Analysis of Players' Speed Thinking in Color Mix Game Application

Ahmad Fairuzabadi(✉), Ahmad Afif Supianto, Herman Tolle
Brawijaya University, Malang Indonesia
zabedhasekar@gmail.com

Abstract—Color Mix Game is an educational game that introduces the theory of color mixing, which is very important for everyday needs, especially in all areas of visual art such as graphic design and videography. Unfortunately, just a few people know this knowledge. The game has become an interesting and fun learning media for its players. In addition to learning media, games can have positive impacts on the players. Among its effects, it can improve basic mental skills for players, such as alertness, speed thinking ability, and concentration ability. Therefore we are interested to analyze the player behavior in the game to see the improvement of their players' speed thinking ability. To perform this analysis, we collect the data by recording every player activity log during playing the game. Every step was taken by the player along with detailed information such as the time of the attack and the distance of the attack will be stored in the database. By using MySQL, the database of this game is built on PhpMyAdmin application. After collecting data from 10 respondents we asked to play this game 2 times, we get the result that the players experienced a speed increase of thinking as much as 32% in the game.

Keywords—Speed Thinking, Educational Game, Player Behavior, Log Data.

1 Introduction

Game is very popular with most people of all ages. Not only fun, games are also able to become a useful media in various fields such as education, entertainment, advertising, and even in the field of research. In fact, there are many studies that say that playing video games can improve basic mental skills. Some of these mental skills are as follows.

1. **Improve basic visual processing capabilities.** Playing video games can increase the visual contrast sensitivity (the ability to distinguish subtle differences in shades of gray aura) [1].
2. **Increase attention and alertness.** According to Green & Bavelier [2], action video games improve the ability to find things quickly. Playing video games also increases the ability to track moving objects [3].
3. **Improve the execution function.** Playing video games is also capable of enhancing multi-tasking capabilities [4]. Games are also capable of improving mental flexibility ie the ability to switch quickly and precisely on conflicting tasks [5].

In addition, the game is trusted to be a tool to study the issue of certain problems in various areas of everyday life. According to Yinyue Qiu, games are a good mathematical tool for learning the interactive decision-making process among players [6]. Masayaki Ueno uses the game as a tool to monitor and record the physiological index of players and is made in clear model evidence [7]. Souhila Benmakre-louf uses the game as a tool for identification of relevant player profile data from serious online games for the benefit of game development itself [8]. Because the game has a huge market of all ages Appaji M Abhishek takes advantage of games as a player's stress level gauge during the game's play [9].

Therefore we are interested to do research on CoMiG (Color Mix Game) as a medium of color mixing theory learning. CoMiG is an arcade game that requires players to think fast and precisely to complete tasks in the game. So in this study, we will analyze the improvement of speed of thinking, and the level of vigilance in playing this game.

2 Color Mixing Theory

Brewster theory is a theory that simplifies the colors that exist in nature into 4 groups of colors. The four color groups are: primary, secondary, tertiary, and neutral colors. This theory was first proposed in 1831. The color group is often shown in a color circle, known as the Brewster color circle [10]. By using the circle, can be seen clearly the color spectrum.

2.1 Primary Colors

The primary color is also called the first color or the color of the principal. It is called the primary color because the color can not be formed from other colors. It is called a staple color because it can be used as a staple ingredient to obtain other colors. The primary colors are:

1. Blue, the actual color name is cyan, which is a pseudo-blue green
2. Red, the real name is magenta, which is purple pseudo red.
3. Yellow.

2.2 Secondary Colors

Secondary color or called the second color is the color of the mixture of two primary colors.

1. Orange/orange is the result of mixing colors between red and yellow
2. Purple/violet is a mixture of red and blue
3. Green, is the result of mixing yellow and blue

3   Color Mix Game (CoMiG)

Color Mix Game is the arcade game that the game tells about 3 heroes that protect their base from enemies who want to seize their headquarters. 3 hero is a fantasy character that represents the primary colors of red, blue and yellow. His enemies are characters that represent secondary and tertiary colors. Players are required to attack the emerging enemies by combining colors that match the color of the enemy. If the player has a color combination selection error, then the enemy is not destroyed and continue to walk towards the hero fortress.

This game consists of 3 levels: (1) normal, (2) hard and (3) survival. Each level has a different level of difficulty. At normal levels, players are required to attack enemies representing secondary colors. At the hard level of his enemies are the characters that represent 3 tertiary colors. And at the survival level, all enemy characters will appear gradually.

The game page can be seen in figure 3. On this page, the heroes are located to the left of the screen hiding behind the fortress. While the enemies appear continuously from the right side of the screen and walk to the right to destroy the hero's herding fortress. Above-the-middle is a score gained by players from destroying enemies.
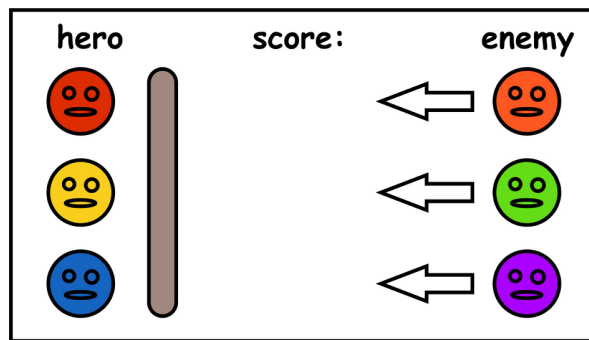

Fig. 1. Game Page

Players are required to get a higher score than the previous game. Each destroys 1 enemy then the player gets 1 score. When the castle is completely destroyed then the game is over.

4   Methodology

Three steps in this research can be seen in Figure 2: (1) Design, (2) Implementation, and (3) Analysis.
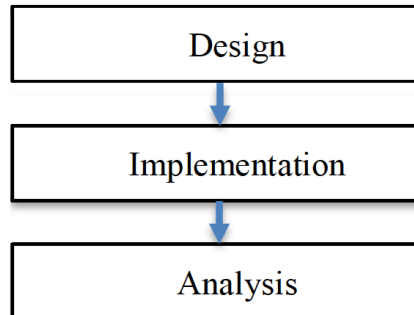
Fig. 2. Research Methodology

4.1 Design

This game is developed by game-engine Unity 3D. In this game-engine, the language used is C # with the addition of PHP as a game link to MySql database. The database is used to store the data of player behavior. The structure of this game system can be seen in Figure 3.
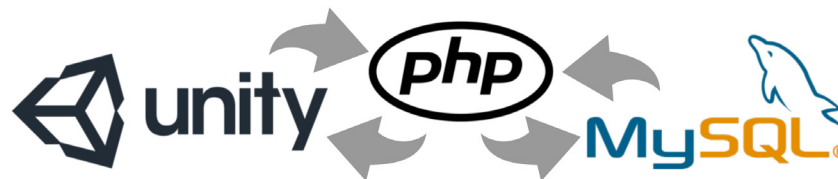

Fig. 3. Game Structure Design

With MySQL, the database of this game is built on PhpMyAdmin application that has been hosted on localhost. The structure of the game database table itself is shown in Figure 4.

Fig. 4. Database structure

Figure 2 can be seen there are 2 tables are table_utama and tabel_detail2. The list of player Ids and names will be stored in table_utama and the log of steps that the player performs will be stored in table_detail2. Table_detail includes enemy color and attack of the player, time of the attack, whether the attack is true or false, the distance between the enemy and the fortress, and also the score obtained by the player.

The data in this study will be collected from the log files of the players' activities in playing CoMiG. Any activities performed by the player will be stored in the database such as opening the tutorial page, selecting the level, and returning to the level selection page. For the analysis needs of this study, every step taken by the player in the game will be recorded, such as choosing a color combination and attacking the coming enemy. Game log files contain detailed information every step made by players that will be stored in table_detail2 in the database. Details of the information are as follows:

1. "id_player" is the player id.
2. "id_stage" is the id level that is played.
3. "id_musuh" is enemy id attacked by a player.
4. "w_musuh" is the color of the enemy attacked by the player.
5. "w_attack" is the color combination chosen by the player to attack the enemy.
6. "t_attack" is the time of attack performed.
7. "ket" is the condition whether the selected color combination matches the color of the attacked enemy color.
8. "score" is the score earned by the player.
9. "jarak" is the distance between the enemy being attacked by a defensive fortress.

All of this detailed information will be stored in the database every time a player attacks one enemy. So from the data, we can do the analysis of the player behavior of each player. From the data "jarak" we can measure the speed of thinking players during the game.

4.2   Implementation

This stage is the application of the design that has been made. At this stage conducted data collection for analysis of the player's ability of speed of thinking in playing this game.

Data collection was done by deploying the game to 10 respondents. 10 respondents are required to play the game 2 times at normal levels. Activity data that players perform in the game will be recorded and stored in the database. From the data can be done a behavioral analysis of each player. 10 respondents can be seen in table 1.

Table 1. Player table

id_player	name
24	Cahyo1
25	Anggi1
26	Ismail1
29	Akhrian1
30	Nindy1
31	Hana1
32	Heri1
33	grace1
34	Agatha1
35	Yanuar1

4.3 Analysis

The stored data player behavior includes the range of attacked enemies and the time of the attack. The data can be a means of measuring the average speed of thinking of each player. The speed of thinking of player can be measured by the distance of the enemy while is attacked. The further distance is the faster thinking of players. After obtaining enemy distance data in each attack, then calculating the average distance of the enemy in 1 game. So from the average distance, we can compare it with the second game data to get the result.

5 Result and Discussion

How to play this game is to click the hero color combination first, then click the enemy that matches the color. If the chosen color combination matches the color of the enemy, then the enemy will be destroyed and the score of the player increases 1. And if the chosen color combination is not suitable then the enemy will continue to walk left to destroy the fortress. How to play this game can be illustrated in figure 5.

In this study, the data needed to measure the speed of thinking of players is the distance data of the enemy with the fortress, and the time of the attack. To get the data, we record it every time the player clicks on the enemy after selecting the hero color combination. Figure 6 illustrates the distance data of these enemies.

From the 10 respondents involved, data on the distance and time of attack performed by each player as described in Table 2.

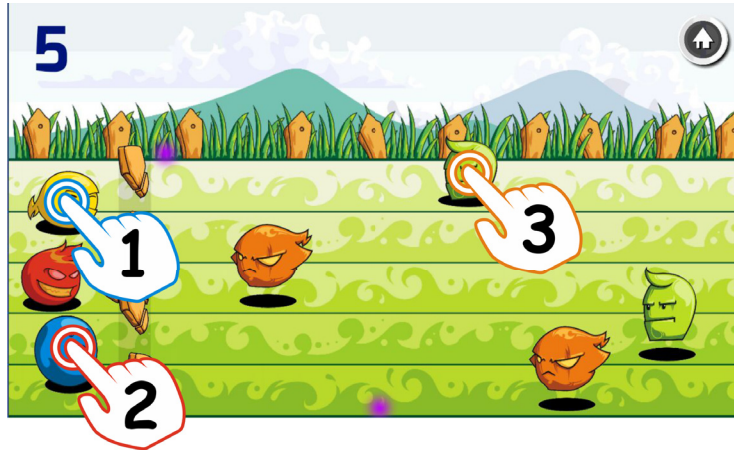So from the data in Table 2, we can map the speed of thinking players as in figure 7.
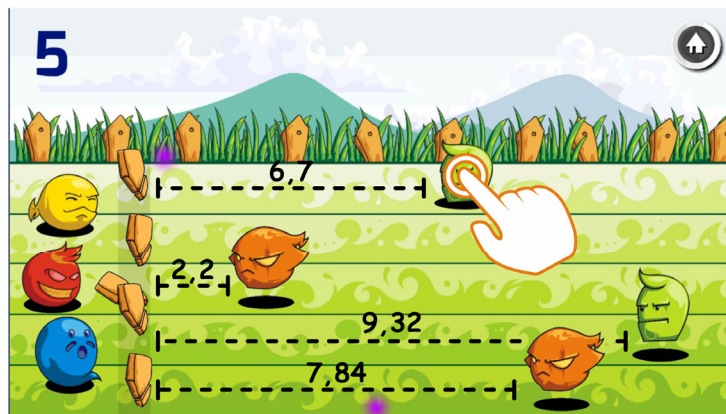
Fig. 5. How To Play CoMiG.

Fig. 6. How To Play CoMiG.

Table 2. Example of log data of player's activity

| Id_Player	Enemy	Attack color	Condition	Score	Distance	Time
33	Orange	Orange	RIGHT	1	6,8202	13.55.33
33	Purple	Purple	RIGHT	2	8,4802	13.55.40
33	Green	Orange	WRONG	2	0,7601	13.55.43
33	Orange	Orange	RIGHT	3	4,1002	13.55.48
33	Green	Green	RIGHT	4	4,9602	13.55.51
33	Orange	Orange	RIGHT	5	5,0602	13.55.55
33	Purple	Purple	RIGHT	6	10,8802	13.55.58
33	Green	Orange	WRONG	6	4,0002	13.56.00
33	Green	Green	RIGHT	7	0,4201	13.56.03
33	Purple	Purple	RIGHT	8	9,2402	13.56.05
33	Green	Green	RIGHT	9	2,4201	13.56.09
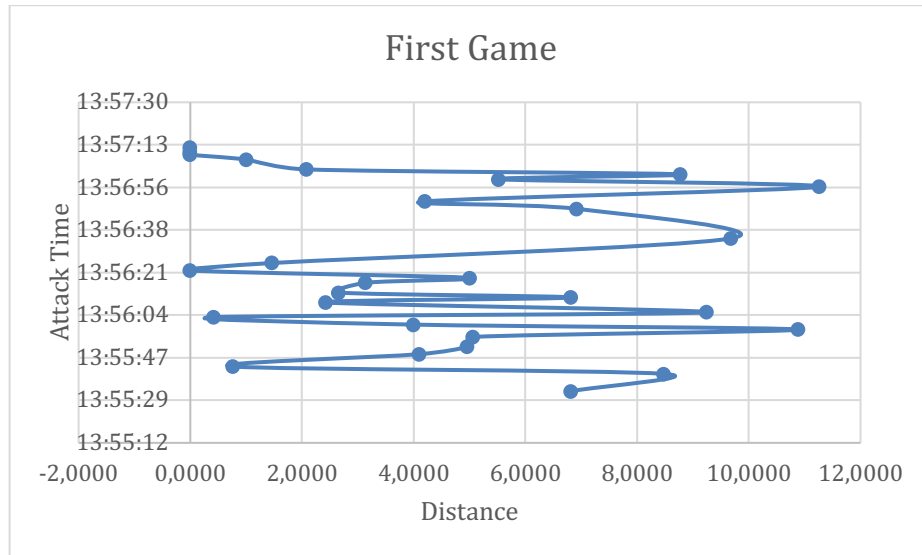
Fig. 7. Player Behaviour in the first game

In figure 5, "Distance" is the distance between the attacked enemy and the fortress. So it can be seen a graph of the player's thinking speed from the beginning until the game ends. After getting the data, then we can compare it with their second game. Then the comparison can be seen in figure 8.
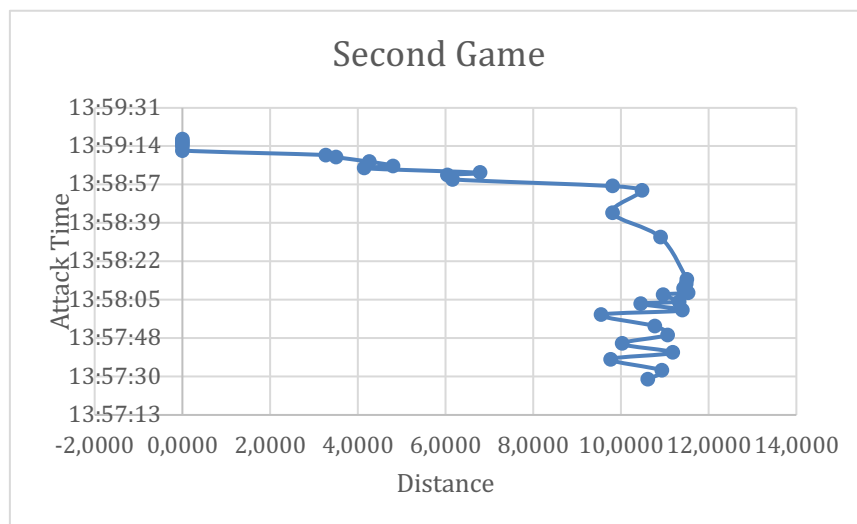

Fig. 8. Player Behaviour in the first game

In Figure 6 it can be seen that the average distance of the enemy being attacked tends to be more distant than the first game. So it can be concluded that in the second game

the players tend to have better-thinking speed. To make sure we have to calculate the difference between the average enemy distance in the first game and the second one. The result of the calculation of the difference in the enemy's distance determines the size of the improvement in the speed of thinking skills of each player in this game. Then the results can be seen in table 3.

Table 3. Quick Thinking skill improvement

id_player	Average of enemy distance		Difference	% improvement
	first game	*Second game*		
24	5,306822778	8,423764051	3,116941274	58,73
25	4,362493765	5,927380167	1,564886402	35,87
26	5,344433929	8,36717942	3,022745491	56,56
29	6,755891095	7,610409395	0,8545183	12,65
30	6,289835484	7,734075385	1,444239901	22,96
31	4,64737275	5,756151667	1,108778917	23,86
32	6,117298829	6,328037758	0,210738929	3,44
33	4,488000286	7,691073939	3,203073654	71,37
34	7,316627435	8,22426	0,907632565	12,41
35	4,800792452	5,863190606	1,062398154	22,13
	Average of skill improvement			32,00

So according to table 3, it can be concluded, that all players experience an improvement in speed thinking skill. And the improvement average of 10 respondents is 32% increase.

6   Conclusion

CoMiG has succeeded in becoming a successful learning media to have a positive impact on its players. In addition as a medium for learning about color mixing theory, CoMiG successfully trained the speed thinking ability of the players. According to the log data stored in the database, from the 10 respondents involved and at 2 times the game, the speed of their thinking in this game increased to 32%.

7   References

[1] Li, Renjie, Uri Polat, Walter Makous, and Daphne Bavelier. (2009). "Enhancing the Contrast Sensitivity Function through Action Video Game Training." Nature Neuro- science 12:549–51. https://doi.org/10.1038/nn.2296

[2] Anderson, Ashley F., Daphne Bavelier, and C. Shawn Green. (2010). "Speed-Accuracy Tradeoffs in Cognitive Tasks in Action Game Players." Journal of Vision 10: 748. https://doi.org/10.1167/10.7.748

[3] Trick, Lana M., Fern Jaspers-Fayer, and Naina Sethi. (2005). "Multiple-Object Track-ing in Children: The 'Catch the Spies' Task." Cognitive Development 20:373–87. https://doi.org/10.1016/j.cogdev.2005.05.009

[4] Chiappe, Dan, Mark Conger, Janet Liao, J. Lynn Caldwell, and Kim-Phoung L. Vu (2013). "Improving Multi-Tasking Ability through Action Videogames." Applied Er-gonomics 44:278–84. https://doi.org/10.1016/j.apergo.2012.08.002

[5] Anderson, Ashley F., Daphne Bavelier, and C. Shawn Green. (2010). "Speed-Accuracy Tradeoffs in Cognitive Tasks in Action Game Players." Journal of Vision 10: 748. https://doi.org/10.1167/10.7.748

[6] Qiu, Y., (2016). Game Theoretic Framework for Studying WBAN Coexistence: 2-player Game Analysis and n-player Game Estimation.

[7] Ueno, M., (2015). Development of Game Player Analysis with Physiological Indexes.

[8] Benmakrelouf, S., (2015). Towards the identification of players' profiles using game's data analysis based on regression model and clustering.

[9] Abhishek, A., (2015). Stress analysis of a computer game player using electroencephalo-gram.

[10] Elia Supriani, P. R. Y. S., (2013). Penereapan Pengetahuan Tentang Pencampuran Warna Melalui Metode Bermain Untuk Meningkatkan Kreativitas Anak Kelompok B TK Mutiara Tahun Ajaran 2013/2014. Penereapan Pengetahuan Tentang Pencampuran Warna Melalui Metode Bermain Untuk Meningkatkan Kreativitas Anak, Volume 1, p. 8.

8   Authors

Ahmad Fairuzabadi is a Student in Faculty of Computer Science, Brawijaya University. (email: zabedhasekar@gmail.com)

Ahmad Afif Supianto is a Lecturer in Faculty of Computer Science, Brawijaya University. He is also Coordinator of Technlogy-Enhanced Learning Research Group (email: afif.supianto@ub.ac.id)

Herman Tolle is a Lecturer in Faculty of Computer Science, Brawijaya University. He is also Coordinator of Multimedia, Games, and Mobile Technology Research Group. (email: emang@ub.ac.id)