Design of Penalties against Useless Plays in Educational Games

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Abstract: In this paper, we present a design of penalties against the action in contravention of the rule to discourage the tendency of unthinking and useless plays, observed while playing the automatically-generated educational games by our design method. Monitoring player's activity and penalizing illegal moves are potential ways of preventing unconsidered activities. Because of the illegal moves and adequate penalties are strongly linked in each educational game, it is necessary to design the penalties individually for each educational game, therefore, we investigated the automatic design of penalties for educational games, generated by the EPIC method. We also introduce a function to automatically implement the penalties, and report the experimental evaluations of educational games with penalties.

Keywords: Educational game, Authoring system, Design method, Automatic improvement

Introduction

We proposed a design for an educational game by exemplifying existing card games [1] and developed an automatic generation function for computer-based educational games [2]. In this study, we present a design for penalties to discourage the tendency of unthinking and useless plays, observed while playing the educational games designed by our method. We also introduce a function to automatically implement the penalty-based design, and report experimental evaluations of educational games with the penalty.

1. EPIC method

We present the embedding problem-solving exercises into a card game (EPIC) method, which transforms an existing card game into an educational one by substituting original cards for new cards that present problems to the players. To move forward in the game, players have to solve the problems provided on the substituted cards, instead of using the property of the original cards.

We explain a simplified version of the Memory game (also known as Concentration), transformed using the EPIC method into an educational game that uses basic arithmetic formulas. The Memory game is a card game in which cards have the same number when flipped are collected by the player, and those that do not are turned face down and left as is. The Memory game is transformed into an educational game in which cards with arithmetic formulas have the same answer when flipped are collected by the player.

If a player fails to solve the problems in playing an educational game made by EPIC method, the player will probably move cards in contravention of the rules of the game. However, because it is necessary to prevent the illegal move, the computer-based

educational game identifies the player's mistake and allows the player a second attempt to choose from a multiple choice-selection.

2. Analysis of Plays of Generated Games

We conducted an experiment to demonstrate how many times a player was able to solve a problem when playing the educational game designed by the EPIC method. Ten subjects played each of the three computer-based educational games for ten minutes. Three educational games were designed from the Old Maid game, Memory game, and the War game. All three games were changed to incorporate exercises that were based on arithmetic formulas using three-figure numbers.

Table 1 shows the number of times the problem was solved, the number of illegal moves, and the number of legal moves during the ten minutes of the game. The ten subjects are indicated by letters from A to J. An illegal move meant that the subject moved cards violating the rules. For example, in the educational Memory game if cards with a different answer were picked up when flipped, the move was considered as illegal.

In this experiment, subjects C and I made more illegal moves than the other subjects. In addition, although they made many more moves, they solved fewer problems. When two subjects were asked about this, they said that they moved cards at random without actually solving the problems until the move was legal by chance. The subjects also said that they did not care that illegal moves were identified by the educational game system.

Table 1. Activities of plays during the one ten-minutes game

	Subjects	A	B	C	D	E	F	G	H	I	J
Old Maid	Solving	10	25	1	38	18	12	28	31	1	16
	Illegal moves	0	1	146	0	0	1	0	0	137	0
	Legal moves	22	27	8	26	21	28	26	21	5	19
Memory	Solving	18	21	3	24	11	14	22	31	0	21
	Illegal moves	0	0	28	0	1	0	0	0	29	0
	Legal moves	27	24	78	45	32	21	48	60	87	28
War	Solving	18	28	0	39	16	16	31	33	0	19
	Illegal moves	0	0	61	0	0	0	0	0	58	0
	Legal moves	18	28	112	39	21	16	31	35	101	19

3. Penalties Corresponding to Game Objective

We decided to penalize illegal moves to discourage unconsidered activity as well as the failure to solve problems. However, the level of penalties imposed differs depending on each game. Although an automatic generation function has been developed for computer-based educational games, it is necessary to design the penalties individually for each educational game. Thus, in this paper, we investigated the automatic design of penalties for educational games that are created by the EPIC method.

Based on an examination of 186 existing card games, we designed a system of penalties. The penalties are given by imposing a disadvantage. This disadvantage deviated from the game's objective. Game's objectives are categorized into four types. Thus, we designed penalties that were in line with the four game's objective, as follows:

- Objective: to score as high as possible/to not score as low as possible
  Penalty: subtract one point from the player's score/add one point to player's score

- Objective: to increase the number of cards /to decrease the number of cards
  Penalty: skip next step that increases the cards/skip next step that decreases the cards
- Objective: to make a high-ranking hand/to make a low-ranking hand
  Penalty: player's hand will slide down one rank in the next game
- Objective: to stay in the game as long as possible/to leave the game as early as possible
  Penalty: give a penalty in a sub-goal of the objective

4. Evaluation

We developed a function to automatically implement penalties in educational games as part of the authoring system [2] on the basis of EPIC method. The penalty function identifies the objective of a game from a combination of words or sentences that are within its rules and automatically implements the corresponding penalty rules.

We conducted an experimental evaluation to confirm whether the educational game improved by the function of implementing penalties to prevent unconsidered activity. For the evaluation, the function improvised the three educational games as mentioned in Chapter 2. We instructed the ten subjects, they were the same members who participated in the evaluation conducted in Chapter 2, to play each game for ten minutes. In addition, we explained to them the penalties were imposed when they made an illegal move.

Table 2 shows the results of subjects C and I. We excluded the results of the other subjects because the results were the same as those described in Chapter 2. The results suggest that the two subjects solved problems when playing the game with penalties. Their activities were almost the same as those of the other subjects playing the normal game.

Table 2. Number of illegal moves in the improved ten-minute game

		Old Maid		Memory		War	
		Normal	Penalty	Normal	Penalty	Normal	Penalty
C	Solving	1	13	3	18	0	26
	Illegal	146	0	28	1	61	0
	Legal	8	21	78	31	112	26
I	Solving	1	14	0	16	0	19
	Illegal	137	0	29	0	58	0
	Legal	5	21	87	24	101	21

5. Conclusions

In this paper, we present a design of penalties against the action in contravention of the rule to discourage the unconsidered plays, observed while playing the automatically-generated educational games by the EPIC method. We also introduce a function to automatically implement the penalty-based design. In experimental evaluations of educational games with the penalty, we confirmed that penalties prevent unconsidered activity.

References

[1] Umetsu, T., Hirashima, T., Takeuchi, A. (2006). Property Exchange Method for Automatic Generation of Computer-Based Learning Games. *Proceedings of ICCE2006* (pp. 283-490).

[2] Umetsu, T., Azuma, T., Hirashima, T., Takeuchi, A. (2011). Ontological Approach to Support Authoring for Game-Based Learning Environments. *Proceedings of ICCE2011* (pp. 26-33).