An Exploratory Study of Student Persistence and its Relationship with Achievement While Using a Game-based Learning Environment

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Abstract: This study tests the common wisdom that persistence leads to academic success. We explore indicators or markers of persistence exhibited by 60 students from Baguio City, Philippines as they played a game-based learning environment called Physics Playground. The study attempted to determine the extent to which the markers of persistence identified by Shute et al. (2013) – specifically time spent, number of level restarts, and number of level revisits – were related with achievement. When clustered the data into two, according to these features, the clusters only differed significantly in terms of time spent and number of restarts. Number of revisits was not significantly different. What was most interesting, though, was that gold and no-badge outcomes were significantly negatively correlated with time spent and significantly positively correlated with number of restarts. These findings imply Shute's markers while possibly indicative of persistence may also be indicative of non-learning behaviors, most notably wheel spinning.

Keywords: Persistence, affect, game-based learning

1. Introduction

"A little more persistence, a little more effort, and what seemed hopeless failure may turn to glorious success." - Elbert Hubbard

Persistence is a disposition – a habit of mind and action. In the context of this study, persistence is the ability to maintain action regardless of a person's feelings to achieve a certain task. Literature claims that persistence mediates academic performance, persistence mediates achievement. Moreover, recent research posits that persistence has been shown to be predictive of academic outcomes (Andersson and Bergman, 2011; DiCerbo, 2014). The more persistent a student is, the more likely he is to succeed at a learning task. We therefore tried to determine whether persistence varied depending on student ability.
We attempt to answer the following research questions:
1) Which students exhibit behaviors that are characteristic of persistence?
2) Does persistence vary by student ability?

2. Methods

The test bed for this study was Physics Playground (PP), a two-dimensional computer game designed for high school students to help them understand balance, mass, conservation and transfer of momentum, gravity, and potential and kinetic energy (Shute et al., 2013; Andres et.al, 2014). Players are presented with a series of challenges in which players must drive a green ball to a red balloon by drawing ramps, levers, pendulums, and springboards.
We gathered data from 62 second year high school students, aggregated from a public and a private school of Baguio City. Students ranged in aged from 13 to 18. Of the participants, 48% were female and 52% were males. Before playing PP, students completed a 16-item multiple-choice pretest for 15 minutes. Students were then assigned a computer on which they would play PP. Students were divided into batches of 15 to 17. Most batches of students played the game for 120 minutes. Two batches played for only 90 minutes because they arrived at the testing venue late.

3. Results

Of the 62 participants in the pool, data from 2 students was excluded because it was corrupted. The analysis therefore includes data from 60 students only.

3.1 Which students exhibit behaviors that are characteristic of persistence?

We clustered the data using the K-means algorithm with K=2. Clusters 1 and 2 had 47 and 13 students, respectively. A cursory examination of the cluster characteristics showed that Cluster 1 tended to have more average time spent and more average number of restarts than Cluster 2. We therefore labelled students in Cluster 1 as "persistent" and those in Cluster 2 as "not persistent". After the data was clustered, we reattached the average time spent, average number of revisits and the average number of restarts to each record.

We then attempted to determine whether the clusters differed significantly by comparing the features of Cluster 1 against those of Cluster 2. We found that Cluster 1 was significantly higher than Cluster 2 in terms of average time spent ($t(58) = 3.547$ two-tailed $p < 0.01$ assuming equal variances) and in terms of average number of restarts ($t(58) = -10.126$ two-tailed $p < 0.01$ assuming equal variances) . In terms of the average number of revisits, there was no significant difference between Cluster 1 and Cluster 2 ($t(58) = -.341$; two-tailed $p > 0.01$ assuming equal variances).

The findings suggest that only two of Shute's markers of persistence were evident within the Baguio data set. Our findings show that time spent in playing the game and average restarts were significantly different between groups and may therefore be markers of persistence. However, average number of revisits was not significantly different, implying that this characteristic might not differentiate a student who is persistent from one who is not.

3.2 Does Persistence Vary by the Student Achievement?

Our measure of achievement was the number of in-game badges the students earned. In PP, a player can earn two types of badges: gold and silver. A gold badge is awarded when a player solves a level with less than three objects while a silver badge is given when a player solves a level with three or more objects (Shute, et. al., 2013).

We correlated the students' persistence indicators with the number of gold badges, silver badges and no badges received. We found that the average time spent was significantly negatively correlated with both number of gold badges ($r = -0.45$, $p < 0.01$) and number of no badges ($r = -0.60$, $p < 0.01$). There was a significant positive correlation between average number of restarts and earning a gold badge ($r = 0.49$, $p < 0.01$) and significant correlation with earning no badge ($r = 0.74$, $p < 0.01$).

We further compared the in-game badges of the students in the two clusters, previously labeled persistent and not persistent. We found significant difference between the clusters with gold and no badge ($t(58) = 5.307$ two-tailed $p < 0.01$ and $t(58) = 9.231$ two tailed $p < 0.01$ assuming equal variance), no significant difference between the clusters and silver badge ($t(58)=-.118$ two-tailed $p>.01$).

4. Conclusion

Both past research and common wisdom associate persistence with learner achievement. This study attempts to determine whether this is in fact the case. We examined the extent to which students exhibited the behaviors that prior research has associated with persistence (time spent, number of level restarts, and number of level revisits) and determined how these factors related with achievement.

When we clustered students into two, according to these features, we found that the clusters only varied significantly in terms of time spent and number of restarts. This implied that, within this data set, only these two persistence markers were salient.

When we examined these two markers against in-game achievement, we found that both gold and no badge outcomes were negatively correlated with time spent and positively correlated with number of restarts. This implies that the relationship between persistence and Shute's markers is more nuanced than previously assumed. It is reasonable to assume, for example, that a player's chances of

earning a gold badge increase as he spends more time on a level. However, we find that the opposite is true in this particular context. Furthermore, both gold and no-badge outcomes were associated with two of the markers of persistence—time spent and number of restarts. This implies that while these markers may indeed be indicative of persistence, they may not be indicative of persistence alone. It is possible that students exhibiting these markers are in fact wheel spinning. Wheel spinning refers to student failure to master a skill in a timely manner (Beck and Gong, 2013). In future work, we intend to tease apart constructive persistence from wheel spinning.

Acknowledgements

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