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Improving academic learning from computer-based narrative games

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ABSTRACT

Although many strong claims are made for the power of computer games to promote academic learning, the narrative content of a game may reduce the learner's tendency to reflect on its academic content. The present study examines adding a low-cost instructional feature intended to promote appropriate cognitive processing of the academic content during play. College students played a computer adventure game in which they guided a character through a bunker in search of lost artwork, building electromechanical devices to open stuck doors along the way. In Experiment 1, students who filled out worksheets about wet-cell batteries before and during the game outperformed students who played the game without worksheets on a written explanation of how wet-cell batteries work ($d = 0.92$), multiple-choice comprehension questions about wet-cell batteries ($d = 0.67$), and open-ended transfer problems about wet-cell batteries ($d = 0.74$). In Experiment 2, participants who completed only the in-game worksheet outperformed the control group on a written explanation of wet-cell batteries ($d = 0.59$) and transfer problems ($d = 0.67$), whereas participants who completed only the pre-game worksheet did not outperform the control group on any measure. These findings point to the learning benefits of adding instructional features suggested by cognitive theories of learning.

1. Introduction

A narrative game (or adventure game) is a game that has a cover story that poses goals for the player. For example, as exemplified in Fig. 1, in *Cache 17* (Koenig, 2008), the player views a cut scene showing that the player's goal is to recover stolen artwork that is hidden in a WWII bunker system, and along the way the player must build a wet-cell battery that can open a stuck door. As summarized in Table 1, in narrative games for learning there can be an inherent conflict between the goal of the game based on the narrative and the goal of the game based on the instructional objective. In the case of *Cache 17*, for example, the narrative theme suggests that the goal is to recover stolen artwork, whereas the instructional goal is to help students learn about electromechanical devices. The narrative theme is intended to prime player motivation which can be expressed through persistence and intensity of game play, whereas the instructional material is intended to prime appropriate cognitive processing such as attending to the relevant information and trying to make sense of it.

Game designers have pointed to the potential contribution of narrative theme (or story line) in games (Dickey, 2006, 2015; Fullerton, 2008; Prensky, 2001; Schell, 2008). For example, Dickey (2006, pp. 250–1) notes: "Within the adventure game genre, narrative provides two main functions: both motivation and a cognitive framework for problem solving." While acknowledging the potentially powerful role of story lines in games, Fullerton (2008, p. 101) notes that story lines can sometimes distract gameplay: "Game designers are still searching for better ways to integrate story into their systems without diminishing gameplay." Visionaries and developers also have recognized narrative theme as a core component in adventure games (Gee, 2007; Klopfer, 2008; McGonical, 2011; Prensky, 2006). Early ethnographic studies and analyses of video game playing noted that players appear to become engaged in game playing through the story line of games, even when the stories are quite simple such as in the case of PacMan (Kent, 2001; Loftus & Loftus, 1983; Turkle, 1995). Subsequently, Lieberman (2004) showed how narrative theme could boost engagement in health games, and Schank (1997, 2002) showed how rich case examples could boost engagement in business game-like simulations.

In contrast, in a recent review of empirical studies comparing learning from a base version of a game versus the same game with narrative theme added, there was not sufficient evidence showing superior learning for the narrative group (Mayer, 2014). Although narrative games for learning may prime the player's motivation, there is danger that the player's main goal can be to win the game rather

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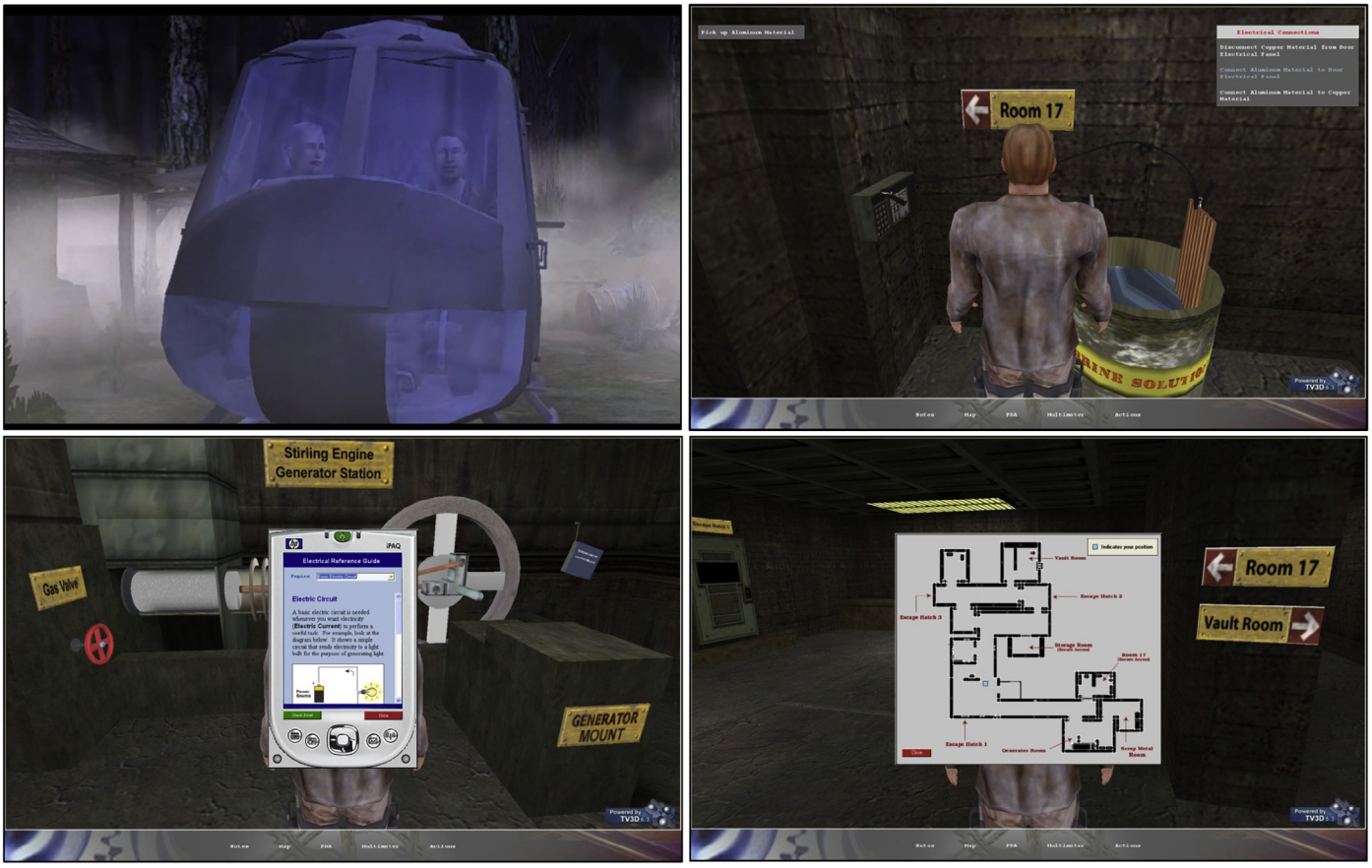

Fig. 1. Screenshots from *Cache 17*. Clockwise from top left: Kate and Alex arrive at the bunker during the introductory cut scene; Alex in front of the barrel of brine for the wet-cell battery task; Viewing the PDA; Viewing the map of the bunker.

than to understand the instructional content that is encountered in the game. For example, Adams, Mayer, MacNamara, Koenig, and Wainess (2012) found that students learned better about electromechanical devices from a PowerPoint presentation than from playing *Cache 17*. This reflects a larger pattern in research on educational games: although there is much excitement surrounding educational games, the evidence for their educational effectiveness is sparse and ambivalent (Mayer, 2014; National Research Council, 2011; O'Neil & Perez, 2008; Tobias & Fletcher, 2011; Vogel et al., 2006).

The present study examines ways to increase academic learning based on the instructional objectives from an adventure game with a strong narrative theme. From a cognitive load perspective (Mayer, 2009; Sweller, Ayres, & Kalyuga, 2011), learners have a limited working memory capacity for building new knowledge as they a play a game. If cognitive capacity is consumed by thinking about the narrative theme, the player may not have sufficient remaining capacity to think deeply about the academic material in the game. The solution attempted in this study is to include adjunct activities that refocus the learner's processing on the core academic content of the game and prime the learner to reflect on this content.

Table 1
Two competing goals of narrative games for learning.

Game feature	Goal	Mechanism
Narrative theme	Recover stolen artwork	Motivational processes
Instructional material	Build a wet-cell battery	Cognitive processes

The value-added approach to research on educational games (Mayer, 2011) seeks to identify features that enhance learning by comparing a base version of a game to a version with an added feature. Recent meta-analyses by Mayer (2014) have identified promising features such as adding hints and advice throughout the game, using conversational wording rather than formal wording, using spoken text rather than printed text, prompting students to explain the material to themselves as they learn, or providing pre-training. Although these guidelines can help game designers build effective games, features that require modifying the game itself can be prohibitive for educators using off-the-shelf games. The addition of simple adjunct materials to games, such as paper-based worksheets (Fiorella & Mayer, 2012) or instruction slides (Erhel & Jamet, 2013), is therefore a practical domain of investigation.

The goal of the present study is to examine a low-cost technique intended to focus the narrative game player on cognitive processing relevant to the instructional goal, namely, the use of pre-game and in-game worksheets. The pre-game worksheet is a sheet of paper that asks the player to write an explanation of how a wet-cell battery works, thereby drawing attention to the major instructional goal in the game. The in-game worksheet is a sheet of paper that asks the player to fill in answers concerning how to build a wet-cell battery during the game. The current study adds to the literature both in the type of game and the type of worksheet added. First, unlike Fiorella and Mayer (2012), the current study uses a narrative game, which involves conflicting goals based on the narrative and based on the educational information. Further, the worksheets in the current study are activity-based, whereas the worksheets employed by Fiorella and Mayer (2012) were more declarative.