The Impact of System Interactions on Motivation and Performance in a Game-Based Learning Environment

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Abstract. The current study examined how students' frequency of interactions with game-based features impacted their system performance (i.e., total trophies won and achievement levels earned) and attitudes toward the game-based system, iSTART-ME. This study (n=40) was a part of a larger study (n=124) conducted with high school students. Results indicate that students' interactions with game-based features were positively related to both their system performance and their posttest attitudes toward the system. These findings provide further support showing that the integration of game-based features has positive effects on students within educational learning environments.

Keywords: Human-computer interactions, learning, motivation, educational technology, game-based features, adaptive environments

1 Introduction

Learning scientists have begun to investigate how game-based features impact students' affect and performance within Intelligent Tutoring Systems (ITSs). When students interact with game-based features incorporated within an ITS, they report improved engagement and an increased likelihood of future system use [1-4]. Although previous work has shown a positive relation between the implementation of game-based features and student affect, it remains unclear whether students' system performance varies as a result of interactions with these features. The current study addresses this question by examining the relation between students' frequency of interactions with game-based features, their system performance, and their posttest self-reported attitudes toward the game-based system, iSTART-ME.

1.1 iSTART-ME

The Interactive Strategy Training for Active Reading and Thinking – Motivationally Enhanced (iSTART-ME) is an adaptive system that was designed to help students improve their reading comprehension ability by teaching strategies in a game-based virtual environment. iSTART–ME incorporates educational games and interactive

features into an adaptive environment which allow students to practice reading comprehension strategies [5].

Previous work has shown that the iSTART-ME system is effective at improving students' reading compression skills [6]. The addition of game-based features into the iSTART-ME system has been shown to increase students' engagement overtime [5]. The current study builds upon this previous work by examining students how the frequency of students' interactions with game-based features impacts system performance and posttest attitudes.

Fig. 1. Screen Shot of iSTART-ME Selection Menu

Inside of the iSTART-ME system, students choose to play games, check their progress in the system, or personalize interface elements (see Figure 1 for screenshot). Students earn points by playing practice games, which were designed to reinforce the iSTART-ME comprehension strategies. As students accumulate more points, they advance to higher achievement levels (maximum of 25), where they have more opportunities to interact with game-based features.

There are four categories of features inside of iSTART-ME: generative practice games, identification mini-games, personalizable features, and achievement screens. Generative practice games provide students the opportunity to write their own self-explanations, whereas the identification mini-games require students to recognize which strategies are used within example self-explanations. For both generative and identification games, students can win trophies based on their performance. Trophies are earned as students progress to varying performance thresholds inside of the generative and identification games. Personalizable features provide students a means to control and represent themselves within the environment. These features include a customizable avatar, a configurable background theme, and a variety of pedagogical agents. Students can also monitor their performance and progress through the system using achievement screens (e.g., points earned, achievement levels, and trophies won).

2 Method

High-school students (n=40) from a mid-south urban environment participated in an 11-session experiment consisting of a pretest, eight training sessions, a posttest, and a delayed retention test. This sample of students was part of a larger study

(n=124) that compared three experimental conditions: iSTART-ME, iSTART-Regular, and a no-tutor control. The current study focused solely on those students who were randomly assigned to the iSTART-ME condition. These students had access to the full game-based system, including all personalizable features and games.

During the first session of the experiment, participants completed a pretest survey including measures of their attitudes, prior knowledge, and comprehension skills. Throughout the following 8 sessions, students freely interacted with the iSTART-ME system (at least 1 hour per session). At the tenth session, students completed a posttest, which contained measures similar to the posttest. Approximately 1 week later, students completed a delayed retention test that included measures of self-explanation ability and reading comprehension.

In the current study, students' attitudes toward the system were measured using posttest questions (see examples in Table 1). Additionally, system performance was represented through students' earned trophies and achievement levels. The total number of earned trophies reflected students' performance across both the generative and identification practice games. Similarly, students' achievement levels reflected the number of points received through interactions with all practice environments.

Table 1. Postest Measure of Student Attitudes

Dependent Measure	Response Statement	Response Scale*
Enjoyment	*"I had fun using the computer system."*	1 - 6
System Reuse	*"I would use this system again."*	1 - 6

*1 (Strongly Disagree) to 6 (Strongly Agree)

3 Results

The current study examined how students' interactions with game-based features impacted their system performance and posttest attitudes. A median split was conducted on students' total frequency of interactions to create two groups: high and low interactors. ANOVAs on the system performance variables revealed that high interactors attained significantly higher achievement levels, $F(1,38) = 13.22$, $p < .001$, and earned significantly more trophies, $F(1,38) = 7.328$, $p < .001$, than the low interactors (see Figure 2 for means). These results indicate that students who interacted with the available features more frequently performed significantly better within the system than students who engaged in fewer interactions.

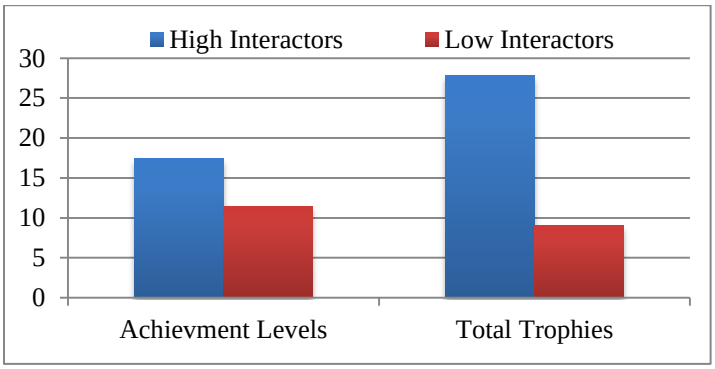

Fig. 2. System Performance Means for High and Low Interactors

Similarly, ANOVAs on the posttest attitudes revealed that high interactors reported greater overall enjoyment, $F(1,38) = 5.59$, $p < .05$, and a higher likelihood to use the system again, $F(1,38) = 4.27$, $p < .05$, than the low interactors (see Figure 3 for means). These results suggest that when students engage with system features more frequently, they enjoy the system more and report a higher likelihood to return for future use.

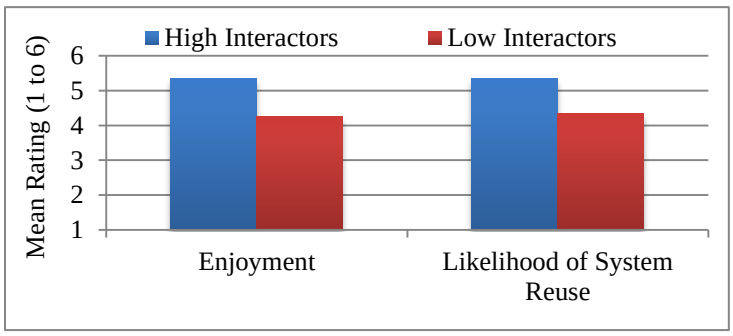

Fig. 3. Posttest Attitude Means for High and Low Interactors

4 Conclusions and Implications

The current work examined how students' total interactions with game-based features impacted their performance and attitudes toward the game-based tutoring system, iSTART-ME. Findings from this study are in line with previous work that has found increases in students' affect when game-based features are incorporated within a learning system [1-4]. The current results add to the literature by showing that students' interactions with game-based features have a positive impact not only on students' affect but also on their system performance. In this work, system performance was measured through the number of trophies and levels earned, which reflect the

quality of practice that students produce within the generative and identification games.

Although the current work provides some insight on the role of game-based features in adaptive environments, future work should focus on isolating varying types of features. This manipulation would allow researchers to decipher the true impact of game-based features at a more nuanced level. Understanding the impact of individual and combinations of features will help designers to optimize systems that simultaneously promote both learning and engagement within a system.

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