Executive Summary: True Game Based Solution, Applications for STEM Education

This Executive Summary reports the major results of The True Game Based Solution project, also known as The Mars Game study. The Mars Game is a digital learning game designed to teach mathematics and programming knowledge and skills. The primary goal of this study was to evaluate whether games designed to impart STEM knowledge in general—and The Mars Game in particular—can be both engaging and effective in increasing learning outcomes.

We performed a randomized controlled trial with a pretest-posttest control group design (Gall, Gall, & Borg, 2007). The study was conducted afterschool. The sample consisted of eighty students at Ocoee High School who were randomly assigned into one of four conditions. There were two treatment and two control groups, with one condition in each group working individually on their respective intervention and one group working in randomized pairs. The interventions that were studied were supplemental and were not replacements for teacher or the core curriculum. Pre-posttests were used to measure learning in math and programming. The EGameFlow scale (Fu, Su, & Yu, 2009) was used to measure engagement.

The study demonstrated that The Mars Game treatment group's overall learning outcomes were significantly greater than the control group. The gains in achievement were driven largely through an increase in programming posttest scores compared to a control group baseline. It also showed that students in the treatment group were significantly more engaged than in the control group, with a large effect size for engagement as a whole and for the immersion, feedback, and perception of knowledge improvement sub-factors of the construct.

Confirming the findings of a previous experimental study of The Mars Game, this current study demonstrated that well-designed and well-integrated serious games, which strike a critical balance between the 'fun' and the learning, have the ability to engage and increase the knowledge and skills of students in STEM subjects. Furthermore, it showed that The Mars Game worked similarly well in an afterschool setting with a highly diverse student population.

Other key findings include:

- Boys and girls learned equally by using the game and were equally engaged.
- The Mars Game intervention had the greatest success with students who are new to the content being taught (ninth graders).
- Digital learning games have the potential to improve the learning outcomes of students who may have previously been switched off from learning (think that math is "horrible").
- Assignment to the treatment group condition mattered more than assignment to work with the respective intervention individually or collaboratively in randomized pairs.

We would like to thank the student participants in Ocoee High School, the teacher facilitators, and our unwavering project champion, Gina Solano. We would also like to thank OCPS for granting us permission to conduct research in the district.