The Development and Preliminary Evaluation of Learners' Flow State of an Online Decision-making Detective Game

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Abstract
Information integration and decisions-making competence have gained much attention in many fields. Assisting learners to have efficient logical reasoning and to make accurate decisions, and further form their decision-making patterns is a great issue. Therefore, exploring learners' status and process in the decision-making game is the foundation for future learning and teaching. The study developed an online detective game to explore learners' flow state as a pilot study. The scenario of this game is to provide the exact position of the missing girl with limited time. The learning goal of this game is to analyze the clues in the game, applying any online tools and information to locate the missing girl's position precisely. There are 48 participants above 20 years old from E-recruitment and participate in the study online. Preliminary results suggested that participants' flow state revealed their high engagement in the game. According to one sample t-test, all nine dimensions of flow are higher than median 3. The learners revealed that they perceived well flow antecedents, especially challenge–skill balance, goals of an activity, control are high above 3.5. Even action–awareness merging which is relatively difficult to achieve high in similar game-based learning was high as well. As for flow experience, concentration, the transformation of time, and autotelic experience were high above 4. The designs and mechanism of this game based on cognitive theory are clear to guide learner joining and engage learners in the game. Future study can explore the effects of provided scaffoldings and learning behavior patterns.

Keywords: Educational Online Game, Game-Based Learning, Decision Making, Flow

Introduction

Decision-making is an important topic in many fields for decades. Decision-making training has gained more attention. Game-based learning (GBL) describes an environment where game content and game play enhance knowledge and skills acquisition, and where game activities involve problem solving spaces and challenges that provide players/learners with a sense of achievement (e.g., Kirriemuir & McFarlane, 2004; McFarlane, Sparrowhawk, & Heald, 2002; Prensky, 2001). During the pandemic period, DGBL became an important alternative and trend in education. DGBL is an approach, where digital games and instructional materials were integrated together. This is due to the fact that DGBL provides students with opportunities to take the initiative in their learning by analyzing, synthesizing, evaluating, and performing higher-order thinking skills, such as critical thinking and problem-solving (Dindar, 2018; Yang, 2015). Moreover, DGBL can potentially improve learning motivation (Huizenga, Admiraal, Akkerman, & ten Dam, 2009), provide immediate feedback (Yang, Lin, & Liu, 2017), develop complex problem-solving skills (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014), reduce anxiety (Pham Q, Khatib Y, Stansfeld S, et al, 2016) and enhance learning performance (Chen & Lin, 2016; Wang & Chen, 2010).

State of flow, referring to high levels of engagement, is important to enhance performance and other learning outcomes. Students with high flow are fully involved in the activity referred to high levels of interactivity, challenge, and feedback (Engeser, 2012). Several researchers have found a positive correlation between students' flow experiences and learning outcomes in game-based learning environments (Hsu & Lu, 2004; Kiili, 2005). Correspondingly, these important factors in students' game flow experiences should be considered when applying game-based learning.

According to Young et al. (2012), successful GBL is not simply providing students with a game and expecting increased motivation and knowledge acquisition; therefore, educational games need to be designed and researched with careful attention to contemporary learning theories. Game designs without appropriate learning/cognitive theories as base would cause negative effect (Charsky & Ressler, 2011; Hong, Cheng, Hwang, Lee, & Chang, 2009; Hwang, Sung, Hung, & Huang, 2012; Provenzo, 1992).

Developing educational game to optimize engagement is necessary. Therefore, game mechanisms of educational games need to be designed and researched with careful attention to integrate instructional strategies and contemporary learning theories (Young et al., 2012; Kebritchi, 2008).

Situated learning (Brown et al., 1989) refers that learner can explore the knowledge and cultivate competence in the real-world context. Game-based learning are gradually applied in different fields of education and provide vivid learning experience (Prensky, 2003). Simulation games scenarios and roles-play may enhance performance (Bayir, 2014; Hou & Lin, 2015; Hou & Liu, 2015; Hou et al., 2016), promote learners' motivation and engagement in learning (Bos & Shami, 2006; Pata, Lehtinen, & Sarapuu, 2006; Wishart, Oades, & Morris, 2007). This study developed an educational digital game based on cognitive theories and flow theories (Lin & Hou ,2016; Hou & Lin, 2015; Hou & Liu, 2015; Hou et al., 2016) – *Finding the little girl Yu* to promote students' engagement and achievement in decision making training.

Methods

Game Design- *Finding the little girl Yu*

The game employed in this study was *Finding the little girl Yu*, a detective and reasoning educational game to train decision-making ability developed by National Taiwan University of Science and Technology Mini Educational Game (NTUST-MEG) research group. Due to covid-19, this is a virtual version; this game designed on Google earth and google document and learners communicate through google meet. Also, they can use all the information and resource from internet. *Finding the little girl Yu* integrates situated learning with a lost girl Yu case, learners have to use their observation, clue analysis, strategy planning and most important decision-making ability. The main game mechanism is clue analysis to promote learners to observe the detail of the clues from the police. Then, learners through decision-making and strategy planning provide the final position of little girl Yu to the police. The whole game is shown as Figure 1 and Figure 2 is the capture shoot of Finding the little girl Yu game experiment.

The participants of this study were 48 participants from e-recruitment from Taiwan and were grouped into 3 people group(n=12) for the learning activity. To evaluate learners' state of flow, this study referred to Kiili's flow scale (2006), which was translated and revised by Hou and Chou (2012). The flow scale includes two dimensions, namely the flow antecedent and flow experience. All scales were scored on a five-point Likert scale. The reliability of the flow questionnaire of group team (Cronbach's alpha=0.87) and personal team (Cronbach's alpha=0.88) showed high internal consistency.

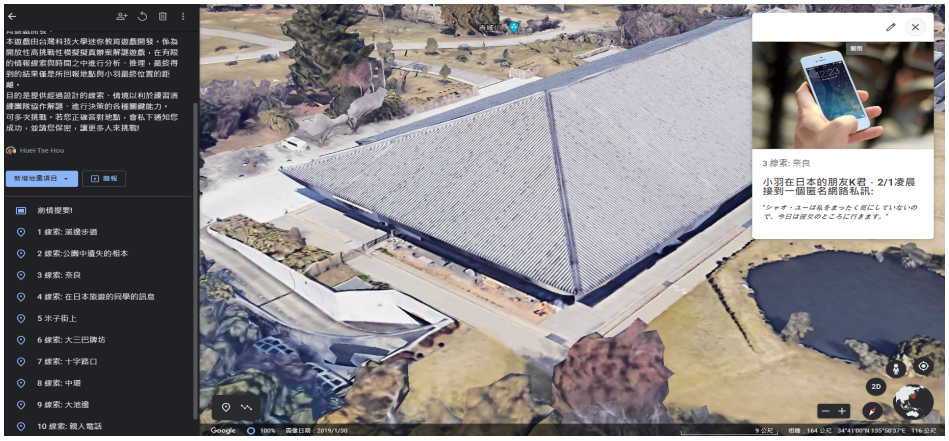

Figure 1. Content of *Finding the little girl Yu*

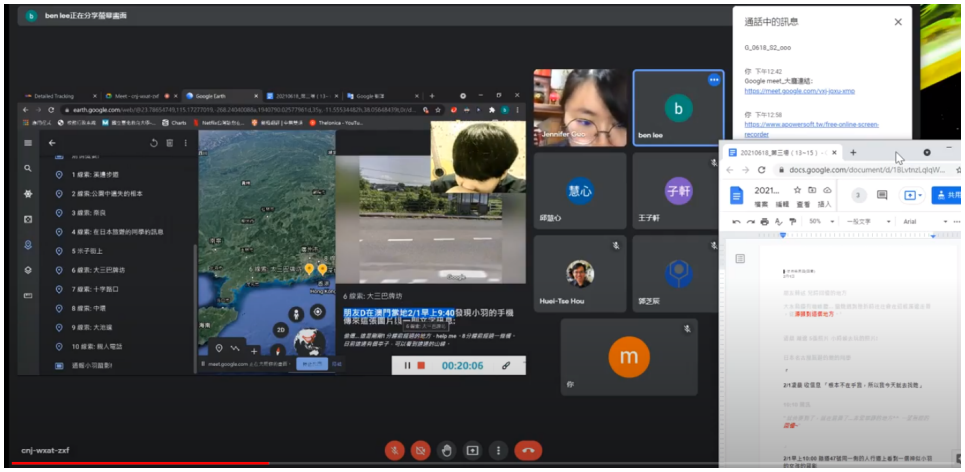

Figure 2. Capture Shoot of *Finding the little girl Yu* Game Experiment

Table 1. Research Procedure

Procedure	Session time	Description
Game instruction	10 minutes	Game instruction and familiar with the game
Playing game	60 minutes	Each group starts play the game.
Posttest	10 minutes	After playing the game, students were asked to complete Flow scale and game acceptance were administered in this session.
Interview	10 minutes	Interview each players their experience and feedback about the game

To evaluate the game *Finding the little girl Yu*, a 90 minutes learning activity was employed. The procedure was shown in Table 1. Participants joined in the google meet for game instruction. They collaborate to finish the task through communicate with google meet and google document. After they all were familiar with the game and interface, they started the game on google earth. After learners completed playing the game, they then took flow scale survey.

Results and Discussions

Finding the little girl Yu, was developed based on cognitive theories, flow theories and situated learning. The game was to assist students to train their decision-making ability. This preliminary research was to evaluate the game with the learners' state of flow.

Table2 revealed the descriptive analysis and one sample t test of the learners' flow state. As shown in Table 2, students in general positively evaluated the game – *Finding the little girl Yu* and the overall flow score (M=3.98, SD=0.44) significantly higher than median 3 (t=15.24, p<0.00). Regarding flow antecedents, *Finding the little girl Yu* provided clear goals and feedback, sense of control and playable. These positive perceptions of flow antecedents revealed that this game had features to assist student positively engaging in the game. Especially challenge–skill balance, goals of an activity, control are high above 3.5. However, one thing to note is that action–awareness merging was significant difference from median 3. This result was different from previous researches (Chen & Hou,2020; Kuo et al., 2018). This finding might be attributed to the nature of this game was designed for training ability and previous studies mainly focus on specific domain knowledge. In this game, learners knew what they were doing and what they were doing for. In knowledge based educational game,

the learning goal were wrapped in the game mechanism and rule, learners would not easily perceive they were learning. Therefore, both game design and the type of educational game might be the reason. Regarding the flow experience, concentration, the transformation of time, and autotelic experience were high above 4. The result showed that learners had engaged in the game.

Table 2 Descriptive Analysis and One Sample T Test of Learners' Flow

Dimension	***M***	***SD***	**Cronbach's Alpha**	**t**	**p**
Flow antecedents	3.86	0.44	0.73	13.33***	0.00
Challenge-skill balance	3.71	0.62	0.33	7.94***	0.00
Goals of an activity	4.28	0.51	0.33	17.24***	0.00
Unambiguous Feedback	3.62	0.64	0.52	6.68***	0.00
Control	3.93	0.78	0.64	8.22***	0.00
Action–awareness merging	3.73	0.66	0.24	7.66***	0.00
Flow experience	4.08	0.55	0.85	13.56***	0.00
Concentration	4.38	0.70	0.89	13.56***	0.00
Time distortion	4.15	0.90	0.82	8.90***	0.00
Autotelic experience	4.33	0.68	0.90	13.48***	0.00
Loss of self-consciousness	3.10	0.93	0.68	0.77	0.44
Overall Flow	3.98	0.44	0.87	15.24***	0.00

* p<.05 ** p<.01 *** p<.001

Conclusions and Limitations

To sum up, *Finding the little girl Yu* integrating situated learning and clue analysis with cognitive design was a well-designed educational game to engage learners. Both group team and personal team learners involved in the game.

The context of finding a lost girl was embedded in the game to enhance the degree of situation and authenticity, which further enabled student being more immersed in game to engage learners and promote decision-making training. This preliminary study showed students' positive evaluation in terms of engagement Especially, action–awareness merging was significant difference from median 3. Which is different from previous researches (Chen & Hou,2020; Kuo et al., 2018). The reason might be that the nature of this game was designed for training ability and previous studies mainly focus on specific domain knowledge.

For the further study, deep analysis of ARCS, anxiety, motivation, gender, high/low learners' difference, and decision-making process behavior will be conducted. Also, how scaffolding in the game might help student to learn better will be investigated. Lastly, interview is needed for further understanding learning gain and triangulation as well.

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