Investigating the Effects of Off-Task Personalization on In-System Performance and Attitudes within a Game-Based Environment

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ABSTRACT

The current study investigates the relation between personalizable feature use, attitudes, and in-system performance in the context of the game-based system, iSTART-ME. This analysis focuses on a subset (n=40) of a larger study (n=126) conducted with high school students. The results revealed a positive relation between students' frequency of interactions with personalizable features and their self-reported engagement and perceived system control. Students who frequently interacted with personalizable features also demonstrated better overall in-system performance compared to students who interacted with these features less often. The current paper adds to the growing literature supporting the potential positive impact that personalizable features have on students' attitudes and performance in adaptive learning environments.

Keywords

Personalization, attitudes, game-based features, off-task behaviors

1. INTRODUCTION

A growing trend in the field of adaptive learning environments has been the study of educational games on users' interest and engagement during learning [1-2]. When games are incorporated into these learning environments, students have demonstrated increased engagement and motivation [3-4]. However, few studies have investigated how features within educational games may lead to off-task behaviors and ultimately influence in-system performance (notable exceptions include [5-6]).

An exploration of the interactive features in educational game environments may allow researchers to identify the aspects of system interfaces that benefit or hinder students' learning. Developers have integrated many types of interactive choice-based features into educational game interfaces, including: personalizable avatars, interactive maps, and customizable background colors. These features have been found to increase student motivation and engagement [7-8]; however, the learning impact of these potentially off-task behaviors is relatively unclear.

Off-task behaviors have been defined as any behavior that does not involve the specific learning task designated to the student [9]. Although off-task behaviors are frequently observed within classrooms [10], tutoring systems [11], and workplaces [12], the impact of these behaviors on learning remains inconclusive [6,9, 13].

For instance, Rowe, McQuiggan, Robinson, and Lester (2009) found that off-task choices within games were negatively correlated to posttest measures of learning performance. These findings are in line with previous work that has suggested a negative relation between off-task behaviors and student learning [5,9]. However, Rai and Beck (2012) found no relation between students' interactions with off-task features and learning performance. These mixed results render it challenging for researchers to decipher the true cost-benefit ratio of game-based features within educational learning environments.

Although previous work has provided some insight into the impact of off-task behaviors on student learning, they have yet to find a "sweet spot" amongst variables such as students' use of personalizable features that elicit off-task behaviors, in-system performance measures, and student attitudes. The current study investigates these relations within the context of the game-based system, iSTART-ME [14].

1.2 iSTART-ME

The Interactive Strategy Training for Active Reading and Thinking – Motivationally Enhanced (iSTART-ME) system is a game-based learning environment designed to improve students' reading comprehension ability. This system is an extension of a previous version of iSTART, which provides students with instruction and practice using reading comprehension strategies while reading challenging texts [15].

The iSTART-ME interface is controlled through a selection menu where students can read and self-explain texts, personalize avatars, play mini-games, earn points, win trophies, and view their

progress in the system (see Figure 1 for menu screenshot). Students earn points and win trophies by playing games. As students accumulate points, they advance through a series of achievement levels. Each subsequent level requires more points to proceed than the previous level. Within iSTART-ME, in-system performance can be measured via students' achievement levels and trophies. Together, these measures represent students' commitment to and quality of strategy practice.

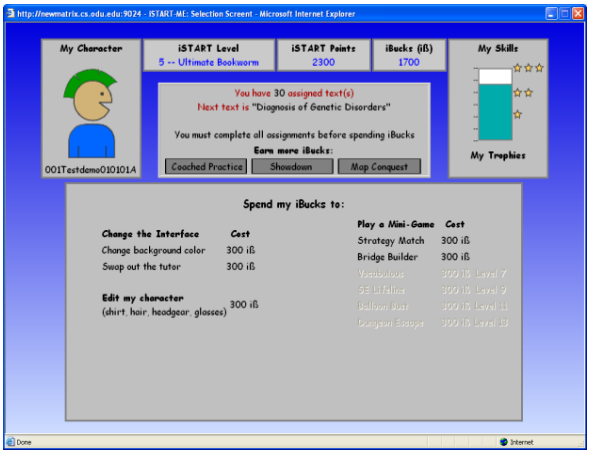

Figure 1. Screenshot of iSTART-ME Interface

System points within iSTART-ME also serve as a form of currency (iBucks) that students can use to buy rewards on the main interface. There are two primary incentives that students can unlock with their earned iBucks: mini-games and personalizable features. Mini-games were added to iSTART-ME to provide students with opportunities to practice the reading comprehension strategies in a game-based environment. Within iSTART-ME, mini-games are considered on-task because they are extensions of the overall learning goal of the system. However, the second incentive that students can unlock, personalizable features, is considered off-task, because it is tangential to the learning task.

Within iSTART-ME, personalizable features include changing background colors, editing a pedagogical agent and customizing an avatar. Students can spend their earned iBucks on these features as many times as they choose for a variety of configurations (see Figure 2 for avatar configuration examples). Personalizable features were added to the system interface as a means to increase students' control and engagement in the iSTART-ME environment. With the addition of these potentially distracting features, it is important to investigate the extent to which students' interactions with these elements impact their attitudes and performance within the system.

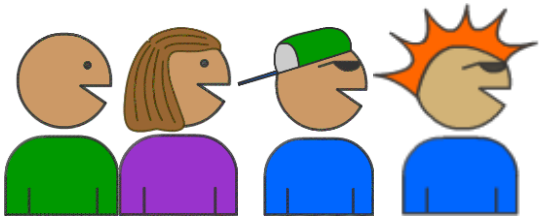

Figure 2. Examples of Avatar Configurations

2. METHODS

Participants in this study included 40 high school students from a mid-south urban environment. The sample included in the current work is a subset of 126 students who originally participated in a larger study that compared three conditions: iSTART-ME, the original version of iSTART, and a no-tutoring control [17]. The current study focuses on the students who were assigned to the iSTART-ME condition. These students had access to the full game-based system in which the game-based interface features were available.

All students completed an 11-session experiment consisting of a pretest, 8 training sessions, a posttest, and a delayed retention test. During the first session, students completed a pretest that included survey measures assessing motivation, prior self-explanation ability, prior reading ability [17], and attitudes toward technology and games. During the following 8 sessions, students engaged with the iSTART-ME interface for a minimum of 1 hour, where they could play games, interact with texts and personalize system features. After training, students completed a posttest, which included measures that were similar to the pretest. Finally, 5 days after the posttest, students returned to complete a retention test, which contained measures similar to the pretest and posttest (i.e., self-explanation and attitudinal measures).

2.1 Self-report measures

Using posttest self-report surveys, we assessed students' attitudes toward the iSTART-ME system (see Table 1 for selected examples). All responses were on a scale of 1 (Strongly Disagree) to 6 (Strongly Agree). Survey measures were combined to create composite scores for boredom, enjoyment, and motivation.

Table 1. Selected Examples of Posttest Self-Report Measures

Dependent Measure	Response Statement	Response Scale
Enjoyment	*"I had fun using the computer system"*	1 - 6
Boredom	*"I felt bored"*	1 - 6
Motivation	*"I was motivated to participate in this study"*	1 - 6
Lack of Control	*"I felt like I had no control over the system"*	1 - 6

1 (Strongly Disagree) to 6 (Strongly Agree)

3. RESULTS

We examined interactions with personalizable features and their relation to students' performance and attitudes during training within iSTART-ME. Using the process data from students' interactions, we calculated the number of times students spent their earned iBucks on personalizable features. We first examined how off-task personalization of any kind (avatar, background theme, or agent) related to in-system performance (achievement levels and trophies won) and posttest attitudinal composite measures (i.e., enjoyment, boredom, and motivation) and a single measure of perceived lack of control. The correlation results in Table 2 indicate that students' number of avatar edits was marginally negatively related to posttest boredom and significantly negatively related to perceived lack of control.

Hence, there was a weak negative relation between students' perceived boredom and lack of control within the system and avatar edits. However, no other personalization feature in the system had a marginal or significant relationship to any of the other dependent variables.

Table 2. Correlations between Frequency of Off-task Personalization Edits and Dependent Measures

Dependent Measure	Avatar Edits (n=30)	Background Theme Edits (n=15)	Pedagogical Agent Edits (n=17)
Achievement Level	.26	.35	.06
Total Trophies Won	.33	.39	-.10
Enjoyment Composite	.11	.07	.14
Boredom Composite	-.35(*M*)	-.13	-.31
Motivation Composite	.19	.15	-.04
Lack of Control	-.36*	-.18	-.21

*p < .05; p<.10 (*M*)

3.1 Differences in avatar interactions

Table 2 reveals that the customizable avatar was the only personalizable feature that showed a significant relation to student attitudes. These results also demonstrate that none of the three personalizable features showed a significant relation to any of the in-system performance measures. Therefore, we focus the remainder of our analyses on students' interactions with the customizable avatar feature. To further explore the relation between avatar editing, attitudes, and in-system performance, we created two categories of students: those who edited their avatar (editors) and those who did not (non-editors). Out of the 40 total participants who completed the iSTART-ME condition, 30 students made at least one edit to their avatar. A median split was performed including only those students who edited their avatar at least once. This median split resulted in 19 students who made at least three or more edits (high editors) and 11 students who performed only one or two avatar edits (low editors). This median split helps to profile students and identify varying patterns of on-line interactions within game-based learning systems.

3.2 Group differences in avatar edits

Differences between high and low avatar editors' attitudes and in-system performance were examined using separate one-way ANOVAs. These analyses revealed a significant difference between high and low editors in terms of overall in-system performance (see Table 3). Compared to high editors, low avatar editors had significantly lower system achievement levels, $F(1,28)=4.22$, $p< .05$, and significantly fewer trophies, $F(1,28)= 5.24$, $p< .05$. These results indicate that students who engaged in more off-task behaviors (i.e., more than two avatar edits) showed significantly better in-system performance relative to students who engaged in fewer off-task behaviors (i.e., only one or two avatar edits).

One potential reason for these editor differences may, in part, be due to the system design. Within iSTART-ME, points are used to unlock various features. Thus, students who earn more points will be able to spend more on off-task features. To examine this issue further, a ratio of points spent to points earned was calculated for each student. A one-way ANOVA on this spending ratio revealed no significant differences between high and low editors, $F(1,28)=.794$, $p=.381$. This finding indicates that high and low editors spent the same relative amount of points throughout their interactions. Although high and low editors spent the same relative amounts, the previous results suggest that high editors were more likely to spend those points on the off-task personalization features, whereas low editors spent their points elsewhere (i.e., they remain on-task).

Separate ANOVAs were also conducted to examine the relation between avatar edits and students' self-reported posttest attitudes toward the system (see Table 3). The results indicated that students who were classified as high editors reported less boredom, $F(1,28)=5.84$, $p<.05$, compared to high editors. Interestingly, low editors reported feeling a higher lack of control within the system, $F(1, 28)=7.62$, $p<.01$, compared to high editors.

Table 3. Mean Overall Performance and Attitudes Scores per Group

Dependent Measure	Low Avatar Editors M (SD)	High Avatar Editors M (SD)
Achievement Level	13.76 (6.25)	18.45 (5.66)
Trophies Won	15.15 (11.77)	36.00 (36.98)
Boredom Composite	2.30 (.93)	1.55 (.59)
Lack of Control	2.36 (1.30)	1.18 (.75)

4. DISCUSSION

The incorporation of educational games within learning environments has demonstrated positive impacts on student engagement [1, 4]. However, many features within these games may promote off-task behaviors. The current study aimed to gain a deeper understanding of the relations among these features, in-system performance, and students' attitudes.

In line with previous work, our results demonstrated significant negative relations among students' interactions with personalizable features, boredom, and lack of control. These results replicate previous work suggesting that personalization potentially augments students' investment and perception of control within a system [7]. ANOVAs revealed distinct differences between high and low avatar editors for their self-reported attitudes and in-system performance. High editors advanced to higher achievement levels and won more trophies compared to low editors. High editors also expressed less boredom and higher levels of perceived control in the system.

In contrast to some prior work [6], the current analyses on off-task behaviors, in-system performance, and student attitudes provide

tentative support for the inclusion of personalized features within adaptive learning environments. Interestingly, the most frequently utilized and influential feature was the customizable avatar. One hypothesis for this effect is that creating a personal avatar may increase students' investment within the system [8]. Future work will explore the relation between avatars and investment, along with the potential benefit that this may have on persistence (i.e., students returning to the training environment).

Additionally, further work is needed to investigate how students' motivation and attitudes mediate choices within the system (both on- and off-task) to affect overall system learning outcomes. The current work begins to explore this complex interaction and examines potential features that can engage students over an extended training period while maintaining performance quality. Investigating these dynamic elements within learning environments will advance our understanding of the proper balance between system designs that promote high levels of both engagement and performance.

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