What Do They Do?: Tracing Students' Patterns of Interactions within a Game-Based Intelligent Tutoring System

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Abstract: The authors examine patterns of interactions within the game-based intelligent tutoring system, iSTART-ME. Forty high school students from a mid-south urban environment interacted with iSTART-ME across eight training sessions. Transitional probabilities were calculated based on students' system interaction patterns, focusing on four types of game-based features: generative practice, identification mini-games, personalizable features, and achievement screens. The results revealed how students transitioned from one type of interaction to another and how those interaction patterns varied as a function of the most recent action performed.

Introduction

Recently, educational designers and researchers have investigated the implementation of game-based features into adaptive learning environments (Jackson & McNamara, 2013). This work has provided valuable insight into how game-based features can influence student engagement and learning. However, despite the rapid expansion of this research, relatively little work has been conducted to investigate the patterns of choices that manifest while students interact with game-based systems. The current study aims to gain a deeper understanding of these emergent patterns by examining students' interactions with various game-based features across multiple sessions within iSTART-ME (i.e., Interactive Strategy Training for Active Reading and Thinking – Motivationally Enhanced).

iSTART-ME

iSTART-ME (Interactive Strategy Training for Active Reading and Thinking - Motivationally Enhanced) is an intelligent tutoring system that utilizes embedded game-based practice. This game-based environment has been shown to be effective at teaching students how to use self-explanation strategies to improve their reading comprehension (Jackson & McNamara, 2013). Within this system, students can choose to interact with various game-based features. Some of the available options include: customizing the interface, generating their own self-explanations and playing educational mini-games (Snow, Likens, Jackson, & McNamara, 2013).

Current Study

Students have previously reported that they enjoyed interacting with the iSTART-ME system and its corresponding components (Snow, Jackson, Varner, & McNamara, 2013). However, one area of research that has not been investigated is *how* students chose to interact with the various types of game-based features embedded within the system interface. The aim of the current study is to investigate the nuanced interaction patterns that are formed through students' engagement with the various game-based components embedded within iSTART-ME.

Method

Participants

40 students (50% male, mean grade level of 10, mean age of 15.5 years; 17% were Caucasian, 73% were African-American, and 10% reported other nationalities) interacted with iSTART-ME as part of an was an 11-session study. Students' interactions within the iSTART-ME system were logged and recorded throughout their time in training. Every interaction in which students engaged involved one of four types of game-based features: generative practice games, identification mini-games, personalizable features, and achievement screens.

Quantitative Method

The current study utilized time-stamped log data to chronologically categorize each student's interaction choices across the multiple training sessions (2 through 9). The sum of all interactions for the 40 students resulted in over 11,000 interaction choices. A statistical sequencing procedure, detailed within D'Mello, Taylor, and Graesser (2007), $P(X_{t+1}| I_t)$, utilized this extensive logging database to calculate the conditional probability of a student's action when provided with the previous action.

Results

In the current study, we examined the patterns that emerge while students engaged with a game-based system. Using the statistical sequencing procedure previously described, we investigated the manifestation of students' choice patterns across time and how those selections varied as a function of students' most recent selection.

Probability of Interactions

We examined the state transition likelihoods between (and within) features (see Figure 1 for complete set of transition probabilities). Figure 1 provides a visual display of the transition likelihoods, with numbers inside a box representing the likelihood of selecting the same feature again, and numbers near a line indicating the likelihood of transitioning from one feature to another. Summing the probabilities on the left side of Figure 1, approximately 74% of all interactions occurred within a loop between the mini-games and generative practice environments. These interactions consisted of staying within or transitioning between the mini-games and generative practice environments (i.e., 74% constitutes the sum of all transition values within and between the two boxes). This result reveals a practice interaction loop, where students most often sought some form of strategy practice and occasionally alternated between the two different types. This analysis also demonstrates that, compared to the practice features, students were less likely to interact with non-practice features in the environment (i.e., personalizable features and achievement screens).

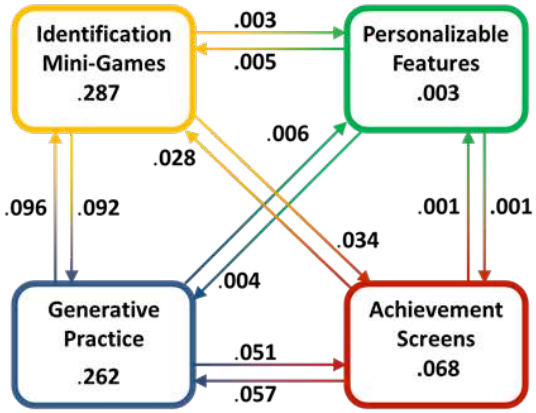

Figure 1. Overall probabilities of interactions (sum of all transitions equals 1).

Discussion

The analyses presented in the current work are one of the first to categorize and trace users' patterns of choices within an adaptive system. The initial results presented here provide valuable insight into *how* users choose to interact with various game-based features. In addition, this innovative method for assessing users' choice patterns may afford learning scientists the opportunity to better understand learners' behaviors over time. However, future work is needed to examine how these patterns may vary as a function of individual differences and evolve over longer periods of interaction. Understanding the way in which students choose to engage within adaptive systems will afford researchers the opportunity to improve the design and adaptability of game-based educational systems.

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