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Detection and Improvement of Low Efficient Learning Game Made by Automatic Generator

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Abstract: We have already proposed and implemented an automatic generation method of learning games. However, we also found that a few generated learning games were not useful for learning. Therefore, we propose detection method of the low efficient learning games and improvement method of the detected games in this paper. Automatic detection function has been implemented. We also report the results of experimental evaluation of the detection function and the improvement method of the detected games.

Keywords: Learning game, Automatic Generation, Design method, Authoring

Introduction

Although we have proposed automatic generation method of learning games [1], a few generated learning games had the least effect in learning. In this paper, we propose how to detect and improve the low efficient learning games.
A learning game is a game where the activity to play is not only attractive as a game but also useful for learning. A lot of computer-based learning games have been implemented [2]. However, it is difficult to develop a learning game, therefore many researchers suggested design method of learning games [3-5].
Although there are several investigations for the design methods of learning games, most of them deal with only restricted part of the design process. Therefore, we have investigated concrete methods to embed problem solving exercises into an existent card game. We call this method as EPIC method. We have already implemented an application to generate computer-based learning games automatically based on EPIC method, and experimental confirmed that the application generated many useful learning games [6].
We also found, however, that a few generated learning games were not useful for learning. Therefore, we propose detection method of the low efficient learning games and improvement method of the detected games in this paper. Automatic detection function has been implemented. We also report the results of experimental evaluation of the detection function and the improvement method of the detected games.

1. Epic method

1.1 Concept of EPIC method

EPIC method is a design method of simple learning games by embedding problem solving exercises into a card game. Figure 1 shows the concept of EPIC method.
A card game is a game using cards, for examples, “Poker”, “Blackjack” or “UNO”.

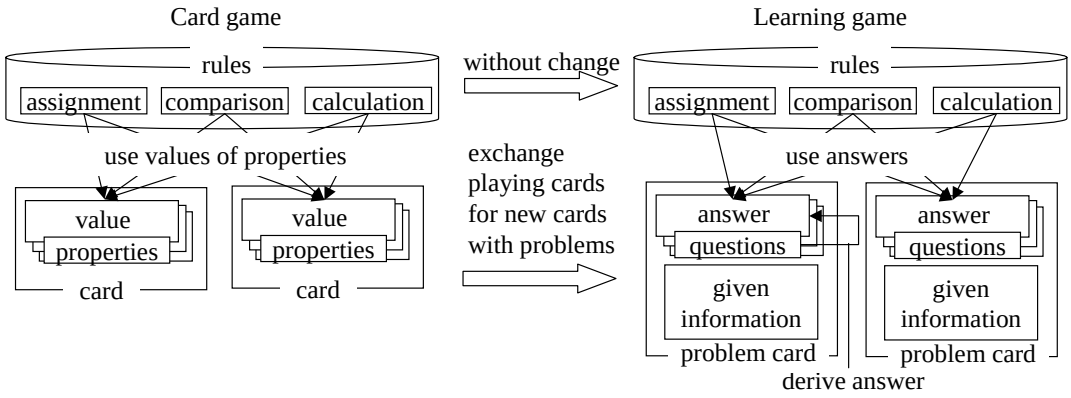

Figure 1. Model of EPIC method

We have proposed a card game model that is a structured representation of a set of concepts within a card game and the relationships between those concepts [6]. The card game model tells that a card of a card game has some properties, for examples, “number”, “mark (suit)” or “color”. The values of these properties are used in playing a card game.

In the card game model, operations of the cards are decided based on only by three evaluations of the values of the cards, that is assignment, comparison or calculation. Therefore, an existing card game is transformed into playable new game by exchanging the cards of the existing card game for other cards whose properties can be performed the three evaluations on. In other words, a new game is also developed by exchanging the cards of existing card game for cards with problem statements. The problem statement consists of given information and questions. The question is used in place of the property of the original card. The answer of the question is used in place of the value of the property. Thus in playing the game made by the exchange, a player has to derive answers from given information since the answers are used in place of values of properties.

Based on the method, we have implemented an application to generate computer-based learning games automatically. However, after further research, some of 120 learning games had poor effect. In next section, we explain the research.

1.2 Experimental uses of Low efficient Learning Games

We conducted an experiment in order to clarify when and how many times a player solved problems in playing a learning game. We added “solve” button in the interface of the computer-based learning game. Then, we told subjects to push the button with each solving a problem in playing the learning games. The learning game recorded the process of the playing, number of times the “solve” button pushed and when the “solve” button pushed.

First, we played each of 120 learning games for 5 minutes. As the result, number of times the “solve” button pushed in 8 learning games is extremely lower than others. Following the result, 4 subjects played each of the 8 learning games and other 8 normal learning games for 15 minutes. The same problems used in the games for the same learning target. We also told the subjects to push “solve” button with each solving a problem.

Table 1 shows the results. The number in the table shows average of the number of times one player pushed “solve” button for 15 minutes. The results suggest that players in playing the low efficient learning games solved fewer problems than in the normal games, even if they used the same problems. We expected that the players ideally solved more problems in the low efficient learning game, because answers were evaluated quite a few times. However, solved problems in the low efficient learning games were fewer than the number of the evaluation of the answers.

Table 1. Average of Number of Problems one Player Solved for 15 minutes

Problem type	Base (normal)	Solved	Base (low)	Solved
Arithmetic formula	Spit	66.50	Old made	3.75
	Pig tail	63.75	War game	1.50
	Memory	38.25	Money game	2.25
Calculating the area of rectangle	Spit	79.00	Old made	5.25
	Pig tail	65.25	War game	2.75
	Memory	39.75	Money game	3.25
Chemical formula	UNO	17.50	No change Poker	1.75
Simultaneous equation	UNO	18.25	No change Poker	1.50

2. Low efficient Learning Games

2.1 Learning in a Game

We investigated the rules in common and difference between normal and low efficient learning games in order to clarify what make players solve problems. We also asked the subjects about the experiment. In this chapter, we explain the result of the investigation.
We found a player derive answers of problems because the answers are useful for a player to decide which to choose in playing a game. In other words, if the result of making a choice based on answers and a player can derive the answers when the player making a choice, the player intends to derive the answers form problems. In normal learning game, a player makes a choice based on answers of problems. There are three types of low efficient learning game: a player has no choice, a player makes a choice but the result of the choice has no concern with answers or a player has no way of seeing problems when the player makes a choice although the result of the choice depend on the answers of the problems.
If a player has no choice, the player cannot change a process of playing a game no matter how the player derives answers. If answers have no concern with result of making a choice, the player has no advantage no matter the player derive the answers because the answers are useless for deciding which to choose. If a player has no way of seeing problems when the player makes a choose, the player cannot solve the problems. In such cases, the player doesn't intend to solve the problems.

2.2 How to Detect low efficient Learning Games

The way to distinguish normal learning game from low efficient learning game is the way to find a game in which the result of making a choice is based on properties of cards.
Such game is picked out by investigating its rules. Based on a card game model as mentioned in 1.1, there are two rules that make a player make a choice: a player choose a value or a player choose a card. In the first step to distinguish suitable game or not, find the two rules form the rules of target game. Second step, find a rule which use the chosen value or card. In case of the choosing a card, third step, check the rule use the value of the property of the chosen card or not. There are three rules that use the value of the property of the choosing card: assigning the value into variable, comparing the value with other value or calculating something with the value. If the rule doesn't use the value, it is not a rule in which the result of making a choice is based on properties. In case of the choosing values, another third step, check the rule also uses the chosen value and a value of a property of a card at the same time or not. There are two rules that use chosen value and a value of a property of a card at the same time: comparing them or calculating something with them. If the rule doesn't use a value of a property of a card, it is not a rule in which making a choice

is based on properties. If the rule uses the value of the property the card in either case, fourth step, check that there is a rule in which a player can see the face of the card before choosing the values/cards. If the card is face-up when the player makes a choice, of course the player can see the face. If the card is face-down, check the card have been opened one at least and the card isn't shuffled (move cards randomly) before the choosing. In that case, the player can see the face of the card before the choosing. There are two rules that open a card: moving a card from private space (cards in which aren't open) into public space with face-up or turn up face-down card. In the end, if the player can see the face, the game which has such rules are suitable for EPIC method. The other games are unsuitable games.
Based on the way to detect, we implemented an application, the name is low efficient detector. The detector is supposed to be used with automatic generator of learning game. If an author try to generate low efficient learning games with the automatic generator, the detector serve notice to the author.

3. How to Improve

It is a way not to deal with unsuitable games, but some of the unsuitable games are popular and simple for learners. Therefore, we propose how to improve low efficient learning games. There are three ways to improve low efficient learning games. First way is making a player assign, compare, calculate the answers instead of a computer. Second way is making a player decide which operation should be done in next. Third way is giving penalty for the mistake on the player. The third way is used in combination first or second way.
First way of improvement is making a player enter the result of the assignment, comparison and calculation. In computer-based learning game, the computer automatically assigns, compares and calculates answers. Therefore, a player doesn't need to deriver the answer if the answer is useless for deciding which to choose. Thus, if the player assign, compare and calculate the answers instead of the computer, the player has to derive the answers. If the player enters wrong one, the computer should tell it is wrong and correct one.
However, some players intend to enter the result of the operation randomly and get the correct one, because the mistake brings down no disadvantage for a player. To prevent such behavior, penalty is given for the mistake of entering on the player. This is third way to improve. It is difficult to add appropriate penalty rule to learning games because how give penalty differs according to games, although it brings about appreciable results.
Second way is making a player decide which operation should be done in next. Sometimes in playing a game, which operation will be done in next is based on the result of the evaluation. Thus, let a player always do every operations, in order to make the player consider which operation should be done in next. In other words, the player has to derive answers in order to consider which operation is legal based on the evaluation of the answers. Of course, it is a good idea to give penalty for illegal operation, too. The penalty may prevent a player from deciding next operation randomly.

4. Evaluations

We conducted two experimental evaluations: one to confirm that detector could detect low efficient learning games, and the other to test the use of improved learning games. For the first evaluation, we entered the 120 learning games as mentioned in 1.1 into the low efficient detector. The detector certainly detected the 8 low efficient learning games as mentioned in 1.1. For the second experimental evaluation, we improved the 8 low efficient learning games as mentioned in 1.2. The learning games for arithmetic and chemical formula were

Table 2. Average of Number of Solved Problems for 15 minutes in improved games

Problem type	How improve	Base game	Not improved	Improved	Penalty
Arithmetic formula	Enter the result of operation	Old made	3.75	17.25	26.25
		War game	1.50	33.00	69.75
		Money game	2.25	35.25	35.25
Calculating the area of rectangle	Decide next operation	Old made	5.25	27.50	32.00
		War game	2.75	40.75	77.50
		Money game	3.25	42.50	42.75
Chemical formula	Enter the result of operation	No change Poker	1.75	15.25	15.50
Simultaneous equation	Decide next operation	No change Poker	1.50	17.50	18.00

improved by making players enter the result of operation. The learning games for calculating the area and simultaneous equation were improved by making players decide next operation. We moreover prepared other 8 learning games by improving the improved 8 learning games by penalty. The 4 subjects played these 16 learning games for 15 minutes. The subjects were the same member of the evaluation in 1.2. We also told the subjects to push "solve" button with each solving a problem in playing. Table 2 shows the results. The number in the table shows average of the number of problems one player solved for 15 minutes. The result suggests that the improvement brought about appreciable results.

5. Conclusion

In this paper, we proposed how to detect and improve the low efficient learning games that are automatically generated by our previous system. We also confirmed the detection and the improvement method of the detected games were useful from the report the results of experimental evaluation. In future work, we should research the possibility of the detection. We think the detection is applicable to compare learning effectiveness of normal learning games, because the detection tells which rule make a player solve problems.

Acknowledgements

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