Design of Complex Problem-Solving Ability Training Games That Combine Simulation Spaces and Plots

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Abstract
The most important thing in complex problem-solving is to recognize the characteristics of the crux of the problem, which is a very important "ability" in the workplace, and the need to understand the problem comprehensively before analyzing it is an important step in making decisions on how to deal with the problem. This study uses *Gather Town* to design a simulation company environment. The first learning objective of this game is that suddenly an important client is coming to visit, and in the absence of a redundant meeting room, the general manager assigns the "The Super Secretary" to coordinate with several key figures (NPCs, Non-Player Character) and propose the best solution to solve this complex problem. Good communication skills are our second learning objective. This game uses *Google Forms* to provide players with dialogues and interactions with key figures NPCs in the *Gather Town* simulation space, and different communication discourse content choices will generate different information and plot development. The participants of this preliminary study were 12 adults over 20 years of age in Taiwan. The results of the study showed that the participants' mean scores for flow, game elements, and game feedback were significantly higher than the median of the scale (i.e., 3), and their activity anxiety scores were lower than 3. In addition, the qualitative opinion feedback collected also showed that the learners also reported that the game was "very realistic, as if we were really discussing and negotiating with them". Therefore, the results of this study suggest that the digital situation simulation mechanism designed in this study has the potential to develop decision-making thinking and communication skills for complex problem-solving.

Keywords: Educational Game, Situated Learning, Scaffolding, Communication Skill, Complex Problem-Solving, Contextual, Online Distance Learning

Introduction

In the workplace, it is not uncommon to find oneself confronted with perplexing decision-making problems that are inherently complex, not because they are difficult to solve, but because they are subject to conflicting variables that complicate and entangle the problem (Dutta, 2018). The intrinsic impact of complex problems on strategy management is serious, confronting management with profound paradoxes (McMillan & Overall, 2016). These problems require consideration of holistic solution strategies because issues and problems are inherently interrelated and dynamically changing (Waddock et al., 2015) and require the active engagement of multiple stakeholders with potentially conflicting perspectives and goals (Edmondson, 2016). Therefore, the ability to solve complex problems in the workplace is one of the important training competencies in the workplace. Kornelakis & Petrakaki (2020) studied that the ability to solve complex problems is a cognitive process of strategic thinking. In addition, Buchanan (1992) suggested that complex problems without explicit conditions and constraints need to be handled in a non-linear way, which requires the coordinator to have a holistic view of the problem situation and to formulate testable hypotheses about possible solutions. Since the problem situation will not reach the coordinator under predefined conditions, defining the problem and finding a solution are equally important (Dutta, 2018). This is related to the inductive reasoning process, in which acceptable solutions are then coordinated through the formation of exploratory hypotheses, so that in the complex problem-solving coordination process, the problem definition and the proposal of a solution are determined simultaneously (Liedtka, 2006).

This study proposes a new online digital game "The Super Secretary" for workplace complex problem-solving skills training. The game is designed on the *Gather Town* platform, with a simulation space and company context, and *Google Form* as the interactive mechanism for NPC dialogues. The contextualized learning game in a simulation space can promote immersion and reflection for learners (Hou, 2015). The game goal of this study is to allow learners to propose the best solution to complex problems through consultation with key colleagues (NPCs) in the game. The game allows learners to make different choices in the dialogues with NPCs to produce different information outcomes and plot developments, and to experience communication skills in dialogues with different characters. At the same time, the game guides learners to construct comprehensive generalization and reasoning, develop complex problem-solving skills, and achieve more organized decision-making.

Methods

This study was conducted with 12 adults over 20 years of age in Taiwan, who participated in the preliminary case study. Before taking the test, none of the participants had taken any relevant courses using the scripted interactive mechanism learning method designed by *Google Form*. The operation of the activity was based on the *Gather Town* game platform, where participants interacted with NPCs in a free-exploration mode, as shown in Figure 1. The hidden cognitive scaffolding is designed in the dialogues, so that each page of the dialogues contains the judgmental thinking of communication skills. When the learner selects a good communication path, the learner will get a good message back, which can increase the strategic thinking of complex problem solving. The cognitive scaffolding tips for communication and complex problem-solving can also be explored during the game. At the end of the task, learner will have completed the learning of communication and complex problem-solving skills.

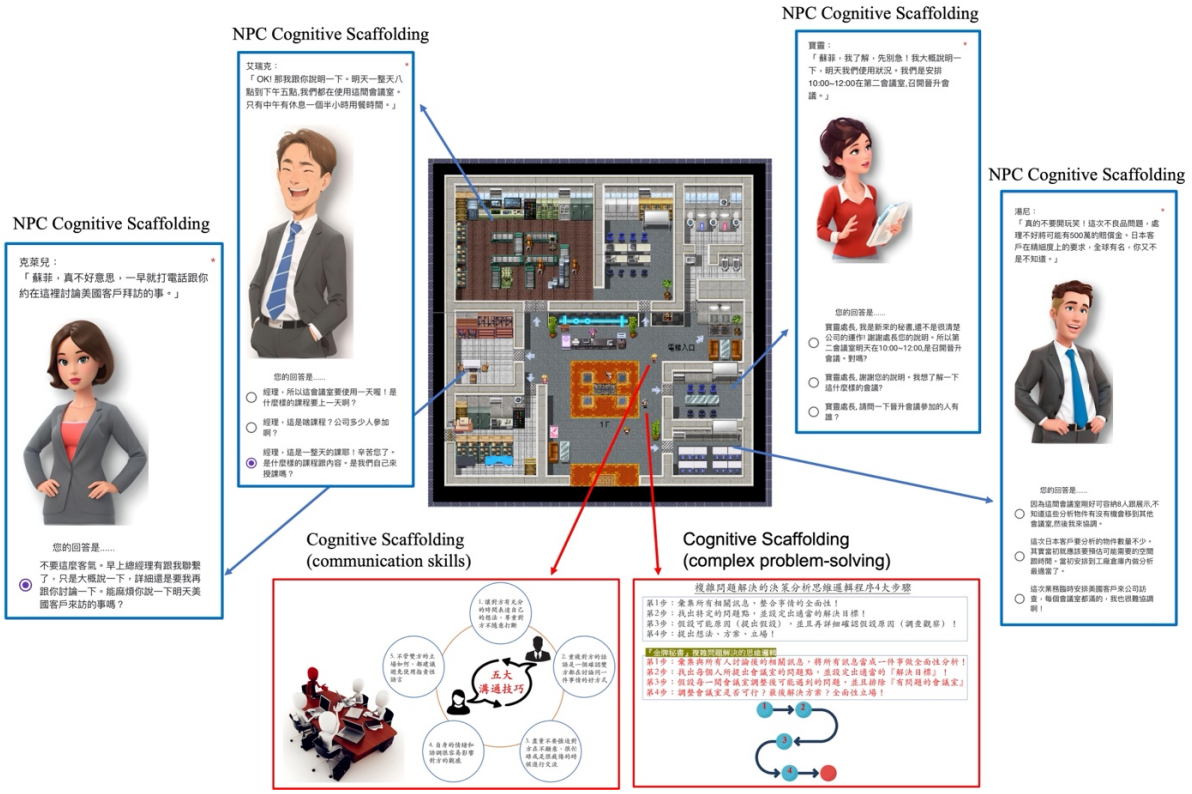

Fig. 1. *Gather Town* simulation platform and scripted interactive mechanism by *Google Form*

Results and Discussions

"The Super Secretary" is based on the learner's free exploration and interactive dialogue with NPCs in the situation simulation space, and finally summarizes the reasoning process, forms an exploratory hypothesis, and then coordinates an acceptable solution to the task as a learning goal. Table 1 shows the descriptive statistical analysis of learners' flow state after completing the task. The overall flow (M=4.19, SD=0.66) is significantly higher than the median of the scale (i.e., 3). Flow antecedents (M=4.23, SD=0.67), flow experience (M=4.17, SD=0.69), and other flow average dimensions are all high at a median of the scale (i.e., 3). Among them, the average concentration ratio of sub-dimensions is as high as 4.42. It is inferred that the overall game design of the scaffolding-oriented NPC plot dialogue interaction mechanism can make learners more immersed in the game. Ou et al. (2021) mentioned that when learners are immersed in a realistic learning environment, their cognitive speed is accelerated, their attention is enhanced, and their critical thinking is improved.

Table 1. *The mean and standard deviation of learners' flow*

	(*N*=12)			
	M	*SD*	*Z*	*Sig.*
Overall Flow	4.19	0.66	2.949**	0.003
Flow antecedents	4.23	0.67	2.809**	0.005
Challenge-skill balance	4.33	0.83	2.881**	0.004
Goals of an activity	4.33	0.72	2.842**	0.004
Unambiguous Feedback	4.08	0.73	2.821**	0.005
Control	4.25	0.87	2.833**	0.005
Playability	4.13	0.64	2.971**	0.003
Flow experience	4.17	0.69	2.944**	0.003
Concentration	4.42	0.76	2.985**	0.003
Time distortion	3.75	0.84	2.413*	0.016
Autotelic experience	4.35	0.87	2.902**	0.004
Loss of self-consciousness	3.71	1.03	2.074*	0.038

*p <0.05, **p <0.01

Table 2 shows the descriptive statistical analysis of learners' game anxiety, game feedback, and game elements. Overall anxiety (*M*=1.84, *SD*=0.52), lower than the median of the scale (i.e., 3) and reaching significance. Moderately low anxiety is an important indicator of sustained flow during gaming activities (Hou, 2015). In addition, overall game feedback (*M*=4.42, *SD*=0.56), game usefulness (*M*=4.40, *SD*=0.64), game ease of use (*M*=4.44, *SD*=0.61), and game elements (*M*=4.38, *SD* =0.74) is also significantly higher than the median of the scale (i.e., 3). Hassan et al., (2021) pointed out that good game elements will cause learners' sense of achievement, participation and improved motivation.

Table 2. *The mean and standard deviation of learners' game anxiety, game feedback, and game elements*

	(N=12)			
	M	*SD*	*Z*	*Sig.*
Game Anxiety	1.84	0.52	-3.061**	0.002
Game Feedback	4.42	0.56	3.066**	0.002
Game Usefulness	4.40	0.64	2.956**	0.003
Game Ease of Use	4.44	0.61	3.089**	0.002
Game elements	4.38	0.74	3.007**	0.003

**p <0.01

Conclusions and Limitations

"The Super Secretary" is a situation simulation online game developed by this research based on the theme of "Coordination tasks for conference room scheduling" in a company, which focuses on the training of complex problem-solving skills. It also allows learners to experience the importance of complex problem solving and inductive reasoning process (Khisty, 2000). In summary, there were significant differences in flow performance, learning anxiety, game experience, and game elements. The preliminary results of this study show that the simulated experiential learning with the company context and colleague interactions, and the introduction of the scaffolding-oriented NPC dialogues, can maintain a high level of flow and reduce learning anxiety during the learning process. The preliminary results of this study show that the digital situation simulation mechanism designed in this study has the potential

to cultivate decision-making and communication skills for complex problem solving. For future research, we can increase the sample size and explore the differences between the scaffolding-oriented NPC plot dialogue interaction mechanism and the general scaffolding mechanism in terms of online learning scaffolding effectiveness, realistic feelings and critical thinking, and do more research. In-depth comprehensive comparative analysis.

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