-test on risk and insurance knowledge was conducted for both groups of learners to assess their level of knowledge and performance regarding risk and insurance prior to participating in the teaching experiment.

(2) Integration of Different Teaching Methods into Financial Education on Risk and Insurance:
The researcher of this study, also acting as the instructor, applied different teaching strategies to the two groups of subjects. The experimental group received instruction through self-developed teaching materials, supplemented by a board game and the digital app "Insurance Strategy Master" for learning. The control group, on the other hand, received instruction through video viewing and presentations created by the researcher.

(3) Post-test of the Teaching Experiment: After the teaching experiment was completed, both groups of learners took a post-test on risk and insurance knowledge, as well as a financial literacy learning motivation questionnaire, to evaluate the differences and effectiveness of the two teaching strategies.

(4) Questionnaire on the Attitude Towards the Integration of Board Games and Apps: After the post-test, the experimental group completed a questionnaire on their attitude towards using the board game integrated with the app. This aimed to further understand and analyze the learners' attitudes towards learning through the combination of the board game and the digital app, thus complementing the parts that quantitative data could not reveal.

Based on the different types of data collected before and after the teaching experiment, corresponding analysis and organization were conducted. The quantitative data include the pre- and post-test results of risk and insurance knowledge, as well as the data from the financial literacy learning motivation questionnaire. These data will be analyzed quantitatively using SPSS statistical software. The qualitative data include the detailed content of the financial literacy learning motivation questionnaire, the responses to the board game integrated with the app attitude questionnaire, and student feedback. After collection and organization, these data will undergo qualitative analysis.

## 4. Research Results and Discussion

The demonstration video for this study can be found at the following link [11]. The research results show that the risk and insurance course was more effective in enhancing students' understanding of risk and insurance concepts in the experimental group. In the experimental group, 64.7% of students indicated that their understanding of risk and insurance concepts was "very much," whereas only 5.9% of students in the control group had the same feeling. Additionally, more students in the experimental group acknowledged the course's usefulness in daily life. In the experimental group, 64.7% of students believed that the course was "very helpful" for their daily life, compared to 47.1% in the control group. This indicates that the teaching strategy combining an app and board game was more effective in helping students comprehend and apply risk and insurance knowledge than the traditional lecture-based method.

In terms of course participation, 64.7% of the students in the experimental group indicated that their level of participation was "very high," compared to 47.1% in the control group. This further suggests that the game-based learning strategy is more effective in increasing students' engagement and interest in learning. The increase in course participation may be due to gamified learning providing a more engaging and interactive learning experience, making students feel more involved and participatory during the learning process. These results show that the risk and insurance

course is effective in improving students' understanding of risk and insurance knowledge, enhancing their perception of applying the knowledge to daily life, and increasing student engagement. A higher proportion of students in the experimental group gave positive feedback on the course, indicating that the teaching strategy combining the app and board game holds positive value in financial education.

We integrated this financial literacy board game into the classroom, allowing students to engage in hands-on activities. According to our survey, about 90% of students believe this game helps them learn about risk management and insurance planning (Fig. 5). The students reported that the disaster experiences in the game changed their views on insurance, and made them realize the importance of insurance, and helped them learn to access risk and choose the appropriate insurance accordingly. Moreover, teachers commented that this teaching approach delivers insurance-related knowledge diversely and engagingly, encouraging students to put it to use.



Figure 5: Five-point scale for student feedback on the course.

## 5. Conclusion

This paper aims to improve the understanding and application of financial risk management and insurance planning concepts through the game process and apply it in everyday situations. This paper designs a financial literacy board game that combines physical cards with a digital application. The game enhances students' immersion and gaming experience through card interaction and a digital interface utilizing image recognition technology, aiding their comprehension of the importance of risk management and insurance planning. Additionally, through different disasters in each round, students learn to assess risks and make reasonable insurance purchasing decisions based on the probability and severity of disasters. Furthermore, the game's interactivity and immersion are heightened by the system's real-time feedback and animation effects, enriching the learning experience.

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