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Fuzzy Smart Reward for Serious Game Activity Design

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Abstract.
Purpose: Serious game has been widely considered to be a potential learning tool, due to its main advantage to provide fun experience in learning. The experience is supported mainly by in-game activities, where feedback is given in the form of rewards. However, rewards often don't work well due to various factors, for example, rewards are always the same, so they are monotonous. We use Appreciative Learning as underlying concept for activity design and fuzzy logic to create the reward behavior, called Fuzzy Smart Reward.
Methods: We use Appreciative Learning as underlying concept for activity design and fuzzy logic to create the reward behavior. Appreciative Learning activities consists of Discovery, Dream, Design and Destiny. We propose fuzzy-based smart reward for those activities. The smart reward takes player achievement in each activity as input for the fuzzy inference system and give the dynamic reward as output.
Result: A game prototype is developed as a test subject. The result shows that the smart reward could dynamically adjust the reward based on game condition and player performance. Test conducted using Game Experience Questionnaire get the score 3.3 out of 4.
Novelty: There aren't many studies on dynamic rewards in structured reward systems; the majority of studies remove dynamic rewards from reward systems. In our research, a "smart reward" is a dynamic reward in a structured reward system that is created using artificial intelligence and is based on activities for appreciative learning. The use of Fuzzy Logic for structured reward behavior is also very rare.

Keywords: Appreciative learning, Fuzzy logic, Game activity design, Reward, Serious game
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INTRODUCTION

Interactive learning has become important tool, especially after the Covid 19 pandemic era [1]. Serious game has been widely considered to be a potential interactive learning tool. This is because of its main strength to provide fun experience [2]. Experience is important to enhance the engagement that led to the understanding about the subject [3]. In serious game, the experience mainly produced by game activities. Activities are one of the main elements of serious game, usually takes form as mission or quest [4]. However, according to [5], the design of activities in serious games is still not well conceptualized. This research uses and adapt the Appreciative Learning as underlying concept for game activities.

The term Appreciative Learning first mentioned by [6] as a new pedagogical approach, derived from Appreciative Inquiry concept. Still from the same researcher, the Appreciative Learning is proposed by [7] to enhance creative perception of secondary school children and to improve computer games development class [8]. Our research is the first to adapt this approach for serious game activity design, we call it Appreciative Serious Game. Appreciative Serious Game consists of four main activities: Discovery, Dream, Design and Destiny. Exploration is the main activity of the Discovery stage. In the Dream activity, player will formulate the objective based on the findings in Discovery activity. Player works towards the objective in Design activity. Finally, Destiny activity is about the achievement of the objective. Figure 1 shows the Appreciative Serious Game activity framework.

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Figure 1 Appreciative Serious Game activity framework

We propose Fuzzy Smart Reward to improve challenge-based immersion experience. Reward is the main feedback for challenge-based immersion experience. Therefore, reward system in serious game should be designed carefully. Research by [9] stated that only a combination of well-designed reward resulted in good learning outcome. Reward provides appreciation for player's right choice, therefore it is like a guidance to do what is right. The problem arise if reward is too easy to predict, that can lead to boredom [10]. To solve the problem, there are research that focus on how to design dynamic reward, that can change according to the achievement of the player. Research conducted by [11] discuss about adaptive reward on mobile-based serious game of health care providers. Dynamic rewards depends on the player achievement criteria, that could be used as input. Lavoue et. al. [12] suggested the importance of reward that can adapt dynamically in a learning environment. Research about dynamic reward conducted by Lopez & Tucker [13] using artificial intelligence to develop personalized reward system. Dynamic reward using artificial intelligence was also carried out in a research by Tondello et. al. [14] to make recommendation in a gamification system. There aren't many research about dynamic reward in the structured reward system, most research separated between dynamic reward and reward system. Smart reward in our research means dynamic reward in a structured reward system, which we use artificial intelligence to form dynamic reward in structured reward system based on Appreciative Learning activities.

We use fuzzy logic as the main method in the smart reward. Fuzzy logic is suitable for games, especially for reward, because it could produce expressive intelligent agent behaviour [15] by allowing any value between 0 (false) and 1 (true). However, the use of Fuzzy Logic for structured reward behaviour is very rare, so far we found only our research that utilized fuzzy logic for reward behaviour [16]. Fuzzy logic in game mainly used to control Non-playable Character (NPC) behaviour, as stated by [17], [18] to map player characteristic and performance [19] to develop user interface for exergame [20]. In the term of game design, research conducted by [21] utilized fuzzy logic to control the behaviour of game parameter, and [22] use fuzzy logic for dynamic difficulty.

The main contribution of this research is to provide smart reward using fuzzy logic for activities in Appreciative Serious Game. This paper is organized in four sections. Section 1 explain about the motivation of this research and provide related work in this field of study. Section 2 discuss about the research method, the architecture of Appreciative Serious Game, smart reward design and detail of the fuzzy system. Section 3 presents the experiment result, and finally Section 4 give the conclusion and future work of this research.

METHODS

Regarding how to achieve contribution and research objectives to provide smart reward for activities in Appreciative Serious Game, this research is conducted in four steps, which consists of the architecture of Appreciative Serious Game, smart reward design, the design of the fuzzy system, implementation and game experience measurement using Game Experience Questionnaire (GEQ).

Serious Game

Serious games are digital games that have other purposes besides entertainment [23], these goals include education. Serious games have the advantage of providing a fun learning experience so that material can be more easily understood, especially for early childhood education [24]. For education, [2] and [25] using games to preserve culture and historical heritage. In another field, namely entrepreneurship learning, [26]

finds that games are a tools that can convey material that requires practice or experience. This is in line with research by [27] which uses games for learning that is dominated by practice, in this case learning programming. This shows that serious games are a potential tool for training and simulation. in his research also found that by using games, learning material can be remembered by students for a longer time.

Architecture of Appreciative Serious Game

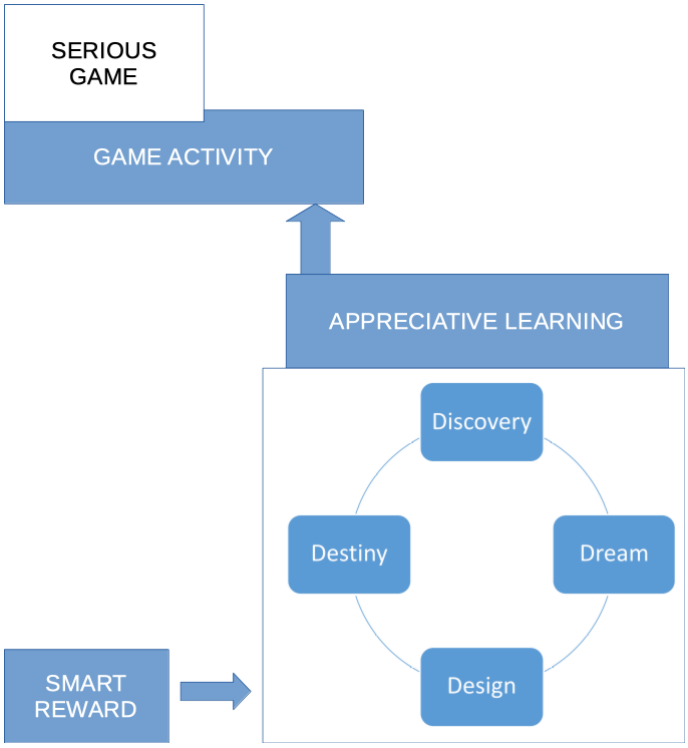

Figure 1. Appreciative Serious Game Architecture

Fig. 1 presents the architecture of Appreciative Serious Game. Appreciative Learning is the underlying concept for game activity in serious games. Appreciative Learning consists of Discovery, Dream, Design, and Destiny. Discovery is related to exploration and discovery activity; the Dream is to formulate the objective from the findings in the Discovery activity. The main gameplay of Appreciative Serious Game lies in the Design activity, where the player will finish the quest to fulfil the objective. Finally, Destiny activity is about an event or feedback after the player achieves the objective. The smart reward will develop an intelligent reward for each activity. Table 1 shows the detail of each activity.

Table 1. Details of each Appreciative Serious Game activity

Activities	Details
Discovery	Explore the area, interact with Non-Playable Character, interact with game objects
Dream	Find objectives, choose objectives
Design	Gather resources/items, finish the quest
Destiny	Complete objectives, get game event, get bonus

Discovery activity is the exploration on the safe area to interact with Non-Playable Characters (NPCs) and objects. In safe area, the player can safely explore and interact with the Non-Playable character (NPC) and the game object / environment. The findings of this activity will be the basis for choosing the objectives in the Dream activity. In the Design activity, player will finish the quest an gather the resources / items. Player will have the feedback for the completed objectives in the form of game event or bonus in the Destiny activities.

Smart reward design

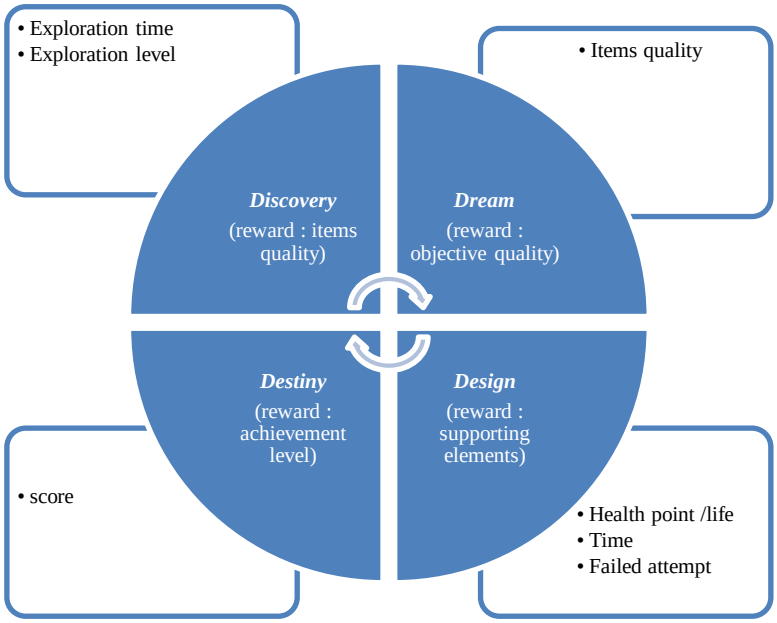

Figure 2. Smart reward design

Fig. 2 shows the smart reward design related to each activities in Appreciative Learning. Reward in Discovery activity is items quality. The exploration time and exploration level will determine the items quality found in this activity. In the Dream activity, the reward is objective quality. The items quality that founded in the Discovery activity will determine the objective quality. The higher objective quality have more attractive reward. Then the Design activity, where the main gameplay take place, the reward is supporting elements to help player overcome the obstacles. The supporting elements depends on three main parameters: Health point/life, time, and failed attempt. The score obtained from this activity will be used for Destiny activity. The score will determine the achievement level. Each reward from each activity will be used for the next activity. Regarding the parameter used in each activity, we use activity design principle from [4].

Fuzzy system for smart reward (Fuzzy Smart Reward)

There are four fuzzy system for all Appreciative Serious Game activities. The development of the fuzzy system consists of three stages: fuzzification, inference and defuzzification. In the fuzzification stage, we have membership function of input and output for each activity. We determine the variable and value for each membership function according to the research by [24]. There are three main components of game design patterns. These three elements are time constraint, limited resources, and turns. Time constraint, as the name suggest, is about time limitation to do some activity. Limited resources are about finite number of item or other resources. Turns means the game provide mechanic to switch between different game element. Table 2 shows the membership functions for each activity and the correlation with game design pattern components.

Table 2. Membership function for each Appreciative Serious Game activity

Activities	Membership Function	Component of Game Design Patterns
Discovery	Input: exploration level	Turns
	Input: exploration time	Time constraint
	Output: items quality	Limited resources
Dream	Input: items quality	Limited resources
	Output: objective quality	Limited resources
Design	Input: Health point / life	Limited resources
	Input: time	Time constraint
	Input: failed attempt	Turns
	Output: supporting elements	Limited resources
Destiny	Input: score	Turns
	Output: achievement level	Turns

The range for each fuzzy linguistic variable value determined using symmetric ratio principle of game balancing [28]. For Discovery activity, we have membership function for exploration level (LVL_EXP) and exploration time (TIME_EXP). The exploration level (in percentage) is how far or how many the exploration done by the player. It may be seen from the number of areas visited, how many button that the player clicked, or the number of item collected. Membership function for exploration level is shown in Fig. 3.

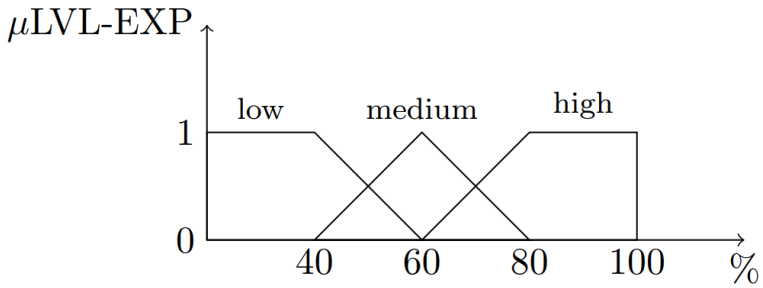

Figure 3. Membership function for exploration level

From Fig. 3, we can calculate exploration level (LVL_EXP) degree of membership (μ) for input (x) for each linguistic variables using Eq. (1).

$$\mu Low[x] = \begin{cases} 1, & 0 \le x \le 40 \\ \dfrac{60-x}{60-40}, & 40 < x < 60 \\ 0, & x \ge 60 \end{cases}$$

$$\mu Medium[x] = \begin{cases} 1, & x = 60 \\ \dfrac{x-40}{60-40}, & 40 < x < 60 \\ \dfrac{80-x}{80-60}, & 60 < x < 80 \\ 0, & 0 \le x \le 40, x \ge 80 \end{cases}$$

$$\mu High[x] = \begin{cases} 1, & 80 \le x \le 100 \\ \dfrac{x-60}{80-60}, & 60 < x < 80 \\ 0, & 0 \le x \le 60 \end{cases} \quad (1)$$

The exploration time (TIME_EXP) shows how much time the player has spent for exploration. We use three linguistic variable: Fast, Normal, and Slow. The exploration time membership function is shown in Fig. 4.

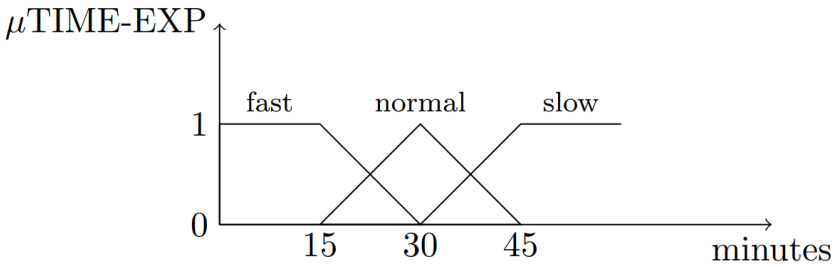

Figure. 4 Membership function for exploration time

The calculation of exploration time degree of membership (μ) for input (x) for each linguistic variable is shown in Eq (2).

$$\mu Fast[x] = \begin{cases} 1, & 0 \le x \le 15 \\ \dfrac{30-x}{30-15}, & 15 < x < 30 \\ 0, & x \ge 30 \end{cases}$$

$$\mu Normal[x] = \begin{cases} 1, & x = 30 \\ \dfrac{x-15}{30-15}, & 15 < x < 30 \\ \dfrac{45-x}{45-30}, & 30 < x < 45 \\ 0, & 0 \le x \le 15, x \ge 45 \end{cases}$$

$$\mu Slow[x] = \begin{cases} 1, & x \ge 45 \\ \dfrac{x-30}{45-30}, & 30 < x < 45 \\ 0, & 0 \le x \le 30 \end{cases} \quad (2)$$

Fig. 5 shows the membership function for output of the Discovery activity, items quality. It has three linguistic variable: poor, average and awesome.

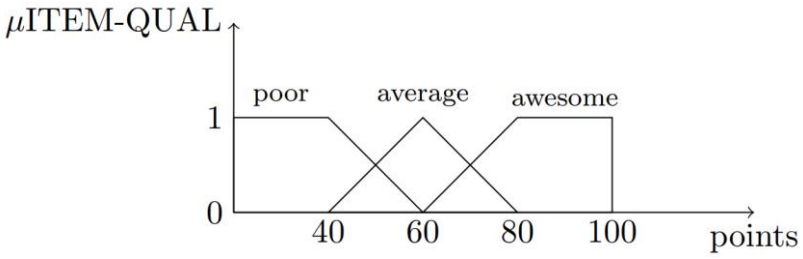

Figure. 5 Membership function for items quality

Table 3 shows the rules that are formed to determine the item quality (ITEM_QUAL) based on the percentage of exploration level (LVL_EXP) and exploration time (TIME_EXP) calculated. Because we use AND operator, the consequent value will be the minimum value of membership degree between antecedents.

Table 3 shows the rules that are formed to determine the item quality (ITEM_QUAL) based on the percentage of exploration level (LVL_EXP) and exploration time (TIME_EXP) calculated. Because we use

AND operator, the consequent value will be the minimum value of membership degree between antecedents.

Table 3. Rules for discovery activity

IF (antecedents)		THEN (consequent)
Exploration Level (LVL_EXP)	**Exploration Time (TIME_EXP)**	**Items quality (ITEM_QUAL)**
Low	Fast	Poor
Low	Normal	Poor
Low	Slow	Average
Medium	Fast	Average
Medium	Normal	Average
Medium	Slow	Awesome
High	Fast	Average
High	Normal	Awesome
High	Slow	Awesome

In Dream activity, the item quality will become the objective quality. It means the value of items quality produced from Discovery activity will become the value of objective quality. Good objective quality will have greater reward than regular objective, however it will be more difficult than the regular objective. The mapping of item quality to objective quality shown in the Table 4.

Table 4. Rules for dream activity

IF (antecedents)	THEN (consequent)
Items quality (ITEM_QUAL)	**Objective quality (OBJ_QUAL)**
Poor	Bad
Average	Regular
Awesome	Good

Next, for the Design activity, the input variable is character health point (HP), time (TIME), and the amounts of failed attempts (FAIL). While the output variable is the support item frequency (ITEM). The output will determine how often the item appears. Fig. 6 is the membership function for character health point (HP).

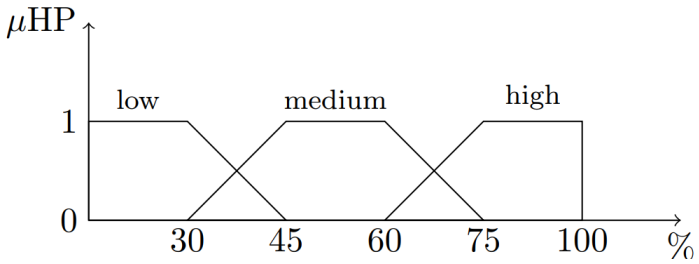

Figure 6. Membership function for character health point

The membership function for character Health Point (HP) is shown in Fig. 6. Low, medium, high are the linguistic variables for this membership function. The degree of membership (μ) for input (x) for each linguistic variable is calculated using Eq (3). It has three linguistic variables: low, medium and high.

$$\mu Low[x] = \begin{cases} 1, & 0 \le x \le 30 \\ \dfrac{45-x}{45-30}, & 30 < x < 45 \\ 0, & x \ge 45 \end{cases}$$

$$\mu Medium[x] = \begin{cases} 1, & 45 \le x \le 60 \\ \dfrac{x-30}{45-30}, & 30 < x < 45 \\ \dfrac{75-x}{75-60}, & 60 < x < 75 \\ 0, & x \le 30, x \ge 75 \end{cases}$$

$$\mu High[x] = \begin{cases} 1, & 75 \leq x \leq 100 \\ \dfrac{x-60}{75-60}, & 60 < x < 75 \\ 0, & 0 \leq x \leq 70 \end{cases} \tag{3}$$

Fig. 7 shows the membership function for time (TIME). TIME is the measurement of the time elapsed since the player starts the game. It has three linguistic variables: Short, Moderate, Long.

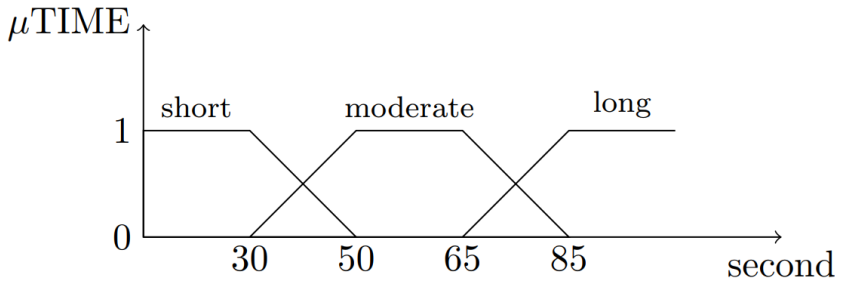

Figure 7. Membership function for time

Eq. (4) is the calculation of Degree of membership (μ) for TIME input (x) for each linguistic variables.

$$\mu Short[x] = \begin{cases} 1, & 0 \leq x \leq 30 \\ \dfrac{50-x}{50-30}, & 30 < x < 50 \\ 0, & x \geq 50 \end{cases}$$

$$\mu Moderate[x] = \begin{cases} 1, & 50 \leq x \leq 65 \\ \dfrac{x-30}{50-30}, & 30 < x < 50 \\ \dfrac{85-x}{85-65}, & 65 < x < 85 \\ 0, & x \leq 30, x \geq 85 \end{cases}$$

$$\mu Long[x] = \begin{cases} 1, & x \geq 85 \\ \dfrac{x-65}{85-65}, & 65 < x < 85 \\ 0, & 0 \leq 65 \end{cases} \tag{4}$$

Fig. 8 is the membership function for the number of failed attempts (FAIL). It has three linguistic variables: rare, occasionally, and often. This membership function represents the number of player's failed attempts or error.

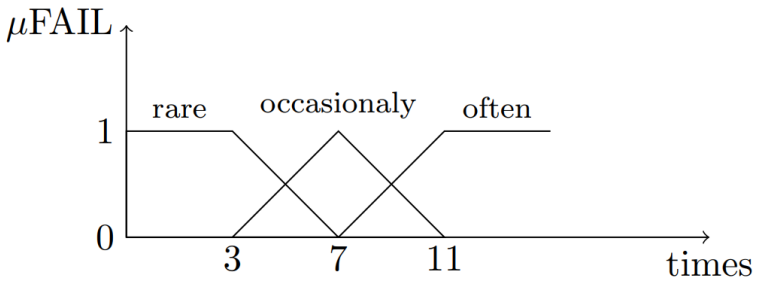

Figure 8. Membership function for failed attempt

Input for FAIL is the number of the failed attempts. Eq (5) shows the calculation of membership degree.

$$\mu Rare[x] = \begin{cases} 1, & 0 \leq x \leq 3 \\ \dfrac{7-x}{7-3}, & 3 < x < 7 \\ 0, & x \geq 7 \end{cases}$$

$$\mu Occasionally[x] = \begin{cases} 1, & x = 7 \\ \dfrac{x-3}{7-3}, 3 < x < 7 \\ \dfrac{11-x}{11-7}, 7 < x < 10 \\ 0, x \leq 3, x \geq 10 \end{cases}$$

$$\mu Often[x] = \begin{cases} 1, & x \geq 10 \\ \dfrac{x-7}{11-7}, 7 < x < 10 \\ 0, x \leq 7 \end{cases} \quad (5)$$

Fig. 9 shows the membership function for output. The output is the frequency of supporting elements or item occurrence. It has two linguistic variables: few and plenty.

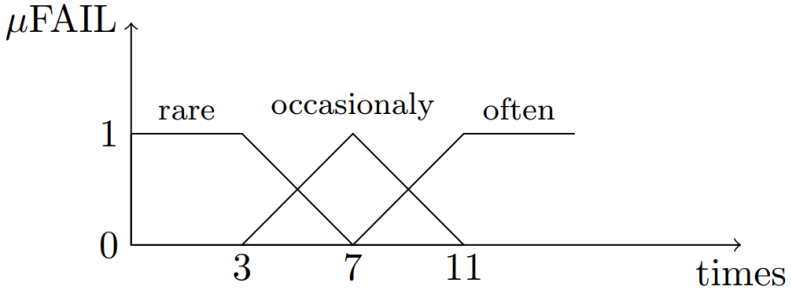

Figure 9. Membership function for supporting elements / item occurrence

The fuzzy system will be implemented into four types of items. The four types of items are ADD_HP, ADD_TIME, SLOW, DOUBLE. ADD_HP will restore player health point. ADD_TIME will add the time remaining. SLOW will add delay to the timer. Then, DOUBLE will double the score obtained. Table 5 shows the list of rules for Design activity.

Table 5. Rules for Design activity

IF			**THEN (ITEM TYPES)**			
HP	***TIME***	***FAIL***	***ADD_ HP***	***ADD_ TIME***	***SLOW***	***DOUBLE***
low	short	rare	plenty	plenty	few	few
low	short	occasionally	plenty	plenty	few	few
low	short	often	plenty	plenty	plenty	few
low	moderate	rare	plenty	few	few	few
low	moderate	occasionally	plenty	few	few	few
low	moderate	often	plenty	few	plenty	few
low	long	rare	plenty	few	few	few
low	long	occasionally	plenty	few	few	few
low	long	often	plenty	few	plenty	few
medium	short	rare	few	plenty	few	few
medium	short	occasionally	few	plenty	few	few
medium	short	often	few	plenty	plenty	few
medium	moderate	rare	few	few	few	plenty
medium	moderate	occasionally	few	few	few	plenty
medium	moderate	often	few	few	plenty	few
medium	long	rare	few	few	few	plenty
medium	long	occasionally	few	few	few	plenty
medium	long	occasionally	few	few	plenty	few
high	short	rare	few	plenty	few	few
high	short	occasionally	few	plenty	few	few
high	short	often	few	plenty	plenty	few
high	moderate	rare	few	few	few	plenty
high	moderate	occasionally	few	few	few	plenty
high	moderate	often	few	few	plenty	few
high	long	rare	few	few	few	plenty
high	long	occasionally	few	few	few	few
high	long	often	few	few	plenty	few

Then, Destiny activity determine the achievement of player based on the score obtained in the Design activity. Fig. 10 shows the membership function for SCORE, and Fig. 11 presents the membership function for achievement level (ACHIEVEMENT), which is identical to SCORE membership function. The achievement is the percentage of total reward in the game.

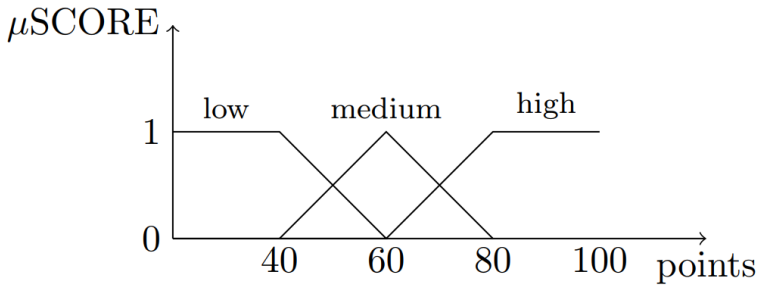

Figure 10. Membership function for player score

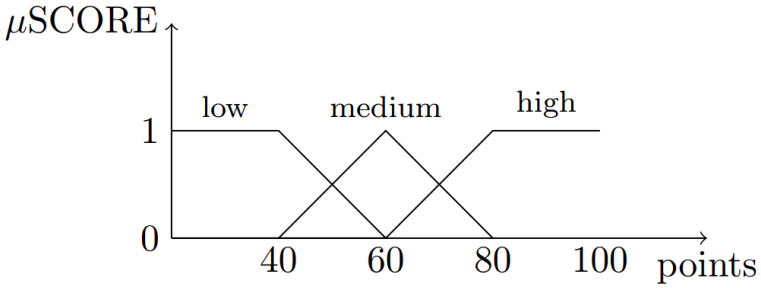

Figure 11. Membership function for achievement

The achievement will be identical with score. Table 6 shows the rules for Destiny activity.

Table 6. Rules for destiny activity

IF (antecedents)	THEN (consequent)
SCORE	**ACHIEVEMENT**
Low	Average
Average	Good
High	Excellent

Game experience questionnaire to measure game experience

A game prototype is developed as a test subject. The prototype is an Appreciative Serious Game and implements Fuzzy Smart Reward. The title of the game is "Evakuator". "Evakuator" is a serious game with the theme of disaster mitigation. "Evakuator" is a puzzle game that used the concept of Appreciative Learning for the activity design according to Table 1. The main objective of the game is to prepare the mitigation item and put it in the correct bag. Game experience questionnaire (GEQ) is used to measure the player experience. GEQ assesses game experience in five elements: Competence, Flow, Immersion, Positive and Negative Affect [29]. We focused on the immersion measurement. The immersive factor is the primary determinant of whether or not the experience provided by the game is good. An immersive experience is one in which the player feels immersed in the game. According to [30], this experience is divided into sensory, imaginative, and challenge-based immersion. Sensory immersion is an immersive experience involving the five senses, such as visuals and sound. Imaginative immersion relates to imagination, such as the world in games, characters, and stories. Challenge-based immersion relates to the challenges offered by the game. A good combination of these three experiences will result in an immersive game and flow experience. Table 7 shows the modified core module of GEQ for this research. The scores for each items are: not at all (score: 0), slightly (score: 1), moderately (score: 2), fairly (score: 3), extremely (score: 4). The average scores will be the total score for GEQ questionnaire, higher value is better.

Table 7. Modified GEQ core module

NO	Player Respond	Elements
1	I was curious with the characters	Sensory and Imaginative Immersion
2	I was fully occupied with the game	Flow
3	I want to get higher score	Challenge
4	I like the visual of this game	Sensory and Imaginative Immersion
5	I forgot everything around me	Flow
6	I felt imaginative	Sensory and Imaginative Immersion
7	I felt that I could explore things	Sensory and Imaginative Immersion
8	I want to win	Challenge
9	I lost track of time	Flow
10	I felt challenged	Challenge
11	I found it impressive	Sensory and Imaginative Immersion
12	I was deeply concentrated in the game	Flow
13	I lost connection with the outside world	Flow
14	I felt time pressure	Challenge
15	I had to put a lot of effort into it	Challenge

RESULT AND DISCUSSION

We develop an Appreciative Serious Game prototype to test the Fuzzy Smart Reward. The genre of this game is puzzle, with the theme of disaster mitigation. "Evakuator" is the title of the game. The game structure is according to Appreciative Serious Game Architecture in the Fig. 1. In Evakuator, player must bring items needed in disaster mitigation and put it in the correct bag. Fig. 12 shows the screenshot of the game.

Figure 12. Evakuator game

Gameplay of Evakuator is focused on challenge-based immersion. To support the sensory and imaginative immersion, there are two playable characters which could be selected by player. Fig. 12 shows Sarbini and Wulansari, two playable characters of Evakuator.

Figure 13. Evakuator characters

We implement the Fuzzy Smart Reward to create dynamic reward. The Fuzzy Smart Reward will produce the reward for all Appreciative Learning activities according to the smart reward design in Fig. 2. Table 8 shows the experiment result for fuzzy system in Discovery activity that resulted in items quality.

Table 8. Result from fuzzy discovery activity

Test. No	Exploration Level (%)	Exploration Time (minutes)	Items Quality
1	55	40	68.8
2	50	90	75
3	80	30	90
4	85	80	90
5	50	50	75
6	40	40	46.67
7	25	70	60
8	80	20	70
9	90	85	90
10	45	50	67.5
11	10	10	20
12	10	70	60
13	70	20	72
14	78	90	90
15	55	50	82.5
16	30	25	20
17	25	50	60
18	50	25	40
19	85	15	60
20	75	60	90

In the experiment for the Discovery activity, we use 20 sample size, with various value of Exploration Level and Exploration Time. In Fig. 12, the smart reward will give the items quality slightly higher than the value of Exploration Level and Exploration Time. If there is a big difference between Exploration Level and Exploration Time, the items quality also still quite high. This is intentional to motivate players more. The items quality produced in the Discovery activity will determine the objective quality as shown in Table 4. Therefore, for Dream activity, the value of objective quality will be the same as items quality.

Table 9 is the result of Fuzzy Smart Reward in the Design activity. It shows the occurrence frequency of supporting elements as shown in Table 5.

Table 9. Result from fuzzy design activity

No	*HP*	*TIME*	*FAIL*	*ADD_ HP*	*ADD_ TIME*	*SLOW*	*DOU BLE*
1	75	35	8	2	6	4	3
2	40	70	4	4	2	2	5
3	80	90	1	2	2	2	7
4	30	60	7	7	2	2	2
5	45	35	2	2	6	2	3
6	60	80	9	2	2	5	4
7	78	42	5	2	4	2	4
8	25	64	3	7	2	2	2
9	14	24	2	4	4	4	4
10	92	50	6	2	2	2	6
11	62	40	7	2	4	2	4
12	36	35	10	5	6	7	2
13	30	75	4	7	2	2	2
14	92	80	3	2	2	2	3
15	15	10	6	6	6	3	3
16	82	95	5	2	2	2	4
17	76	20	1	2	7	2	2
18	40	55	0	4	2	2	5
19	28	60	8	7	2	4	2
20	70	30	3	2	7	2	2

Then, Destiny activity determine the achievement of player based on the score obtained in the Design activity. As shown in Fig. 10 and Fig. 11, ACHIEVEMENT is identical to SCORE membership function. The ACHIEVEMENT is the percentage of total reward in the game.

We measure several serious games with puzzle genre (Puzzle Pieces [31], the Lost Han-dynasty bronze mirrors [32], and Express Cooking Train [33]) using GEQ, including Evakuator without Fuzzy Smart Reward then compare the GEQ score with Evakuator which has Fuzzy Smart Reward. There are 10 respondents for this survey, 5 of the are avid-gamer and the rest are casual gamer. The respondents played the same games. Tabel 10 shows the average GEQ score for serious games without Fuzzy Smart Reward, and Table 11 shows the average GEQ score for Evakuator with Fuzzy Smart Reward.

Table 10. Overall GEQ score for serious games without fuzzy smart reward

RESPONDENT NO.	OVERALL GEQ SCORE				AVERAGE GEQ SCORE
	PUZZLE PIECES	LOST HAN-DYNASTY BRONZE MIRROR	EXPRESS COOKING TRAIN	EVAKUATOR (WITHOUT FUZZY SMART REWARD)	
1 (AVID-GAMER)	3,2	3,1	3,4	3,2	3,225
2 (AVID-GAMER)	3	3,1	3,2	3,1	3,1
3 (AVID-GAMER)	2,8	2,9	2,7	2,8	2,8
4 (AVID-GAMER)	3,1	2,9	2,9	2,9	2,95
5 (AVID-GAMER)	3	3	3,1	3,2	3,075
6 (CASUAL-GAMER)	3,3	3,2	3,4	3,2	3,275
7 (CASUAL-GAMER)	3	3,1	3,1	3,2	3,1
8 (CASUAL-GAMER)	3,1	3,2	3	3,4	3,175
9 (CASUAL-GAMER)	3,2	3,3	3,2	3	3,175
10 (CASUAL-GAMER)	3,2	3,1	3	3,1	3,1
			TOTAL GEQ AVERAGE SCORE		**3,0975**

Table 11. Overall GEQ score for serious games with fuzzy smart reward

RESPONDENT NO.	EVAKUATOR (WITH FUZZY SMART REWARD)
1 (AVID-GAMER)	3,4
2 (AVID-GAMER)	3,4
3 (AVID-GAMER)	3
4 (AVID-GAMER)	2,8
5 (AVID-GAMER)	3,1
6 (CASUAL-GAMER)	3,5
7 (CASUAL-GAMER)	3,4
8 (CASUAL-GAMER)	3,7
9 (CASUAL-GAMER)	3,2
10 (CASUAL-GAMER)	3,5
OVERALL GEQ SCORE	**3,3**

From the survey, Fuzzy Smart Reward could slightly improve the experience of player. Most of the respondents feels more motivated because of the dynamic reward.

CONCLUSION

The experiments shows that the Fuzzy Smart Reward could dynamically adjust the reward or achievement according to the game condition and player performance and improve the player experience. Therefore, the Fuzzy Smart Reward could be used as a framework to develop serious games. However, the smart reward works best only for simple gameplay in an action puzzle game. It may not works very well in a more complex game, like Role-Playing Game or Strategy. For future works, the smart reward could use the enhanced Appreciative Learning for more complex game, like strategy or Role-Playing Game. The Appreciative Learning concept could be developed specifically for each game genre. The smart reward will follow the concept to generate dynamic reward.

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