CS6460: Develop Financial literacy and Metacognition via Gaming

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Abstract— Financial literacy is very important as it has a material impact on a family’s budget. It helps in understanding the value of money and various decisions related to money. Studies have found financial literacy to be very low which might lead to incorrect decisions. Financial literacy and metacognition are related as metacognition help in the development of critical thinking, and decision making which is important aspects. The following paper will discuss how financial literacy and metacognition are related as well as the correct age and method to start financial literacy.

1 INTRODUCTION

In the increasingly risky market around the world and variation of globalization and deglobalization, financial competency becomes a key trait for every individual. Financial competency helps in understanding the value of money and helps in handling finances better way. Managing finances starts from daily/monthly household budget to retirement savings. Financial competency can be the key to prosperity and lack of financial literacy might result in poor finances, debt, no investment, stress, etc.

Financial competency is achieved via financial literacy and financial literacy is very low around the world (Lusardi, A., & Mitchell, O. S. (2011)). Financial competency and metacognition are closely related. That is because metacognition is thinking about thinking. Metacognition helps in decision making, critical thinking, evaluation of strategies, and making changes to strategies for reaching the goal (Masek & Yamin (2011)).

All the skills archived through metacognition help in financial competency. For example, decision-making helps in taking decisions of investment, and critical
thinking will help in the pre-evaluation of financial investment. Evaluation of strategies helps in better risk assessment in financial investment and adjusting financial investments.

Development of metacognition starts at an early age (Fisher 1998) and so financial literacy can also start at an early age. Understanding money, the usefulness of savings, spending, or using recourses wisely are some topics that can start at an early age of 5 years. Normally a 5-year-old and above child will recognize numbers and so can recognize currency and slowly learns to add and subtract. This is the right age when the benefits of savings, spending, etc. can start. Based on the research it can be found that problem-based learning improves critical thinking (Masek & Yamin 2011) and this can be an important trait for learning financial literacy.

Finance is a topic that might not be interesting for kids for obvious reasons. Most kids in today’s digital age kids have iPads and laptops on which they like to play games or watch videos. Gamification has helped in cultivating new literacies (Hsu & Wang 2010) and it can be used for financial literacy to make the topic interesting.

Games are getting introduced to kids at a very early age and games can be made interesting to teach both metacognition and financial literacy indirectly. Rasco, Chan, Peko, & Sundaram (2020) studies personalized persuasive serious games for financial literacy among young decision-makers. According to their study financial literacy has four domains managing money, planning, choosing the product, and staying informed. A platform or game which supports all four aspects of financial literacy is ideal.

The study from Kiryakova, Angelova & Yordanova (2014) discusses the usage of gamification in learning and presents the argument that today's generation grew up with digital technologies, and keeping using traditional ways to learn might not keep students engaged and motivated for the learning process. The study explores software like learning management platforms (LMS) and Moodle (a popular gaming platform) for gamifying the learning process. Sanmugam, Zaid, Abdullah, Aris, Mohamed, & van der Meijden (2016) found in the study that
games kept students engaged in learning and motivation was badges and leaderboards. As part of the study, teachers gave the initial introduction to topics that students will learn via gamification to ensure it will not be a shock for students. Then different rewarding points and badges were also introduced in the game to keep students engaged.

Nieto-Márquez & Baldominos & Pérez-Nieto conducted and study to understand the relationship and effectiveness between digital apps used by schools to teach metacognitive skills in students. This study reveals how games, puzzles, activities etc help in development of metacognitive skills.

2 EXISTING SOLUTIONS

Already some existing games are available either on the internet or the app store or in the marketplace. The solutions make kids learn some aspects of financial literacy and competency. Google search with the keyword "financial literacy games for kids" and there were few results that came up. Some of the results were common across multiple websites or suggestions.

Common games across multiple websites were Peter pig’s money counter, Counting with coins, and wise pockets.

Peter pig's money counter targets kids from 5-8 years of age and as per the description allow kids to count and sort coins and currency. Knowing currency is a very important skill and sorting is an important metacognitive skill, but the game does not teach anything more related to finance. After understanding the currency kid should also learn about saving, spending, and other aspects of money. Also, the game only introduces dollars as a currency and might not appeal to the public outside of the US.

Counting with coins is a game that introduces the concept of spending for example how many candies you can buy in $2 if each candy cost $1. This is a great way to introduce how to spend money and teaches basic concepts of spending money. The game does not teach anything about coins or dollars or about other financial concepts of earning, spending, savings, etc.
Wise pockets is an interactive game that teaches kids about managing money but the game is suitable for kids from 11 years and older. The game does not take care of kids below 11 years who have skills of basic math and might have a little piggy bank where they collect coins or money. There are other games also which introduce some concepts of financial literacy and spending.

2.1 Limitations with existing solutions

Even though games exist for financial literacy but most of the games are for kids above 10 years old. Games for 5–10-year-old kids are very less and do not satisfy the need for basic financial competency. Also, the key concept of spending and saving should be understood at an early age is lacking in most games.

Does not teach to spend wisely: Spending money wisely is very important, and it should be learned at an early age. This in turn will result in more savings and help in achieving financial goals. All the games show how to buy things with money or count the money but none of them shows how to spend wisely to save some money.

Does not teach how savings help in the future: Savings are normally done for security. Keeping money aside for emergencies and a fallback plan in case of unexpected events. Having savings in the account allows you to take more risks. None of the games shows the usefulness of savings in the future.

Does not support the development of metacognition: Games do help in learning about some aspects of financial literacy but metacognition helps in better financial planning as it helps in critical thinking, evaluation of strategies, and making changes to strategies.

Does not show consequences of overspending: Overspending money has consequences like lack of savings. This is a potential risk for individuals in case of unexpected events and can lead to financial debt. Games do not show how overspending can be harmful and should be avoided.
3 PROPOSED SOLUTION

A game that can introduce the concepts of earning, spending, and savings can be very useful for teaching some key concepts of financial literacy. Going with more complex topics like interest, investment, etc. might make the game uninteresting for the kids.

The game should be easily understood by a child of 5-year-old. The game should provide instructions or prompts to guide the player. Castronovo, Van Meter, & Messner (2022) found in their study that prompts in constructive educational games help in learning and improve metacognition. If the involvement of a parent is needed for the child of 5 or 6 years old, it is also a positive sign. Miller, & Kocurek (2017) found in their study that games should enhance parent-child interaction which helps in the improvement of metacognitive abilities.

The solution should address the limitations of the game by playing. Saving, and spending wisely are traits that come from a habit and cannot be achieved via reading books or classroom teachers. These habits can be developed via practical applications but are not suitable for 5–10-year-old kids. So a better way is to teach them via some fun activity. Some board games like “Monopoly for kids” are on the market which teaches lessons of spending wisely but playing that game might require parents which might not be possible all the time.

So, the game should be created in a way that requires parent involvement to some extent, and the player can read instructions at each level and play the games. Consequences of overspending, saving, etc. should be indirectly taught via gaming.

3.1 Game Overview

Mario is a game that most of the kids have played. Mario collects coins and then occasionally gains energy to kill the enemy. The proposed game is inspired by Mario with some additions and modifications to financial learning.

The target of the game is to collect maximum coins with minimum energy loss. Below is how the game will run:
The player needs to collect coins at each stage.
Collecting coins will reduce the energy level of the player.
Energy below eighty percent will terminate the game.
The player needs to eat food after each stage to boost energy.
Each food or snack consumption will cost the player a collected coin.
The player needs to eat food within the limit to save coins.
Energy is also lost rapidly if the player has a collision with fire.
As the level increases obstacle increases so more energy might be lost.
Prior savings might help gain full energy at higher levels.

The above outlines how the game runs at each stage and there are some rules:

- It is not necessary to collect all the coins at each level.
- If energy is going below eighty percent, the player can exit the stage at any time.
- The maximum energy level can be 100%.
- The player can keep eating food and can lose all coins, but energy can be a maximum of 100 percent.
- The player cannot eat food if there are no coins in account.
- Energy level increases quickly with healthy food options and slowly with junk food.
- The player can cross any stage at any time.

The above rules and format promote multiple things related to financial literacy. Ids playing. The game will learn the spending money wisely and how much to spend. The motivation to gather maximum coins with minimum energy loss will help kids to learn some important aspects of financial literacy.

3.2 Technology stack

The game will be developed using PyGame which uses Python as a coding language. The game uses Python version 3.8 or higher and a few other general python libraries. The game will be a platform game that will be arcade style and contains 2D graphics. Due to the limitation of time accommodating 3D graphics is not possible.
The game will need the installation of python on any machine and will be provided in executable (.exe) file format so that anyone can run it. The game is created with an 800x800 screen size and uses assets that are available free online.

Python is a free language that is available online and supports many features including creating a game. Because of this python seems to be a better option for the game.

3.3 Game Limitations

The game does achieve some topics of financial literacy and metacognition. However, both financial literacy and metacognition are very big topics. All the aspects cannot be covered in a given amount of time frame. Financial literacy has topics like budgeting, credit, debit, investment, planning, and retirement planning which are few from the list.

Covering all these topics is not possible in the game and it might not be correct to cover all the topics for kids from 5-10 years old. Children from 5-10 years old do not know anything about retirement, investment, or any of the advanced topics.

So, the project scope was trimmed to limit to the small topic of savings and spending. Similarly, the development of metacognition is not a process of a day or a year. This happens as the age increases. Covering all the aspects of Metacognition are also not possible. However, some aspects of metacognition can be used in gaming which supports learning of financial topics as well as promotes the development of metacognition.

4 FINANCIAL LESSON LEARNED VIA GAME AND RESULTS

The game developed has interfaces as shown below. The game demo can be seen at the link https://youtu.be/MKi4nmM4Gj0. Additional images of the game are also attached in Appendix.

The game teaches multiple lessons about financial literacy:

Spend Wisely: Spending wisely is a very important aspect of financial literacy. In the game, spending more than needed does not takes energy level above 100% but
the game allows to eat all the apples and candies until the balance of the coin reaches zero. A wise player will eat sufficient apples/candies in-game to keep the player alive for the next level but will not overeat to make balance zero. This also impacts the critical thinking capability of the player.

**Save for the future:** As the level, in-game increases the number of obstacles (fire) also increases. Fire causes a rapid decrease in energy and a player can lose the game if the energy level goes below eighty percent. The player needs additional coins in savings to regain energy if a significant amount of energy is lost by going on fire.

**Overspending:** Overeating apples/candies cause a loss of coins and might end the game quickly. If the player loses all the coins by eating apples or candies and loses energy by going into the fire, the player might not have enough balance at later levels to regain energy for playing further resulting in the termination of the game.

**Spend right:** Apple gains energy quicker. Candy gains energy slower. Promotes good eating habits. Spending and developing good habits are very important, so spending money in the right way is very important.

**Metacognition:** The instructions are to keep the player informed about the goal of the game and legends. As per the study by Nandunie, Lahiru, and Tiroshan (2020) instructions in video game helps to develop metacognitive skills. Each intermediate level shows the instructions on what kind of food should be eaten and how many coins are lost by eating. This instruction supports the development of metacognition.

All the lessons also help in the development of critical thinking, evaluation of strategies, and making changes to strategies.

### 4.1 Survey results

For the evaluation of game, I conducted a survey of 13 questions. The questions are covered wide variety of topics from feedback about game to participants experience in playing video game and learning about financial literacy. The questions are listed in the Appendix at the end.
- Survey had total 44 participant, 32 Male and 12 Female.
- Out of 44, 31 people are from 30-40 years old.
- Only 1 participant has not played video game before and 2 have not enjoyed playing video game.
- 34 participants feel they learned something from playing video game.
- 38 participants feel that financial literacy is very important.
- 32 participants have never talked to kids about finance or financial literacy and 4 participants did not respond to question.
- 36 participants feel that game-based learning will be useful for learning financial literacy.

Below is summary of survey results:

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<td>&gt;50-60</td>
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<tr>
<td>Good but needs improvements</td>
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</tr>
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<td>Grand Total</td>
<td>44</td>
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</table>

*Figure 1—Feedback about “Demo of game” according to age group and gender*

### 4.2 Possible bias in survey

There is possibility of biases in survey. Most of the people participated were of the similar age group. As the response of survey was low, I shared survey with friends and family which might cause conformity bias. Some questions can have option of Not applicable, but option was missed which might have caused bias. There might be some other bias which needs to be identified.
5 CHALLENGES

During the analysis and development of the game, several challenges were encountered. This section will discuss the challenges which were encountered during the scoping of goals as well development of the game.

5.1 Challenges

Mandell (2006) found in the study that people/schools who get financial literacy knowledge in schools tend to lose the knowledge by the time they are in the job market and hence they are not financially literate. But the target audience for the project is kids from 5-10 years old and they are not near the job market, nor do they normally have any money to spend other than maybe a piggy bank. How to make all gear work together which can create an engine of better financially literate people.

Scope of project: Finance is a very big topic that cannot be understood in a short period. It not only requires theoretical knowledge but practical implementations. So, the scope was trimmed down to earning and saving money as saving for the future is very important.

Retaining the knowledge: Gamification of financial literacy was effective as retaining the knowledge of challenges faced in the game is a lot easier.

Engaging audience: Engaging kids 5-10 years old is a challenging task playing Games is the activity that most kids enjoy. Some kids of 5 or 6 years old might not be able to understand the game completely. So, parent engagement might be needed.

Motivation to play the game: Playing a game is a motivation but the game should be engaging enough for kids to keep continue playing else the goal will not be achieved. Hence collecting coins is made challenging as the levels progress.

5.2 Technical Challenges

Developing a game from scratch is a challenging task, so, to mitigate the challenge the base code for the game was taken from an online tutorial of PyGame, and
proper signoff of usage of code with consent was taken via email. The goal of the project was to introduce financial literacy and not to learn technology. Some portions of existing code were removed to achieve the project goals and correct additions and modifications were done.

Modifications like energy level calculator and loss of energy in case of a collision with fire were done. The addition of an intermediate level was done to achieve the objective of financial literacy of the game.

6 FUTURE WORK

The game developed has lots of potential for growth in teaching financial literacy as well as technical capabilities. Some of them are listed below:

- Test the game with real users. The game is targeted toward kids 5-10 years old and a real test with kids in the age group is needed.
- Get feedback from the experience of kids and their parents is necessary. This will help in potential improvements and corrections in the game.
- Conduct Surveys with parents to understand they want kids to learn. Patents are the first teachers in almost every kid’s life and they know the best what is the best topic which kids should learn related to finance which can be beneficial in long term.
- Research on topics related to financial literacy is needed to include the lessons in the correct format. Brainstorming sessions might help in developing the game more kids friendly.

The existing game needs the following additions/modifications:

- Modify the Game to add more prompts and sound effects.
- Add top scores for player motivation.
- Add levels to make the game more interesting.
- Add more challenges to make the game more interesting.

Some of the enhancements are possible in the technical stack of the game. The game is currently developed via PyGame and is in 2D format. However, today’s graphics and technology have achieved almost real 3D effects.
7 CONCLUSION

Financial literacy is very important, and many people are not financially literate. People who have got formal training for financial literacy tend to lose it if not used frequently. Saving, spending, planning for retirement, investment is few of the important aspects of financial literacy.

Planning for future, making adjustment to plans, critical thinking about plans and strategies and decision making are some of the key aspects which are needed for financial planning. These skills are developed through and are directly related to Metacognition. Development of metacognition starts at very early age.

Having good metacognitive skills helps in better financial planning, so some basic lessons of financial literacy can start at an early age. Most of the kids today have digital devices like iPad or laptop access and are interested in gaming. So, gamification of financial literacy was done so introduce some basic lessons of savings and spending. Games have long lasting reflection on memory and lots of schools are also adopting gaming as a fun and engaging way to teach.

Gamification of financial literacy is a fun way to learn as finance might not be an interesting topic for kids from 5-10 years old. So, a game was developed which helps in lessons of earning, savings, spending wisely and taking right decisions. These lessons are related to financial literacy and metacognition which was the goal of project.

The game developed indirectly teaches lessons of spending wisely, consequences of overspending, decision making and spending in right way. Survey results showed that most of the people found that Gamification might be useful in teaching financial literacy. The demo of game was rated Good by most of the survey participants with scope of improvements. To conclude, gamification is good way to learn financial literacy which is low in most of the people and it is important for young generation to begin learning topic of financial learning at early age.
8 REFERENCES


10. Nandunie N. Harischandra; Lahiru A. Jayakody; Tiroshan Madusanka: Impact of metacognition and age group on contemporary video game
interface and gameplay design (2020) 2020 International Research Conference on Smart Computing and Systems Engineering (SCSE)


12. Nieto-Márquez & Baldominos & Pérez-Nieto (Apr 2020): Digital Teaching Materials and Their Relationship with the Metacognitive Skills of Students in Primary Education (Reference#2)

13. https://piazza.com/class/l2zfw553n634xg?cid=95_f9 (reference for signoff from TA to reuse some code from git repo)


16. The game was developed with the help of tutorials and code base located at repo https://github.com/russs123/Platformer.

17. Assets for game were picked from https://opengameart.org/

18. Sounds for game: https://mixkit.co/free-sound-effects/game/
10 APPENDICES

**Figure 2**—Start screen of the game

**Figure 3**—Instructions for the game
Figure 4—Level 3 of the game

Figure 5—Intermediate level to regain energy level. More energy is regained more coins are lost.
Survey Questions:

1. What is your age?
2. What is your Gender?
3. Have you played Video games before?
4. Have you enjoyed playing video game/s?
5. Have you learned something from Gaming?
6. Do you have kids?
7. Have you ever taught your kids about finances like currency familiarization, savings, spending, investing etc?
8. Have YOU ever learned about finances like currency familiarization, savings, spending, investing etc?
   Attached video link  [https://youtu.be/MKi4nmM4Gj0](https://youtu.be/MKi4nmM4Gj0)
9. Please see video above (it is less than 2 mins) and read little bullet points. What do you think about the game?
10. Do you think above game or similar games will help kids in learning financial literacy?
11. Have you or your kids have played games related to financial literacy?
12. How important is financial literacy?

Survey results:

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**Figure 6**—35 results of survey.

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**Figure 7**—Remaining results of survey.