What do students learn by playing an online simulation game?

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Abstract. Studies suggest that simulations and games not only improve target language skills, but they can also support knowledge creation regarding a broader variety of topics. Thus, we wanted to explore how playing an online simulation game affected knowledge of energy supply and its relationship to environmental and economic factors among learners of English as a Foreign Language (EFL) in Japan. This particular topic was selected due to its immediate relevancy in Japan which faces energy supply and environmental issues in the wake of the Fukushima nuclear accident. The presentation will report on a qualitative exploration of debriefing reports produced by Japanese university students after playing Energy City, an online simulation game. The game models various urban scenarios in which the objective is to supply sufficient energy to power a city with electricity while minimizing environmental impacts, addressing stakeholder concerns and balancing a budget. Students used the game in small groups, after which they completed debriefing reports designed to foster reflection on the game playing experience. We performed a content analysis on the reports to identify major trends and themes which could offer insights regarding the learning outcomes. The results indicate the possibility that gameplay may influence attitudes toward nuclear power production and personal behavior with regard to energy consumption. The principal investigator intends to use these results to author a quantitative survey instrument for the purpose of investigating whether attitude and/or behavior change occurs at a statistically significant level.

Keywords: content-based instruction, game-based instruction, learning outcomes.

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1. Introduction

This paper presents the content learning outcomes of using a simulation game, *Energy City* (Jason Learning), in four English as a Foreign Language classes taught by the principal investigator in a content-based instructional framework at a Japanese university.

The principal investigator used a simulation game in the courses because a growing body of empirical data strongly suggests that simulations and games can improve knowledge of a variety of educational content (e.g. Clark et al., 2011) as well as foreign language skills (Peterson, 2013). Thus, a game seemed ideal for integrating content and language instruction.

The principal investigator chose the topic presented in *Energy City*—energy generation and conservation strategies in an urban setting—because (1) it is relevant in post-Fukushima Japan (Aldrich, 2013), and (2) simulations and games may be effective tools for educating people on issues related to climate change (Eisenack & Reckien, 2013).

However, we were uncertain what, if anything, the students were learning about the topic from playing the game. We believed this to be problematic, particularly in the case of politically-charged topics such as energy and conservation strategies in Japan. Therefore, we wanted to explore the learning outcomes of playing *Energy City* in terms of information, knowledge and attitudes that may influence their behavior in the broader socio-cultural and political context.

We conducted a qualitative analysis of debriefing reports submitted by students after playing the game. The analysis revealed themes that could provide some indication as to what the students learned about energy and conservation strategies. In this paper we present these findings and outline research goals going forward.

2. Method

2.1. Participants

The target population of the present study was comprised of students in four mandatory English as a Foreign Language courses at a Japanese university (n=67). Most of the students were male (84%), first-year students (57%) from the school of science (46%) or engineering (31%).

2.2. Materials

2.2.1. Energy City

We adopted *Energy City* (Jason Learning) as the core lesson material in the present study (Figure 1). The object of this simulation game is to plan and implement a virtual city's energy and conservation strategies in order to maintain an adequate energy supply while not imparting excessive damage to the environment.

Figure 1. Screenshot of *Energy City*; used with permission of *Jason Learning*

2.2.2. Debriefing report

We used a debriefing report for the game as the data collection medium. The report was authored in a Google Form generally following the guidelines set forth by Kriz (2008). Specifically, the report consisted of four prompts as follows: How did you feel after playing the game? What happened in the game? What did you learn from playing the game? How can you apply what you learned in real life? In all, 92 reports were submitted with a total word count of 6,132 and an average response length of 26 words.

2.3. Coding and results

We performed a qualitative analysis of the debriefing reports using the coding schedule shown in Table 1, which is based on the taxonomy of outcomes proposed

by Kraiger, Ford and Salas (1993). We further sub-categorized the text based on emergent themes within the larger taxonomy.

Table 1. Coding schedule

Outcomes	Learning Constructs	Nature of Evidence
Cognitive	Declarative Knowledge	Accurate propositions about game elements
	Mental Models	Interrelating game elements
	Metacognitive Skills	Self-awareness, awareness of nature of material
Affective	Attitude	Direction and/or strength
	Motivation	Self efficacy, goal setting

2.3.1. Cognitive outcomes

We found evidence of each learning construct for this type of outcome, as shown in Table 2. We further found that the emergent themes in the text were well aligned with major concepts introduced in the game, such as strengths and weaknesses of various energy generation technologies.

Table 2. A summary of cognitive learning outcomes and associated emergent themes

Learning Constructs	Theme	Example
Declarative Knowledge	Budgeting	*I learned that it is important how to use money.*
	Technology	*I understood the usefulness of natural energy and the nuclear power*
	Environment	*Environmental quality is important.*
	Public policy	*It's quite hard to listen to stakeholders and make your city better.*
	Communication	*In the game, we learned how important it is to listen to citizens' offers.*
Mental Models	Technology	*I learned that air quality will drop greatly by relying on fossil fuels and that bio fuels have a negative on air quality.*
	Environment	*I learned how to deal with the balance between the economy and environment.*
	Game vs. real world	*In fact, nuclear power plants have various problems, but in the game those are great in energy and air quality!*
Metacognitive Skills	Planning	*We have to endure a few years if you want to gain a good final outcome.*
	Public policy	*I could play this game at the view from a manager not a resident. So I got a new view.*

2.3.2. Affective outcomes

We found evidence of each learning construct for this type of outcome. The results are summarized in Table 3. Notably, several of the students expressed positive attitudes toward the use of nuclear power plants, and even the intention to advocate for their use. This result was unexpected in that we assumed an overall negative attitude toward nuclear power in the general population (Aldrich, 2013).

Table 3. A summary of affective learning outcomes and associated emergent themes

Learning Construct	Theme	Example
Attitudes	Pro-renewable	*We need clean energy to make our life better.*
	Anti-fossil fuel	*We shouldn't use oil power plants very often both in this game and in reality.*
	Pro-nuke	*Nuclear power plant is great!*
	Anti-nuke	*I disagree nuclear. That's because it is danger.*
	Conditional nuke	*If you live in a country which don't have earthquake, nuclear energy will be good help.*
	Environment	*We should think environment.*
Motivation	Public policy	*I will vote with careful.*
	Nuclear advocacy	*I will be critical about abandoning nuclear power plant. It'd better to reconsidering.*
	Knowledge sharing	*I want to share new knowledge with my friends.*
	Conservation	*When it is summer, I will not use air conditioner.*
	Innovation	*I want to create a new energy.*

3. Discussion

Overall, we found that the emergent themes collectively accounted for all major elements of the *Energy City* game. The students reported new understanding of planning and implementing an energy strategy, including the crucial role of financial resources, the nature of various energy generation technologies, and the importance of environmental health. Notably, the students were also able to think critically about the game itself, recognizing that it can provide new perspectives while distinguishing it from reality.

Further, the data indicate two affective outcomes in particular that deserve further exploration. First, an apparent support of nuclear energy was notable in a socio-

cultural context of strong scepticism toward this technology. Second, students expressed motivation to adopt energy-saving consumption behaviors.

We believe results related to attitudes toward nuclear power generation and energy consumption behavior are of primary interest because of the current energy supply situation in post-Fukushima Japan. However, because the present study is qualitative, and because we did not measure attitudes prior to playing *Energy* City, we cannot determine whether playing the game persuades learners to change their perspectives regarding this topic—either negatively or positively—in a manner that is statistically significant. Therefore, the principal investigator intends to design a survey based on the present results to gather quantitative data on perspectives regarding nuclear power generation and conservation behavior.

4. Conclusions

The purpose of the present study was to explore the learning outcomes of playing the *Energy City* simulation game. In particular, we were interested in discovering whether learners using the game gained knowledge of energy and conservation strategies in an urban setting, and whether playing the game influenced attitudes and motivation regarding the topic. We conducted a qualitative analysis of debriefing reports that students completed after playing the game. We found evidence of both cognitive and affective learning outcomes, and that these outcomes were closely related to the main themes represented in the game. Specifically, learners reported a greater understanding of energy generation technologies, and motivation to modify their behavior to address the current energy situation in Japan.

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