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ENGAGE: A Game Based Learning and Problem Solving
Framework (Task 1 Month 16-18)
Progress, Status and Management Report
Monthly Progress Report

Period Covered by the Report
July 1 through September 30, 2013

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Technical Information

1. Technical Progress / Highlights - Observations

The early results of the Algebra Challenge (detailed in the previous report) showed that mastery of linear equation solving can be reached in just 1.5 hours of play. More importantly, that mastery is not reached by a select few, but by the nearly the whole classroom. The average mastery rate for all grades was 92.9% after 1.5 hours. This is especially surprising since many of the participants were in elementary school, where algebra is usually not considered (it is commonly a milestone for 7th and 8th graders). We believe the adaptive nature of the game was instrumental in achieving these results. Only a tiny percentage of students finished the game without requiring at least some remediation. Some grades required significantly more effort and review than others. The game was able to adapt in real-time to each student in order to maximize the likelihood of mastery. As a result, some students played almost 10 times more levels than others. The engagement structures of the game ensured that they persisted through this challenge.

We continued to improve our games and game-based learning tools over the summer quarter. We implemented a revamped interface for the Teacher portal to improve ease of use for teachers to enter and manage on student accounts. We also worked with a group of math teachers to create specific lesson units that use the games as a teaching tool and which can be integrated into a standard math curriculum. Our plan is to begin trials with those units next year. All of the games are now running on iPad and Android platforms and suitable for play on tablets, so some of the trials may take place using the teacher tablet system that is currently being co-developed with Engaged Learning.

Based on item analysis results we decided to remove what we had previously been calling “far transfer” questions from each game assessment, and to focus instead on only testing on material most relevant to the game in which the assessment is embedded.

The “Algebra Adventure” or word problems game is still undergoing development. In this game, students literally “pull” values and concepts from the story and form them into an equation. The equations are then combined with each other to determine the final answer. The largest challenge here at the moment is designing a user interface that is meaningful and intuitive. We expect to begin playtesting the interface in the next reporting period as well as create a robust system for generating these word problems in specific progressions and with specific “themes” (such as word problems that take place in a fantasy world, science fiction world etc.)

We are in the planning stages of more large-scale and statewide challenges, with one being developed in Norway for late this year and one in Minnesota for early next year. Additional challenges will help us maximize the percentage of mastery for a greater set of common core concepts.

2. Results or Problems and Solutions

Due to the large volume of data we have collected we are looking to hire an additional grad student or postgrad to help with data analysis. One of these datasets is the Baker data set, in which several researchers observed students playing Treefrog Treasure, Creature Capture, and Refraction. They coded the students for affective and behavioral states while playing; these were synced up with the replay data. The hope is that we can learn classifiers which can tell if students are confused, frustrated, bored, happy, concentrating, etc. while playing based solely on game play data.

We also have many datasets collected from various game sites. One in particular is a Treefrog Treasure dataset in which numberlines are given out nearly at random, with the denominator, numerator, representation, hinting system, and fraction animations all changed at every numberline. The idea here is to learn from data what pattern of numberlines contributes to the greatest engagement and ability to solve

future numberlines. How players interact with our games may give us some information about what they will do in the future, how well they understand the content, or what emotions they are currently experiencing.

In most cases, the most difficult part of these tasks is not the algorithm used to issue the predictions, but the construction of features, that is: what parts of the gameplay should we pay attention to? We could for example evaluate the time it takes to beat levels, the amount that players re-try the same strategy over and over, or how shallow their search strategy appears to be. Therefore one of our projects will be to automatically generate many of these features by taking advantage of the fact that players are in a game with a clearly defined goal. We will do this by creating a state space of different game states and constructing those features on the resulting search graph. We will be developing this using data gathered from both Refraction and Treefrog Treasure, with the intent of predicting affective states of players and the ability to answer numberlines correctly. That in turn will feed back into our automated assessment and adaptivity.

3. Significant Accomplishments Anticipated During Next Reporting Period

- Perform trials of new game-based curriculum
- New format for encoding game progressions so that they can be “called” by an external app
- Improvements to enable real-time feedback for teachers

4. Publications relevant to this effort

"A Mixed-Initiative Tool for Designing Level Progressions in Games" - Eric Butler, Adam M. Smith, Yun-En Liu, and Zoran Popovic. ACM Symposium on User Interface Software and Technology (UIST) 2013

5. Meetings and Events (Please include meetings with subcontractors)

August 19-22 - Serious Play Conference. Redmond, WA. “Evidence for Game-Based Development of World-Class Expertise and School Mastery”

6. Changes to the Contract Organization

None.