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Level Design of Platform Games Using Interest Curves

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Abstract

In this study, the user experience for level design with or without an interest curve was examined for a platform game, "Super Mario Maker 2", one of the most popular platform games. Two different types of stages with nine segments within the game were created and customized based on an interest curve with ups and downs and a gradually increasing difficulty curve. In addition, a total of 20 participants were divided into two groups, each with 10 people playing a type of the game and taking a questionnaire on the player's satisfaction and immersion. As a result, it was confirmed that the average values of satisfaction and immersion for the interest curve-based level design were 3.79 and 3.99, respectively, higher than the average values of satisfaction and immersion for the sequential level design of 3.59 and 3.84.

Keywords: Level Design, Platform (Video) Games, Interest Curves, Flow, Difficulty, Challenges.

I. INTRODUCTION

This research performs comparative evaluation on the gameplay experiences of a platform game, when the degree of difficulties of its levels is designed based on the interest curves with ups and downs or a steadily increasing trend. Interest is one of the most important key components of a gameplay. The word, interest is the feeling of wanting to give your attention to something or of wanting to be involved with and to discover more about something [1]. The interest in a game can immerse players into the game for a long time [2]. The interest a player feels through the game may be interest in the story, it may be the emotion that comes from the process of acquiring new skills or solving problems, and it may be derived from the rewards obtained by solving a challenge.

Csikszentmihalyi [3] recognized and named the psychological concept of flow for a highly focused mental state conducive to productivity that comes from the creative sense of accomplishment and heightened function and insisted that the balance between the challenge and the player's ability is effective in sustaining the flow.

Schell [4] highlights the importance of properly placing hook points over time. The quality of an entertainment experience can be measured and explained by the extent to which its unfolding sequence of events is able to hold a guest's interest. He introduces a successful interest curve that allows game players to start with a little interest in the game when they encounter the game, and quickly experience a hook point with gradually increasing attention, then experience a decisive hook just before the end of a stage.

In a game, a level is one of the most influencing elements that are strongly involved in the player's immersive and interesting experiences. Therefore, the level design of the game is very important. As Csikszentmihalyi mentioned, level design should increase the level of difficulty gradually with the prospect of increasing the player's ability for an immersive experience. However, in addition to this, as suggested by Schell, it can be assumed that in order to maintain the interest of the player, it is necessary to include hooks at appropriate points rather than sequentially increasing the difficulty level. Therefore, in this study, the levels of a platform game, Super Mario Maker 2, were designed by controlling the difficulty level and the reaction of the player to the level design using the interest curve was examined.

II. RELATED RESEARCH

This section describes research related to interest curves used in level design of platform games. To this end, the platform game and various elements that affect the difficulty of the game are discussed.

II.I Interest Curves

Dewey [5] defined interest as "influence of object upon personal advantage" and described it as "a state of being completely immersed in thinking that an activity is valuable." Interest has an active and dynamic nature, has an object, and is said to be a self-expression activity for the object. In particular, he said that when users realize that two different phenomena or facts are related to each other, interest can be maintained continuously. In other words, the special experience in the process of obtaining the desired result continues to arouse interest rather than obtaining the desired result quickly and accurately.

The interest curve can be viewed as a sequence of stages in which a game is played, that is, a process of the player's play experience. Schell [6] said that the interest curve of successful entertainment starts with a certain degree of interest in the public at point A, and then goes to point B, which is called hook.

In this case, both A and B hooks give hints to the future development and helps keep attention in the C through F sections. And he said that he was satisfied with and the experience was over at point G, which is a kind of climax, and point H, which is the end [6] (Figure 1).

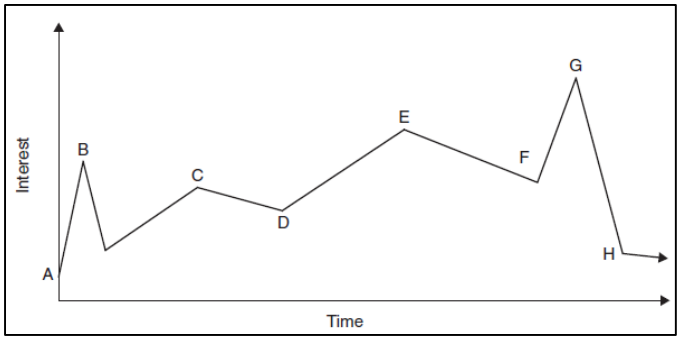


Fig. 1. Interest Curve

A game experience with a long-playing time can also be expressed as one interest curve, and the entire interest curve can be formed in a fractal shape including several sub-interest curves (Figure 2). The aesthetic elements, challenges, levels, and difficulty that increases as the stage progresses are directly involved in the interest curve, and the interest curve of the entire game composed of these elements repeats various sub interest curves as shown in Figure 2.

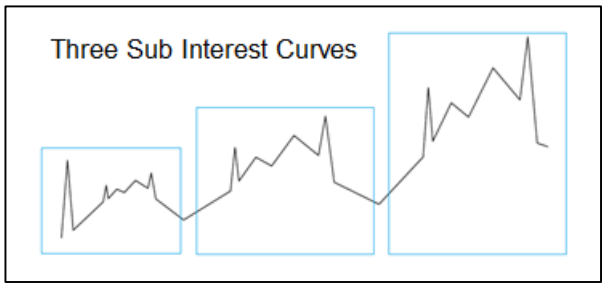


Fig. 2. Fractal Interest Curve

II.II Level Design Elements of Platform Games

Platform games are a subclass of action games, and are games played based on platforms. Nintendo's Super Mario game is a representative example of a platform game, in which a playable character runs or jumps on a block-shaped platform while moving, defeating enemies, or passing obstacles [7].

Level design refers to the design of the arrangement of elements that make up the game, and includes spatial structure and stage composition, scenarios, monster placement, and player manipulation.

Difficulty adjustment is the most important task in level design, and it is to appropriately adjust the player's experience of challenge and success based on the elements that compose gameplay. Difficulty is determined by the relationship of game objects such as enemies, bosses, obstacles, and rewards, but it can be said to be an experience evaluated through interaction with the player playing it.

Rollings and Adams [8] explained that there are various challenges such as physical challenges, logic and inference challenges, lateral-thinking challenges, memory challenges, intelligence-based challenges, knowledge-based challenges, pattern-recognition challenges, moral challenges, and spatial-awareness challenges, coordination challenges, reflex/reaction time challenges, and many applied challenges, and gameplay is the process of solving a series of challenges presented in the game. Platform games such as the Super Mario series are games with a high frequency of pattern recognition challenges. Character movement, end-of-game boss attacking, and pauses proceed according to patterns, and players can easily control the game by recognizing and learning these patterns.

Earlier, Dewey [5] explains that when users realize that two different phenomena or facts are related to each other, interest can be maintained. According to Dewey's argument, the pattern recognition task in platform games is a task related to the difficulty level, and it is also a significant factor that helps the player to continue to play the game with interest.

Sorenson and Pasquier [9] target the Super Mario Bros. game. The main six elements that compose the level include block, pipe (height and plant piranha), hole (width), staircase (height, direction), platform (width) and enemy. Each game level determines weights for these elements and combines them with a genetic algorithm to create a game level. The overall difficulty of each game level is calculated as the sum of these factors.

As the researchers pointed out, the difficulty of the game includes interactions with the player, such as elements of challenging objects of the game content, the player's operation ability, and the degree of understanding of learning tasks.

In platform games, the size of the map and object composition, player manipulation according to the characters' movement and attack method, and the player's learning intensity for the game progress are the basic elements of the difficulty setting, and various difficulty levels can be realized through a combination of these elements.

III. SUPER MARIO LEVEL DESIGN

Nintendo's Super Mario Maker 2 game is a game where players can create maps, various objects, and enemies, and play with other players. The game consists of maps made of tiles and objects and allows players to construct maps and objects to create stages, and to play with other players with their own designed game. For this study, two different types of stages were created: one with a stage in which the degree of difficulty gradually increases and the other with a stage to which a level design using an interest curve is applied.

The size of the map of the stage was determined and divided into nine sections at random. The learning contents necessary for the game progress including the pattern recognition task were adjusted, and the player operation method according to the movement and attack method of the character was designed. Finally, the difficulty of the nine sections of the stage was adjusted through a combination of object composition, player control method, and learning task.

The size of the map is determined by how many tiles can be placed at the maximum. The map used in this experiment is composed of a total of 648 tiles with 24 horizontally and 27 vertically in one region. If one tile is both horizontal and vertical 1 meter, the total of 9 regions of one stage is 216 meter long and 243 meter long, and the total number of tiles used is 52,488.

Table 1. Types of terrain and difficulty

ID	Terrain	Properties				Difficulty
		Move	Height	Speed	Attack	
T1	Ground					0
T2	Gentle Slope		1			1
T3	Steep Slope		2			2
T4	Mushroom	1	1	1		3
T5	Spike Trap			1	1	2
T6	Block				1	1
T7	Ice Block			1	1	2
T8	Hard Block				1	2

Table 2. Types of enemies and difficulty

ID	Enemies	Properties					Difficulty
		Move	Speed	Dire-ction	Length	Power	
E1	Goomba	1					1
E2	Koopa Troopa	1				1	2
E3	Piranha Creeper		1	1		1	3
E4	Chain Chomp	1	1		1	1	4
E5	Koopa	1	1	1	1	2	6

Table 3. Types of obstacles and difficulty

ID	Obstacles	Properties					Difficulty
		Move	Repeat	Dire-ction	Range	Power	
O1	Burner		1	1	2		4
O2	Magnum Killer	1	2	2	1		6
O3	Cannon		1	2		1	4
O4	Icicle	1		2			3
O5	Twister	1		1		1	3
O6	Grinder				1	3	4

Objects include terrain, enemies, and obstacle devices. The terrain used in the experiment was ground, gentle slope, steep slope, mushroom terrain, spike trap, block, ice block, and hard block (Table 1). The enemies are Goomba, Koopa Troopa, Piranha Creeper, Chain Chomp, Koopa (Table 2), and obstacles include burner, Magnum killer, Cannon, Icicle, Twister, and Grinder (Table 3).

Difficulty of each terrain type is dependent on the mobility, height, speed, and attack power. Enemies uses the mobility, speed, attack direction, distance, and attack power. Obstacle associated difficulty depends on the mobility, repetition, attack direction, life range, and attack power.

The character's movement method is closely related to the player's operation skill, and the degree of difficulty is determined according to the difficulty of the operation technology that defines the movement method. Manipulation skills are also related to the character's attack behavior, and there are cases where it has to move while attacking. There are six different types of movements used in this experiment. Similarly, movements and attacks are combined as the six different cases. Difficulty in movement and attack is related to jumping, continuity, obstacles, attack skills, and stepping skills (Table 4).

Table 4. Controlling skills and difficulty

List	Move			Repeat	Attack		Difficulty
	Low jump	High jump	Obs-tacle		Attack	Tread	
C1	1						1
C2	1		1				2
C3		2					2
C4		2	1				3
C5		2		1			3
C6		2			2		4
C7	1					2	3
C8				1		2	3
C9	1			1		2	4
C10	1		1		2		4
C11	1			1			2
C12	1				2		3

The learning intensity refers to the degree to which the player understands the game's world and the rules or game skills he needs to know to play the game. Usually, for experienced players, the learning ability is excellent, so gameplay is not difficult, but unskilled players may find it difficult to play the game.

There are 13 learning contents related to understanding the movement and objects for this experiment. However, most of them are mastered when experienced repeatedly, and if they are repeated three or more times, it does not significantly affect the difficulty. Therefore, in the case of the same learning challenge, only 2 times were included when setting the difficulty level.

Table 5. Learning contents and difficulty

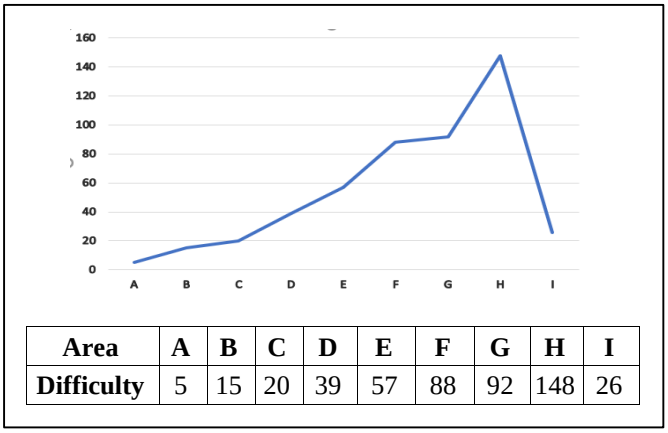
List	Learning contents	Difficulty
L1	Movement restriction by terrain height	1
L2	Attack by stepping on the enemies after jumping	2
L3	Attack by additional operation after jump attack	3
L4	Adjusting jump distance	3
L5	Usage of game maker blocks	1
L6	Checking the effect of items	2
L7	Further attacks using items	2
L8	Identify attack types of enemies	2
L9	Identify devices that cannot be attacked	2
L10	Identify devices that can be attacked	2
L11	Check for fixed devices	2
L12	Check for mobile devices	2
L13	Identification of devices that help the character move	2

Table 6. Level design with A to I segments

Area	Elements of level Design			Difficulty
	Object	Control Skill	Learning	
A	T1	C1*2, C3	L1	5
B	T1, (E1*2)*2	C1*2, C2*2, C3*2	L1	15
C	T1, E3*2	C2, C4*2	L1, L4, L8	20
D	T1, (E1*2)*2, E4, O1	C2*2, C3, C4, C7, C12	L2, L3, L4, L9, L11	39
E	T1, (T2*2)*2, (T3*2)*2, E1*2, E2, O6*2	C4*3, C5*2, C7, C10, C12	L1, L2*2, L3, L9	57
F	T1, E4*3, (O1*2)*3, E3*4	C2*4, C3, C5, C12*3	L3, L4, L8*2, L9*2, L11*2	88
G	T1, (T4*4)*2, (O4*5)*2	C4*3, C5*3, C9, C12	L2, L4, L8*2, L12*2	92
H	T1, (O3*5)*2, O4*5	C2*6, C5*5, C9*5, C12*6	L2*2, L4*2, L8*2, L11*2, L12*2	148
I	T1, E5	C4*2, C12*3	L4, L8	26

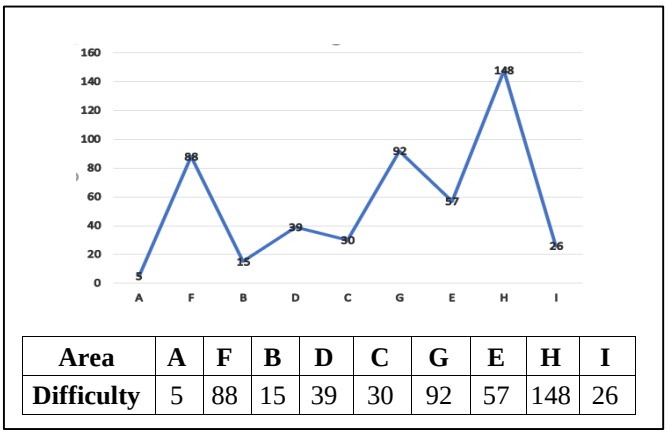
In order to examine the player's reaction to the level design using the interest curve, one stage was divided into nine segments from A to I, and each segment was designed with different difficulty levels (Table 6).

Afterwards, two stages were produced based on the gradually increasing difficulty levels (Figure 3), and an interest curve with ups and downs (Figure 4).



Area	A	B	C	D	E	F	G	H	I
Difficulty	5	15	20	39	57	88	92	148	26

Fig. 3. Level Design with Increasing Difficulty



Area	A	F	B	D	C	G	E	H	I
Difficulty	5	88	15	39	30	92	57	148	26

Fig. 4. Level Design with Interest Curve

IV. EXPERIMENTS

This section looks at the user experiences with the customized platform game using Super Mario Maker 2. The experiments were performed by 20 users who were classified into two groups and played a stage designed with or without an interest curve. They answered a questionnaire on play satisfaction and immersion experience after playing one of the two stages.

IV.I Game Setting

One stage with gradually increasing difficulty levels and the other stage designed based on an interest curve with ups and downs were produced. A total of 20 experimenters who knew about the Super Mario game were divided into groups A and B of 10 each, and the experiment was conducted in November 2020. Group A played the stage designed based on the interest curve, and group B played the stage with gradually increasing difficulty levels.

IV.II Survey

The satisfaction questionnaire consists of a total of 12 questions on a 5-point scale of 2 questions on difficulty appropriateness, 3 questions on operability, 3 questions on motivation, and 4 questions on fun. The Flow State Scale-2 (FSS-2), which is an immersion state scale developed by Jackson and Martin [10], was used for the immersion test. It is a measure composed of 36 questions each with 4 questions. FSS-2 is an assessment developed by abbreviating FSS and developing a total of 9 questions on a 5-point scale. The reliability of FSS-2 was reported as an average of .77 for each item.

IV.III Results

IV.III.I Difficulty

Table 7 shows the average number of attempts until users pass each segment of both stage types. The average numbers of attempts in each section from both stages are similar to each other. In addition, the number of attempts in sections A to I increases gradually, and through this, it is possible to confirm that the levels of each region are designed as planned.

Table 7. Average number of attempts to pass each segment

Segment	Stage with Sequential Difficulty		Stage with Interest Curve	
	Order	Mean	Order	Mean
A	1	2	0	0
B	2	5	5	5
C	3	10	7	7
D	4	19	19	19
E	5	20	18	18
F	6	18	19	19
G	7	38	29	29
H	8	30	35	35
I	9	9	10	10

In the interest curve-type level design, the number of attempts of the experimenters in each section is plotted as Figure 5. This looks like the interest curve presented in Figure 4.

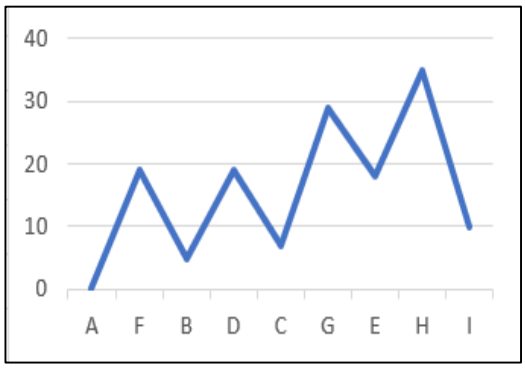


Fig. 5. Average attempts in each segment of the stage designed with the interest curve

IV.III.II User satisfaction and immersion

As a result of satisfaction survey, the overall average of group A who played the stage with levels designed based on of the interest curve was 3.79, which was higher than that of group B who played the stage of sequential level design.

Comparing the averages of each factor, there is no significant difference between the two groups in the case of achievement and motivation, but the satisfaction of group A was pretty high in terms of the adequacy of the difficulty level arrangement, the feeling of operation, and the fun (Table 8).

Table 8. Assessment result on the user satisfaction

Factors	A Group	B Group
Difficulty satisfaction	3.5	3.25
Control	3.7	3.3
Achievement & Motivation	3.9	3.9
Fun	4.08	3.9
Total mean	3.79	3.59

Looking at the results of the immersion questionnaire, group A showed an overall average of 3.99, higher than group B's 3.84. Looking at each factor, there was no significant difference between the two groups, but the average of Group A was clearly high in challenge-skill balance, clear goals, and loss of self-consciousness (Table 9).

Table 9. Result of the flow state scale-2 (FSS-2)

Factors	A Group	B Group
Challenge-Skill Balance	4.0	3.2
Action-Awareness Merging	3.4	3.6
Clear Goals	4.4	3.9
Unambiguous Feedback	3.6	3.7
Concentration on Task	4.4	4.6
Sense of Control	3.6	3.5
Transformation of Time	4.4	4.4
Autotelic Experience	3.8	3.8
Loss of Self-Consciousness	4.3	3.9
Total mean	3.99	3.84

V. DISCUSSION AND CONCLUSION

In this study, two types of stages of a platform game, Super Mario Maker 2, were built using a sequentially growing difficulty levels and an interest curve-based levels with ups and downs. To show the effectiveness of the proposed approach in designing a game stage using the interest curves, both game

stages were played by 20 experimenters by dividing them into two groups. According to the post experiment survey, it was observed that both satisfaction and immersion criteria were high in the stage with levels designed based on the interest curve with intermediate up and down hooks.

In the satisfaction survey, in particular, the high score of 4.08 for fun, as Schell said [6], is a result of supporting the need for hooks at appropriate timing rather than sequential increase in difficulty in order to maintain the public's continued interest in entertainment.

The high measurement value of participants' challenge-skill balance reflects their confidence in their ability. The high scale of participants who experienced the interest curve type seems to be caused by the relatively easy levels found in the middle of the stage. This strategy could remove the burden or fear of the continuous hardship in playing the game, help users control the gameplay independently and enjoy the game. These seem to be reflected in the clear goal criterion by the user group A who played the interest curve type stage. It can be said that you can play by deciding what you want to achieve in the game without burdening your own abilities.

Through this study, it was possible to confirm that the positive evaluations of players about the level design using the interest curve. Nevertheless, this study has a limitation that these results were derived through too few experimental groups. This study should be reinforced through additional experiments conducted by more participants.

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