Studying Implicit Science Learning in Digital Games

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Purpose of Study

EdGE and their partners are building and studying science-learning games that people choose to play in their free-choice time. In these games, the game mechanics provide accurate scientific models. We theorize that through playing the games, learners build implicit understandings of these scientific phenomena (Polanyi, 1966; Thomas & Brown, 2011). This poster reports on the first phase of the research in which we are identifying the strategic moves that emerge from our video observations of high school students playing the games. We use video analysis to identify strategies that emerge as players advance in the games. Then we use educational data mining (EDM) methods to relate the strategies to game log data that we collect from a much larger sample of players. We are also building upon those cognitive strategies to develop classroom activities that can bridge game-based learning with formal STEM learning.

Design of Intervention

Impulse immerses players inside an N-body simulation with accurate gravitational interactions and elastic collisions. Players must navigate their particle (green) to a goal through ambient particles that will explode upon contact.

To succeed, players must predict the motion of the particles and interactions between particles, thus predicting the laws of Newtonian physics.

Capturing the Videos

Data were collected from 69 high school students (29 female) from urban and suburban schools in the Northeastern United States. Players were recorded with Silverback, which captures players’ onscreen game activities, and audio and video of their faces. Players were asked to “think aloud” or discuss the game with a partner.

Coding the Videos

Two researchers built a coding system for strategic moves. They trained a third researcher to code the 69 videos. Ten videos were double coded by two independent researchers and one of the coding system developers, achieving Cohen’s Kappas ranging from 0.39 to 92. Kappas exceeded 0.70 for all codes related to implicit science learning.

Coding Scheme for Player Moves in Impulse

Intended strategy: Move toward goal
The learner intended to move the player particle toward the goal (κ = 0.798)

Intended strategy: Stop/slow down
The learner intended to stop or slow the motion of the player particle (κ = 0.819)

Intended strategy: Keep path clear
The learner intended to move non-player particles to keep the path of the player particle clear (κ = 0.832)

Some As Last Target
The learner intended to move the same target as the last action (κ = 0.869)

Connecting Moves to Strategies

Building Detectors

Classifiers for each code were created within RapidMiner 5.3 that map the student behaviors in the features distilled from the clickstream data to the training labels, using 148 decision trees with 4-fold cross-validation at the student level. Kappas for these classifiers ranged from 0.45 to 0.94 and A’ values all exceeded 0.80. Strong paths from the float (Kappa = 0.727, A’ = 0.914) and Stop/Slow Down (Kappa = 0.522, A’ = 0.804) are presented here.