Educational Game Enjoyment, Perceptions, and Features in an Intelligent Writing Tutor

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Abstract

The ability of educational games to promote students' engagement in learning and practice depends on perceived enjoyment of those games. This study investigated high school students' perceptions and enjoyment of games within the Writing Pal intelligent tutoring system. In accord with research on motivation, results showed that perceived helpfulness and difficulty of the games were the main predictors of enjoyment, whereas graphics quality and writing apprehension were not. Perceived difficulty was most salient for generative practice games in which students had to apply strategies to write original text.

Introduction

Digital games have become a popular approach within educational technology due to their assumed motivational potential (Dondlinger, 2007; Young et al., 2012). Some learning technologies, including intelligent tutoring systems (ITSs), can require significant time investment for training and practice leading to student boredom or disengagement (McNamara, Jackson, & Graesser, 2009). Games are believed to leverage students' enjoyment of gaming to promote engagement in such environments. However, individual games can differ remarkably in their design (e.g., narrative and rewards), and students likewise differ in their game preferences and attitudes toward the learning domain. If the success of educational games depends upon students' game perceptions, then a crucial goal for educational technology research is to better understand how game design and student attitudes interact to influence enjoyment (Quick, Atkinson, & Lin, 2012).

In this study, we examine how students' enjoyment of educational games for writing varies based on writing apprehension and perceptions of game utility, difficulty, and graphics. We conduct this research in the context of Writing Pal (W-Pal), an ITS that provides strategy instruction via a animated lessons, educational games, and writing practice with automated feedback (Roscoe & McNamara, in press; Roscoe, Varner, Weston, Crossley, & McNamara, in press).

Enjoyment, Motivation, and Game Design

For educational games to motivate students to play, and thereby engage in target learning tasks or acquire new strategies, the games must be perceived as enjoyable. The games must entice students to continue playing despite obviously embedded learning goals and expectations.

Educational game researchers have proposed several frameworks characterizing either game players or game features with respect to enjoyment. Several taxonomies describe players' goals for gaming, such as earning points, collecting treasures, exploring new worlds, discovering game mechanics, socializing, and defeating other players (Quick et al., 2012; Yee, 2006). Other taxonomies describe generalized game features that players may find enjoyable, such as fantasy, narrative, challenge, fellowship, discovery, expression, physical activity, altruism, and competition (Hunicke, LeBlanc, & Zubek, 2004; Winn, 2008). Altogether, educational game researchers have developed a lengthy list of factors that may promote enjoyment, although many of these taxonomies have not been empirically validated (Quick et al., 2012).

Another limitation of such taxonomies is that they tend not to be grounded in formal motivational theories (Ryan, Rigby, & Przybylski, 2006), but instead are derived from observation or self-reported preferences. Nevertheless, there is some overlap between motivational theories and gaming taxonomies, such as perceptions of one's capabilities and improvement (e.g., earning points and achievements), social interactions (e.g., competition, fellowship, and role-playing), and personal goals.

For example, expectancy-value theories posit that individuals' engagement in learning tasks depends upon task-value beliefs and expectations of success (Wigfield & Eccles, 2000). Students are more likely to engage in tasks that appear beneficial and offer opportunities for success and growth. Similarly, self-determination theory argues that enjoyment arises when three needs are met: competence, autonomy, and relatedness (Ryan et al., 2006). Students are more likely to enjoy and persist in tasks that foster feelings of challenge, capability, and choice, and offer social interaction. Finally, achievement goal theories (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002) emphasize how students' decisions are driven by their goals for achievement, such as competing favorably with others or mastering the subject for the sake of personal satisfaction. Together, these theories suggest that students' attitudes and expectations in the learning domain, and their perceptions of the games as helpful for learning or developing competence, may be important predictors of students' enjoyment of educational games.

Quick et al. (2012) have argued that it is important to "consider game design and player perceptions in tandem, because both are integral parts of game experiences" (p. 12). In this study, we examine how students' anxiety toward writing, along with perceptions of game utility and difficulty, influence their enjoyment of educational games for writing strategies. We then consider how relations among these factors may differ based on the nature of the writing games and tasks.

Game-based Strategy Practice in Writing Pal

W-Pal is an ITS developed to support adolescent students' acquisition of writing strategies across three phases of the writing process (Roscoe et al., in press). Eight instructional modules are included, which cover strategies for prewriting (*Freewriting* and *Planning*), drafting (*Introduction Building*, *Body Building*, and *Conclusion Building*), and revising (*Paraphrasing*, *Cohesion Building*, and *Revising*). Students are introduced to specific strategies via short animated videos narrated by pedagogical agents. W-Pal also allows students to practice these strategies by writing prompt-based, persuasive essays. Natural language processing (NLP) algorithms generate holistic quality ratings and guide formative feedback on students' strategy use (McNamara, Crossley, & Roscoe, 2012).

A unique aspect of W-Pal is that it incorporates a suite of 16 games (see Table 1) that target specific strategies. W-Pal games offer an intermediate level of practice in which students can focus on a few strategies in isolation before trying to apply them simultaneously in a single essay. Students are typically asked to view the lessons, play the practice games, and then write practice essays for each of the modules. Cognitively, this breakdown of essay composition into manageable sub-goals is important because novice writers often struggle to coordinate the multiple tasks of the writing process (Breetvelt, van den Bergh, & Rijlaarsdam, 1994). Prior analyses have found that students' performance in W-Pal games positively predicted learning of writing strategies (Roscoe, Brandon, Snow, & McNamara, in press). Students who earned higher scores in the games were better able to articulate strategies for planning, drafting, and revising essays.

Table 1. Brief Descriptions of Writing Pal Practice Games

Game (Module)	Description
Freewrite Flash (Freewriting)	Fill the Idea Meter and earn Idea Flash Cards by freewriting on a prompt.
Mastermind Outline (Planning)	Repair the Mastermind Mainframe by assembling an outline from given argument and evidence statements
Planning Passage (Planning)	Travel to various destinations and earn souvenirs by selecting appropriate arguments and evidence.
Dungeon Escape (Introductions, Conclusions)	Escape by avoiding the guard and rising waters. Select doors by labeling attention-grabbing techniques.
Essay Launcher (Introductions)	Rescue spaceships by selecting thesis statements and attention-grabbers for sample introduction paragraphs.
Fix It (Introductions, Body, or Conclusions)	Evaluate paragraphs for missing key elements, such as thesis statements and evidence. Fix the broken circuit board.
RoBoCo (Body)	Build robots by writing topic and evidence sentences for a given thesis.
Lockdown (Conclusions)	Stop computer hackers by writing conclusions based on a given outline.
Adventurer's Loot (Paraphrasing)	Explore different locations and obtain treasure by correctly identifying use of paraphrasing strategies.
Map Conquest (Paraphrasing)	Earn flags by identifying paraphrasing strategies, and then use those flags to conquer the game board.
Undefined & Mined (Cohesion)	Disarm mines by identifying undefined referents in short texts.
CON-Artist (Cohesion)	Catch a thief by following clues. The clues are solved by selecting transition words to link given sentences.
Speech Writer (Revising)	Help a friend on the debate team revise a speech. Identify the major problems and then edit the speech to improve it.

W-Pal games exhibit a variety of designs. For example, one salient dimension is the presence of *narrative*. In *Essay Launcher*, students must rescue spaceships and guide them to Earth. To do so, students select an appropriate thesis

statement for an introduction paragraph ("repair the ship") and identify the attention-grabbing technique used ("set the course"). In *Lockdown*, students take on the role of an agent for the Writing Intelligence Agency, and must help "protect essays" from hackers by writing conclusion paragraphs based on an outline. NLP algorithms assess paragraph quality and determine whether the student-generated conclusion is in "danger," "at risk," or "secure."

Other games lack a strong narrative focus. *Undefined & Mined* helps students practice cohesion building by identifying undefined referents. Students read texts and click on undefined terms, each of which is associated with a mine. Correct selections disarm a mine, but mistakes cause an explosion. In *Fix It,* students evaluate paragraphs for flaws, such as missing evidence. Students select the problem in the Regular Round and then select text to fix the problem in a Bonus Round. Correct fixes earn a Golden Circuit. In the final phase, students repair a circuit board via a *Sudoku*-like puzzle, and Golden Circuits are used to automatically fill in one correct answer. There are three versions of Fix It: Introduction Building (IB), Body Building (BB), and Conclusion Building (CB).

Another key dimension for W-Pal games is the nature of the practice task. Many games embed an *identification* task in which students label strategy exemplars or problems that could be improved using a strategy. For example, Essay Launcher involves the identification of thesis statements and attention-grabbers, and Undefined & Mined requires identification of undefined words. In *Planning Passage*, students take a "roadtrip" and unlock destinations and souvenirs by identifying applicable argument and evidence sentences. In *Dungeon Escape*, students escape a dungeon while avoiding rising waters and a guard. To unlock doors and get to the exit, students identify the attention-grabbing techniques (Introduction Building) or attention-holding techniques (Conclusion Building) exhibited in a paragraph.

Other games in W-Pal involve *generative practice* in which students author original text or assemble an outline. Lockdown is one such generative game. In *Speech Writer*, students help a friend prepare for an upcoming debate by revising an essay. Students first identify problems in the essay, and then try to edit the essay to fix the problems. NLP algorithms assess whether the revised essay improves along various dimensions from the original essay, which determines the final score. Speech Writer combines both identification and generative practice, with greater emphasis on the generative aspects. In *RoBoCo*, students are placed in the role of an engineer at the Robot Body Company who must develop new robot models. Students earn robot heads by writing topic sentences and robot bodies by writing evidence sentences. The student-generated texts are rated via NLP algorithms that determine how many robot parts are awarded. After two rounds of writing, assemble earn parts (if any) into robots. The final robots are displayed on stage during the Annual Show. The final score (expressed as profit for the company) is based on text quality and number of robots.

An important facet of W-Pal design is that students interact with all of the W-Pal games during training. Thus, rather than rating individual, isolated games, students can play and evaluate multiple games within the same context. Thus, comparisons can be made across games and game features. For this study, our questions were 1) *How do perceptions of game utility, difficulty, and graphics, along with students' prior writing attitudes, influence their enjoyment of educational games?* 2) *Do relationships among enjoyment, game perceptions, and writing attitudes differ across individual games or game types?*

Method

Participants

High school students (n = 65) from a large, urban area in the Southwest United States participated in a lab-based summer program using W-Pal. Average age was 16, with 70.8% female students. With regards to ethnicity, 6.2% of students identified as African-American, 15.4% as Asian, 24.6% as Caucasian, and 44.6% as Hispanic. Average grade level was 10.2 with 35.4% of students reporting a GPA of 3.0 or below.

Procedure

Students attended 10 sessions over 2-4 weeks. The first and final sessions included tests of reading comprehension, vocabulary, writing proficiency, strategy knowledge, and writing attitudes. Sessions 2-9 were devoted to training. Some students (n = 33) used the full W-Pal, including essay writing, lessons, and games. In each session, these students wrote and revised one essay and completed one module. Students rated each game immediately after playing. A comparison group interacted only with the essay and feedback tools (n = 32). These students wrote and revised two essays per session with feedback. For the current paper, only game perceptions and writing attitudes from the W-Pal condition students are discussed here.

Measures

Game-perception Surveys

Students used a 4-point scale to rate games on *enjoyment, helpfulness for learning*, *ease of gameplay*, and *graphics*. Higher ratings indicated a more positive response. Two additional questions were asked as a check to make sure the games were playable. Overall, students considered game instructions to be understandable (M = 3.4, SD = 0.4) and game controls to be clear (M = 3.5, SD = 0.4).

Writing Apprehension Test

Students' attitudes toward writing and their own writing abilities influence their enjoyment of writing and their writing performance (e.g., Daly & Miller, 1975; Pajares, 2003). The Daly-Miller Writing Apprehension Test (WAT) is a 26-item measure in which students rate their agreement to statements about writing on a 5-point scale (Daly & Miller, 1975). Students respond to both positively-worded ("Writing is a lot of fun") and negatively-worded items ("I'm not good at writing"). Higher WAT scores indicate greater comfort with writing whereas lower scores indicate more apprehension. Prior research with the measure has shown high reliability (r = .92-.94).

Results

Overall Attitudes, Perceptions, and Enjoyment

Average WAT scores (M = 63.0, SD = 18.3) suggested that many students experienced a moderate to high level of writing apprehension. Indeed, many students (40%) scored below 60, indicating strong anxiety. Despite apprehension about writing, students rated the W-Pal games as enjoyable (M = 3.0, SD = 0.5). Games were also perceived as helpful (M = 3.1, SD = 0.5), somewhat easy to play (M = 2.8, SD = 0.5), and graphically appealing (M = 3.3, SD = 0.5).

A regression analysis was conducted to examine how students' attitudes and perceptions influenced game enjoyment. Enjoyment was not significantly correlated with WAT scores (r = .20, p = .26), but was significantly correlated with perceived helpfulness (r = .88, p < .001), ease (r = .52, p < .001), and graphics (r = .65, p < .001). All four variables were entered as predictors of enjoyment in a linear regression. The overall model was significant, $F(4,28)$ = 42.48, p < .001, with an R^2 of .86. Only helpfulness (β = .76, t = 7.00, p < .001) and ease (β = .30, t = 7.00, p < .001) were significant predictors of enjoyment. Writing apprehension (β = -.04) and perceptions of game graphics (β = .07) were not significant predictors.

Overall, students' writing anxiety did not seem to hinder enjoyment of the games, which provides further support for the motivational potential of games. Similarly, enjoyment was not influenced by game graphics. This result is encouraging because it suggests that educational games need not include 3D environments with lifelike graphics. However, graphics ratings were very similar across games. Thus, this result should be further explored with games that are more variable in graphic quality.

Enjoyment of W-Pal games seemed to be most related to perceived helpfulness. As one might expect based on motivational theories (e.g., Ryan et al., 2006; Wigfield & Eccles, 2000), games that are perceived to be beneficial may better engage students' interest. Similarly, perceived ease also contributed to enjoyment. Students are likely drawn to games in which they can experience competence, perhaps building their self-efficacy for writing (Ryan et al., 2006). Together, these findings suggest that *utility* may be a key factor for educational game design. Rather than on focusing on graphics or other "bells and whistles," it may be crucial for students to appreciate how the game will help them improve. It may be difficult to fully disguise many learning tasks as games, but perhaps such disguises are not necessary if students value what the games have to offer educationally (while also being reasonably fun).

Individual Game Ratings and Perceptions

The preceding analyses collapsed ratings across all W-Pal games. However, individual games differ with respect to particular features, mechanics, and demands. To explore how these differences influenced predictors of enjoyment, mean ratings were obtained for each game (Table 2) and separate regressions (Table 3) were conducted.

Table 2. Mean Enjoyment and Game Perception Ratings.

Game	Enjoy	H	E	G
Freewrite Flash	3.1	3.2	2.6	3.2
Mastermind	3.3	3.4	2.8	3.2
Planning Passage	2.8	3.2	2.9	3.2
Essay Launcher	2.7	2.9	2.6	3.3
Dungeon Esc. (IB)	3.3	3.3	3.2	3.4
Fix It (IB)	3.2	3.2	3.1	3.3
RoBoCo	2.2	2.5	2.0	3.3
Fix It (BB)	3.2	3.3	3.3	3.4
Lockdown	2.7	2.8	2.4	3.3
Dungeon Esc. (CB)	2.9	2.9	2.7	3.3
Fix It (CB)	3.2	3.4	3.3	3.4
Adventurer's Loot	3.1	3.1	3.0	3.4
Map Conquest	3.2	3.3	2.8	3.4
Und. & Mined	3.2	3.2	2.9	3.3
CON-Artist	3.5	3.5	3.3	3.4
Speech Writer	2.5	2.8	2.4	3.3

Note: H = helpfulness, E = ease, and G = graphics.

Overall, students appeared to enjoy most of the games (i.e., most means > 2.5). However, a few games stood out as somewhat less enjoyable than others: *RoBoCo*, *Speech Writer*, *Lockdown*, and *Essay Launcher*. These games also tended to receive somewhat lower ratings with regard to helpfulness and ease. These results parallel previous observations showing that helpfulness and ease of gameplay predicted enjoyment across games. In this case, individual games that were perceived as more challenging and less helpful were rated as somewhat less enjoyable.

Regressions were conducted to test how helpfulness, ease, graphics, and writing apprehension differentially

predicted enjoyment for individual games (Table 3). All of the regressions were significant (i.e., *p*-values < .01 or .001). Helpfulness ratings were a significant, positive predictor of enjoyment for 15 of the games, and were the *only* predictor of enjoyment for half of the games. Ease was a positive predictor for six games and graphics appeal was a positive predictor for four games. Writing apprehension did not predict enjoyment for any game.

Table 3. Significant Predictors of Game Enjoyment.

Game	R^2	*F*	Predictors		
Freewrite Flash	.57	9.15	H		
Mastermind Outline	**.57**	**8.92**	**H**	**E**	
Planning Passage	.58	9.68	H		
Essay Launcher	.94	106.57	H		G
Dungeon Esc. (IB)	.55	8.64	H		
Fix It (IB)	.51	6.97	H		
RoBoCo	**.73**	**18.25**	**H**	**E**	
Fix It (BB)	.74	18.97	H		
Lockdown	**.76**	**22.53**	**H**	**E**	**G**
Dungeon Esc. (CB)	.44	5.39	H		
Fix It (CB)	.58	9.59			G
Adventurer's Loot	**.38**	**4.33**	**H**	**E**	
Map Conquest	.55	8.21	H		
Und. & Mined	**.76**	**21.77**	**H**	**E**	
CON-Artist	.58	9.47	H		
Speech Writer	**.79**	**26.06**	**H**	**E**	**G**

Note: H = helpfulness, E = ease, and G = graphics. Games in which ease of play predicted enjoyment are highlighted in bold.

Discriminating Game Features

To better understand how features influenced relations among enjoyment, helpfulness, and ease of gameplay, we contrasted the six games for which both helpfulness and ease were predictors of enjoyment (*Mastermind Outline*, *RoBoCo*, *Lockdown*, *Adventurer's Loot*, *Undefined & Mined*, and *Speech Writer*) with the nine games for which helpfulness was a predictor but ease was not a predictor.

Overall, the nine "Help-Only Games" were rated as more enjoyable, more helpful, and easier than the six "Help/Ease Games." One straightforward interpretation of these results is that greater game challenge increased the salience of difficulty in students' perceptions of games. When games are seen as easy, then students' enjoyment of the game may be primarily a function of whether the task is beneficial or useful for learning. However, as students experience more challenge or failure, perceived difficulty begins to influence enjoyment, perhaps due to frustration. This interpretation is supported by motivation research, which argues that utility and competence affect task enjoyment (Ryan et al., 2006; Wigfield & Eccles, 2000).

Table 4. Mean Enjoyment, Helpfulness, and Ease for Games Based on Regression Pattern Grouping.

	Game Grouping			
Rating	Help-Only	Help/Ease	*t*(32)	*p*
Enjoyment	3.1 (.51)	2.8 (.54)	3.41	.002
Helpfulness	3.1 (.50)	2.9 (.57)	3.41	.002
Ease of play	2.9 (.55)	2.6 (.59)	4.82	<.001

With respect to game features, the primary difference appeared to be the nature of the learning task. Specifically, four of the Help/Ease Games involved *generative practice* (Mastermind Outline, RoBoCo, Lockdown, and Speech Writer) in which students had to author original text or an outline. In *Adventurer's Loot*, students must analyze an original sentence, and then determine which of four target sentences instantiates a specified paraphrasing strategy. In *Undefined & Mined*, students must carefully study a text to determine which pronouns and referents are defined or undefined based on the textual context. These games require thoughtful application of writing strategies; perceptions of these games as more difficult were accurate.

Interestingly, traditional game features mentioned in game taxonomies did not seem to discriminate among the Help-Only and Help/Ease Games. Both groups included narrative (e.g., RoBoCo and Dungeon Escape) and non-narrative games (e.g., Undefined & Mined and Fix It), and games with fantasy elements (e.g., RoBoCo, Adventurer's Loot, Essay Launcher, and Dungeon Escape). Both groups also included games with simple mechanics in which each round featured similar game play (e.g., Essay Launcher, and Undefined & Mined) and cases in which game play varied across different phases (e.g., Fix It and Speech Writer). In sum, for educational games incorporated into W-Pal, traditional game features seemed less important to enjoyment than did the perceived utility of the games.

Discussion

Given the motivational potential of educational games, it is important to explore how and why students enjoy games for learning. In this study, high school students interacted with practice games in the W-Pal tutor. Students perceived these games to be enjoyable, useful for learning, easy to play, and graphically appealing. The central finding was that the *helpfulness* of the games for learning strategies was the strongest and most consistent predictor of enjoyment. Students enjoyed the games more when they felt the games helped them improve their writing. However, as students experienced greater *difficulty* with generative practice, perceived enjoyment and helpfulness somewhat decreased. These findings parallel research on motivation and learning, which emphasizes the role of

utility and *competence* expectations (Ryan et al., 2006). Students' enjoyment of educational games may be a balancing act between whether the game seems to help or hinder learning progress (Easterday, 2011). Factors that relate to enjoyment of entertainment games (e.g., narrative and exploration) may be less salient in educational settings.

One limitation was the sample size of students using W-Pal games (n = 33). This constraint was necessary because each student required 10 sessions (about 3 weeks) to finish the study. Another limitation is that students could not play each game multiple times during that period. It is plausible that students' game perceptions would evolve over time. Specifically, easier games may become boring as students master them; harder games may become more enjoyable as students overcome initial failures and notice improvement in their scores and strategy use. Temporal aspects of game perceptions could not be assessed in the current study.

For ITS developers who wish to incorporate educational games to promote engagement, these findings suggest two recommendations. First, the utility of the games should be made salient to students, perhaps through mechanics or feedback that highlight students' progress and improved performance. Positive feedback can improve the efficacy of ITSs (Mitrovic, Ohlsson, & Barrow, 2013), and such feedback could guide students' attention to game benefits and promote feelings of competence leading to enjoyment. Second, differences in game enjoyment may inform methods for adaptive game selection and design. Based on students' levels of engagement and performance, student models may guide learners along different progressions. Some students may need to play identification games (or a "tutorial mode") first, to build confidence and skill, and only then advance to generative practice. However, skilled students may play difficult games from the outset. Starting with easy games might be less engaging and perhaps hinder motivation for higher-performing students.

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