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DESIGN AND EVALUATION OF A PROMPTING INSTRUMENT TO SUPPORT LEARNING WITHIN THE DIFFUSION SIMULATION GAME

SEOLIM KWON

MIGUEL LARA

Indiana University Bloomington

JAKE ENFIELD
California State University, Northridge

THEODORE FRICK
Indiana University Bloomington

ABSTRACT

Conducting an iterative usability testing, a set of prompts used as a form of instructional support was developed in order to facilitate the comprehension of the diffusion of innovations theory (Rogers, 2003) in a simulation game called the Diffusion Simulation Game (DSG) (Molenda & Rice, 1979). The six subjects who participated in the study stated that the prompts were necessary in order to properly complete the game and that they would have done worse without them. However, the game performance and learning test scores did not correspond to the notion that the prompts significantly enhanced the learners' performances in the DSG or increased their knowledge of the underlying game theory. We assume that, as the DSG is a complex strategy game, the prompts may not be sufficient support by which to help learners. As such, it is possible that the game requires a different type of instructional support. We further speculate upon potential factors that could have affected the subjects' learning and performances. Several suggestions in regard to methods that could be used to improve the learning effectiveness of the game have been proposed.

INTRODUCTION

The goal of using the Diffusion Simulation Game (DSG) is to provide a virtual scenario within which students can put into practice their knowledge of and skills

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related to the diffusion of innovations theory as largely influenced by Rogers (2003). Rogers's model for the diffusion of innovations, developed in 1962, explains the process by which new ideas and practices spread between and within social systems. A board version of the DSG has been played since the 1970s, by undergraduate and graduate students as a complement to a course for pre-service teachers at the School of Education at Indiana University. A study of the board version of the DSG conducted by Molenda and Rice (1979), which included 143 participants, concluded that the game was realistic, valuable, pleasant, and stimulating.

The online version of the DSG has been used for years in a course at a large Midwestern university to help teach this theory. Since its introduction at the university, it has started to gain popularity outside of the university. Nearly 9,000 game plays of the free version have taken place over the last 2 years and over 200 licenses have been sold in the past year (Lara, Myers, Frick, Aslan, & Michaelidou, 2010). However, reports are still being made by the learners that the game is difficult to play. Enfield, Myers, Lara, and Frick (2012) discovered that about half of the 10,000 sessions did not extend past the second turn. Hence, in this study, the prompts were designed in order to address the learners' cognitive and emotional struggles by providing supportive information. The purpose of this study was to investigate the effectiveness of these supportive prompts on players' game performance and mastery of the learning objectives. The learners' perceptions of the helpfulness of the prompts were also explored. Furthermore, the learners' preferences between forced and optional prompts were also examined. The following research questions guided the study:

1. How does the game performance of the learners who are provided with forced prompts (those that popup abruptly, forcing learners to pay attention to them) during the game play differ from those learners who utilized the optional prompts (those that indicate to the learners that the prompt is available, but that it can easily be ignored)?
2. How does the game performance of the learners who are provided with prompts during the game play differ from the game performance of the learners who are not provided with prompts?
3. Does a learner's game subject knowledge (diffusion of innovations theory) improve after playing the game when the prompts are provided?
4. Are learners' characteristics associated with an improvement in game subject knowledge?
5. How do learners perceive the helpfulness of the prompt information provided throughout the game?
6. In which ways could the design of the prompts be enhanced in order to improve game performance and increase understanding of the game subject knowledge?

REVIEW OF THE LITERATURE

Simulation Games and Learning

In the past few years, an increasing number of simulations have been developed as commercial games. In addition, such games have become increasingly popular in regard to instruction in dealing with complex domains of reality (Leutner, 2002). Leemkuil, de Jong, and Ootes (2000), however, claimed that the advantages of games and simulations are not always evident in regard to learning unless they are accompanied by instructional support, such as prompts, feedback, debriefings, or reflections. Without instructional support, they say that several learning problems may occur, such as acquiring misconceptions (Leemkuil et al., 2000) and incomplete or disorganized knowledge (de Jong & van Joolingen, 1998) as well as experiencing cognitive overload (Kirschner, Sweller, & Clark, 2006). Kirschner et al. insisted that until learners build proper schemas by which to integrate new information with their prior knowledge, guidance in the learning process is important.

Prompts and Feedback

Among the different types of instructional support used in this study, a set of prompts was used as a way to support learning. According to Shute (2008), the prompt is described as a strategic hint that guides the learner in the right direction. The prompt is different from feedback in that feedback is intended to modify a learner's current thinking or behavior (Shute, 2008), while a prompt is intended to provide a generic strategy hint, not necessarily according to the learner's current thinking or behavior.

The reason that the prompt was used as the form of instructional support in this game rather than feedback is because the DSG is a complex strategy game and, as such, it is almost impossible for researchers to accurately guess learner's current thinking behind their game actions and hand out solutions to modify misconceptions. Thus, the prompt was considered to be the more feasible form of support.

After deciding to use prompts, we next needed to determine when the prompt should be delivered. The timing of the prompt delivery was decided based upon an estimate of when the learners generally make mistakes within the game. Detailed explanations of the prompt's development and implementation are introduced in the Methods section.

Prompts and Pre-Tutorial Information

A number of researchers have focused their studies on the critical aspect of the timing of instructional support in simulation game-based learning. Leutner (1993) and Elshout and Veenman (1992) found that providing information exactly at the moment it is needed by the learner is much more effective than providing all of the necessary information prior to the learner's interaction with the game.

The prompts used in this study were also given during the learner's interaction with the game. The reasoning for this intervention was based on three assumptions: *cognitive load, immediacy,* and *relevancy* assumption. First, it was assumed that learners who play games would not be enthusiastic about reading tutorials or instructional materials before beginning the game as they would want to play the game immediately (*cognitive load assumption)*. Second, the learners only focus on information when they start to see the immediate connection between the information and the problems that they are encountering (*immediacy assumption*) (Reeves & Aggen, 2002). Third, the learners understand the learning resources better when they are used in relevant learning situations within the game play rather than before the game play when the learners have not been exposed to the game scenario (*relevancy assumption*).

Prompts, Adaptive Advice, and Background Information

Using a computer-based simulation game, Leutner (1993) compared the effects of pure-discovery, adaptive advice, and permanent background information and found that the students without any support (pure-discovery treatment group) learned how to play the game (game knowledge), but only acquired a minimum of the domain knowledge, whereas the students who explored the game with the assistance of system-initiated adaptive advice (adaptive advice treatment group) acquired a high degree of domain knowledge, but learned to play the game only to a limited degree. Leutner also found that the effect of non-adaptive information (permanent background information treatment group), which the learners could use to refer to strategy-related information anytime during the game play, was significant in the delayed memory retention test, whereas the effect of adaptive advice was significant only in the immediate learning post-test.

Similar to how Leutner (1993) compared the effects of adaptive advice and permanent non-adaptive information in the DSG research, we also initially decided to study the effects of adaptive and learner-requested advice. However, during our pilot-tests, we discovered that while playing games, learners are not inclined to ask questions and seem to prefer solving problems on their own in order to not be distracted. Therefore, we determined that forced prompt during game play was the more reasonable choice in regard to supporting learning in the DSG play.

The Diffusion Simulation Game

The purpose of the DSG is to provide a virtual scenario within which students can put their knowledge and skills about change management concepts and strategies into practice. In addition, such a game raises awareness among the learners about how challenging and difficult the process of diffusing a new idea can be, regardless of how useful that idea might seem. Playing the DSG gives learners an experience through which they can assimilate the diffusion strategies and concepts proposed by Rogers (2003). (See Figure 1.)

Figure 1. Screenshot of the Diffusion Simulation Game (v. 2).

In the DSG, the student plays the role of a change agent in a junior high school. The learner's mission is to successfully diffuse the implementation of a specific instructional strategy in the school, persuading up to 22 staff members to adopt the new strategy. The student has to consider different elements of the diffusion of innovations theory in order to succeed in the game, such as adopter type, adoption phases, social networks, opinion leaders and communication channels.

The diffusion of innovations theory attempts to explain the process by which new ideas and practices spread between and within social systems (Valente & Davis, 1999). Diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 11). The DSG attempts to teach the following concepts, which are aligned with the diffusion of innovations theory:

a. Most individuals do not adopt an innovation immediately, but, instead, pass through a series of adoption phases starting from being aware of the innovation and ending in its full adoption and implementation.
b. The innovation adoption rate varies from person to person. Some persons tend to be eager to try out new ideas, while others are rather reluctant to any type of change.
c. Communication channels play a critical role in the process of diffusing an innovation. Mass communication tends to be more suitable for raising awareness about an innovation, especially for early adopters, whereas interpersonal channels are more appropriate for having potential adopters try and appraise the innovation.
d. Within a group, the opinions of some people toward the adoption of an innovation are more important than others because these individuals represent the opinion leaders and, as such, have more influence in the diffusion of innovation process.
e. Communication networks refer to the interconnection of the individuals within a system and are significant determinants in the adoption of the innovation process.
f. Change agents are individuals who generally work for a change agency. Their goal is to secure the adoption of a particular innovation by a group of people.

METHODS

Subjects

Seven subjects agreed to participate in a usability test of the prompt instrument. Six additional subjects were recruited for this study after necessary modifications were made to the prompt instrument. The 13 subjects were students from a large Midwestern university. The latter six subjects were recruited through a classified

ad posted on the university online system, ensuring that they had not played the DSG previously and had no prior knowledge about the diffusion of innovations theory. Three of the six subjects were international students, while the rest were from the United States.

Six subjects were randomly assigned either to the forced prompting (FP) group or the optional prompting (OP) group. The subjects in the FP treatment group were required to read all of the prompt information provided, while the participants in the OP treatment group were given the option of ignoring the prompts.

Data Collection

The data collection process involved two researchers conducting the following steps in sequential order: administering a pre-game demographic interview, administering a pre-game learning test, presenting a 2-minute video tutorial explaining the game rules and familiarizing players with the game interface, having the subjects play a single game session, administering a post-game learning test, and administering a post-game learning experience interview. The game session and post-interview were all recorded using a screen-capturing program.

Detailed descriptions of how the data sources were collected during each research process will be discussed in the Data Sources section. The research was conducted in the Virtual Experience lab at the School of Education of the large midwestern university. This lab is specifically designed to facilitate the observation of learners' interactions with digital games.

DESIGN AND DEVELOPMENT OF THE PROMPT INSTRUMENT

The use of prompts with the DSG was tested for usability in order to create the prompt instrument. Through the usability tests, four important attributes of the prompt instrument were identified: the content, timing, frequency, and medium of delivery of the prompt information.

Prompt Contents

The objective of providing prompts was to guide learning and help the players apply the important concepts of the diffusion of innovations theory that the game is designed to teach. Since the DSG is a complex game, we made sure that the information in the prompts was short and succinct and did not cause additional cognitive overload (Mayer & Moreno, 2002; Phye & Bender, 1989). The role of the prompt was to "straighten things out in the flood of data" (Leutner, 1993, p. 115).

At the same time, we also avoided presenting the game strategies too explicitly. Rather than teaching the players what actions to take (performance-driven prompts), what concepts they ought to keep in mind (learning-driven prompts)

were presented. For example, when providing prompts about the *awareness* stage, one of the prompts read "To get multiple people past the *awareness* stage, use mass communication channels" instead of telling them exactly which diffusion activities to choose in the *awareness* stage. Seven prompts were developed for the learners, each of which addresses a particular concept of the diffusion of innovations theory, such as the adoption stage, adopter types, and types of diffusion activities.

Frequency

In order to teach the diffusion of innovations theory during the learners' game time, the prompts were provided at a predetermined time within two academic calendar years (see in Figure 2), which were built into the context of the DSG. By testing the prompts using seven subjects and gathering information from the game plays as well as the learners' speak-aloud and interview data, we were able to gather information on when certain prompt information should be given.

Distribution of the Prompts

According to Kirschner, Sweller, and Clark (2006), unsuccessful learners experience cognitive overload particularly at the beginning of discovery-based learning experiences such as the DSG because they do not have sufficient schemas through which to process problem-solving skills in a new environment. In light of this understanding, majority of the prompts were provided earlier in the game in order to support the learners as they built the appropriate schemas.

Medium of Delivery

A Wizard of Oz design approach (Dahlbäck, Jönsson, & Ahrenberg, 1993) was used to rapidly test the effectiveness of the prompts by employing

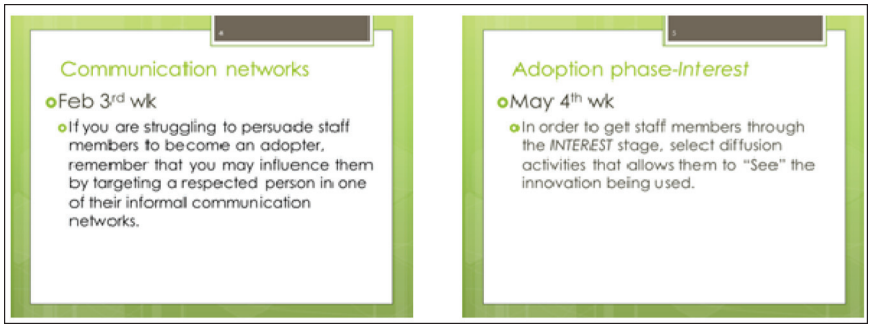

Figure 2. Prompt Sample.

several pre-existing commercial tools. Adobe Connect (see Figure 3) allowed the researchers to monitor the learners' game performances as well as check whether they viewed the prompt information. MSN Messenger was used to notify the appearance of prompts by making a beeping sound and producing a flashing effect.

DATA SOURCES

Pre- and Post-Game Tests

The pre-game test was intended to measure the current knowledge participants have before playing the Diffusion Simulation Game. The same instrument was used as a post-game test to measure learning gained from playing the DSG. Both of the tests included the same six scenario-based questions, which tested the learners' understanding and application of the diffusion of innovations theory. In order to measure the learning application from the game more accurately, the test items were designed based around a business context (Figure 4) rather than the K-12 educational context provided by the DSG.

Each question in the testing instrument was associated with the information provided in the prompts; however, it was not required that the learner read the prompts in order to correctly answer the questions. That is, without any prompts, simply playing the DSG provides learners with opportunity to gain the content and application knowledge to accurately answer the questions. The prompts were intended to facilitate the learning process and reduce the learning time and effort needed. It was expected that the learners who received the prompt information would answer the associated questions correctly in the post-interview because they had the chance to apply recommended strategies when playing the game and had opportunities to learn why and why not certain strategies would work.

Game Performance

Number of Adopters

This indicator refers to the number of adopters used in order to measure the game performance. In this case, a learner's game performance in the DSG could range from 0 to 22, representing the number of staff members who adopted the innovation.

Adoption Points

The total number of adopters was not the primary indicator of game performance because, in the game, some of the staff members are harder to get as adopters than others, depending upon their adopter types (from *innovator* to

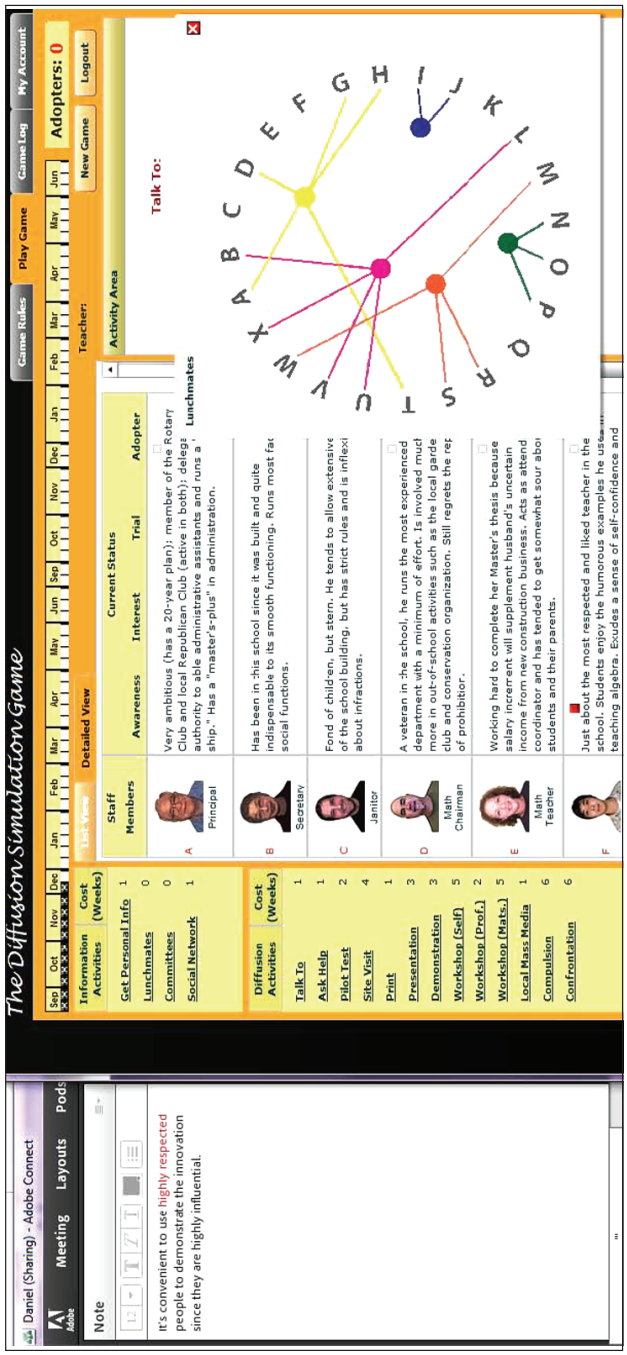

Figure 3. Screenshot of the DSG being played inside of the Adobe Connect software.

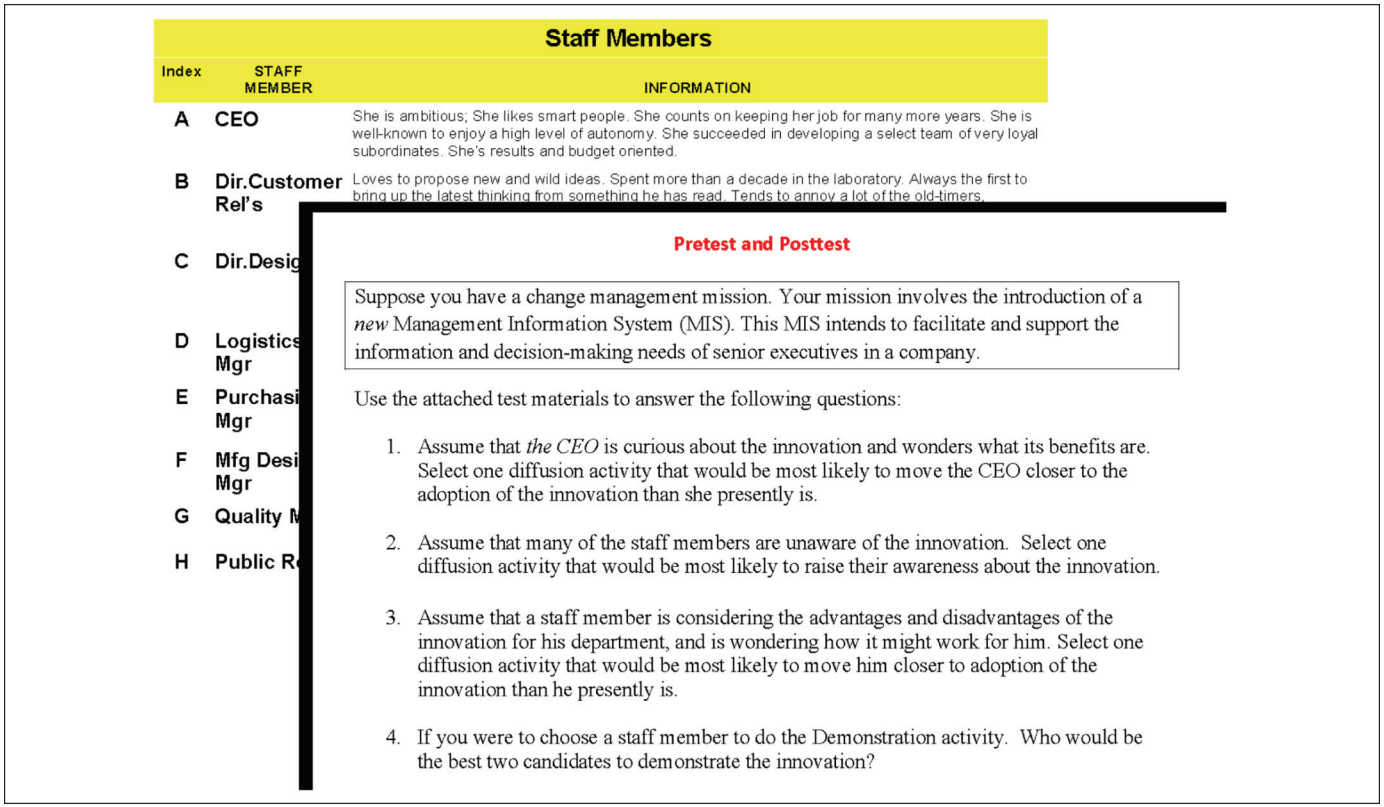

Figure 4. Screenshot of the Pre- and Post-Game Tests.

laggard) and because a learner may have had many of the staff members very close to adoption without having completely gained them as adopters.

For these reasons, the staff members' adoption stages (*awareness, interest* or *trial*) and the total number of adoption points per staff member were taken into consideration for calculating adoption points. For instance, Subject A obtained nine adopters and ranked second among the six subjects, whereas Subject D obtained 7 adopters and ranked third. Although there does not appear to be much difference between the two subjects in regard to the adopter numbers, when analyzing the results of both games, it was noticed that Subject A had 14 staff members in the *Trial* phase, whereas Subject D only had seven staff members in the *Trial* phase. In other words, Subject A had twice as many staff members who were very close to becoming adopters than Subject D.

The adoption points were calculated as the sum of the ratios of the adoption points obtained per staff member to the total number of actual points needed to get each specific staff member to become an adopter. For example, the principal requires 11 points to become an adopter. A subject who had only gotten 5 points would have scored 5/11 for the principal. This calculation was then repeated for the rest of staff members and then summed in order to obtain the overall performance per game session.

Pre- and Post-Game Interviews

Additional sources for collecting data were the pre- and post-game interviews. The pre-game interviews were conducted in order to collect the learners' background information, such as their prior game experience, ethnicity, academic program and grade level before they started the game. The post-game interviews were conducted upon completion of the game play in order to identify the subjects' perceptions in regard to how helpful the prompts were as well as their suggestions on design changes.

RESULTS AND FINDINGS

Research Question 1

> How does the game performance of the learners who are provided with forced prompts (those that popup abruptly, forcing learners to pay attention to them) during the game play differ from those learners who utilized the optional prompts (those that indicate to the learners that the prompt is available, but that it can easily be ignored)?

To answer the question, the participants in the forced prompting (FP) treatment group were required to read all of the prompt information provided, while the participants in the optional prompting (OP) treatment group were given the option to ignore the prompts. Using Adobe Connect, researchers were

able to check on participants' access to the prompts. Interestingly, it turned out that all of the participants in the OP group chose to read each provided prompt. We were thus unable to investigate differences between these two groups. We observed that players were in need of some type of guidance during the game.

Research Question 2

> How does the game performance of the learners who are provided with prompts during the game play differ from the game performance of the learners who are not provided with prompts?

The results from the data collected for research question 1 showed that practically no difference existed in regard to the forced and optional prompting that each group received and, as such, we cannot compare the effects of each type of prompt on the DSG performance. As we could not compare game performance according to the type of prompts, we, instead, added research question 2 in order to, at least, understand the game performance difference between the group that received prompts versus the group that did not receive prompts. The game result for the subjects who did not receive prompts was taken from a study conducted by Lara, Enfield, Myers, and Frick (2010).

Table 1 provides the results of the game performance in terms of the adoption points obtained by the subjects who received prompts versus those who did not receive prompts. Within the study conducted by Lara and colleagues, four participants played the game without prompts. The subjects did not have any previous knowledge of the diffusion of innovations theory and had not played any version of the DSG before participating in the study. Contrary to original expectations, no statistical significance existed between the group with and without prompts ($t(8) = 1.026$, $p < .05$).

Research Question 3

> Does a learner's content knowledge (diffusion of innovation theory) improve when playing the game with prompts?

As can be seen in Table 2, no significant difference was found between the pre- and post-test results, which means that the learners may not have gained a significant amount of knowledge regarding the diffusion of innovations theory by playing the DSG with prompts ($t(5) = .363$, $p > .05$).

Research Question 4

> Are learners' characteristics associated with an improvement in game subject knowledge?

The pre-game interview, which collected the subjects' background information at the beginning of the study was used in order to address this question. The

Table 1. Game Performance Results

	With prompts								Without prompts					
Subjects	A	B	C	D	E	F	Mean	*SD*	G	H	I	J	Mean	*SD*
Adoption points	17.6	16.3	13	12.3	11.9	11.7	13.8	2.51	14.3	10	14.6	9.5	12.1	2.7

Table 2. Pre- and Post-Test Results

	Subjects	Subject A	Subject B	Subject C	Subject D	Subject E	Subject F	Mean	*SD*
Learning test of the diffusion of innovations theory	Pre-test result	4	2.5	4.5	2	2	3	3	1.05
	Post-test result	5	5	2.5	3.5	3.5	2.5	3.67	1.13
	Test result improvement (= Post-test result– Pre-test result)	1	2.5	–2	1.5	1.5	–0.5	0.67	1.63

information is included in Table 3. Upon further examination of the game performance, it was noticed that two learners scored better than their peers. In order to understand how and why these learners did so much better than their peers, any potential connections between the learners' game performance and their background information was speculated below.

DSG Performance Variables I: Cultural Background & Language Barriers

From the results shown in Table 3, cultural background can be speculated as one of the potential factors that would have affected game performance.

Two of the three students who had K-12 experiences in the United States had higher scores in regard to the game performance than the other three international students. As the DSG storyline is based on the U.S. K-12 system, it is likely that U.S. students would more easily understand and become engaged in

Table 3. Pre-Game Interview Information

Subjects		Subject A	Subject B	Subject C	Subject D	Subject E	Subject F
Game result	Adoption points	17.6	16.3	13	12.3	11.9	11.7
Pre-game interview result	K-12 background in US	Y	Y	N	N	Y	N
	Self-reported level of game skills	High	Above average	Average	Low	Low	Low
	Type of games learners enjoy	Simulation strategy ("Civilization")	Simulation strategy, action, arcade	Online card	Tetris, online card games	Console	Kid's arcade
	Frequency of playing any games	Weekly	Weekly	Everyday	Rarely	Every other month	Almost never
	Gender	M	M	M	F	M	M
	Grade level	Grad	Grad	Grad	Grad	Under-grad	Grad

the game context than the learners who have not had U.S. K-12 background experiences. According to the post-interview with Subject B, the staff members described in the game seemed very familiar, which made the game more interesting to him.

The language barrier might also have been an issue for the non-U.S. learners as the DSG is a text-heavy game, which requires proficiency in English communication. In addition, the game contains culturally relevant phrases for international students to understand. The majority of the international students asked the meaning of several terms, such as "runs a tight ship," "have a master's-plus in administration," and "regrets the repeal of prohibition."

DSG Performance Variables II: Past Simulation Strategy Game Experiences

According to Table 3, the game scores of Subjects A and B, who play simulation strategy type games at least once a week, ranked first and second. One speculation is that frequent simulation strategy type game experience might be related to success in the DSG to some degree (Subrahmanyam & Greenfield, 1994). Following section describes how the learners who have rich experiences in simulation strategy games display certain competencies in game behaviors more frequently than those lacking simulation strategy game experience and how that could have affected their game performance in the DSG.

Understanding game interface, objectives, and rules: Before the game began, each of the participants was allowed to read the game rules and listen to the video tutorial for as long as they wanted. However, the learners' speak-aloud data and post-interview information revealed that only the learners who have had frequent simulation strategy game experiences had no questions or encountered any problems during the game. The remaining learners asked questions about the game interface, including how to begin the game, how the game points work, and what were the game objectives.

Information reading behavior: Unlike the high performers, the low performers did not seem to read the game feedback or prompt information carefully. When Subjects E and F incorrectly matched the diffusion activities with the staff members, a warning message appeared stating that their action is not appropriate; however, the learners repeatedly conducted the same wrong activity. On the other hand, both learners who have had frequent simulation strategy game experiences spent more time reading the game feedback and prompt information than the other learners and did not display any observed obvious mistakes.

De Jong and van Joolingen (1998) introduced several reasons why unsuccessful learners mismanage information during learning experiences. One of the reasons is *confirmation bias*. Dunbar (1993) found evidence that some subjects

have a strong inclination to search for evidence that only supports their original assumptions rather than stating a new hypothesis when confronted with outcomes that disagree with their original assumptions. A second reason De Jong et al. (1998) raised as to why lower achieving learners mismanage information is the "unable-to-think-of-an-alternative-hypothesis" phenomenon, which means that the subjects will stick to their current hypotheses (despite conflicting evidence) simply because they do not have any alternatives. Another explanation can be found in a study completed by Kuhn, Schauble, and Garcia-Mila (1992), in which they stated that some of the subjects have a habit of not using the whole range of potential information in problem-solving situations and, instead, rely only on a limited set of information. This inefficient behavior is particularly dangerous in the DSG because it is a complex learning environment that contains a great deal of information that may cause learners to fail if they do not perform a thorough analysis of the game information and game feedback.

Interpreting prompt information: Subject D said she had difficulty interpreting the information in the prompt and said that many of the prompts sounded alike to her. Subject F, on the other hand, said that each prompt had several different ways in which it could be interpreted. These issues can be partly attributed to the learners' lack of ability to interpret the data correctly.

Schauble, Glaswer, Raghavan, and Reiner (1991) explored learners' behaviors in scientific discovery-based learning and have found that higher achieving learners were more proficient in interpreting data, discovering principles among variables, and making inferences of the value for the variables. Klahr, Fay, and Dunbar (1993) observed that in real world-based learning, such as simulation games, learners may find it difficult to interpret and analyze real world feedback as it is not usually so straightforward compared to the simple right/wrong binary type of feedback. Both of the learners in our study who had sufficient simulation strategy game experiences said that they did not have any difficulties interpreting the prompts in the DSG.

Retaining prompt information: Another pattern found in the lower achieving simulation strategy gamers' play was that they seemed to forget the prompt information provided to them as they proceeded through the game. For example, at the beginning of the game, the observations showed that Subjects E and F used the provided prompts that they received in their game play, but the further the game progressed, the more they began using strategies that contradicted these prompts. During the post-interview they confessed they failed to recall the prompt information that they had previously received. Unsurprisingly, while the lower achieving players used a more random strategy throughout the game, both learners who had sufficient simulation strategy game experience were observed to be persistent in attempting to continuously apply the advice given by the prompts.

Research Question 5

> How do the learners perceive the helpfulness of the prompt information provided throughout the game?

As can be seen in Table 4, all of the learners in the study agreed that the prompts are needed in the DSG. Five of the six learners stated that they would have performed worse without the prompts and the same number agreed that the prompts did not distract them from their game play. While all six of the learners agreed that the DSG requires support based on prompts, they evaluated the helpfulness of the prompts on an average of 3 out of 5 points. The two high game

Table 4. Post-Game Interview Information about the Prompts and the Game

Subjects		Subject A	Subject B	Subject C	Subject D	Subject E	Subject F
Game result	Adoption points	17.6	16.3	13	12.3	11.9	11.7
Post-game Interview Result about the *Prompts*	Necessity of prompts in this game	Required	Required	Required	Required	Required	Required
	Expected game performance without the prompts	Worse	Worse	Worse	Worse	Almost the same	Worse
	Distraction by the prompts (1 least-5 most)	1	1	1	1	4	1
	Helpfulness of the prompts (1 least-5 most)	3	4	3	3	3	4
	Preferred prompts: Optional/ Forced?	F	O	Learner-requested feedback	Depends on game skills	F	Depends on game progress
Post-game Interview Result about the *Game*	Level of game enjoyment (1 least-5 most)	5	4	2	4	3	3.5
	Level of game difficulty (1 least-5 most)	2	3	3	3	4	3

performers said that the prompts were not helpful because they already knew most of the strategies specified in the prompts. The other learners mentioned that they needed more guidance than was provided in the prompts. Specific suggestions from these learners will be introduced in the response to Research Question 6.

In addition, the learners were asked whether they preferred forced (those that popup abruptly forcing the learners to pay attention to them) or optional prompts (those that indicate to the learner that the prompt is available, but can be easily ignored). Interestingly, two learners preferred the forced prompts, one learner preferred the optional prompts, and the other three learners stated that they preferred a more customized prompt instrument that would consider the learner's needs, current game stage, and game skills.

Research Question 6

> In which ways could the design of the prompts be enhanced to improve game performance and increase understanding of the game subject knowledge?

As can be seen in Table 5, the higher achieving learners were satisfied with the frequency and timing of the prompts, whereas lower achieving learners felt that they needed more specific prompts, particularly at the beginning of the game.

This result coincides with the Kirschner, Sweller, and Clark (2006) claim that extensive guidance should be provided to novices at the beginning of learning until they increase their level to expert.

CONCLUSION

Providing prompts as a form of instructional support was perceived by the learners as a necessary intervention in order to play the DSG and understand the underlying diffusion of innovations theory better. However, the game scores and learning test outcomes did not correspond to the notion that the prompts significantly enhanced the performances of all of the learners in the DSG or increased their knowledge of the underlying game theory.

Below are some suggestions as to how to make the prompt that we designed more effective in regard to supporting learning in the DSG. These suggestions are based on what we observed from the game play, listened from the interviews, or learned from the analyses of the game scores and learning test outcomes.

First, for learners who do not have rich simulation game experiences, it is important for the instructors or game facilitators to help them understand the game objectives and become fully acquainted with the game rules and interfaces. Such an orientation will protect the learners from suffering extraneous cognitive overload (van Merriënboer & Sweller, 2005) and maximize the positive impact of the prompts.

Second, the instructors should also ensure that a non-U.S. learner's lack of English proficiency or unfamiliarity with the U.S. school system will not

Table 5. Post-Game Interview Information about the Prompts Preferences

Subjects		Subject ct A	Subject ct B	Subject C	Subject D	Subject E	Subject F
Game result	Adoption points	17.6	16.3	13	12.3	11.9	11.7
Post-game Interview Result about the Prompt Attributes (X indicates *appropriateness)*	Frequency	X	X	Need more	X	Need more at the beginning, need less at the end	Need more at the beginning
	Timing	X	X	Some were appropriate, some were late	X	Need more at the beginning, need less at the end	Need more at the beginning
	Specificity	NA	X	Some ok, some require more specificity	More specificity	More specificity	NA
	Medium of delivery	X	X	X	X	NA	N

negatively influence their enjoyment of the DSG. Educational games, especially complex games, are usually more text-based than graphics-based; hence, language barriers or learners' cultural backgrounds can keep learners from enjoying the game and meeting the goal of the game objectives. In order to prevent this problem, the game should be preceded by an in-depth clarification about the context of the game and any difficult terms used within it.

Third, educational game developers need to consider the learners' intrinsic cognitive load, which is related to the difficulty of the subject matter (Sweller & Chandler, 1994), when designing a game. The prompt instrument was originally employed in order to help manage the complexity of the game; however, even with the addition of the prompt, the learners did not significantly enhance their game performance or increase their knowledge of the underlying game theory (Tables 1 and 2) and still found the game challenging (Table 4).

One way by which to decrease the intrinsic cognitive load and maximize the effects of the prompts is to use part-task training (Reigeluth, 1999; van Merriënboer, Clark, & de Croock, 2002). Part-task training is defined as offering additional practice when learners encounter a learning gap that they need to overcome in order to proceed with the simulation. For instance, a game could have a virtual mentor who provides customized tutoring or drill-and-practice to a user in order to help that user develop a particular skill or gain a particular set of knowledge.

From our observation and interview results (Table 5), we can also make inferences about alternative instructional support methods that would better serve both the higher and lower achieving learners. In this study, while predetermined prompt information was offered at a predetermined time for all of the learners, future studies could adopt Gaynor (1981), Mason and Bruning (2001), and Roper's (1977) findings and suggest that for lower performers an immediate or just-in-time/on-demand feedback be instituted. For the higher achieving learners, facilitative and delayed feedback, similar to the prompt instrument that we designed for this study, may still be acceptable (Hanna, 1976).

LIMITATIONS

In this study, we observed that the particular prompt instrument that we developed and used in the DSG did not lead to significant game play or subject matter learning success. Instead, it only led to a small improvement in particular subjects' game and learning test scores. It is also important to note that the subject pool for this study was small and that the subjects' unique qualities may have strongly influenced the outcome of the study. In addition, as the subjects only played the game once, future research might investigate whether repeated game play or game play with additional interventions might increase game engagement or learning outcome success.

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Direct reprint requests to:

Seolim Kwon
1603 E. 3rd St., #214
Bloomington, IN 47401
e-mail: seolkwon@umail.iu.edu